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SUMARIO • SUMMARY

Los resúmenes de los trabajos publicados en la Revista Cultura, Ciencia y Deporte, se incluyen enlas bases de datos: ISI Web of Science, SCOPUS, EBSCO, IN-RECS, DICE, LATINDEX, REDALYC, DIALNET, RESH, COMPLUDOC, RECOLECTA, CEDUS, REDINET, SPORTDISCUS, MIAR, PSICODOC, CIRC, DOAJ, ISOC, DULCINEA, SCIRUS, WORLDCAT, LILACS, GTBib, RESEARCH GATE, SAFETYLIT, REBIUN, Universal Impact Factor, Genamics, Index Copernicus, e-Revistas, Cabell's Directory. Scientific Journal Impact Factor, ERIH PLUS, DLP, JOURNALS FOR FREE, BVS, PRESCOPUS RUSSIA, JournalTOCs, Viref, Fuente Académica Plus, ERA. Sello de calidad en la cuarta convocatoria de evaluación de la calidad editorial y científica de las revistas científicas Españolas, FECYT 2013. Los artículos de la revista CCD son valorados positivamente por la ANECA para la evaluación del profesorado (ANEP/FECYT [A]).

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Nuevos logros de la revista Cultura, Ciencia y Deporte

Estimados/as lectores/as de Cultura, Ciencia y Deporte,

Nos complace presentarles el número 51, volumen 17, de nuestra querida revista Cultura, Ciencia y Deporte. Sean nuestras primeras palabras de agradecimiento a todas aquellas personas que han permitido llegar a ser una revista tan longeva: a sus fundadores, el Dr. Antonio Sánchez Pato y D. Juan de Dios Bada Jaime; a todos los editores que han trabajado durante estos 17 años en la revista; a todos los editores de sección que tan arduo y meticuloso trabajo han realizado en el seguimiento de sus artículos; a las personas que desde un primer momento apostaron por este sueño y se unieron al consejo de redacción y el consejo asesor de la revista; a las personas que han trabajado en el área técnica jurídica, secretaría y maquetación de la presente revista; a todos los autores y lectores. Gracias.

Con la celebración de este número 51 la revista cambia su estética, incluyendo también novedades en cuanto a funcionalidad, siendo los artículos del presente número los primeros que incluyen en su versión web el lector inteligente HTML.

Esperamos que las novedades incluidas en el presente número sean de su agrado.

Raquel Vaquero-Cristóbal, Lucía Abenza-Cano, Juan Bada, Álvaro Díaz-Aroca, Adrián Mateo-Orcajada y Antonio Sánchez-Pato

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New achievements of the Journal Cultura, Ciencia y Deporte

Dear readers of Cultura, Ciencia y Deporte,

We are pleased to present to you the 51st issue, volume 17, of our beloved journal Cultura, Ciencia y Deporte. Let our first words of thanks go to all those who have made it possible for us to become such a long-lived journal: to its founders, Dr. Antonio Sánchez Pato and D. Juan de Dios Bada Jaime; to all the editors who have worked on the journal during these 17 years; to all the section editors who have worked so hard and meticulously on the follow-up of their articles; to the people who, from the very beginning, bet on this dream and joined the editorial board and the advisory board of the journal; to the people who have worked in the legal technical area, secretariat and layout of this journal; to all the authors and readers. Thank you.

With the celebration of this 51st issue, the journal changes its aesthetics and also includes new features in terms of functionality, with the articles in this issue being the first to include the HTML smart reader in their web version.

We hope you enjoy the new features included in this issue.

Raquel Vaquero-Cristóbal, Lucía Abenza-Cano, Juan Bada, Álvaro Díaz-Aroca, Adrián Mateo-Orcajada y Antonio Sánchez-Pato

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CULTURA, CIENCIA Y DEPORTE

Efectos de una formación en inclusión sobre la autoeficacia del profesorado de Educación Física

Effects of an inclusive Physical Education workshop on teachers' self-efficacy

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Resumen

La competencia percibida por el profesorado de Educación Física parece ser fundamental a la hora de incluir con éxito a estudiantes con discapacidad en sus aulas. No obstante, gran parte de los docentes manifiestan no tener la formación suficiente para llevar a cabo el proceso de inclusión educativa. Así, el presente estudio tuvo como objetivo analizar el efecto de un programa de formación continua en Educación Física inclusiva, basado en el programa *Deporte Inclusivo en la Escuela*, sobre la autoeficacia de docentes en activo. Un total de 16 participantes (11 hombres y 5 mujeres; 39.19±8.94 años) asistieron a un curso de formación con una duración de cinco sesiones de tres horas cada una. Se adoptó un diseño pre-experimental sin grupo control y medidas pre-test y post-test. Los resultados mostraron un aumento significativo en todas las subescalas (discapacidad intelectual, física y visual) y dimensiones (en la tarea, adaptaciones específicas, instrucciones a los iguales y seguridad) de la variable autoeficacia. Estos hallazgos sugieren que la formación continua en inclusión del profesorado de Educación Física puede aumentar su capacidad y seguridad percibidas para incluir eficazmente a estudiantes con discapacidad en sus clases.

Palabras clave: actividad física adaptada, deporte, discapacidad, estudiantes, necesidades educativas especiales.

Abstract

Physical Education teachers' self-confidence seems a key factor to successfully include students with disabilities in mainstream classes. Notwithstanding this, a large number of teachers state that they do not have sufficient specific training to carry out the educational inclusion process. Thus, the present study aimed to analyze the effect of an inclusive Physical Education training program, based on the *Inclusive Sport at School* program, on in-service teachers' self-efficacy. A total of 16 participants (11 men and 5 women; 39.19±8.94 years) attended to a workshop lasting five sessions of three hours each. A pre-experimental design was adopted without a control group and pre-test and post-test measures. Results showed a significant increase in all subscales (intellectual, physical and visual disabilities) and dimensions (in task, specific adaptations, instructions to peers and safety) of the self-efficacy variable. These findings suggest that continuous professional development in inclusive Physical Education for in-service teachers could increase both their perceived ability and safety to effectively include students with disabilities in their classes.

Keywords: adapted physical activity, sport, disability, students, special education needs.

Introducción

A pesar de que la inclusión de estudiantes con discapacidad (ECD) en los centros educativos tiene una historia de alrededor de cuarenta años (Lidor & Hutzler, 2019), no fue hasta la Declaración de Salamanca (UNESCO, 1994) cuando multitud de organismos internacionales proclamaron los principios políticos y prácticos para favorecer la integración afectiva y efectiva de niños, jóvenes y adultos con Necesidades Educativas Especiales (NEE) en las aulas. En aquel informe se defendía el derecho a la educación para personas con NEE, así como su participación en centros educativos ordinarios, independientemente de sus capacidades, intereses y características, siendo los sistemas educativos los que se debían adaptar a sus necesidades.

Uno de los entornos que parece ser muy adecuado para propiciar la inclusión de estudiantes con NEE por discapacidad es la asignatura de Educación Física (EF; Block & Obrusnikova, 2007; Tant & Watelain, 2016). Según Murphy y Carbone (2008), la participación en contextos físico-deportivos tiene importantes beneficios sobre las personas con discapacidad, ofreciendo una oportunidad única para desarrollar un bienestar físico, social y emocional. Así, con el objetivo de satisfacer los principios de la Declaración de Salamanca citados anteriormente, cada comunidad educativa y, por ende, cada docente de EF como último responsable en su disciplina deberá ser quien facilite la participación de todos los estudiantes, independientemente de sus capacidades, en sus clases.

Obrusnikova (2008) destacó que uno de los factores más determinantes en la competencia y confianza percibidas por los docentes de EF a la hora de incluir ECD en sus clases es tener una preparación académica sólida. Sin embargo, recientemente, se ha sugerido que el profesorado de EF en activo no percibe la suficiente confianza para incluir a ECD en el aula debido, entre otros motivos, a la escasa formación inicial (Rekaa et al., 2019). Por ejemplo, Crispel y Kasperski (2019), tras entrevistar a diez profesores que participaron en un programa de formación en NEE, encontraron que no se sentían lo suficientemente preparados para acomodar a ECD en sus clases. Tras finalizar la instrucción, los mismos participantes reportaron una mejora en su actitud hacia la discapacidad, así como en su habilidad para llevar a cabo la inclusión en sus clases. De manera similar, Maher y Fitzgerald (2020) encontraron que todos los profesores de EF entrevistados en su estudio, independientemente del contexto profesional en el que se hubieran desarrollado, argumentaron la carencia en su aprendizaje inicial sobre NEE e inclusión. Así, parece ser que los profesores de EF no sienten que su preparación profesional inicial y sus experiencias prácticas sean adecuadas para afrontar la enseñanza de EF con ECD en entornos inclusivos (Block et al., 2016, 2020; Wilhelmsen & Sørensen, 2017).

De este modo, para mejorar la capacitación del docente será preciso desarrollar programas de formación continua específicos, debidamente fundamentados y estructurados, vinculados a la formación en EF inclusiva (Block et al., 2020). En los últimos años se han realizado varias experiencias en este sentido. Por ejemplo, Reina, Healy, et al., (2019) elaboraron el programa *Incluye-T*, con una duración total de 18 horas (divididas en seis sesiones de tres horas), incorporando en cada sesión un componente teórico, seguido de un módulo práctico orientado a las vivencias de los participantes en diferentes tipos de actividades físicas inclusivas, detallando sus características en todas las partes. En otro programa, Neville et al. (2019) puntualizaron las partes temporales que seguían, las cuales comprendieron aspectos teórico-prácticos de la inclusión, aunque sin profundizar en el contenido desarrollado.

El programa propuesto en esta investigación, denominado *Deporte Inclusivo en la Escuela* (DIE; Pérez-Tejero et al., 2013), se enmarca en una amplia metodología de intervención en actividad/educación física inclusiva. Se trata de un programa eminentemente práctico que busca dotar a los profesionales de la actividad física y del deporte de recursos y herramientas para poder adquirir los conocimientos sobre cómo desarrollar eficazmente actividades físico-deportivas con personas con discapacidad y, en segunda instancia, transferirlos a sus realidades particulares. Así, una de las vertientes del *programa DIE* pretende dar respuesta a la escasez de programas de desarrollo profesional orientados a docentes de EF en activo para que éstos puedan mejorar su capacidad para incluir a ECD y realizar actividades de concienciación sobre la discapacidad en sus aulas (McKay et al., 2015). En definitiva, se procura mejorar la calidad educativa a través del aprendizaje continuo del profesorado. Tal y como indican en su trabajo Taliaferro et al. (2015), lo ideal para preservar las competencias y afianzar el conocimiento docente será vincular la formación teórica con experiencias prácticas. De este modo, el *programa DIE* propone transmitir el contenido de EF inclusiva a través de temas y prácticas relevantes para que los profesores retengan el conocimiento adquirido, reconozcan la realidad e importancia de la inclusión, y se sientan más confiados a la hora de afrontar sus clases en su contexto específico.

En consecuencia, los profesores de EF son los encargados de transferir a su día a día los conocimientos recibidos en la formación, con los objetivos de, entre su alumnado, promover la práctica de EF inclusiva, dar a conocer los diferentes deportes adaptados y paralímpicos mediante una metodología inclusiva y concienciar sobre la situación de las personas con discapacidad en la práctica deportiva. De este modo, a lo largo de su recorrido, desde el curso 2012-2013, el *programa DIE* se ha aplicado en 264 centros educativos, tanto de Educación Primaria como Secundaria, Bachillerato y Ciclo Formativo de Grado Superior, y ha contado con la participación activa de 33842 estudiantes sin discapacidad, 8256 con discapacidad y 456 docentes de EF (Programa Deporte Inclusivo en la Escuela, 2021).

Uno de los factores determinantes para que la inclusión de los ECD sea efectiva es el comportamiento del profesor, y éste se ve influido principalmente por dos moderadores (Hutzler et al., 2019): por un lado, la autoeficacia, entendida como el juicio de un individuo acerca de su propia capacidad para organizar y ejecutar las acciones requeridas para producir un resultado pretendido (Bandura, 1977) y, en segundo lugar, sus actitudes e intenciones (Hutzler et al., 2019; Wilhelmsen & Sørensen, 2017).

Diversos autores sugieren que a través de la formación continua del profesorado será posible mejorar su autoeficacia (Özer et al., 2013; Saloviita & Consegnati, 2019), hecho que parece estar directamente relacionado con la capacidad para incorporar eficazmente a ECD en las clases de EF (Block et al., 2010). Así, esta variable está siendo frecuentemente incorporada y analizada en la literatura respecto a la inclusión educativa (Tümkaya & Miller, 2020). Por ejemplo, en España, varios estudios han evaluado el efecto de un programa

teórico-práctico de formación en inclusión sobre profesores en activo, demostrando que la intervención realizada mejoró su percepción de autoeficacia (Reina, Healy, et al., 2019; Reina, Santana, et al., 2019). Asimismo, investigaciones en países internacionales han mostrado una mejora en la autoeficacia tras participar en distintas experiencias de EF inclusiva, tanto en profesores en activo (Neville et al., 2019), como en futuros docentes (Alhumaid et al., 2020; Wang et al., 2020).

Si bien hoy en día, como se ha mencionado anteriormente, existen programas de formación del profesorado de reciente creación que han mostrado buenos resultados, éstos todavía son limitados y la competencia percibida en materia de inclusión es insuficiente. Por ello, es necesario seguir desarrollando propuestas debidamente fundamentadas y validar su utilidad para la mejora de la calidad docente (Block et al., 2020). Por consiguiente, el objetivo de esta investigación fue evaluar el efecto de un programa de formación continua en EF inclusiva sobre la percepción de autoeficacia de profesorado en activo de la Comunidad de Madrid. Se hipotetizó que, tras participar en la formación, el profesorado mejoraría su autoeficacia hacia la inclusión de ECD en susaulas.

Método

Diseño

El estudio adoptó un diseño pre-experimental de investigación, sin grupo control y con medidas pre-test y post-test. Se incorporaron una serie de consideraciones éticas en el diseño del estudio, que incluyeron: consentimiento informado por escrito, anonimato de los participantes y derecho a retirarse del estudio en cualquier momento. El estudio fue aprobado por el Comité de Ética de la Universidad Politécnica de Madrid. La presente investigación respeta los acuerdos de la Declaración de Helsinki.

Participantes

Las personas que recibieron la formación fueron maestros o profesores de EF de centros de la Comunidad de Madrid, en activo durante el curso académico 2019-2020, que asistieron voluntariamente al curso "Actividades inclusivas en el aula de Educación Física: programa educativo DIE" tras ser admitidos por el Centro Regional de Innovación y Formación (CRIF) "Las Acacias". Un total de 25 docentes tomaron parte en el curso, de los cuales dieciséis (N = 16) completaron la información necesaria para ser elegibles como muestra en el estudio. Esto es, haber asistido y participado activamente en las cinco (N = 5) sesiones propuestas y haber completado el pre-test y el post-test en fecha y forma. Por tanto, el 64% del total de asistentes al curso se utilizó para desarrollar este estudio. La Tabla 1 recoge los detalles de los participantes.

Tabla 1. Características demográficas de la muestra

Etapa del profesorado	N	Sexo (N)		Edad (años)		Experiencia docente EF (años)	
		Hombre	Mujer	*M*	*DT*	*M*	*DT*
Primaria	7	6	1	37.71	7.93	10.17	7.22
Secundaria	8	4	4	38.38	8.60	11.38	8.81
Ciclo formativo	1	1	-	56	-	33	-
Total	16	11	5	39.19	8.94	12	8.99

Instrumento

Para la recogida de datos cuantitativos se empleó el cuestionario *Escala de Autoeficacia del Profesorado de Educación Física hacia el alumnado con Discapacidad-2 (EA-PEF-AD-2)*, traducido y validado al español por Reina, Ferriz, et al. (2019). La versión original de este cuestionario puede consultarse en Block et al. (2013). Se trata de una herramienta diseñada para investigar la autoeficacia del profesorado hacia la inclusión de ECD intelectual, física o visual. El cuestionario está compuesto por un total de 29 ítems, divididos en 3 subescalas (discapacidad intelectual, física y visual) que, a su vez, recogen 4 dimensiones distintas (instrucciones a los iguales, estando en la tarea, adaptaciones específicas y seguridad). Para ubicar al encuestado en contexto, el cuestionario dispone de una breve descripción de un estudiante con discapacidad y, posteriormente, se plantean las preguntas, de tipo: "*¿Cómo de competente te sientes para mantener a David centrado en la tarea durante la realización del test físico?*" (dimensión *estando en la tarea*), o "*¿Cómo de competente te sientes para modificar las reglas del juego para Sofía?*" (dimensión *adaptaciones específicas*). El grado de competencia percibida para cada situación descrita está basado en una escala tipo Likert, provista con un rango de 1 (*sin confianza*) a 5 (*confío completamente*). Así pues, las puntuaciones más altas en estas tres subescalas se asocian a una mayor competencia percibida para incluir a un estudiante con NEE por discapacidad en EF. La cuarta y última parte del EA-PEF-AD-2 incluye preguntas sobre características demográficas de los encuestados, como edad, sexo, etapa de docencia actual, años de experiencia docente, cursos previos completados en EF adaptada/inclusiva, y experiencias previas y frecuencia de contacto con personas con discapacidad.

Las mediciones se administraron anónimamente a los sujetos participantes en la intervención como pre-test antes del comienzo del programa, mientras que el post-test se administró en la semana posterior a la finalización del curso. Para mantener el anonimato, el pre- y el post-test se relacionaron utilizando un código de libre elección por parte del encuestado.

Por otro lado, al finalizar el programa se realizó una evaluación cualitativa en la que se solicitó a los asistentes que comentaran subjetivamente su experiencia. Este enfoque nos permitió detectar los principales temas emergentes narrados en primera persona. Se diseñó una plantilla con una serie de preguntas para conocer en profundidad la opinión del profesorado sobre la formación recibida y se procedió a la realización de entrevistas semi-estructuradas, llevadas a cabo individualmente con cada participante. El entrevistador asistió a la última jornada del curso y se aisló con cada uno

de los participantes en una sala con un ambiente agradable y sin distracciones, con el objetivo mantener una conversación distendida. La duración media de cada una de las entrevistas fue de unos 10 minutos. Para realizar el análisis cualitativo a posteriori, con el permiso de los participantes, se grabaron las entrevistas, se transcribieron textualmente a un documento Word y se registraron de forma anónima mediante un número de identificación personal. La precisión de las transcripciones se verificó con las grabaciones.

Procedimiento: programa de formación DIE

La intervención en cuestión consistió en cinco jornadas, cada una de ellas con una duración de tres horas, llevadas a cabo en cuatro semanas consecutivas entre los meses de febrero y marzo de 2020. Todas las sesiones se implementaron por la tarde, es decir, después del horario lectivo en los centros educativos regulares. En conjunto, 15 horas de formación al profesorado en las que se trataron diferentes contenidos relacionados con la inclusión en las clases de EF, siguiendo una metodología de enseñanza activa y participativa.

Las sesiones fueron puestas en práctica por cuatro ponentes diferentes, todos ellos doctores en Ciencias de la Actividad Física y de Deporte, y cada uno especialista en una de las discapacidades tratadas durante el programa de formación (discapacidad física, lesión neurológica, discapacidad sensorial y discapacidad intelectual). Así, cada docente se encargó de una de las jornadas, exceptuando uno de ellos que, además, impartió la sesión introductoria.

La primera sesión se realizó en un aula de informática; las sesiones restantes se realizaron en las instalaciones propias de EF (pista polideportiva y/o gimnasio). En ésta se explicó en qué consiste el *programa DIE* (Figura 1), definiendo sus objetivos, contenidos, estructura y recursos docentes (Ocete-Calvo et al., 2015; Pérez-Tejero et al., 2013). Asimismo, se mostró el funcionamiento de la plataforma de materiales de apoyo en línea (www.deporteinclusivoescuela.com) para el diseño y generación de las distintas sesiones. Por último, se constituyeron los 11 grupos de trabajo (formados por dos o tres integrantes) que posteriormente liderarían las sesiones en el resto de las jornadas.

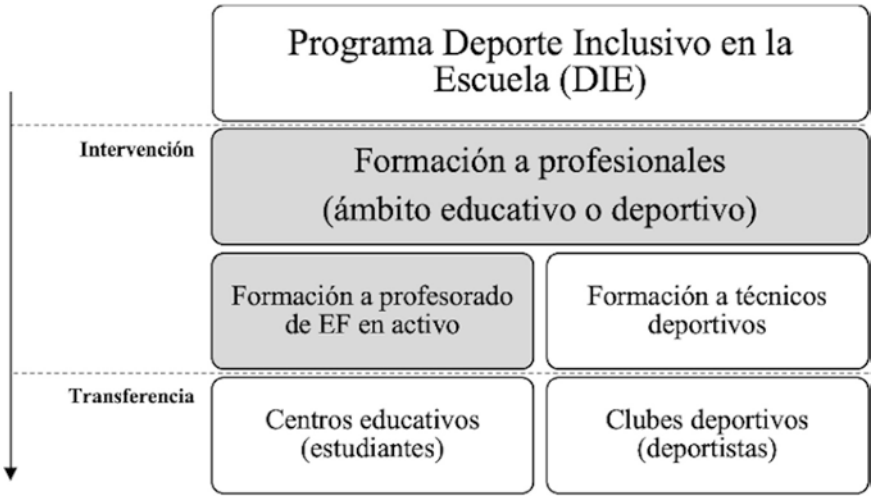

Figura 1. *Ámbitos de actuación del programa DIE. Nota: los campos sombreados hacen referencia al área en la que se enmarca la intervención objeto de este trabajo.*

La segunda, tercera, cuarta y quinta jornadas correspondieron a las sesiones diseñadas a partir de los contenidos del *programa DIE* relacionadas con la discapacidad física, lesión neurológica, discapacidad sensorial y discapacidad intelectual, respectivamente. La Tabla 2 recoge una breve descripción de la formación, así como los deportes seleccionados para las jornadas prácticas, que fueron desarrollados de manera inclusiva: parte de los participantes simulaban la discapacidad durante la práctica, mientras que otros no, participando todos de manera conjunta y respetando el objetivo de la tarea (Pérez-Tejero, 2013). Es importante destacar que para el desarrollo de las sesiones fueron los mismos participantes, con la supervisión del ponente, los que llevaron a cabo las distintas tareas. Cada uno de los grupos generó una sesión en la plataforma DIE, de la modalidad deportiva que hubieran seleccionado, ésta se revisaba por el experto en cuestión y se ponía en práctica siendo el resto de los compañeros los que actuaban en las tareas. De esta manera, todos los asistentes simularon el rol de docente y de estudiante a lo largo de las cinco jornadas. Al finalizar cada sesión, se agrupaban todos los asistentes para proporcionar un feedback grupal. En total, se realizaron prácticas de 11 deportes distintos, vivenciando así algunas de las diferentes posibilidades de práctica deportiva inclusiva que ofrece una determinada discapacidad.

Tabla 2. Características de las sesiones del programa Los deportes indicados se trabajaron siempre de manera inclusiva

Sesión 1	Pre-test La EF inclusiva: rango de participación y adecuación de tareas Principales consideraciones según tipo de discapacidad del alumno Explicación del *programa DIE* Uso de la plataforma en línea DIE para el desarrollo de sesiones
Sesión 2	EF inclusiva para ECD física: características y estrategias de enseñanza para el profesorado Explicación teórica y puesta en práctica de sesiones de rugby y baloncesto en silla de ruedas y voleibol sentado
Sesión 3	EF inclusiva para estudiantes con lesión neurológica: características y estrategias de enseñanza para el profesorado Explicación teórica y puesta en práctica de sesiones de Boccia, fútbol 7 y bádminton
Sesión 4	EF inclusiva para ECD sensorial: características y estrategias de enseñanza para el profesorado Explicación teórica y puesta en práctica de sesiones de Goalball, atletismo y discapacidad visual y deportes para la discapacidad auditiva
Sesión 5	EF inclusiva para ECD intelectual: características y estrategias de enseñanza para el profesorado Explicación teórica y puesta en práctica de sesiones de baloncesto, bádminton y rugby con discapacidad intelectual Post-test

Análisis de datos

Para el análisis descriptivo se calcularon todas las puntuaciones descriptivas de autoeficacia, expresadas en media (M) y desviación típica (DT). Posteriormente se realizó la prueba de Kolmogorov-Smirnov para comprobar la distribución de las puntuaciones en las variables de estudio, que resultó no adecuarse a la normal, por lo que aplicaron pruebas no paramétricas. Se realizó el test Wilcoxon para muestras relacionadas con el fin de determinar posibles diferencias pre-post por participantes. El análisis estadístico se realizó empleando el software *Statistical Package for Social Sciences* (*IBM SPSS Statistics for Mac, version 26.0; Armonk, NY, USA*). La significación estadística se estableció en un nivel de $p < .05$. Para realizar el análisis cualitativo se utilizó el software *QSR Nvivo, versión 10*. Los datos se codificaron en unidades de análisis *verbatim* y se agruparon en categorías utilizando como referencia los temas abordados en cada pregunta.

Resultados

Entre los 16 participantes, un bajo número ($N = 4$) habían recibido anteriormente alguna formación en actividad/ educación física adaptada/inclusiva, mientras que un 50% de ellos ($N = 8$) se habían visto involucrados previamente en alguna situación de EF o deportiva con alumnos con discapacidad. Dentro de este último grupo, se observaron distintas situaciones: trabajar con un niño/a con discapacidad 1 a 1 (25%); con un pequeño grupo de niños/as con discapacidad (25%); con un alumno/a con discapacidad en un centro educativo (87.5%); y, con un pequeño grupo de alumnos/as con discapacidad en un centro educativo (25%). Ninguno de los participantes había sido asistente de un estudiante con discapacidad en clase de EF. Por otro lado, las experiencias con ECD reportadas por el conjunto de los participantes se mostraron distintas según la tipología de ésta: en cuanto a discapacidad intelectual, un 31% reportaron no tener ninguna experiencia previa, un 50% una o dos veces, y un 19% muchas veces. Con discapacidad física, un 25% del profesorado manifestó no tener experiencia, un 56% una o dos veces, y un 19% muchas veces. Por último, la discapacidad visual había sido la menos tratada, siendo un 69% los que declararon carecer de experiencia, un 25% una o dos veces, y un 6% muchas veces.

En cuanto a los resultados obtenidos respecto a la variable autoeficacia, los datos mostrados en la Tabla 3 revelan un efecto positivo significativo del programa de intervención sobre los participantes en todas las subescalas (discapacidad intelectual, física y visual) y dimensiones (en la tarea, adaptaciones específicas, instrucciones a los iguales, y seguridad). Cabe destacar la obtención de una significación de $p < .01$ en 8 de las 9 dimensiones estudiadas, excepto en la dimensión *en la tarea*, dentro de la variable *discapacidad intelectual*, cuyo valor de significación estadística fue de $p = .012$.

Tabla 3. Diferencias prepost en las variables de estudio

Escala	Dimensión	Pre-test		Post-test			
		M	*DT*	*M*	*DT*	*Z*	*p*
Discapacidad intelectual	En la tarea	3.48	0.60	4.03	0.68	2.53	.012*
	Adaptaciones específicas	3.44	0.59	4.19	0.72	2.96	.003**
	Instrucciones a iguales	3.27	0.69	4.17	0.70	3.30	.001**
Discapacidad física	Seguridad	3.38	1.05	4.17	0.64	3.09	.002**
	Adaptaciones específicas	3.54	0.87	4.25	0.64	2.88	.004**
	Instrucciones a iguales	3.13	0.88	4.21	0.63	3.34	.001**
Discapacidad visual	Seguridad	2.98	0.69	4.17	0.64	3.31	.001**
	Adaptaciones específicas	3.17	0.88	4.02	4.02	3.03	.002**
	Instrucciones a iguales	3.02	0.76	3.96	0.57	3.31	.001**

* $p < 05$; ** $p < .01$

La evaluación cualitativa del programa por parte de los asistentes evidenció, en primer lugar, un alto cumplimiento en el nivel de expectativas.

> *Me ha encantado el curso. Os animo a repetirlo. Enhorabuena a todos. (P10)*
> *Excelente organización y muy buenos ponentes. (P14)*

Los temas que emergieron con claridad y consenso mayoritarios fueron la coherencia de la metodología utilizada con los objetivos planteados, la adecuación de los espacios físicos y medios materiales y el tratamiento de los contenidos. Respecto a este último aspecto, se valoró positivamente en nivel de profundidad y la secuencia de presentación.

Respecto a las actividades prácticas, los participantes opinan que el diseño ha sido adecuado al contenido y que la dinámica ha favorecido el intercambio de experiencias y el trabajo colaborativo, siendo muy útil para la práctica docente. Alguno de los participantes destaca la relevancia de los contenidos recibidos, así como la labor docente:

> *Me ha resultado muy interesante y de utilidad para cuando me vea en alguna situación en la que pueda tener alumnos con alguna discapacidad. Los profesores muy buenos. (P3)*

Otros, sin embargo, son más críticos con la metodología práctica del curso y consideran necesario otro enfoque para esta parte:

> *Creo que, teniendo un plantel de ponentes excelente para las sesiones, sería bastante mejor que dirigieran las sesiones prácticas dichos ponentes. Está bien la idea de hacer a la gente partícipe en el curso y que diseñe las sesiones con la plataforma [DIE] pero, la verdad, es que las sesiones que hicimos dirigidas por no expertos (ojo, que yo mismo fui uno de ellos) quedaron muy básicas. (P5)*

Cabe destacar, por último, que más de la mitad de los participantes reportaron haber puesto en práctica las enseñanzas recibidas en sus sesiones tras la realización del curso.

Discusión

La finalidad de esta investigación fue analizar el efecto de un programa de formación en EF inclusiva sobre la variable autoeficacia de docentes en activo, independiente de la etapa formativa en la que se encontraran. Los resultados obtenidos aluden a que el curso ofrecido tuvo un efecto positivo y significativo sobre todos los participantes, sugiriendo que, después de haber participado activamente en el programa, se sienten más competentes y seguros para incluir en sus sesiones a ECD intelectual, física o visual. Así, podemos confirmar que la hipótesis de partida fue confirmada. Además, la evaluación cualitativa de la intervención sugiere que el planteamiento propuesto en la intervención ha sido acertado.

Esta formación fue puesta en práctica conforme a su fundamentación previa (Ocete-Calvo et al., 2015; Pérez-Tejero et al., 2013). Según nuestro conocimiento, en España, el *programa DIE* es un programa educativo de referencia orientado a la formación de la EF inclusiva y del deporte adaptado que se ha llevado a cabo –y sigue haciéndolo– tanto en el aula como fuera de ella, desde una perspectiva holística de la enseñanza. Gracias a los buenos resultados obtenidos tras su implementación en los estudiantes durante varios años consecutivos (Ocete-Calvo, 2016), el DIE también se ha trasladado con éxito diferentes ámbitos (Figura 1), como herramienta en la formación.

La evaluación cuantitativa sugiere una muy buena adecuación de la propuesta a las necesidades de los participantes, con un aumento significativo en todas las subescalas y dimensiones de la autoeficacia tras la intervención. Estos resultados están en línea con otras investigaciones similares. Por ejemplo, Sari (2007) evidenció cómo los docentes que recibieron una formación en discapacidad auditiva, a diferencia del grupo control, aumentaron sus conocimientos en la deficiencia, mostraron mejores actitudes y perfeccionaron su relación con la gestión del aula para favorecer entornos inclusivos. Más recientemente, Kwon y Block (2017) concluyeron que un programa de EF adaptada podría proporcionar un impacto positivo significativo sobre el aprendizaje y en la autoconfianza de los participantes para incluir a ECD. En otro de los estudios citados anteriormente, Reina, Healy, et al. (2019) reportaron mejoras significativas en la autoeficacia de

docentes en activo, en comparación con el grupo control, para todas las subescalas analizadas (discapacidad intelectual, física y visual), tras haber recibido una formación basada en el programa *Incluye-T*, un programa de formación de corte similar (en estructura, formato y duración) al *programa DIE*.

De este modo, el programa de formación propuesto en este estudio, así como los llevados a cabo en otras investigaciones, pretenden dar respuesta a la necesidad de aprendizaje del profesorado (Abellán et al., 2019; Block et al., 2010; Hutzler & Barak, 2017; Saloviita & Consegnati, 2019), mejorando sus niveles de autoeficacia para optimizar la práctica inclusiva en las clases. Tal y como sugieren Emmers et al. (2019), aquellos profesores que tengan más experiencias en la enseñanza con ECD mostrarán actitudes más deseables hacia la inclusión y una mejor calificación en la escala de autoeficacia. En consecuencia, la exclusión y falta de pertenencia que habitualmente perciben los ECD en EF podría reducirse gracias a la mejora de esta variable en el profesorado (Block et al., 2020). Cabe destacar que en el proceso de inclusión en EF aparecen factores que influyen en las actitudes y competencia mostrada por el docente hacia la inclusión de los ECD, como las actitudes mostradas por estudiantes sin discapacidad hacia la integración de sus compañeros con discapacidad (Ocete-Calvo, 2016; Rekaa et al., 2019). En esta línea, el *programa DIE* también ha mostrado como, en su proceso transferencia al aula, la participación conjunta de estudiantes con y sin discapacidad mejoró la percepción de los segundos hacia la inclusión de los ECD, reflejando valores como la tolerancia, la igualdad y el bienestar con los demás (Ocete-Calvo et al., 2017). Conjuntamente, las actitudes positivas mostradas por docentes y estudiantes, así como una mayor percepción de autoeficacia por parte del profesorado, podrán derivar en procesos exitosos de inclusión en EF (Wilhelmsen & Sørensen, 2017).

Teniendo en cuenta la reciente aprobación y próxima aplicación de la Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica 2/2006, de 3 de mayo, de Educación (LOMLOE; Ministerio de Educación y Formación Profesional, 2020), programas educativos como el propuesto en esta investigación pueden favorecer al cumplimiento de dos de los objetivos más importantes de la Ley, los cuales son evitar la segregación del alumnado y reforzar la capacidad inclusiva del sistema. Concretamente, el artículo 74.5 de la LOMLOE destaca: «Corresponde asimismo a las Administraciones educativas […] proporcionar los recursos y apoyos complementarios necesarios y proporcionar las atenciones educativas específicas derivadas de discapacidad o trastornos de algún tipo durante el curso escolar». Asimismo, en la disposición adicional cuarta, se añade: «Las Administraciones educativas velarán para que las decisiones de escolarización garanticen la respuesta más adecuada a las necesidades específicas de cada alumno o alumna». De este modo, en la parcela correspondiente a la materia de EF, el *programa DIE* puede dotar de herramientas útiles y eficaces al profesorado con el objetivo de hacer frente a la demanda de la comunidad educativa, siendo la propia administración educativa la que ofrezca este tipo de formaciones continuas.

Aunque los resultados de la presente investigación representan un progreso en la limitada evidencia científica acerca del desarrollo profesional del profesorado de EF en la inclusión de estudiantes con NEE por discapacidad, deben considerarse una serie de limitaciones. En primer lugar, la muestra no fue lo suficientemente amplia como para generalizar los resultados obtenidos, de modo que deben ser tratados con cautela. Asimismo, los participantes no fueron seleccionados de manera aleatorizada, sino que fueron ellos mismos los que decidieron participar en el programa. En tal caso, factores como la motivación por el aprendizaje y el interés por incluir a ECD en sus aulas pueden haber condicionado la mejora en la variable analizada. Futuras investigaciones deberían emplear un diseño experimental puro con una muestra más extensa para obtener resultados más concluyentes. Por otro lado, a pesar de que las sesiones desarrolladas durante el programa fueron supervisadas por los ponentes, una de las críticas que se debe tener en cuenta, haciendo referencia a las respuestas del análisis cualitativo, es que no cumplieron con las expectativas de algún participante. En posteriores intervenciones se debería acordar previamente con los participantes la forma de llevar a cabo la práctica. En tercer lugar, en este estudio se midió la autoeficacia relacionada con la inclusión de estudiantes con tres tipos de discapacidades; intelectual, física y visual. Así, los hallazgos del estudio actual no deben extrapolarse a la mejora de la autoeficacia para incluir a estudiantes con otros diagnósticos. Próximos estudios deberían tratar de examinar el impacto del desarrollo profesional en la autoeficacia relacionada con la inclusión en un espectro de discapacidades más amplio. Por ejemplo, sería interesante evaluar la autoeficacia del profesorado a la hora de incluir a estudiantes con las discapacidades más incidentes en el sistema educativo español entre el alumnado con NEE, tras la discapacidad intelectual (29,9%), como son los trastornos graves de conducta/personalidad (23,8%) y los trastornos generalizados del desarrollo (23,2%) (Ministerio de Educación y Formación Profesional, 2020a).

En conclusión, atendiendo al objetivo planteado en este estudio, los hallazgos obtenidos han mostrado que un programa de formación como el propuesto en esta investigación puede mejorar la autoeficacia de docentes en activo para incluir a ECD en el aula de EF. De esta forma, el *programa DIE* podría destacar como base de una formación continua apropiada para que el profesorado de EF cumpla con las demandas curriculares de los ECD, incluyéndolos eficazmente en sus clases y, por lo tanto, fomentando su educación integral (Ministerio de Educación y Formación Profesional, 2020b).

Referencias

Abellán, J., Sáez Gallego, N. M., Reina, R., Ferriz, R., & Navarro Patón, R. (2019). Percepción de autoeficacia hacia la inclusión en futuros maestros de educación física. *Revista de Psicología del Deporte*, *28*(1), 143-156.

Alhumaid, M. M., Khoo, S., & Bastos, T. (2020). Self-efficacy of Pre-Service Physical Education Teachers Toward Inclusion in Saudi Arabia. *Sustainability*, *12*(3898), 1-13. https://doi.org/10.3390/su12093898

Bandura, A. (1977). Self-efficacy: Toward a Unifying Theory of Behavioral Change. *Psychological Review*, *84*(2), 191-215. https://doi.org/10.1007/978-3-319-75361-4

Block, M., Haegele, J., Kelly, L., & Obrusnikova, I. (2020). Exploring Future Research in Adapted Physical Education. *Research Quarterly for Exercise and Sport*, 1-14. https://doi.org/10.1080/02701367.2020.1741500

Block, M., Hutzler, Y., Barak, S., & Klavina, A. (2013). Creation and validation of the self-efficacy instrument for physical education teacher education majors toward inclusion.

Adapted Physical Activity Quarterly, *30*(2), 184-205. https://doi.org/10.1123/apaq.30.2.184

Block, M., Kwon, E. H., & Healy, S. (2016). Preparing Future Physical Educators for Inclusion: Changing the Physical Education Teacher Training Program. *Revista Da Associação Brasileira De Atividade Motora Adaptada*, *17*(1), 9-12. https://doi.org/10.36311/2674-8681.2016.v17n1.02.p9

Block, M., & Obrusnikova, I. (2007). Inclusion in Physical Education: A review of the literature From 1995-2005. *Adapted Physical Activity Quarterly*, *24*, 103-124. https://doi.org/10.1080/1034912X.2012.697737

Block, M., Taliaferro, A., Harris, N., & Krause, J. (2010). Using Self-Efficacy Theory to Facilitate Inclusion in General Physical Education. *Journal of Physical Education, Recreation & Dance*, *81*(3), 43-46. https://doi.org/10.1080/07303084.2010.10598448

Crispel, O., & Kasperski, R. (2019). The impact of teacher training in special education on the implementation of inclusion in mainstream classrooms. *International Journal of Inclusive Education*, 1-12. https://doi.org/10.1080/13603116.2019.1600590

Emmers, E., Baeyens, D., & Petry, K. (2019). Attitudes and self-efficacy of teachers towards inclusion in higher education. *European Journal of Special Needs Education*, 1-15. https://doi.org/10.1080/08856257.2019.1628337

Hutzler, Y., & Barak, S. (2017). Self-efficacy of physical education teachers in including students with cerebral palsy in their classes. *Research in Developmental Disabilities*, *68*, 52-65. https://doi.org/10.1016/j.ridd.2017.07.005

Hutzler, Y., Meier, S., Reuker, S., & Zitomer, M. (2019). Attitudes and self-efficacy of physical education teachers toward inclusion of children with disabilities: a narrative review of international literature. *Physical Education and Sport Pedagogy*, *24*(3), 249-266. https://doi.org/10.1080/17408989.2019.1571183

Kwon, E. H., & Block, M. (2017). Implementing the adapted physical education E-learning program into physical education teacher education program. *Research in Developmental Disabilities*, *69*, 18-29. https://doi.org/10.1016/j.ridd.2017.07.001

Lidor, R., & Hutzler, Y. (2019). Including Students with Disabilities in a Physical Education Teacher Preparation Program: An Institutional Perspective. En *Teacher Education in the 21st Century* (pp. 1-19). IntechOpen. https://doi.org/http://dx.doi.org/10.5772/57353

Maher, A. J., & Fitzgerald, H. (2020). Initial teacher education and continuing professional development: the perspectives of special school physical education teachers. *Curriculum Studies in Health and Physical Education*, *11*(1), 18-33. https://doi.org/10.1080/25742981.2019.1696687

McKay, C., Block, M., & Park, J. Y. (2015). The impact of paralympic school day on student attitudes toward inclusion in physical education. *Adapted Physical Activity Quarterly*, *32*(4), 331-348. https://doi.org/10.1123/APAQ.2015-0045

Ministerio de Educación y Formación Profesional. (2020a). *Estadística de las Enseñanzas No Universitarias. Alumnado con Necesidad Específica de Apoyo Educativo Curso 2018-2019*. http://www.educacionyfp.gob.es/eu/servicios-al-ciudadano/estadisticas/no-universitaria/alumnado/apoyo/2018-2019.html

Ministerio de Educación y Formación Profesional. (2020b). Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica 2/2006, de 3 de mayo, de Educación (LOMLOE). *Boletín Oficial del Estado*, *30 de diciembre de 2020*, *230*, 122868-122953.

Murphy, N. A., & Carbone, P. S. (2008). Promoting the participation of children with disabilities in sports, recreation, and physical activities. *Pediatrics*, *121*(5), 1057-1061. https://doi.org/10.1542/peds.2008-0566

Neville, R. D., Makopoulou, K., & Hopkins, W. G. (2019). Effect of an Inclusive Physical Education (IPE) Training Workshop on Trainee Teachers' Self-Efficacy. *Research Quarterly for Exercise and Sport*, 1-13. https://doi.org/10.1080/02701367.2019.1650877

Obrusnikova, I. (2008). Physical educators' beliefs about teaching children with disabilities. *Perceptual and Motor Skills*, *106*(2), 637-644. https://doi.org/10.2466/PMS.106.2.637-644

Ocete-Calvo, C. (2016). *Deporte Inclusivo en la Escuela: diseño y análisis de un programa de intervención para promover la inclusión del alumnado con discapacidad en Educación Física* [Tesis Doctoral, Universidad Politécnica de Madrid]. http://oa.upm.es/39683/

Ocete-Calvo, C., Lamata, C., Coterón, J., Durán, L. J., & Pérez-Tejero, Y. J. (2017). La percepción de los alumnos de Secundaria y Bachillerato hacia la inclusión de compañeros con discapacidad en Educación Física. *Psychology, Society and Education*, *9*(2), 299-310. https://doi.org/10.25115/psye.v9i2.846

Ocete-Calvo, C., Pérez-Tejero, J., & Coterón, J. (2015). Propuesta de un programa de intervención educativa para facilitar la inclusión de alumnos con discapacidad en educación física. *Retos*, *27*(1), 140-145. https://recyt.fecyt.es/index.php/retos/article/view/34366

Özer, D., Nalbant, S., Aglamis, E., Baran, F., Kaya Samut, P., Aktop, A., & Hutzler, Y. (2013). Physical education teachers' attitudes towards children with intellectual disability: The impact of time in service, gender, and previous acquaintance. *Journal of Intellectual Disability Research*, *57*(11), 1001-1013. https://doi.org/10.1111/j.1365-2788.2012.01596.x

Pérez-Tejero, J. (2013). Centro de Estudios sobre Deporte Inclusivo: Cuatro años de fomento del deporte inclusivo a nivel práctico, académico y científico. En *Serie «Cuadernos del CEDI-1»*. Madrid: Universidad Politécnica de Madrid, Fundación Sanitas, Psysport.

Pérez-Tejero, J., Barba, M., García-Abadía, L., Ocete-Calvo, C., & Coterón, J. (2013). *Deporte Inclusivo en la Escuela*. Madrid: Universidad Politécnica de Madrid, Fundación Sanitas, Psysport.

Programa Deporte Inclusivo en la Escuela. (2021). *Histórico DIE*. http://www.deporteinclusivoescuela.com/programa-die/historico-die

Reina, R., Ferriz, R., & Roldan, A. (2019). Validation of a Physical Education Teachers' Self-Efficacy Instrument Toward Inclusion of Students With Disabilities. *Frontiers in Psychology*, *10*(2169), 1-10. https://doi.org/10.3389/fpsyg.2019.02169

Reina, R., Healy, S., Roldán, A., Hemmelmayr, I., & Klavina, A. (2019). Incluye-T: a professional development program to increase the self-efficacy of physical educators towards inclusion. *Physical Education and Sport Pedagogy*, *24*(4), 319-331. https://doi.org/10.1080/17408989.2019.1576863

Reina, R., Santana, A., Montesdeoca, R., & Roldan, A. (2019). Improving self-efficacy towards inclusion in in-service

physical education teachers: A comparison between insular and peninsular regions in Spain. *Sustainability*, *11*(5824), 1-10. https://doi.org/10.3390/su11205824

Rekaa, H., Hanisch, H., & Ytterhus, B. (2019). Inclusion in Physical Education: Teacher Attitudes and Student Experiences. A Systematic Review. *International Journal of Disability, Development and Education*, *66*(1), 36-55. https://doi.org/10.1080/1034912X.2018.1435852

Saloviita, T., & Consegnati, S. (2019). Teacher attitudes in Italy after 40 years of inclusion. *British Journal of Special Education*, *46*(4), 465-479. https://doi.org/10.1111/1467-8578.12286

Sari, H. (2007). The Influence of an In-service Teacher Training (INSET) Programme on Attitudes towards Inclusion by Regular Classroom Teachers Who Teach Deaf Students in Primary Schools in Turkey. *Deafness & Education International*, *9*(3), 131-146. https://doi.org/10.1179/146431507790559996

Taliaferro, A. R., Hammond, L., & Wyant, K. (2015). Preservice physical educators' self- efficacy beliefs toward inclusion: The impact of coursework and practicum. *Adapted Physical Activity Quarterly*, *32*(1), 49-67. https://doi.org/10.1123/apaq.2013-0112

Tant, M., & Watelain, E. (2016). Forty years later, a systematic literature review on inclusion in physical education (1975-2015): A teacher perspective. *Educational Research Review*, *19*, 1-17. https://doi.org/10.1016/j.edurev.2016.04.002

Tümkaya, G., & Miller, S. (2020). The perceptions of pre and in-service teachers' self-efficacy regarding inclusive practices: A systematised review. *Elementary Education Online*, *19*(2), 1061-1077. https://doi.org/10.17051/ilkonline.2020.696690

UNESCO. (1994). *Declaración de Salamanca y Marco de Acción para las Necesidades Educativas Especiales*. https://unesdoc.unesco.org/ark:/48223/pf0000098427_spa

Wang, Y.-S., Liu, L., Wei, X.-W., & Block, M. E. (2020). The Self-Efficacy of Preservice Physical Education Teachers in Disabilities Education in China. *Sustainability*, *12*(18), 7283. https://doi.org/10.3390/su12187283

Wilhelmsen, T., & Sørensen, M. (2017). Inclusion of children with disabilities in physical education: A systematic review of literature from 2009 to 2015. *Adapted Physical Activity Quarterly*, *34*(3), 311-337. https://doi.org/10.1123/apaq.2016-0017

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Attitudes towards physical education teachers from a cross-cultural perspective: German and Chilean students' viewpoints

Actitudes hacia el profesor de Educación Física desde una perspectiva intercultural: La mirada de estudiantes alemanes y chilenos

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Resumen

El papel del profesor en la generación de actitudes favorables hacia la Educación Física es esencial, porque su comportamiento influye directamente en la forma en que los estudiantes valoran la asignatura. El propósito de este estudio es analizar las actitudes hacia los profesores de Educación Física desde la perspectiva de los adolescentes alemanes y chilenos. Participaron 2030 estudiantes (1001 chicas y 1029 chicos, M_{edad} = 14.44 ± 1,8). Se utilizó el "Cuestionario de Actitudes de los Escolares hacia la Educación Física". Se adoptó un modelo de doble componente (*afectivo* y *cognitivo*). Los estudiantes alemanes otorgaron mayores puntuaciones al componente *afectivo*, mientras que los estudiantes chilenos dieron mayor valoración al componente *cognitivo*, encontrándose diferencias significativas entre los dos grupos en ambos componentes (p < .001). No se encontraron diferencias significativas según sexo en ninguno de los componentes. Las diferencias de nacionalidad parecen influir en las actitudes de los estudiantes hacia la Educación Física. Al identificar estas diferencias, puede ser posible planificar metodologías que generen actitudes favorables hacia la actividad física utilizando estrategias que trasciendan a los países.

Palabras clave: actitudes, educación física, adolescentes, intercultural.

Abstract

The physical education teacher's role in the generation of favourable attitudes towards physical education is essential, because his behaviour directly influences how students rate the subject. The purpose of this study is to analyse the attitudes towards physical education teachers from the German and Chilean adolescents' perspective. 2030 students participated (1001 girls and 1029 boys, M_{age} = 14.44 ± 1.8). The "Questionnaire on Students' Attitudes towards Physical Education" was used. A dual component model (*affective* and *cognitive*) was adopted. German students gave higher scores to the *affective* component than Chilean students, while Chilean students gave higher scores to the *cognitive* component, indicating significant differences between the two groups for the two components (p < .001). No significant gender differences were found in any of the components. The differences in their nationality seemingly influence the students' attitudes towards physical education. By identifying these differences, it may be possible to plan methodologies that generate favourable attitudes towards physical activity, using strategies that transcend countries.

Keywords: attitudes, physical education, adolescents, cross-cultural.

Introduction

Physical education, like other sectors of the school curriculum, is concerned with students' learning and development. However, physical education has the privilege of being a subject in school that develops this learning from bodily experience. For this reason, it is important to note that depending on how students perceive these experiences, they generate certain beliefs or appraisals that influence their attitudes towards bodily experiences (Silverman & Subramaniam, 1999). Attitudes are defined as predispositions to respond favourably or unfavourably towards an object, person or situation (Ajzen, 2005) and are evaluative judgements, either positive or negative, about a person, object or issue (Hogg & Vaughan, 2010).

Attitudes towards physical education result from the encounter between students and the physical education classes in which they participate (Säfvenbom et al., 2014). When bodily experience in class is valued in a positive way, students' attitudes reflect a greater willingness to repeat the experience. If these experiences are negative, it is likely that students will seek to avoid these activities (Hopple & Graham, 1995). With increasing emphasis on the cultivation of physical activity habits within the objectives of physical education, attitudes are of crucial relevance since positive attitudes towards physical education classes are a necessary component in the generation of an active lifestyle (Chung & Phillips, 2002; Dismore & Bailey, 2011; Kjonniksen et al., 2010; Prochaska et al., 2003).

Several studies have concluded that, in general, the majority of students maintain positive attitudes towards physical education (Carcamo-Oyarzun et al., 2017; Dismore & Bailey, 2010; Gerlach et al., 2006; Hernández et al., 2010; Phillips & Silverman, 2015; Rikard & Banville, 2006; Silverman & Subramaniam, 1999; Stelzer et al., 2004; Subramaniam & Silverman, 2007). However, there are determinants that impact these attitudes to different degrees. Studies that have addressed this issue identify several determinants that influence students' attitudes, with the curriculum and the teacher as the most influential factors (Luke & Sinclair, 1991; Phillips & Silverman, 2015; Subramaniam & Silverman, 2000). The teacher plays a fundamental role in generating positive attitudes towards physical education because his behaviour either directly (Lavay et al., 2012) or indirectly (Jung & Choi, 2016) affects the physical education learning process and directly influences curricular development and other attitude determinants (Luke & Sinclair, 1991).

Teacher behaviour has been associated with both positive and negative attitudes, with accentuated differences depending on student gender (Luke & Sinclair, 1991; Nicaise et al., 2006; Nicaise et al., 2007; Olafson, 2002; Shropshire et al., 1997). Luke and Sinclair (1991) reported that students identified the teacher as a negative determinant of attitudes. This identification was greater among females than among males; however, the majority of girls who perceived the teacher negatively did not participate in physical education classes. Olafson (2002) conducted a series of interviews with teenage girls about physical education and concluded that participants in their study expressed a dislike for physical education and generated strategies to avoid participating in physical education classes, a phenomenon called 'resistance to physical education'. This resistance is due to the curriculum in physical education teaching, intolerance to certain peer relations, and the dominant way in which cultural messages about femininity are presented (Olafson, 2002), factors in which the physical education teacher may have a direct influence. Flintoff and Scraton (2001) also posited that adolescent women highlight the negative aspects of their physical education teachers; they are sarcastic towards their skills, hold low expectations of them, and show no concern. However, this is not true for all teachers; some students mentioned positive features such as fair treatment independent of ability and approachable ways of teaching (Flintoff & Scraton, 2001). Shropshire et al. (1997) found that girls perceived physical education teachers in a more positive way than boys did; girls considered physical education teachers friendly and felt the teachers had a greater willingness to help them. Teachers' feedback to students is also perceived differently according to student gender; feedback influences perceptions of competence for girls more than for boys (Nicaise et al. 2006). Additionally, girls perceive an increased frequency of support and provision of technical information, whereas boys claim that teachers criticize them more and that they are more likely to ignore their mistakes (Nicaise et al. 2007). This female-positive perception of feedback was also noted by Chedzoy and Burden (2009), female pupils showed a strong need for special attention from the teacher, whereas boys expected the teacher to give them instructions on practical activities and training.

In addition to the gender, interculturality is outlined as a relevant aspect in how students from different countries perceive the subject and the teacher who teaches it, taking into account that the global situation of physical education classes presents similar developmental problems in various parts of the world (Hardman ,2008). The literature that adopts a cross-cultural approach to this subject includes a study by Stelzer et al. (2004), which analysed students' attitudes towards physical education in four countries (Czech Republic, Austria, England and United States). Despite the fact that most of these students showed positive attitudes towards physical education, students from the Czech Republic and Austria had significantly more positive attitudes than did students in England and the United States. Additionally, all of these countries, with the exception of the Czech Republic, presented significant differences according to gender, with boys demonstrating more positive attitudes than girls. Another study that considered attitudes towards physical education among schoolchildren from different countries was by Dismore et al., (2006), who compared the views of schoolchildren in Japan and England towards physical education. The authors confirmed that students have very good acceptance of the subject and that Japanese students have more positive attitudes towards physical education compared with their English counterparts. In another cross-cultural study, Chung and Phillips (2002) surveyed secondary school pupils in the United States and Taiwan and focused on attitudes towards physical education and exercise in their free time. As in the studies mentioned above, these authors found differences according to gender and nationality: boys manifested more favourable attitudes towards physical education than girls did, and students in Taiwan presented more positive attitudes towards physical education than American students did. Although these investigations do not indicate the cause of these differences in cross-cultural attitudes towards physical education, the authors of these studies posit that this phenomenon may be explained by different organizational factors, such as curriculum content (Chung & Phillips, 2002), number of students per teacher

(Stelzer et al., 2004), and perceptions of the usefulness of physical education (Dismore et al., 2006).

Physical education teachers play a fundamental role in creating positive attitudes towards physical education because their behaviour, actions and decisions directly influence how students rate the subject. Given the scarcity of cross-cultural studies on this topic, this study has two purposes: first, to analyse attitudes towards physical education teachers from the perspectives of Chilean and German students; second, to determine these students' similarities and differences by nationality and gender.

Materials and Methods

Participants

Because this study was cross-cultural and given the statements by Brandl-Bredenbeck (2005), we generated a strategy to compare Chilean and German students based on similar characteristics in both samples. To achieve this aim, we sought equivalence between the educational establishments to which these students belonged according to the following criteria: a) age within grade (grades 5 and 7 in primary, 9 and 11 in secondary at Chilean schools, equivalent to grades 5, 7, 9 and 11 in German secondary schools); b) co-educational schools (males and females in mixed schools); c) type of school (municipal schools, subsidized private schools and private schools in Chile and *Gesamtschule, Erweiterte Realschule and Gymnasium* in Germany); and d) population unit (urban and rural). These criteria allowed us to develop a probabilistic stratified sample of 2,030 schoolchildren (49.3 % female and 50.7 % male, age M = 14.44 ± 1.8), of whom 1,054 lived in the Saarland Region in Germany (49.0 % female and 51.0 % male, age M = 14.44 ± 1.7) and 976 lived in the Araucanía Region in Chile (49.7 % female and 50.3 % male, age M = 14.45 ± 1.9). Authorization for this project was provided in Germany by the Saarland Ministry of Education, Women, Family and Culture and in Chile by the Araucanía Region's Regional Ministerial Education Secretariat. Once the authorizations were official and the educational establishments where the questionnaire would be administered were chosen, the participating students' parents were asked to sign an informed consent form, and the students signed an informed assent form.

Instrument

The 'Questionnaire on Student Attitudes to Physical Education' was used to collect data. It was created and validated by the Sports Science Institute at Saarland University (Cárcamo, 2012; Wydra, 2001) using the back-translation method (Hambleton, 1996) for its translation to Spanish. This questionnaire was developed using theoretical constructs in the literature on attitudes towards physical education (Silverman & Subramaniam, 1999; Subramaniam & Silverman, 2000). These constructs were organized into four areas: socio-demographic data, attitudes towards physical education classes, attitudes towards the physical education teacher, and physical activity habits. Content validity was established through a literature review considering variables that have previously been validated as important with regard to students' attitudes towards physical education (Silverman, 2017; Silverman & Subramaniam, 1999; Subramaniam & Silverman, 2000) and by submitting the questionnaire to expert judgement by Chilean and German professionals in the fields of pedagogy and psychology. The questionnaire was pilot-tested with students from both countries (grade 9 in Chile, grades 7 and 11 in Germany; 87 students in total) to establish the clarity of the questions and to detect difficulties in comprehension by the students.

This study adapted the section of the questionnaire on attitudes towards physical education teachers. The dual component view was adopted, which considers an *affective* component that is related to emotions and a *cognitive* component that is related to beliefs (Subramaniam & Silverman, 2007). This is the most widely used model for researching attitudes towards physical education (Donovan et al., 2015; Phillips & Silverman, 2015; Subramaniam & Silverman, 2007). The *affective* component was constructed with items that presented statements reflecting the schoolchildren's emotional factors towards the teacher (e.g., 'My physical education teacher is understanding'). The *cognitive* component explored the students' opinions of their teacher's performance in class (e.g., 'My physical education teacher gives very varied classes'). Each component consisted of 10 items (20 in total) for which the students indicated their degree of (dis)agreement, scaled from 1 = 'completely disagree' to 4 = 'completely agree' for positive statements and from 1 = 'completely agree" to 4 = 'completely disagree' for negative statements. The questionnaire presented an acceptable degree of reliability, with a Cronbach's alpha of 0.766 for the affective component and 0.780 for the cognitive component.

Process

Interviewers in Chile and Germany were trained to follow an established protocol for presenting and explaining the questionnaire to students. The anonymity of the responses was emphasized, and the students were told that they should reply sincerely. The questionnaires were self-administered but were overseen by the interviewers. Each respondent received a questionnaire and answered individually. The interviewer was allowed to help the respondents with any issues related to understanding the interpretation of the items. The questionnaire was mostly administered during classes not related to physical education to avoid biasing the answers.

Statistical Analysis

Data analysis was conducted with the IBM SPSS Statistics v.25 program. A descriptive analysis was performed (frequencies, mean, standard deviations and confidence intervals) of the affective and cognitive components by country and gender variables. To determine whether there were differences between countries and gender, a multivariate analysis of variance was applied. To interpret significance, a $p \leq .05$ alpha level was established. To quantify the effect size, eta square (η^2) has been used, considering small (η^2 = .01), medium (η^2 = .06), and large (η^2 = .14) effects (Cohen, 1988).

Results

Generally, and considering the total sample, students have favourable attitudes towards their physical education teachers, with a mean of 2.94 in the affective component and 2.98 in the cognitive component (4 maximum). Table 1 (affective component) and Table 2 (cognitive component) present the descriptive statistics of students' attitudes towards their physical education teachers according to gender and country.

Results According to the Affective Component

In the affective component (Table 1), German students presented a higher value than Chilean students did, with significant differences between both groups (F(1, 1828) = 15.060, p < .001, η^2 = .09). According to gender, for the affective component, females presented a slightly higher mean than males did; however, no significant differences were found between genders (F(1, 1828) = 1.23, p = .266). When analysing the gender results according to country, the general trend was maintained: in the affective component, females presented higher values than males did both in Germany and in Chile. However, the differences were not significant (Germany: p = .822, Chile: p = .891), and there was no interaction between gender and country (F(1, 1828) = .07, p = .953).

Table 1. Descriptive statistics of the *affective* component of the attitudes of schoolchildren towards physical education teachers according to gender and country.

	Germany			Chile			Total		
	N	M (SD)	CI 95%	N	M (SD)	CI 95%	N	M (SD)	CI 95%
Females	490	3.00 (0.53)	[2.94-3.04]	423	2.90 (0.48)	[2.85-2.95]	913	2.95 (0.51)	[2.92-2.99]
Males	505	2.97 (0.56)	[2.93-3.03]	414	2.88 (0.43)	[2.84-2.93]	919	2.93 (0.51)	[2.91-2.98]
Total	995	2.98 (0.54)	[2.95-3.02]	837	2.89 (0.46)	[2.86-2.92]	1832	2.94 (0.51)	[2.92-2.97]

Results According to the Cognitive Component

In the cognitive component (Table 2), Chilean students presented higher values in relation to German students, with significant differences between both groups (F(1, 1844) = 6.507, p < .001, η^2 = .06). Regarding gender, males presented a higher mean than females did, although these differences were not statistically significant (F(1, 1844) = .577, p = .456). Regarding the gender results according to country, males presented higher values than females did for both German and Chilean schoolchildren, although there were no significant differences between gender according to country (Germany: p = .907, Chile: p = .979) or interactions between country and gender (F(1, 1844) = .03, p = .858).

Table 2. Descriptive statistics of the *cognitive* component of the attitudes of schoolchildren towards physical education teachers according to gender and country.

	Germany			Chile			Total		
	N	M (SD)	CI 95%	N	M (SD)	CI 95%	N	M (SD)	CI 95%
Females	485	2.94 (0.53)	[2.89-2.98]	442	3.00 (0.48)	[2.96-3.05]	927	2.97 (0.51)	[2.93-3.00]
Males	492	2.96 (0.52)	[2.91-3.00]	429	3.01 (0.46)	[2.97-3.06]	921	3.00 (0.50)	[2.95-3.02]
Total	977	2.95 (0.52)	[2.90-2.98]	871	3.01 (0.47)	[2.97-3.04]	1848	2.98 (0.51)	[2.95-3.00]

Discussion

In general, the students from both countries have favourable attitudes towards their physical education teachers. This finding is consistent with other studies addressing this issue (Gerlach et al. 2006; Hernández et al. 2010; Shropshire et al., 1997). The results show that both Chilean and German students show positive attitudes towards their teachers, although there are significant differences between the countries. Studies on this issue from a cross-cultural perspective suggest that these differences may be explained by organizational factors specific to different countries (Chung & Phillips 2002; Dismore et al., 2006; Stelzer et al. 2004). Therefore, it is necessary to reflect on elements that may suggest the causes of such differences.

One of the factors with the greatest influence on attitudes towards physical education is the curriculum (Luke & Sinclair 1991; Phillips & Silverman 2015; Subramaniam & Silverman 2000). The differences between Chile and Germany are understandable considering that both nations have very disparate approaches to curricula. The physical education curriculum in Chile, which is called 'Physical Education and Health' (Ministerio de Educación de Chile 2013), emphasizes health (Moreno et al., 2013) with a curricular structure based on lessons for the construction of healthy physical habits that are oriented on three axes: motor skills, active and healthy life, and security, fair play and leadership (Ministerio de Educación de Chile, 2013). In contrast, Germany is a federally organized country, and each Bundesland (State) has its own curriculum for physical education, called '*Sportunterricht*'. However, most states have adopted a curriculum based on the concept of 'ability to act', developed by Dietrich Kurz in 1977, wherein multiple perspectives on physical education are proposed (Kurz, 2000). The subject must address six dimensions: body experience, social learning, health education, adventure education, the sporting spirit, and the willingness to do better (Krüger, 2012). Classes must incorporate these six pedagogical dimensions, all of which are equally important, so that students can experience them all and give meaning to movement based on their experience and interests (Wydra, 2007). Contrasting the curricula of both countries, we begin to understand the differences between Chilean and German students regarding their attitudes towards physical education teachers. When the curriculum focuses on the generation of healthy habits, the teacher's main objective is to promote physical activity (Larsson & Nyberg, 2017). In this case, the teacher may focus on teaching in a deterministic manner

by emphasizing functionality and the performance of tasks related to health so that students relate these actions to concepts more than to emotions. Thus, it is possible that Chilean schoolchildren give greater value to cognitive components than to affective ones. In contrast, in Germany, where the curriculum requires that the teacher must equally address various dimensions (Krüger, 2012), the fact that students can give meaning to their classes individually (Wydra, 2007) and can focus not only on the health concept but also on dimensions related to emotions may lead German students to give higher value to the affective component than Chilean students do.

According to Stelzer et al. (2004), in addition to curriculum, another factor that may influence these differences is the number of students per course. In the current study, the average number of students per class was much lower in the German sample (25 students per class) than in the Chilean sample (31 students). A high number of students per class is considered a negative factor for the development of physical education (Deutscher Sportbund, 2006); therefore, this situation may influence students' perception of classes. Classes with fewer students would allow teachers to conduct more personalized classes that better serve the needs of students, which is highly valued by students (Ryan et al., 2003) especially females (Chedzoy & Burden, 2009). In this context, German students would receive more attention from their teacher, which may lead them to value the affective component more in relation to Chilean students.

With regard to gender, when analysing students' attitudes towards physical education teachers, the results indicated that there were no significant differences between females and males. This finding concurs with other current studies (Hernández et al. 2010; Nicaise et al. 2006; Nicaise et al. 2007) that have found no gender differences in students' opinions towards their teachers. Considering that previous studies show significant differences between females and males (Koca et al., 2005; Shropshire et al., 1997) due to the influence of new education policies oriented towards gender equality in physical education classes, a change in trend is taking place (Hernández et al., 2010). It is also noteworthy that females present higher values in the affective component than males do. This finding agrees with studies indicating that females demonstrate a strong need for personal bonding with a teacher and that they expect more attention and help from teachers (Chedzoy & Burden, 2009). In addition, females perceive that their performance in classes is not criticized as much as the performance of males and that they receive more encouragement from their teachers (Nicaise et al., 2006; Nicaise et al., 2007). Knowing this, it is important that the teachers think through their pedagogical decisions, in order to get the female students to participate, which depends in large part on the teacher-student interaction (Martos-García et al., 2020).

Conclusion

The findings of this study conclude that schoolchildren have very positive attitudes towards the physical education teacher. Furthermore, the results indicate that nationality should be a factor to be considered in the study of attitudes towards the physical education teacher, since statistically significant differences were found between the two countries. It seems necessary to go even deeper into the subject, generating studies that determine exactly how cross-cultural differences can influence students' attitudes towards physical education. The identification of these aspects would allow the generation of educational strategies that transcend countries. Given that this study was based on the attitudes of adolescents towards their physical education teachers, it is necessary to conduct further studies on how children in primary schools perceive their physical education teachers. Adolescence may be too late to generate favourable attitudes towards physical activities because students' motivation and perception of competence are in the process of being consolidated. For this reason, early experiences in physical education are relevant for the generation of an active lifestyle and lifelong participation in sport activities (Kirk, 2005). Therefore, it is pertinent to extend the research to this age range.

The teachers' awareness of their students' perceptions can be useful in developing strategies that do not only focus on physical activity, but also seek to improve affective and cognitive aspects. Converting the learning experience into a more person-centered process while interacting at a personal level and addressing the students' concerns could enhance the development of positive attitudes towards physical education. Finally, it is necessary to emphasize the results of this investigation to teachers so that they can take advantage of students' openness and disposition when they students have favourable attitudes towards them. Positive attitudes present a good basis to achieve adequate learning and to generate adherence to physical activity, giving teachers a valuable tool for conducting their classes as they seek to strengthen their teaching methodologies to encourage activities that generate favourable attitudes towards physical education.

References

Ajzen, I. (2005). *Attitudes, personality, and behavior.* Maidenhead, Berkshire, England: Open University Press.

Brandl-Bredenbeck, H. P. (2005). Comparative Physical Education - What, why and how?. In U. Pühse and M. Gerber (eds.) *International comparison of physical education: Concepts, problems, prospects* (pp. 19–31). Aachen: Meyer & Meyer Sport.

Cárcamo, J. (2012). *Der Sportunterricht aus Sichtweise der deutschen und chilenischen Schüler und Schülerinnen: Eine empirische Untersuchung unter besonderer Berücksichtigung des Bundeslandes Saarland und der Región de la Araucanía*. Doctoral Thesis, Saarland University.

Carcamo-Oyarzun, J., Wydra, G., Hernandez-Mosqueira, C., & Martinez-Salazar, C. (2017). Actitudes hacia la Educación Física: Grados de importancia y conformidad según escolares de Chile y Alemania. Una mirada intercultural. *Retos: nuevas tendencias en educación física, deporte y recreación* (32), 158–162. https://doi.org/10.47197/retos.v0i32.52824

Chedzoy, S., & Burden, R. (2009). Primary school children's reflections on Physical Education lessons: An attributional analysis and possible implications for teacher action. *Thinking Skills and Creativity, 4*(3), 185–193. https://doi.org/10.1016/j.tsc.2009.09.008.

Chung, M. H., & Phillips, D. A. (2002). The relationship between attitude toward Physical Education and leisure-time exercise in High School students. *The Physical Educator, 59*(3), 126–138.

Cohen, J. (1988). *Statistical power analysis for the Behavioral Sciences*. New York, NY: Routledge Academic.

Deutscher Sportbund. (2006). *DSB-Sprint-Studie: Eine Untersuchung zur Situation des Schulsports in Deutschland.* Aachen: Meyer & Meyer.

Dismore, H., & Bailey, R. (2010). 'It's been a bit of a rocky start': Attitudes toward physical education following transition. *Physical Education & Sport Pedagogy, 15*(2), 175–191. https://doi.org/10.1080/17408980902813935

Dismore, H., Bailey, R., & Izaki, T. (2006). Japanese and English school students' views of Physical Education: A comparative study. *International Journal of Sport and Health Science,* 4, 74–85. https://doi.org/10.5432/ijshs.4.74

Dismore, H., & Bailey, R. (2011). Fun and enjoyment in physical education: Young people's attitudes. *Research Papers in Education, 26*(4), 499–516. https://doi.org/10.1080/02671522.2010.484866

Flintoff, A, & Scraton, S. (2001). Stepping into active leisure? Young women's perceptions of active lifestyles and their experiences of school Physical Education. *Sport, Education and Society, 6*(1), 5–21. https://doi.org/10.1080/713696043.

Gerlach, E., Kussin, U., Brandl-Bredenbeck, H.P., & Brettschneider, W-D. (2006). Der Sportunterricht aus Schülerperspektive. In Deutscher Sportbund (ed.), *DSB-Sprint-Studie: Eine Untersuchung zur Situation des Schulsports in Deutschland* (pp. 115–152). Aachen: Meyer & Meyer.

Hambleton, R. (1996). Adaptación de tests para su uso en diferentes idiomas y culturas: fuentes de error, posibles soluciones y directrices prácticas. In J. Muñiz (ed.) *Psicometría* (pp. 207-238). Madrid: Universitas.

Hardman, K. (2008). Physical Education in schools: A global perspective. *Kinesiology, 40*(1), 5–28.

Hernández, J. L., López, C., Martínez, M. E., López, A., & Álvarez, M. J. (2010). Percepción del alumnado sobre los comportamientos instructivos del profesorado y satisfacción con la Educación Física: ¿Una cuestión de género? *Movimento, 16*(4), 209–225.

Hogg, M. A., & Vaughan., G. M. (2010). *Psicología social* (5ª ed.). Madrid: Médica Panamericana.

Hopple, C., & Graham, G. (1995). What children think,feel, and know about physical fitness testing. *Journal of Teaching in Physical Education, 14*(4), 408–417. https://doi.org/10.1123/jtpe.14.4.408

Jung, H., & Choi. E. (2016). The importance of indirect teaching behaviour and its educational effects in physical education. *Physical Education and Sport Pedagogy, 21*(2), 121–136. https://doi.org/10.1080/17408989.2014.923990.

Kirk, D. (2005). Physical Education, youth sport and lifelong participation: The importance of early learning experiences. *European Physical Education Review, 11*(3), 239–255. https://doi.org/10.1177/1356336X05056649.

Kjonniksen, L., Fjortoft, I., & Wold, B. (2010). Attitude to physical education and participation in organized youth sports during adolescence related to physical activity in young adulthood: A 10-year longitudinal study. *European Physical Education Review, 15*(2), 139–154. https://doi.org/10.1177/1356336X09345231.

Koca, C., Aşçi, F. H., & Demirhan G. (2005). Attitudes toward physical education and class preferences of turkish adolescents in terms of school gender composition. *Adolescence, 40*, 365–375.

Krüger, A. (2012). Multiperspectivity as a basis of current German physical education. *Movement & Sport Sciences, 78*, 11–23. https://doi.org/10.1051/sm/2012020.

Kurz, D. (2000). Pädagogische Perspektiven für den Schulsport. *Körpererziehung, 50*(2), 72–78.

Larsson, H., & Nyberg, G. (2017). 'It doesn't matter how they move really, as long as they move.' Physical education teachers on developing their students' movement capabilities. *Physical Education and Sport Pedagogy, 22*(2), 137–149. https://doi.org/10.1080/17408989.2016.1157573.

Lavay, B., Henderson, H., French, R. & Guthrie, S. (2012). Behavior management instructional practices and content of college/university Physical Education teacher education (PETE) programs. *Physical Education and Sport Pedagogy, 17*(2), 195–210. https://doi.org/10.1080/17408989.2010.548063.

Luke, M. D., & Sinclair. G. D. (1991). Gender differences in adolescents' attitudes toward school Physical Education. *Journal of Teaching in Physical Education, 11*(1), 31–46. https://doi.org/10.1123/jtpe.11.1.31.

Martos-García, D., Fernández-Lasa, U., & Usabiaga, O. (2020). Coeducación y deportes colectivos. La participación de las alumnas en entredicho. *Cultura, Ciencia y Deporte, 15(45)*, 411-419

Ministerio de Educación de Chile. (2013). *Bases Curriculares de Educación Física y Salud (Básica y Media).* Santiago de Chile: Gobierno de Chile.

Moreno, A., Rivera, E., & Trigueros, C. (2013). Sistema de medicion de la calidad de la Educación Física chilena: Análisis crítico. *Movimento, 20*(1),145–167.

Nicaise, V., Cogerino, G., Fairclough, S., Bois, J., & Davis, K. (2006). Teacher feedback and interactions in Physical Education: Effects of student gender and physical activities. *European Physical Education Review, 13* (3), 319–337. https://doi.org/10.1177/1356336X07081799.

Nicaise, V., Bois, J., Fairclough, S., Amorose, A., & Cogerino, G. (2007). Girls' and boys' perceptions of physical education teachers' feedback: effects on performance and psychological responses. *Journal of Sports Sciences, 25*(8), 915–926. https://doi.org/10.1080/02640410600898095.

Olafson, L. (2002). "I hate Phys. Ed.": Adolescent girls talk about Physical Education. *The Physical Educator, 59*(2), 67–74.

Phillips, S. R., & Silverman, S. (2015). Upper elementary school student attitudes toward Physical Education. *Journal of Teaching in Physical Education, 34*(3), 461–473. https://doi.org/10.1123/jtpe.2014-0022.

Prochaska, J., Sallis, J. F., Slymen, D., & McKenzie, T. (2003). A longitudinal study of children's enjoyment of Physical Education. *Pediatric Exercise Science, 15*(2), 170–178. https://doi.org/10.1123/pes.15.2.170.

Rikard, L., & Banville, D. (2006). High school student attitudes about physical education. *Sport, Education and Society, 11*(4), 385–400. https://doi.org/10.1080/13573320600924882.

Ryan, S., Fleming, D., & Maina, M. (2003). Attitudes of middle school students toward their Physical Education teachers and classes. *The Physical Educator, 60*(2), 28–42.

Säfvenbom, R., Haugen, T., & Bulie, M. (2014). Attitudes toward and motivation for PE. Who collects the benefits of the subject? *Physical Education and Sport Pedagogy, 20*(6), 629–46. https://doi.org/10.1080/17408989.2014.892063

Shropshire, J., Carroll, B. & Yim, S. (1997). Primary school children's attitudes to Physical Education: Gender

differences. *European Journal of Physical Education, 2*(1), 23–38. https://doi.org/10.1080/1740898970020103.

Silverman, S. (2017). Attitude research in Physical Education: A review. *Journal of Teaching in Physical Education, 36*(3), 303-312. https://doi.org/10.1123/jtpe.2017-0085

Silverman, S., & Subramaniam, P. R. (1999). Student attitude toward Physical Education and physical activity: A review of measurement issues and outcomes. *Journal of Teaching in Physical Education, 19*(1), 97–125. https://doi.org/10.1123/jtpe.19.1.97

Stelzer, J., Ernest, J., Fenster, M., & Langford, G. (2004). Attitudes toward physical education: a study of high school students from four countries: Austria, Czech Republic, England and USA. *College Student Journal, 38*(2), 171–718.

Subramaniam, P. R., & Silverman, S. (2000). Validation of scores from an instrument assessing student attitude toward physical education. *Measurement in Physical Education and Exercise Science, 4*(1), 29–43. https://doi.org/10.1207/S15327841Mpee0401_4.

Subramaniam, P. R., & Silverman, S. (2007). Middle school students' attitudes toward physical education. *Teaching and Teacher Education, 23*(5), 602–611. https://doi.org/10.1016/j.tate.2007.02.003.

Wydra, G. 2001. Beliebtheit und Akzeptanz des Sportunterrichts. *Sportunterricht, 50*(3), 67–72.

Wydra, G. 2007. *Sportpädagogik zwischen schulischer Pflicht, Gesundheitsorientierung und Erlebnishunger*. Saarbrücken. Sportwissenschaftliches Institut, Universität des Saarlandes.

CULTURA, CIENCIA Y DEPORTE

Competitive anxiety and trigger timing in female sport pistol shooters

Ansiedad en competición y tiempo de disparo en tiradoras de pistola deportiva

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Abstract

Olympic shooting is a precision sport, influenced by both physical and psychological parameters. The main objective of the study was to analyze the effects of competitive anxiety in female sport pistol shooting during the qualification and the final rounds. Twenty-three women, including 5 elite shooters, who competed at a national Spanish Olympic shooting championship, participated in the study. All shooters completed a socio-demographic and a Competitive State Anxiety Inventory-2 (CSAI-2) questionnaire 10 minutes before each competition round. Performance was measured at competition by use of electronic targets Sius Ascor D941. Demographic and anxiety variables were registered using a questionnaire and the CSAI-2, respectively. Wilcoxon signed-rank, U *Mann-Whitney* tests, *linear regressions* and Pearson correlations were used for the data analysis. Our results showed that pre-competition anxiety impairs performance and increases trigger time. In addition, there are a strong relation between the physical condition and the psychological variables of somatic anxiety and self-confidence for the finalist shooters. We conclude that anxiety modified trigger time and that shooters' physical condition is inversely related to anxiety and positively related with performance and self-confidence. For this reasons, physical condition programs could be recommended for Olympic shooting.

Keywords: Olympic shooting, stress, performance, self-confidence, gun.

Resumen

El tiro olímpico es un deporte de precisión, influenciado por factores físicos y psicológicos. El principal objetivo del estudio fue analizar los efectos de la ansiedad precompetitiva y competitiva en mujeres de la modalidad de pistola deportiva durante la clasificación y la final olímpica. Veintitrés mujeres, incluyendo cinco tiradoras de élite, que compitieron en un Campeonato de España participaron en el estudio. Todas las deportistas completaron un cuestionario sociodemográfico y el CSAI-2 10 minutos antes de cada ronda de competición. El rendimiento fue medido mediante blancos electrónicos Sius Ascor D941 durante la competición. Para el análisis de datos se usaron las pruebas de Wilcoxon, U Mann–Whitney, regresiones lineales y correlaciones de Pearson. Los resultados mostraron que la ansiedad precompetitiva afecta al rendimiento y aumenta el tiempo de disparo. Además, existe una fuerte correlación entre la percepción de la condición física y las variables psicológicas de ansiedad somática y autoconfianza para las atletas finalistas. Nosotros concluimos que la ansiedad modifica el tiempo de disparo y que la condición física de las tiradoras se relaciona de forma inversa con la ansiedad y de forma positiva con la autoconfianza y el rendimiento. Por estas razones, programas de actividad física podrían ser recomendables en tiro olímpico.

Palabras clave: Tiro olímpico, stress, rendimiento, autoconfianza, arma.

Olympic shooting includes several disciplines, such as pistol, rifle and shotgun. The female Olympic pistol category consists of two modalities: a) air pistol (caliber 4.5), with a single shooting precision component and b) sport pistol (caliber 22), which includes a shooting precision stage, similar to air pistol in its technique and execution, and a rapid fire phase with a clear temporal limitation in the execution of the shot, where five shots per set are performed with 3 second (shoot) and 7 second (rest) intervals between shots (RFEDETO, 2014).

Due to the high precision requirements (Mon-López, Tejero-González, et al., 2019), performance in shooting can be influenced by many parameters, both physical and psychological (Reinkemeier et al., 2006). Among the physical-physiological parameters, the ability to stabilize the weapon seems to play a very important role (Hawkins, 2011). This ability is determined by the shooters' postural stability (Pellegrini & Schena, 2005), their physical condition (Gulbinskienė & Skarbalius, 2009) ,as well as their ability to reduce muscular tremor which may in turn be the result of various other factors (Lakie, 2010). Mental preparation plays also a very important role: shooters must remain calm and completely focused on the target under psychological pressure during competition. Anxiety has been identified as a very important psychological parameter that influences performance in sport in general (Ortega et al., 2017) and in Olympic shooting in particular (Causer et al., 2011; Kayihan et al., 2013; Nieuwenhuys & Oudejans, 2010, 2011).

Various anxiety levels can be defined, corresponding to different situations during which stress levels can vary, such as training or actual shooting conditions (Kayihan et al., 2013). In addition, the shooters' level influences anxiety. Thus, higher anxiety values having been reported in lower level shooters (Kayihan et al., 2013). Furthermore, decreases in performance have been reported under high anxiety, when compared with low anxiety conditions (Nieuwenhuys & Oudejans, 2010, 2011). Specifically, state anxiety can lead to a significant impairment in performance in Olympic shooting, as it influences the goal-directed attention of the shooters (Causer et al., 2011) and could be a differential element of the sport level (Spancken et al., 2021). Evidence suggests that anxiety caused by highly stressful conditions (competition) can cause differences in trigger times between novice and experienced athletes (Vickers & Lewinski, 2012). Anxiety can also importantly reduce the action time in police pistol shooting from the first shot. However, other studies report that an increase in the anxiety levels could increase the execution time in precision tasks (Nibbeling et al., 2014).

The activation level (defined as the change in the basal arousal level while performing a task) which is related to anxiety, was also found to be inversely correlated with performance in pistol shooting, as it decreases the total execution time, as well as the time intervals between shots (Vaez et al., 2011). High pressure-stress conditions have been also found to impair performance in police officers, causing changes in body position, in visual attention and in movement (trigger pulling) times (Nieuwenhuys & Oudejans, 2010, 2011). Also in skeet shooting, performance has been found to be influenced by anxiety, as changes have been detected in the movements of the shotgun, combined with increases in the amplitude/speed of the gun barrel displacements (Causer et al., 2011). On the other hand, training programs specially designed to minimize the effect of anxiety on parameters such as the ones mentioned above should be implemented to improve performance (Nieuwenhuys & Oudejans, 2011).

Additionally, physical condition has been related to shooting performance. Factors like the finger flexor or shoulder isometric abduction forces have been related directly to performance (Mon-López, Zakynthinaki, et al., 2019). However physical condition also seems to affect shooters psychologically. Thus, physical training could improve the mental wellness of the shooters and specifically their self-confidence depending on the experiences of each athlete (Mon-López, Moreira da Silva, et al., 2019).

Although it has been previously proved that anxiety affects shooting performance, there is controversy regarding the effect of this psychological variable on trigger time. Moreover, the number of studies that examine the effects of anxiety in female shooting is very limited. Consequently, the aim of this study was to analyze the effects of pre-competition anxiety on trigger time and performance in female pistol shooting at two different competition stages: the qualifying low-stress round and the highly stressful final competition.

Materials and Methods

Participants

Twenty-three female shooters aged 38.30 ± 12.40 years with an experience of 10.76 ± 8.18 years and 8.59 ± 7.67 hours of weekly training participated in this study. Data were collected during the sport pistol Spanish Olympic championship, which took place in Granada (Spain). As inclusion criteria, shooters must have had accredited a minimum score of 500 points in previous shooting sport pistol competitions (RFEDETO, 2014). From the total number of participants five belonged to the elite Spanish group and have scored 581 points once or 577 points two times in national/international events previously (RFEDETO, 2014). Participants who had suffered injuries during the last year and with less than one year of experience in the sport pistol modality were excluded from the study.

The possibility to voluntary participate in this study was offered to all competitors. The participation percentage was 95.83% (only one shooter denied). An informed consent was signed by all the participants before data collection. This study was approved by the ethics committee of the Polytechnic University of Madrid.

Materials and variables

The demographic and training questionnaire design was carried out by two professional coaches with more than five years of international experience independently. Later, both questionnaires were discussed by the two researchers until an agreement was reached. In case of discrepancy in any of the questions, one of the researchers acted as judge.

The final demographic and training questionnaire included the following variables: age (years), weekly training (hours), experience (years), injuries suffered during the last year, elite (yes or no) and self-perception of the competition importance (according to the athlete's annual competition program), performance level and physical condition (all in a Likert scale 1-10). Electronic targets (model Sius Ascor D941) were used to measure performance. The following performance variables were analysed during the qualification round: Precision stage score, rapid fire stage score, total performance (qualification total score, sum of the score obtained during the precision and the rapid-fire stage), triggering time (hundredths of a second), points average per shot. In addition, during the

final round only triggering time (hundredths of a second) and points average per shot were used due to the specific characteristics of the final shooting system.

Pre-competitive and competitive anxiety were evaluated using the Competitive State Anxiety Inventory-2 (CSAI-2) questionnaire in its Spanish version of Márquez (1992). This questionnaire was previously validated by Fernández et al. (2007) and used in different sports (Cervantes et al., 2009; Prados et al., 2011). CSAI-2 consists of 27 items with a Likert type scale from 1 (nothing) to 4 (a lot) and three subscales: somatic anxiety, cognitive anxiety and self-confidence. The reliability of the CSAI-2 questionnaire in our study was: somatic anxiety α = .705; cognitive anxiety α = .871 and self-confidence α = .913.

Procedure

The Spanish rules and regulations were followed throughout the entire competition (RFEDETO, 2014). All athletes were allowed to train in the official stand and targets, the day before the competition. All shooters competed with their own pistols, sportswear and supplementary material. The full questionnaire was given to all shooters ten minutes before the qualification rounds, starting close to their shooting stands. During the second phase of the study (the final round), only the eight athletes who were classified were asked to fill in the same questionnaire, again ten minutes before the competition start.

The competition consisted of: (1) qualification round, in which all participants took part, consisting of 60 shots divided in two stages (precision and rapid-fire shooting). This round begun with 6 series of five shots, where each series had to be fired in 5 minutes (precision shooting). Another 6 series of five shots followed, during which each shot had to be fired in 3 (up to 3.2) seconds (rapid fire), with a 7 (up to 7.1) seconds resting time between shots (the athletes had to lower their arm down at a 45° angle before firing each shot). Prior to each series the athletes were allowed to perform one series of five test shots (ISSF, 2020). (2) An Olympic rapid-fire final round where only 8 athletes participated (time allowed to shoot was equal as in the qualifying round), consisting of two stages: one semi-final and two finals (one for the gold medal and one for the bronze). The semi-final begun with 5 series of 5 shots. The top two athletes after the semi-final advanced to the gold medal match, while the 3rd and the 4th ranked athletes went to the bronze medal match. The principle adopted to assign points during the medal matches was hit or miss: a shot of 10.2 points or more counted as a hit, while a shot lower than 10.2 points counted as a miss. The competitors' performance was validated after the finals by the Spanish national committee of referees. Both points and trigger times were given by the electronic targets model Sius Ascor D941.

Statistical Analysis

The normal distribution of the variables was tested using the Shapiro-Wilk test. Since the variables did not fit the normal distribution, nonparametric tests were used. Wilcoxon signed-rank test were used to compare anxiety values and trigger times in the qualification and final rounds. In addition, according to (Rosenthal et al., 1994) , effect size was calculated for those comparison with statistical differences using $r = (Z/\sqrt{N})$ and with the following effect size ranges: small r = .10 to < .30; medium r = .30 to < .50 and large r = ≥ .50. Mann-Whitney U test was used to compare finalist and non-finalist shooters. The shooters' performance was calculated using linear regressions. The relations between somatic anxiety, cognitive anxiety and self-confidence and the rest of the variables were calculated using Pearson correlations. IBM SPSS Statistics software (Version 25.0. IBM Cor) was used to make the mathematical calculations. The level of significance was set to 0.05.

Additionally, in order to compare performance between the qualifying and the final rounds, only the score of the rapid-fire stage was taken into account (to avoid comparison of performance between events of unlike shots). Lastly, the statistical analysis of the present study included only the scores up to the semi-finals. Due to the small number of athletes that participated in the medal rounds (only four), these data were excluded from the analysis.

Results

Factors Affecting Performance depending on the stage.

The statistical analysis revealed that the qualification performance for all shooters was positively affected by the number of training hours, $F_{(1,21)}$= 5.28, p = .032, and that the age and performance were inversely correlated, $F_{(1,21)}$ = 12.35, p= .002. No statistically significant correlations were found between overall performance and the rest of the variables (p > .05). On the other hand, performance during the qualification rapid-fire stage was positively affected by the athletes' physical condition, $F_{(1,21)}$ = 4.80, p = .039, but not by any of the rest of the variables (p > .05). The performance of the precision stage was not found to be affected by any of the variables (p < .05).

Regarding the final (only the eight athletes classified), performance was found to be positively related to the perceived shooting status $F_{(1,6)}$ = 8.33, p = .028, the physical condition $F_{(1,6)}$ = 9.09, p = .024, as well as with training hours $F_{(1,6)}$ = 9.33, p = .022 and inversely related to age $F_{(1,6)}$ = 6.03, p = .049, and somatic anxiety $F_{(1,6)}$ = 8.93, p = .024.

Differences between finalists and non-Finalists

Total, precision stage and rapid-fire stage performances of the non-finalists during the qualifications round were not affected by any variable (p > .05). However, a tendency of negative correlation was found between performance and cognitive and somatic anxiety. Contrary, the finalists' total performance during the qualifications round was found to be affected by their perceived shooting status, $F_{(1,6)}$ = 7.89, p = .031, as well as the physical condition, $F_{(1,6)}$ = 6.40, p = .045. During the precision stage, finalists' performance were affected by shooting status, $F_{(1,6)}$ = 16.9, p = .006, while during the rapid fire stage performance was not affected by any variables (p > .05).

Differences were found between finalists and non-finalists in their total performance Z = -3.78, p < .001, their performance during the precision, Z = -3.10, p = .002, and the rapid-fire round, Z = -3.72, p < .001. Differences were also found regarding their age, Z = -2.66, p = .007. No differences were found between finalists and non-finalists regarding the rest of the variables (p > .05).

Differences Between Final and Qualification Rounds

For the 8 finalists, performance during rapid fire shooting as well as self-confidence was significantly lower in the final round than in the qualification round (Z = -1.97, p = .049).

Trigger times and cognitive anxiety were on the contrary increased during the final round (Z = 2.17, p = .030 and Z = 2.37, p = .018, respectively). No significant differences were found in somatic anxiety before entering the finals (p > .05) Table 1.

Table 1. Cognitive anxiety somatic anxiety selfconfidence trigger time and performance during qualifying and final rounds

	Qualifying		Final				Effect size
Variable	*M*	*SD*	*M*	*SD*	*z*	*p*	*r*
Cognitive anxiety	27.99	18.22	42.55	26.53	2.37	.018	.83
Somatic anxiety	43.92	12.88	51.34	15.63	1.63	.102	
Self-confidence	59.84	18.29	49.95	26.09	-1.97	.049	.69
Trigger time	2.74	0.12	2.84	0.07	2.17	.030	.76
Performance	9.42	0.19	9.29	0.21	-1.97	.049	.69

Notes. M = mean; SD = standard deviation Z = z-score; p = level of significance r = effect size

Correlations between cognitive anxiety, somatic anxiety, self-confidence and the rest of the variables

During the qualifications round, self-confidence was found to be positively related to physical condition (r^2 = .17, p = .025). Score and somatic anxiety were negatively related to precision stage performance (r^2 = .13, p = .047) for the whole group of athletes. In addition, negative relations were found for the non-finalists between cognitive anxiety and perceived competition (r^2 = .23, p = .036) and precision stage performance with both cognitive (r^2 = .24, p = .031) and somatic anxiety (r^2 = .24, p = .031). No statistically significant correlations were found between anxiety or self-confidence and the rest of the variables (p > .05) (see Table 2).

Table 2. Correlations between cognitive anxiety, somatic anxiety, self-confidence and the rest of the variables during the qualifications round.

	All shooters			Non-finalists			Finalists		
Variable	CA	SA	SC	CA	SA	SC	CA	SA	SC
Age	.07	.14	.00	.22	.11	.08	-.05	-.19	-.11
Competition Importance	-.06	.02	.18	-.48*	-.27	.25	.34	.36	.11
Shooting status	-.05	.04	.27	-.29	.08	.20	.16	.14	.38
Physical condition	-.02	.09	.41*	.07	.31	.35	-.13	-.11	.61
Experience	-.08	-.10	-.01	-.25	-.20	-.03	.20	.02	.05
Training hours	-.14	-.13	.23	-.36	-.24	.10	-.06	.08	.34
Score in precision stage	-.12	-.36*	.18	-.49*	-.49*	.30	.26	.24	.06
Score in rapid-fire stage	.01	-.13	.00	.02	.10	-.17	.09	.12	.31
Total performance	-.06	-.27	.10	-.36	-.30	.10	.21	.21	.20

CA = cognitive anxiety; SA = somatic anxiety; SC = self-confidence * p < .05

Concerning the final round, the statistical analysis of the 8 finalists (see Table 3) revealed a negative correlation between somatic anxiety and perceived shooting status (r^2 = .50, p = .025), physical condition (r^2 = .71, p = .004), number of training hours (r^2 = .53, p = .020) and average score during the finals (r^2 = .59, p = .012). However, self-confidence was found to be positively related to perceived shooting status (r^2 = .56, p = .017), physical condition (r^2 = .64, p = .009) and average score during the finals (r^2 = .49, p = .027).

Table 3. Correlations between anxiety, self-confidence and the rest of the variables during the finals

Variable	Cognitive anxiety	Somatic anxiety	Self-confidence
Age	.20	.52	-.29
Competition Importance	-.19	-.47	.44
Shooting perceived status	-.36	-.71*	.75*
Percieved physical condition	-.55	-.84**	.80**
Experience	.17	.27	.02
Training	-.43	-.73*	.47
Average Score	-.32	-.77*	.70*

* p < .05; ** p < .01

Discussion

The results showed that, during the qualifications round, the shooters' performance was not affected by pre-competitive anxiety, although a tendency of inverse correlation could be observed between performance and somatic/cognitive anxiety, which is in accordance with the existing literature (Bueno et al., 2002; Kais & Raudsepp, 2005; Mullen et al., 2005). However, this inverse correlation between performance and anxiety became statistically significant during the final stages of the competition.

It was also observed that the participating female shooters had medium to high levels of cognitive/somatic anxiety and self-confidence. Interestingly, the high anxiety values were not registered, as is usually the case in other types of sports (Cervantes et al., 2009). Despite the high levels of anxiety, the self-confidence of the athletes was high, and this could explain the high-performance levels of these female shooters. Similar results were also reported in the study of Prados et al. (2011) where high-level gymnasts showed higher levels of anxiety than lower levels gymnasts, but also higher levels of self-confidence.

Our results also showed an increase in the cognitive anxiety levels and a decrease in self-confidence for the shooters qualified for the final round. This is a fact that could be related to the importance of the forthcoming final round. Shooting-specific studies refer to the possibility of activation-anxiety bands that could determine performance. It has been suggested that the theory of Individual Zones of Optimal Functioning (IZOF) is also valid in Olympic shooting (Bertollo et al., 2012). Furthermore, these psychological changes will depend on how the shooter interprets its (like something positive or negative) (Moreira da Silva et al., 2021), which can be different between athletes (Athan & Sampson, 2013). Additionally, the state anxiety could be a differential element between the sport level of the athletes (Spancken et al., 2021)

The results of the present study also revealed that the trigger time was also influenced by anxiety, in accordance with other studies where differences in trigger time related to the athletes' experience were observed under anxiety conditions (Vickers & Lewinski, 2012). However, in the study of Vickers and Lewinski (2012) the actions were reported to be accelerated, thus leaving the trigger time unchanged; also in the studies of (Nieuwenhuys & Oudejans, 2010, 2011) the trigger times were found to be reduced under high stress conditions.

Our results are in accordance with the study of Nibbeling et al. (2014) where a delay in the trigger pull was also reported. These differences could be due to the differences in the way points were assigned during the qualifications round (sum of series of shots without decimal points) as well as during the finals (hit of 10.2 points or miss), which could be pressing the athletes to work outside their individual trigger time, decreasing their performance. Similarly the changes in anxiety levels between the different competition stages could be the reason for the slowing down of the action; the study of Causer et al. (2011) also reports that anxiety situations decrease the ability to fix attention on a goal, thus decreasing performance. Additionally, the perceived state of self-control is reduced with the number of shots performed (final stage is after the qualifying round) and this lower perceived state self-control could explain partly the decrease in shooting performance (Englert et al., 2021). Consequently, to reduce the negative effects of anxiety, coaches should implement coping interventions (Kent et al., 2018), specific training programs (Nieuwenhuys & Oudejans, 2011) and the use of professional psychological support (Moreira da Silva et al., 2021). In this line, mindfulness techniques could improve shooting performance (Josefsson et al., 2020).

Regarding the importance of the athletes' physical condition, the results of the present study are in accordance with other studies (Gulbinskienė & Skarbalius, 2009; Mon et al., 2015). In this line, the perceived physical condition has been found to be positively correlated with somatic anxiety as well as self-confidence. Accordingly, existing studies have pointed out that physical condition (Mon-López, Moreira da Silva, et al., 2019) and shooting perceived status (Hanton et al., 2008) could influence the self-confidence for the finalist

shooters. For this reason, it seems logical to recommend physical condition programs (Krasilshchikov et al., 2007).

The present study is based on data recorded during a very important shooting competition (a Spanish championship qualifying for international competitions), a fact that highlights the importance of the results. In addition, it should be mentioned that the number of studies in Olympic shooting that are based on data recorded under real competition conditions is very limited (Ihalainen et al., 2017; Mon, Zakynthinaki, Cordente, Barriopedro, et al., 2014; Mon, Zakynthinaki, Cordente, Monroy Antón, et al., 2014). However, even though the 95% of the shooters participated in the study, the sample is very limited, especially concerning the final data (registered from only eight shooters). This imposes limitations on the statistical power of our results and futures studies should be contacted using larger samples. In addition, due the controversy regarding the trigger time, future studies should confirm the anxiety effect on the rapid-fire stage in female sport pistol, or even in other shooting modalities where there is a time limitation to shoot.

Conclusions

The results of the present study revealed that high levels of pre-competition anxiety can cause a decrease in performance in female sport pistol, as well as changes in the shooting time. In addition, performance and self-confidence was found to decrease, while cognitive anxiety and trigger time was found to increase during the final round when compared to the qualifying round. As a practical application, coaches should apply appropriate programs to reduce anxiety levels and to improve the shooting time during the different parts of the competition. Therefore, programs of activation control techniques (Bueno et al., 2002; Kais & Raudsepp, 2005; Mullen et al., 2005), coping interventions (Kent et al., 2018), specific training programs (Nieuwenhuys & Oudejans, 2011) and professional psychological support (Moreira da Silva et al., 2021) should be included in Olympic shooting.

References

Athan, A., & Sampson, U. (2013). Coping with pre-competitive anxiety in sports competition. *European Journal of Natural and Applied Sciences*, *1*(1), 1-9.

Bertollo, M., Robazza, C., Falasca, W. N., Stocchi, M., Babiloni, C., Del Percio, C., Marzano, N., Iacoboni, M., Infarinato, F., & Vecchio, F. (2012). Temporal pattern of pre-shooting psycho-physiological states in elite athletes: A probabilistic approach. *Psycholoy of Sport and Exercise*, *13*(2), 91-98. 10.1016/j.psychsport.2011.09.005

Bueno, J., Capdevila, L., & Fernández-Castro, J. (2002). Sufrimiento competitivo y rendimiento en deportes de resistencia. *Revista de Psicología del Deporte*, *11*(2), 209-226.

Causer, J., Holmes, P. S., Smith, N. C., & Williams, A. M. (2011). Anxiety, movement kinematics, and visual attention in elite-level performers. *Emotion*, *11*(3), 595-602. https://doi.org/10.1037/a0023225

Cervantes, J. C., Rodas, G., & Capdevila, L. (2009). Perfil psicofisiológico de rendimiento en nadadores basado en la variabilidad de la frecuencia cardíaca y en estados de ansiedad precompetitiva. *Revista de Psicología del Deporte*, *18*, 0037-0052.

Englert, C., Dziuba, A., Wolff, W., & Giboin, L.-s. (2021). An investigation of the effects of self-reported self-control strength on shooting performance. *Psychology of Sport and Exercise*, *52*, 101839. https://doi.org/10.1016/j.psychsport.2020.101839

Fernández, E. M. A., Río, G. L., & Fernández, C. A. (2007). Propiedades psicométricas de la versión española del Inventario de Ansiedad Competitiva CSAI-2R en deportistas. *Psicothema*,*19*(1), 150-155.

Gulbinskienė, V., & Skarbalius, A. (2009). Peculiarities of investigated characteristics of lithuanian pistol and rifle shooters´ training and sport performance. *UGDYMAS KÛNO KULTÛRA*, *73*(2), 21-27. https://doi.org/10.33607/bjshs.v2i73.433

Hanton, S., Neil, R., Mellalieu, S. D., & Fletcher, D. (2008). Competitive experience and performance status: An investigation into multidimensional anxiety and coping. *European journal of sport science*, *8*(3), 143-152. https://doi.org/10.1080/17461390801987984

Hawkins, R. (2011). Identifying mechanic measures that best predict air-pistol shooting performance. *International Journal of Performance Analysis in Sport*, *11*(3), 499-509. https://doi.org/10.1080/24748668.2011.11868568

Ihalainen, S., Mononen, K., Linnamo, V., & Kuitunen, S. (2017). Which technical factors explain competition performance in air rifle shooting? *International Journal of Sports Science & Coaching*, *13*(1), 78-85. https://doi.org/10.1177/1747954117707481

ISSF. (2020). General Technical Rules. ISSF.

Josefsson, T., Gustafsson, H., Rostad, T. I., Gardner, F. L., & Ivarsson, A. (2020). Mindfulness and shooting performance in biathlon. A prospective study. *European journal of sport science*, 1-20. https://doi.org/10.1080/17461391.2020.1821787

Kais, K., & Raudsepp, L. (2005). Intensity and direction of competitive state anxiety, self-confidence and athletic performance. *Kinesiology*, *37*(1), 13-20.

Kayihan, G., Ersoz, G., Özkan, A., & Mitat, K. (2013). Relationship between efficiency of pistol shooting and selected physical-physiological parameters of police. *Policing*, *36*(4), 819-832. 10.1108/PIJPSM-03-2013-0034

Kent, S., Devonport, T. J., Lane, A. M., Nicholls, W., & Friesen, A. P. (2018). The effects of coping interventions on ability to perform under pressure. *Journal of sports science & medicine*, *17*(1), 40.

Krasilshchikov, O., Zuraidee, E., & Singh, R. (2007). Effect of general and auxiliary conditioning on specific fitness of young pistol and rifle shooters. *Asian Journal of Exercise & Sports Science*, *4*, 01-06.

Lakie, M. (2010). The influence of muscle tremor on shooting performance. *Experimental Physiology*, *95*(3), 441-450.

Márquez, S. (1992). Adaptación española de los cuestionarios de antecedentes, manifestaciones y consecuencias de la ansiedad ante la competición deportiva. I. Estructura factorial. *Revista de Psicología del Deporte*,

Mon-López, D., Moreira da Silva, F., Calero Morales, S., López-Torres, O., & Lorenzo Calvo, J. (2019). What Do Olympic Shooters Think about Physical Training Factors and Their Performance? *International journal of environmental research and public health*, *16*(23), 4629. 10.3390/ijerph16234629

Mon-López, D., Tejero-González, C., & Calero, S. (2019). Recent changes in women's Olympic shooting and effects in

performance. *PLoS ONE*, *14*(5), e0216390. https://doi.org/10.1371/journal.pone.0216390

Mon-López, D., Zakynthinaki, M. S., Cordente, C. A., & García-González, J. (2019). The relationship between pistol Olympic shooting performance, handgrip and shoulder abduction strength. *Journal of Human Kinetics*, *69*, 7. https://doi.org/10.2478/hukin#2019#0009.

Mon, D., Zakynthinaki, M. S., Cordente, C. A., Antón, A. J. M., Rodríguez, B. R., & Jiménez, D. L. (2015). Finger Flexor Force Influences Performance in Senior Male Air Pistol Olympic Shooting. *PLoS ONE*, *10*(6), e0129862. https://doi.org/10.1371/journal.pone.0129862

Mon, D., Zakynthinaki, M. S., Cordente, C. A., Barriopedro, M. I., & Sampedro, J. (2014). Body sway and performance at competition in male pistol and rifle Olympic shooters. *Bio Hum Kinetics*, *6*, 56-62. https://doi.org/10.2478/bhk-2014-0010

Mon, D., Zakynthinaki, M. S., Cordente, C. A., Monroy Antón, A., & López Jiménez, D. (2014). Validation of a Dumbbell Body Sway Test in Olympic Air Pistol Shooting. *PLoS ONE*, *9*(4), e96106. https://doi.org/10.1371/journal.pone.0096106

Moreira da Silva, F., Malico Sousa, P., Pinheiro, V. B., López-Torres, O., Refoyo Roman, I., & Mon-López, D. (2021). Which Are the Most Determinant Psychological Factors in Olympic Shooting Performance? A Self-Perspective from Elite Shooters. *International journal of environmental research and public health*, *18*(9), 4637. https://doi.org/10.3390/ijerph18094637

Mullen, R., Hardy, L., & Tattersall, A. (2005). Sport psychology. *Journal of Sport Exercise & Psychology*, *27*, 212-225.

Nibbeling, N., Oudejans, R. R., Ubink, E. M., & Daanen, H. A. (2014). The effects of anxiety and exercise-induced fatigue on shooting accuracy and cognitive performance in infantry soldiers.*Ergonomics*, *57*(9), 1366-1379. 10.1080/00140139.2014.924572

Nieuwenhuys, A., & Oudejans, R. R. (2010). Effects of anxiety on handgun shooting behavior of police officers: a pilot study. *Anxiety Stress Coping*, *23*(2), 225-233. 10.1080/10615800902977494

Nieuwenhuys, A., & Oudejans, R. R. (2011). Training with anxiety: short-and long-term effects on police officers' shooting behavior under pressure. *Cognitive Processing*, *12*(3), 277-288. 10.1007/s10339-011-0396-x

Ortega, F. Z., Fernández, S. R., Extremera, M. O., Sánchez, M. C., Cuberos, R. C., & González, M. d. M. C. (2017). Análisis de la resiliencia, ansiedad y lesión deportiva en fútbol según el nivel competitivo. *Cultura, ciencia y deporte*, *12*(35), 135-142. http://dx.doi.org/10.12800/ccd.v12i35.885

Pellegrini, B., & Schena, F. (2005). Characterization of arm-gun movement during air pistol aiming phase. *J Sport Med Phys Fit*, *45*(4), 467-475.

Prados, J. A. L., García, I. F., & Lluch, Á. C. (2011). Ansiedad estado y autoconfianza precompetitiva en gimnastas. *Rev Int Cienc Deporte*, *7*(23), 76-91. 10.5232/ricyde2011.02301

Reinkemeier, H., Bühlmann, G., & Konietzny, A. (2006). Tiro olímpico con pistola: Técnica · Entrenamiento · Táctica · Preparación Psicológica · Armas. MEC High Tech Shooting Equipment. http://books.google.es/books?id=ohAWMwAACAAJ

RFEDETO. (2014). Reglamento Técnico General para todas las Modalidades de Tiro. Real Federación Española de Tiro Olímpico. http://www.tirolimpico.org/apps/displayFile/es/RFEDETO/public/pages/normativas-y-reglamentos.cms_xhtml

Rosenthal, R., Cooper, H., & Hedges, L. (1994). Parametric measures of effect size. The handbook of research synthesis, 621(2), 231-244.

Spancken, S., Steingrebe, H., & Stein, T. (2021). Factors that influence performance in Olympic air-rifle and small-bore shooting: A systematic review. *PLoS ONE*, *16*(3), e0247353. https://doi.org/10.1371/journal.pone.0247353

Vaez, S., Naji, M., Hassanzadeh, N., & Esmaeilpour Marandi, H. (2011). Arousal and activation in a pistol shooting task. *Mil Med*, *12*(4), 185-190.

Vickers, J. N., & Lewinski, W. (2012). Performing under pressure: Gaze control, decision making and shooting performance of elite and rookie police officers. *Hum Mov Sci*, *31*(1), 101-117. 10.1016/j.humov.2011.04.004

CULTURA, CIENCIA Y DEPORTE

Valoración del aprendizaje técnico del voleibol mediante la metodología observacional por pares en estudiantes universitarios

Assessment of Volleyball Technical Learning Using Peer Observational Methodology in University Students

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Resumen

El Espacio Europeo de Educación Superior defiende metodologías formativas para que los alumnos aprendan a aprender. El objetivo del estudio es conocer la valoración del alumnado sobre el proceso de enseñanza-aprendizaje de la técnica deportiva de voleibol mediante la metodología observacional por pares. Participaron 215 alumnos del Grado de Ciencias de la Actividad Física y el Deporte en la asignatura de segundo curso "Deportes colectivos de colaboración-oposición" durante los cuatro cursos comprendidos entre 2015 y 2019. Los estudiantes de cada curso se distribuyen en grupos de prácticas diferentes presentando una formación inicial en el ámbito del voleibol diversificada, aunque con todos se realizó la misma intervención en el bloque temático del voleibol durante el primer trimestre. Se ha realizado un estudio de carácter descriptivo en el que se ha calculado la tendencia central y la dispersión. Se ha realizado la comparación de grupos mediante pruebas de MANOVA. Se ha utilizado la escala validada (Álvarez et al., 2020) de evaluación del proceso Enseñanza de la Técnica Deportiva por Pares en la Educación Superior. Los alumnos valoran muy positivamente el proceso de enseñanza-aprendizaje obteniendo medias entre 4.00 y 4.50 sobre 5.00. La intervención tuvo efectos en la valoración de los alumnos obteniendo diferencias significativas en escala total y factores: diseño, fases, metodología y observación, permitiendo al profesorado mejorar el proceso de enseñanza-aprendizaje de la técnica deportiva del voleibol.

Palabras clave: Metodologías activas, enseñanza por pares, aprendizaje cooperativo, proceso enseñanza-aprendizaje, educación superior.

Abstract

The European Higher Education Area defends training methodologies so that students learn to learn. The objective of the study is to know the assessment of the students about the teaching-learning process of the volleyball sports technique through the observational methodology by pairs. 215 students of the Degree in Physical Activity and Sports Sciences participated in the second-year subject "Collaborative-opposition collective sports" during the four years between 2015 and 2019. The students of each course are divided into different practice groups presenting a diversified initial training in the field of volleyball, although the same intervention was carried out with all of them in the thematic block of volleyball during the first trimester. A descriptive study has been carried out in which the central tendency and dispersion have been calculated. The groups were compared using MANOVA tests. The validated scale (Álvarez et al., 2020) has been used to evaluate the process of Teaching Sports Technique by Peers in Higher Education. The students value the teaching-learning process very positively, obtaining averages between 4.00 and 4.50 out of 5.00. The intervention had effects on the evaluation of the students, obtaining significant differences in total scale and factors: design, phases, methodology and observation, allowing teachers to improve the teaching-learning process of volleyball sports technique.

Keywords: Active methodologies, peer teaching, Cooperative learning, Teaching learning process, higher education.

Introducción

El Espacio Europeo de Educación Superior (EESS) exige una renovación pedagógica y apuesta por un modelo basado en un tipo de aprendizaje en el que, la metodología fundamental del proceso formativo, permita al estudiante aprender a aprender mediante la adquisición de competencias para el aprendizaje permanente y constructivo (Chiva-Bartoll et al., 2018; Gargallo-López et al., 2020). Esta renovación pedagógica supone un cambio fundamental en el tipo de aprendizaje que deben recibir los alumnos universitarios en la actualidad (Muñoz-San Roque et al., 2016).

Se ha demostrado que el aprendizaje cooperativo entre alumnos es de gran utilidad en la enseñanza de las habilidades técnicas deportivas, siendo posible su aplicación en cualquiera de los diferentes niveles educativos: primaria, secundaria, ciclos formativos, enseñanzas superiores (Gómez & Gil, 2018; Otero et al., 2014; Salmerón, 2013). El aprendizaje cooperativo se entiende como una estructura de trabajo en la que las decisiones del alumnado están supeditadas a las directrices y condiciones establecidas por el docente (Gómez & Gil, 2018). Boud (2010) manifiesta que el aprendizaje de los estudiantes es mayor, si junto a los profesores, se convierten en socios responsables del aprendizaje y van asumiendo la responsabilidad de los procesos de enseñanza-aprendizaje (EA) y desarrollando la capacidad para juzgar la calidad de su propio trabajo, así como el de los otros, según unas normas acordadas. Este aprendizaje cooperativo conlleva una reestructuración de la configuración de la enseñanza por modelos de aprendizaje más autónomos y reflexivos en los que cambian las relaciones alumno-profesor y alumno-alumno. Estos modelos de aprendizaje son el punto de inflexión que cambia el foco de la clase de la enseñanza del docente, al aprendizaje del alumnado, donde el profesor facilita el éxito del proceso y el alumno es protagonista directo y activo (Cañadas et al., 2018; del Arco-Bravo et al., 2019; Izquierdo, 2019; Vera-Lacarcel et al., 2008).

La investigación educativa debe ser una actividad científica y, por tanto, formal, sistemática, controlada, empírica y objetiva, además debe poseer los atributos del método científico (Tejedor, 2014). Su objetivo básico debe aportar explicaciones razonables de los hechos o fenómenos estudiados, a fin de contribuir a la creación de un cuerpo coherente de conocimientos, orientados a producir la información necesaria para mejorar la acción educativa (Tejedor, 2018). Toda intervención debe ser evaluada de manera objetiva, siendo el cuestionario el instrumento más utilizado para ello (Otero et al., 2014). La mayoría de los cuestionarios deben diseñarse "ad hoc" por las particularidades de cada investigación (León et al., 2017; Villardón-Gallego et al., 2013).

Son diversos los estudios que se centran en estudiar los beneficios y bondades de incorporar, en los procesos de enseñanza-aprendizaje, metodologías participativas y cooperativas. Del Arco et al. (2019), con el objetivo de conocer el efecto del método de enseñanza denominado clase invertida valida un cuestionario formado por cuatro dimensiones: el cambio de rol docente y discente, la integración de las TIC en el proceso de enseñanza-aprendizaje, el desarrollo del proceso de evaluación propuesto y finalmente, el desarrollo de la autonomía. Izquierdo et al. (2019) construye un cuestionario para medir el aprendizaje cooperativo en la formación de maestros de Educación Primaria. Muñoz-San Roque et al. (2016) validan un cuestionario para medir la autopercepción del nivel de desarrollo de la competencia de aprender a aprender. Gómez y Gil (2018) estudian el estilo de aprendizaje y su relación con la educación entre pares estableciendo cuatro objetivos: analizar las propiedades psicométricas de las puntuaciones del instrumento de medida de las características del compañero tutor; analizar el estilo de aprendizaje predominante del alumnado de la ESO; analizar las respuestas de este alumnado en relación a la educación entre iguales; y contrastar la relación entre el estilo de aprendizaje de este alumnado y sus respuestas relativas al compañero tutor. En definitiva, se analiza la importancia de dar valor al grupo en aras de la promoción de la motivación que contribuya al fomento de los procesos de intercambio de conocimientos entre los estudiantes.

La necesidad de hacer partícipe y protagonista del proceso de enseñanza-aprendizaje al alumnado a través de metodologías activas y participativas, obliga a investigar sobre la evaluación de este estilo de enseñanza, para lo que se construyó y validó un cuestionario ad hoc con el objetivo de evaluar el Proceso de Enseñanza Aprendizaje de la Técnica Deportiva por Pares en la Enseñanza Superior (Etepes) (Álvarez et al., 2020) formado por seis dimensiones: diseño; fases; aprendizaje autónomo; metodología; observación; conocimientos previos.

Así, el objeto de estudio de esta investigación es conocer la valoración del alumnado sobre el proceso de enseñanza-aprendizaje de la técnica deportiva del voleibol, basado en la metodología observacional por pares llevada a cabo en la Educación Superior en el Grado de Ciencias de la Actividad Física y del Deporte que permita mejorar el mismo.

La hipótesis de investigación responde a que los estudiantes participantes en la enseñanza del voleibol mediante la metodología observacional por pares perciben de forma positiva y eficaz el aprendizaje de la técnica deportiva.

Método

Participantes

Estudio cuasiexperimental longitudinal-transversal con medidas pre y post intervención. Participaron 215 alumnos del Grado de Ciencias de la Actividad Física y el Deporte de la Universidad de Zaragoza, todos matriculados en la asignatura anual de segundo curso "Deportes colectivos de colaboración-oposición" (asignatura obligatoria de 9 créditos) durante los cursos 2015/2016, 2016/2017, 2017/2018 y 2018/2019, impartida en los cuatro años por el mismo profesor el cual es el responsable de la asignatura desde el año 2000.

Los alumnos de cada curso corresponden a un grupo:

- Grupo 1: 2015/2016, 54 alumnos.
- Grupo 2: 2016/2017, 53 alumnos.
- Grupo 3: 2017/2018, 54 alumnos.
- Grupo 4: 2018/2019, 54 alumnos.

El 28.80% de los estudiantes son de género femenino y el 71.20% de género masculino. La edad media es de 20 años.

Instrumento

Se ha utilizado la escala de evaluación del proceso enseñanza de la técnica deportiva por pares en la educación superior "Etepes" (Álvarez et al., 2020). El instrumento está compuesto por seis dimensiones *(Diseño*, *Fases*, *Aprendizaje*, *Metodología*, *Observación y Conocimientos previos)* y 21 ítems, con una fiabilidad medida con alfa de Cronbach de .91 en la prueba inicial y .94 en la prueba final. La escala es de tipo Likert, oscilando entre 1 y 5 (1= totalmente de acuerdo; 5=totalmente en desacuerdo).

Procedimiento

El trabajo de campo se realizó mediante un cuestionario a través de Google Forms con presencia del encuestador antes y al final del programa de intervención. Se solicitó a los participantes que lo cumplimentaran y que consultaran cualquier duda que tuvieran con los ítems. El tiempo invertido en la realización fue de unos 10 minutos cada vez. Los criterios de exclusión fueron:

- No haber realizado alguno de los test (pre-post).
- Haber faltado a más de un 10% de la intervención educativa.

La universidad de origen de la investigación avaló el proceso a través de su aceptación dentro de los programas de Innovación Docente de la Universidad de Zaragoza.

Durante todo el estudio se garantizó el anonimato de las respuestas en cumplimiento de las normas éticas de investigación del Código de Buenas Prácticas en Investigación de la Universidad de Zaragoza (2018), administrando y siendo aceptado por los participantes el correspondiente consentimiento informado para participar en el estudio.

Intervención

La intervención se ha realizado a través de la metodología observacional por pares, en el bloque temático del voleibol durante el primer trimestre de cada curso en el que los estudiantes trabajan juntos para mejorar su propio aprendizaje y el de su pareja. Es necesario tener en cuenta que en el proceso de EA de una modalidad como el voleibol, con respuestas inciertas y abiertas, el deportista debe ser capaz de atender primero a los mecanismos de percepción y de decisión para acabar con el mecanismo de ejecución "fundamento técnico-táctico utilizado" (Marteniuk, 1976), eso supone mucho más tiempo de práctica para dominar los tres mecanismos de intervención motora que se dan prácticamente de manera simultánea (Álvarez, 2011). Es clave adaptar constantemente este contexto cambiante para facilitar la mejora global del alumno, facilitando la interpretación del juego y su disfrute. La observación directa e indirecta de todo este proceso y su análisis y corrección posterior ayuda al alumno a asimilar mejor y antes su aprendizaje técnico-táctico y el de su pareja.

La intervención quedó compuesta por 14 sesiones presenciales y dos no presenciales utilizando un modelo pedagógico conocido como "aula invertida" que transfiere el conocimiento teórico fuera del aula y permite utilizar el tiempo de clase para facilitar la adquisición y práctica de conocimientos (del Arco-Bravo et al., 2019). Este modelo pedagógico permite al alumno ser el protagonista de su aprendizaje y a partir de unas orientaciones iniciales del docente sea capaz de aprender de forma autónoma gracias a la observación y el análisis, en este caso de la técnica deportiva del voleibol, siempre bajo la supervisión y guía del profesor responsable.

Las fases de este proceso pedagógico fueron:

1. *Formación inicial teórico-práctica.*

   En las ocho primeras clases, cuatro teóricas y cuatro prácticas, se enseñan los fundamentos técnico-tácticos, así como los errores más comunes bajo las directrices del profesor.
2. *Diseño autónomo de la hoja de observación (supervisado por el profesor).*
3. *Aplicación de la hoja de observación directa y grabación.*

   En la clase práctica cinco se realiza el análisis de observación directa de los fundamentos técnico-tácticos y grabación por parte de los alumnos.
4. *Aplicación de la hoja de observación indirecta a través de la grabación.*

   En el seminario uno los alumnos realizan esta observación en el laboratorio.
5. *Diseño autónomo de tareas de corrección (supervisada por el profesor).*
6. *Aplicación de tareas de corrección.*

   En la clase práctica seis y siete, los alumnos aplican las tareas de corrección diseñadas por ellos a su pareja.
7. *Segunda aplicación de la hoja de observación directa y grabación.*

   En la clase práctica ocho se realiza el análisis de observación directa de los fundamentos técnico-tácticos y grabación por parte de los alumnos.
8. *Segunda aplicación de la hoja de observación indirecta a través de la grabación y evaluación del proceso.*

   En el seminario dos los alumnos realizan esta observación en el laboratorio y valoran el proceso.

Se han determinado cuatro grupos diferentes formados por los alumnos matriculados en segundo curso en la asignatura en los últimos cuatro cursos (grupo 1: 2015/2016; grupo 2: 2016/2017; grupo 3: 2017/2018; grupo 4: 2018/2019). A cada uno se le aplicó un proceso formativo diferente, diferenciándose por la formación previa y las modificaciones realizadas en el proceso. La formación previa corresponde a si en el primer curso han utilizado este tipo de metodología observacional por pares y las modificaciones corresponden al intento de mejora del proceso realizado, teniendo en cuenta los resultados obtenidos en las intervenciones anteriores, ya que la mejor investigación educativa será aquella que contribuya a mejorar la práctica (Tejedor, 2018). Siguiendo a Gessa (2011), un programa se debe juzgar en términos de su efectividad para ayudar al profesorado a maximizar el aprendizaje del alumnado, debe ser un punto de partida para la toma de decisiones, gracias a la retroalimentación obtenida a partir de los resultados, que ayuden a mejorar el proceso. La formación inicial puede tener repercusiones en la toma pre y las modificaciones del proceso en la toma post intervención.

Los grupos quedaron de la siguiente forma:

Grupo 1:

- Formación previa: los alumnos en primer curso no han recibido formación previa específica sobre la metodología observacional por pares antes de la intervención.

- Modificaciones: no hay al ser el primer grupo que realiza el proceso.

Grupo 2:

- Formación previa: los alumnos han recibido formación previa en la asignatura de primer curso de "Actividades acuáticas", concretamente en la enseñanza de estilos de natación a través de la metodología observacional por pares. La hoja de observación en esta asignatura se les da hecha.

- Modificaciones: en cuanto al análisis de la técnica deportiva a través de la observación indirecta en laboratorio se sugiere el uso de programas como "Kinovea" de descarga gratuita a través de la red.

Grupo 3:

- Formación previa: los alumnos han recibido la misma formación previa que el grupo 2.

- Modificaciones: desde el inicio de curso los alumnos tienen clara la fundamentación teórica, los objetivos y el proceso que se va a llevar a cabo gracias a la lectura de un documento explicativo en formato de artículo científico. Además, en el proceso realizado se le da más importancia a la adecuada construcción de la hoja de observación y a la observación indirecta a través del programa Kinovea explicado en el laboratorio. Por último se les explica a los alumnos las diferencias del aprendizaje en modalidades eminentemente técnicas y sin variaciones en el entorno, como la natación, y en deportes colectivos en cuestiones de mecanismos de ejecución motriz y tiempo necesario para el aprendizaje. El objetivo de esta intervención es que entiendan las fases del proceso y las apliquen siendo conscientes desde el principio de que el tiempo dedicado es insuficiente.

Grupo 4:

- Formación previa: los alumnos han recibido la misma formación previa que el grupo 2 y 3.

- Modificaciones: ninguna, no se realiza ninguna modificación diferente al grupo 3.

Análisis de datos

Se utilizó el paquete estadístico de SPSS versión 22. Se ha realizado un estudio de carácter descriptivo en el que se ha calculado la tendencia central (a través de la media) y la dispersión (con la desviación estándar). Se ha realizado la comparación de grupos mediante pruebas de MANOVA. La *d* de Cohen se utilizó para calcular los tamaños del efecto. El nivel de significación se estableció en $p < 0.05$.

Resultados

Los resultados de la efectividad de la intervención relativa al proceso enseñanza de la técnica deportiva por pares en estudiantes universitarios se muestran en la tabla 1. El efecto de interacción (Grupo x Tiempo) resultó ser significativo en la escala total (ETEPES) ($p < .001$, $Eta^2 = .108$) y en sus factores Diseño ($p < .05$, $Eta^2 = .052$), Fases ($p < .05$, $Eta^2 = .051$), Metodología ($p < .05$, $Eta^2 = .064$) y Observación ($p < .05$, $Eta^2 = .034$). Los resultados del grupo 1, tanto en el pre-test como en post-test han sido inferiores al resto de grupos. Los grupos 3 y 4 han tenido valoraciones más altas que el resto de grupos.

Tabla 1. Efectividad de la intervención en el proceso de enseñanza de la técnica deportiva por pares en estudiantes universitarios

Constructo	Grupo	Pre Media±*SD*	Post Media±*SD*	Cambio durante la intervencón	Efecto Grupo x tiempo *p*	*Eta*^{2}
ETEPES	1	3.89 ± .66	3.75 ± .83	▼0.14	.000	.108
	2	4.16 ± .37	3.94 ± .44	▼0.22		
	3	4.34 ± .36	4.32 ± .37	▼0.02		
	4	4.35 ± .37	4.40 ± .31	▲0.05		
DISEÑO	1	4.08 ± .83	3.95 ± .92	▼0.13	.011	.052
	2	4.45 ± .41	4.18 ± .49	▼0.27		
	3	4.49 ± .37	4.47 ± .37	▼0.02		
	4	4.52 ± .37	4.52 ± .35	=		
FASES	1	4.04 ± .87	3.88 ± .92	▼0.16	.011	.051
	2	4.37 ± .49	4.07± .64	▼0.30		
	3	4.46 ± .45	4.41 ± .43	▼0.05		
	4	4.47 ± .47	4.47 ± .40	=		
APRENDIZAJE	1	3.74 ± .96	3.68 ±1 .01	▼0.06	.615	.009
	2	4.11 ± .59	3.95 ± .67	▼0.16		
	3	4.35 ± .57	4.31 ± .60	▼0.04		
	4	4.40 ± .59	4.42 ± .54	▲0.02		
METODOLOGÍA	1	3.95 ± .81	3.66 ±1 .02	▼0.29	.003	.064
	2	4.16 ± .57	4.02 ± .61	▼0.14		
	3	4.30 ± .49	4.37 ± .54	▲0.07		
	4	4.30 ± .48	4.46 ± .47	▲0.16		
OBSERVACIÓN	1	4.04 ± .92	3.87 ±1 .09	▼0.17	.034	.040
	2	4.39 ± .62	4.14 ± .70	▼0.25		
	3	4.44 ± .55	4.46 ± .49	▲0.02		
	4	4.47 ± .55	4.57 ± .41	▲0.10		
CONOCIMIENTOS PREVIOS	1	3.47 ± .80	3.48 ±.90	▼0.01	.533	.010
	2	3.47 ± .70	3.28 ± .75	▼0.19		
	3	3.99 ± .65	3.88 ± .77	▼0.11		
	4	3.97 ± .63	3.97 ± .77	=		

Eta^2 *= tamaño del efecto; p = nivel de significación; Pre = valoración previa; Post = valoración posterior; SD = desviación estándar*

Discusión

Las medias obtenidas van a indicar el grado de satisfacción de los alumnos con el proceso llevado a cabo. La diferencia de opinión inicial entre grupos se puede observar en los valores pre y la final en el post. El cambio de opinión y efecto de la intervención relativa al proceso de EA viene de la diferencia entre el pre y el post indicando el efecto de interacción (Grupo x Tiempo) si se han obtenido diferencias significativas. Así, los resultados obtenidos son:

Constructo Escala total (ETEPES)

Este constructo mide la intervención realizada de manera global, sin dividir en factores. Las medias obtenidas indican como los alumnos están bastante de acuerdo con el proceso EA utilizado, siendo el grupo 1 el único que tanto en la toma pre como post obtiene un valor menor de 4.00. Este resultado puede ser debido a que el grupo 1 no ha tenido formación previa en este tipo de metodología en el curso anterior por lo que su opinión es posible no tenga los suficientes argumentos para darle una valoración mayor, ya que según la autorregulación del aprendizaje a mayor conocimiento mayor capacidad para valorar (Muñoz-San Roque et al., 2016).

Con respecto a la valoración de medidas pre y post entre grupos todos los valores son superiores a su anterior. La mayor diferencia de opinión inicial se da entre el grupo 1 y 2 (▲0.27) que puede ser debido a que el segundo grupo sí tuvo una formación previa específica sobre este tipo de metodología observacional por pares en la asignatura de primer curso, concretamente en Actividades acuáticas en la enseñanza de los estilos de natación. La mayor diferencia de opinión final se da entre los grupos 2 y 3 (▼0.38) y de forma general puede ser debida a la mayor formación previa recibida al comienzo de la intervención por los grupos 3 y 4 a los cuales se les explico detalladamente todo el proceso a seguir en la asignatura a través de un documento en formato artículo científico elaborado gracias a los resultados obtenidos con anterioridad, que sin duda les da una formación previa muy superior a los grupos 1 y 2.

El efecto de interacción (Grupo x Tiempo) resultó ser significativo en ETEPES y con un tamaño del efecto grande ($p < .001$, *Eta*^{2} = .108). En los tres primeros grupos el efecto de la intervención ha hecho que los valores post sean inferiores al pre siendo mayor en los grupos 1 y 2 y mucho menor en el 3. El grupo 4 consigue que el resultado post sea superior al pre. La mayor diferencia en la intervención se produce en el grupo 2 (▼0.22), que puede ser debida a que a pesar de utilizar el mismo tipo de metodología, su aplicación y resultados es diferente según en qué modalidad se aplica debido a las variaciones o no del entorno. Estas variaciones afectan a los clásicos mecanismos de ejecución motriz que participan en el acto motor, ya establecidos por Marteniuk (1976), como son el mecanismo de percepción, decisión y ejecución. Así, el proceso de EA en una modalidad individual como la natación, donde prácticamente no hay variaciones en el entorno, solo hay que prestar atención al mecanismo de ejecución "la técnica", mientras que en un deporte colectivo, con continuas variaciones del entorno, el deportista debe ser capaz de atender primero a los mecanismos de percepción "lectura de la situación de juego y dónde está el móvil" y de decisión "qué tengo que hacer y qué técnica tengo que utilizar" para acabar con el mecanismo de ejecución "fundamento técnico-táctico utilizado" lo que lo hace mucho más difícil. El proceso de EA de cada modalidad hace que para los deportistas principiantes sea más fácil la mejora de la técnica en modalidades predominantemente técnicas que en cualquier deporte colectivo. A su vez, la curva de aprendizaje

en etapas iniciales de EA es mayor en las modalidades eminentemente técnicas que en los deportes colectivos que van a necesitar mucho más tiempo de práctica para dominar los tres mecanismos de intervención motora que se dan prácticamente de manera simultánea (Álvarez, 2011). La falta de tiempo para asimilar todo el proceso de aprendizaje en el deporte colectivo podría ser la causa de la diferencia negativa entre la toma pre y post del grupo 2, al compararla el alumnado con su experiencia previa en natación. Estas diferencias ya no se dan en los grupos 3 y 4 lo que puede ser debido a las modificaciones introducidas en la intervención y a la explicación realizada a los alumnos sobre el tiempo insuficiente para el asentamiento del proceso realizado.

La intervención ha hecho cambiar la opinión del alumnado obteniendo peor valoración al final de la misma en los dos primeros grupos, igualándose en el tercero y mejorando en el cuarto. Las posibles causas, más concretas a las ya indicadas, se irán analizando en cada uno de los factores.

Todos los factores se comportan de la misma forma encontrando las mayores diferencias de opinión inicial pre entre grupos 1 y 2, y la final post entre el 2 y el 3. El mayor efecto de intervención negativa se da en el grupo 2 que se iguala en el 3 y en el 4 es positiva.

De los seis factores que componen el ETEPES cuatro de ellos han obtenido diferencias significativas en el efecto de interacción (Grupo x Tiempo).

Constructo Diseño

El primero de los factores, "Diseño", hace alusión a la importancia de realizar una adecuada construcción, tanto de la hoja de observación, como de las tareas de corrección. Las hojas de observación/evaluación pueden ofrecer numerosas ventajas como: conducir a los estudiantes hacia un aprendizaje más directo y efectivo; situar a los alumnos en su aprendizaje (nivel de partida) y hacia donde progresa a medida que va repitiendo según la información recibida por su compañero; facilitar la labor del docente; favorecer la responsabilidad del alumno haciéndoles más autónomos e independientes en su aprendizaje; estimular la participación activa del discente en el proceso de aprendizaje, potenciando unas relaciones interpersonales más positivas; fomentar la autoestima en los alumnos y la confianza en sí mismos. La elaboración de este tipo de materiales curriculares ad hoc se considera como motivo de experimentación que se pueden argumentar y modificar a partir de la práctica y de la experiencia, permitiendo mejorar, en definitiva, los procesos de EA. (Gómez-Gonzalvo et al., 2017). La utilización continua de estos instrumentos propios facilita que el alumno tome conciencia y asuma aspectos fundamentales de los contenidos que está aprendiendo, aumentando así su eficacia (Vernetta et al., 2009). Este factor obtiene las medias más altas, alcanzando en el grupo 1 valores de 4.00 y en el resto cercanos al 4.50 mostrando la gran importancia que le dan los alumnos a la construcción de sus propios instrumentos en el proceso. Después de las primeras clases impartidas por el profesor (formación inicial teórico-práctica) los alumnos deben elaborar sus propias fichas-hojas de observación de los fundamentos de la modalidad deportiva que les permitan detectar los errores más importantes de la técnica y poder diseñar tareas adecuadas de corrección, intentado cumplir con los principios de integración de una buena calidad educativa: *adecuación* a las características de los alumnos universitarios; *integración* en el proceso de enseñanza-aprendizaje, es decir, debe tener continuidad durante todas las sesiones de la Unidad Didáctica; *relevancia* en cuanto a la ejecución final técnica, focalizando la atención en aquellos aspectos técnicos indicados favoreciendo una observación más rigurosa y detallada de los mismos por parte de los alumnos como futuros docentes y *formativa* ya que implica que los alumnos no sólo sean ejecutantes, sino también evaluadores y correctores de sus compañeros, permitiéndoles una mayor responsabilidad y comprensión de sus aprendizajes, así como una mayor autonomía. El papel del profesor se resume en supervisar el trabajo y aclarar dudas, existiendo siempre la posibilidad de diálogo con los alumnos. Todos los instrumentos elaborados por los alumnos, hojas de observación, tareas para la corrección de los errores pueden irse modificando a lo largo del proceso, reforzando la puesta en práctica de "aprender haciendo", fomentando el trabajo por pares y pequeños grupos donde se genera un clima de aprendizaje y de puesta en común tanto de los conocimientos como de los resultados inmediatos lo que facilita que tomen conciencia y asuman aspectos fundamentales de los contenidos que está aprendiendo, favoreciendo la interiorización del aprendizaje y aumentando así su eficacia (Méndez-Giménez et al., 2016).

El efecto de interacción (Grupo x Tiempo) resultó ser significativo con un tamaño del efecto mediano (p <.05, Eta^2 = .052). Los valores pre de los grupos 1 y 2 son superiores a los post, obteniendo la mayor diferencia en el grupo 2 (▼0.27). En el grupo 3 son muy parecidas e iguales en el 4. El diseño de la hoja de observación en natación se les dio hecha, mientras que en esta asignatura deben diseñarla ellos. En cuanto al diseño tanto de la hoja de observación como de las tareas correctivas es importante indicar que es más complejo en las modalidades colectivas donde hay muchas más variables a tener en cuenta que en una modalidad individual sin variaciones en el entorno como se ha explicado con anterioridad.

Constructo Fases

El segundo constructo denominado "Fases proceso" recoge ítems donde se desglosa la importancia de las diferentes fases utilizadas en el proceso. Las medias obtenidas por encima de 4.00 muestran la conformidad con la importancia de todas las fases del proceso de EA que sin duda van a aplicar en su futuro profesional. El efecto de interacción (Grupo x Tiempo) resultó ser significativo y con un tamaño del efecto mediano (p <.05, Eta^2 = .051). La mayor diferencia intervención se vuelve a dar en el grupo 2 (▼0.30) siendo probablemente la falta de tiempo para aplicar debidamente todas las fases del proceso en el voleibol la causa de la misma.

Constructo Aprendizaje

El tercero constructo denominado "Aprendizaje autónomo" contiene ítems donde se valora la importancia de la implicación activa del alumno en el proceso a través del cual se hace responsable de su formación. Las medias obtenidas en el grupo 1 y 2 están cercanas a 4.00 y en el 3 y 4 cercanas al 4.50 ratificando la importancia que le da el alumno al uso de metodologías activas que le impliquen en el proceso haciéndole responsable de su formación El aumento de protagonismo y de autonomía se potencia con el trabajo cooperativo que los alumnos deben realizar, en momentos presenciales y no presenciales (del Arco-Bravo et al., 2019), construyendo, en este caso, sus propios instrumentos de observación-evaluación para la identificación de los errores técnico-tácticos más importantes y la confección y aplicación de las tareas de corrección, lo que sin duda ayuda fomenta y

desarrolla el aprendizaje autónomo y prepara al alumno para afrontar los retos y cambios hacia el futuro durante toda la vida profesional y personal (Gargallo-López et al., 2020). El efecto de interacción (Grupo x Tiempo) no es significativo en este factor.

Constructo Metodología

El cuarto constructo denominado "Metodología observacional por pares" comprende ítems donde se valora esta metodología frente a las tradicionales y la importancia de la misma en su formación. El aprendizaje basado en problemas y la metodología observacional por pares son los factores que ejercen una influencia mayor y determinante en el desarrollo de las competencias necesarias para transferir conocimiento e innovar en el puesto de trabajo, mayor que el resto de metodologías (Muñoz-San Roque et al., 2016). Las medias obtenidas todas superiores a 4.00, excepto la del grupo 1, indican la importancia que le dan a este tipo de metodología con respecto a otras más tradicionales. El efecto de interacción (Grupo x Tiempo) resultó ser significativo y con un tamaño del efecto mediano (p <.05, Eta^2 = .064). Los grupos 1 y 2 obtienen valores pre superior al post siendo la mayor diferencia la del grupo 1 (▼0.29). Los grupos 3 y 4 obtienen valores post superiores al pre (▲0.07 y ▲0.16) lo que indica que tras el proceso EA los alumnos le dan una mayor importancia para su formación a la metodología observacional por pares con respecto a otro tipo de metodologías tradicionales donde el alumno reproduce las tareas y consignas del docente. Cuando se trabaja en cooperación con los demás, las personas adquieren estrategias de aprendizaje más eficaces y resuelven problemas con un mayor éxito y el aprendizaje por pares, entre iguales se convierte en un eficaz instrumento de aprendizaje activo, en el que además se considera la diversidad del alumnado para intervenir en los procesos de EA en común (Gómez & Gil, 2018). Además, al final de cada sesión se realiza un feedback grupal de todo lo acontecido, buscando una mayor asimilación de conceptos, ya que un mayor procesamiento deliberativo en la formación da lugar a tener una mayor convicción en esa nueva actitud, lo que, a su vez, determina que esa actitud permanezca más en el tiempo, resista mejor a ataques posteriores de información contra-actitudinal y prediga más eficazmente el proceso cognitivo y la conducta de las personas (Duran, 2010).

Constructo Observación

El quinto constructo denominado "Observación" recoge ítems donde se exponen los tipos de observación a realizar. Las medias obtenidas a excepción del post del grupo 1 son superiores a 4.00 y cercanas al 4.50 en el grupo 3 y 4 mostrando la gran importancia que le dan los alumnos a la capacidad de observación, fundamental en esta profesión para aprender a enseñar, y ser capaces de identificar los errores en el campo de la motricidad (ejecución técnica). La mayor diferencia entre grupos post se da entre el 2 y 3 (▲0.32) y el efecto de interacción (Grupo x Tiempo) resultó ser significativo y con un tamaño del efecto pequeño (p <.05, Eta^2 =. 034). Esta diferencia entre grupos podría deberse a que en el grupo 2 el docente sugiere pero no obliga ni explica el uso del programa para análisis de la técnica deportiva Kinovea para la observación indirecta, mientras que en el 3 y 4 el docente incide en la importancia de la observación indirecta en el laboratorio, que permite analizar las veces que sean necesarias la técnica grabada, y en el uso del programa Kinovea, explicando en clase las bases de su uso básico. En estos grupos 3 y 4 la diferencia de opinión tras intervención es positiva a favor del post (▲0.02 y ▲0.10), indicando que los alumnos la consideran más importante al final que al principio con valores finales superiores al 4,5. Para aprender a enseñar hay que desarrollar la capacidad de "Aprender a observar". El alumno observador es un alumno que observando aprende, complementa su saber hacer y se convierte en un alumno más autónomo que destaca la información importante. Hay que formar al alumno educador para que sea capaz de ver las cosas que los ojos no expertos no ven, tener la capacidad de discriminar, diferenciar y responder de acuerdo con el contexto que nos encontremos. El alumno debe adquirir estructuras de conocimiento profundas y elaboradas sobre los contenidos de la enseñanza, los aspectos pedagógicos y psicológicos y las características de sus alumnos que le permitan crear un clima adecuado de aprendizaje. Se le debe formar en el conocimiento del movimiento, capacidad de observación que le permita detectar e identificar los aspectos relevantes del mismo, capacidad de diagnóstico y de intervención para la mejora del proceso de enseñanza-aprendizaje (Álvarez, 2011). Al final del proceso los alumnos deben ser capaces de "Diseñar, desarrollar y evaluar los procesos de enseñanza-aprendizaje relativos a la actividad física y del deporte, con atención a las características individuales y contextuales de las personas". Un aspecto importante en la consecución de resultados positivos reside en el hecho de favorecer en el alumnado la toma de decisiones en la elaboración autónoma de las planillas y otras herramientas de observación. Así mismo, se valora como fundamental la inclusión de pautas consensuadas de guía del proceso, contribuyendo así a hacer más efectivos los procesos de autorregulación. (Álvarez-Valdivia, 2017).

Constructo Conocimientos previos

El sexto constructo denominado "Conocimientos previos" aglutina ítems que exponen la necesidad de tener conocimientos previos para llevar a cabo esta metodología. Es el único factor que da una media inferior a 4.00 en todos los grupos y tomas pre y post. Los alumnos consideran que los conocimientos previos son necesarios pero no tan importantes como otros factores sin haber efecto de interacción (Grupo x Tiempo) significativo.

El trabajo desarrollado reafirma las conclusiones de los estudios que defienden nuevos planteamientos en un entorno de enseñanza orientada al aprendizaje, eje central de la reforma en la que se encuentra inmerso el sistema universitario español, donde los resultados obtenidos van a aportar una retroalimentación valiosa para ayudar a entender y mejorar el proceso establecido ya que, la opinión de los estudiantes sobre los planes de estudio u otros aspectos organizativos y funcionales es fundamental, por ser uno de sus principales protagonistas y además los principales afectados de su acción pedagógica (Martínez-Otero et al., 2018).

Los resultados del presente trabajo muestran como los estudiantes están de acuerdo con los beneficios que aporta la metodología observacional por pares, confirmando lo establecido por otros autores como una de las formas más efectivas para mejorar el desarrollo de estrategias interpersonales, incrementar la intencionalidad formativa, fomentar el diálogo y la capacidad de realizar juicios con los otros compañeros e incluso docentes para evaluar, mejora los procesos y productos del aprendizaje de las material específicas así como el desarrollo de competencias en general, produciendo todo ello un cambio actitudinal hacia el aprendizaje. Los resultados encontrados suponen un indudable valor formativo que ayuda a formar alumnos

más autónomos, responsables, críticos (Cañadas et al., 2018; del Arco et al., 2019; Ibarra et al., 2012; Moreno et al., 2014; Prins et al., 2005) y como la sociedad demanda, ciudadanos más democráticos (Chiva, 2019; Izquierdo et al., 2019). Los resultados obtenidos tienen que servir como punto de partida de siguientes intervenciones.

Conclusiones

- Los alumnos valoran muy positivamente el proceso de enseñanza utilizado para la enseñanza de la técnica deportiva a través de la metodología observacional por pares obteniendo medias entre 4.00 y 4.50 sobre 5.00.

- Las intervenciones han tenido efectos en la valoración de los alumnos obteniendo diferencias significativas en la escala total y en los factores: diseño, fases, metodología y observación, permitiendo al profesorado mejorar el proceso gracias a la retroalimentación recibida.

Aplicaciones prácticas

Los resultados animan a dar un paso adelante en el proceso de EA y considerar nuevos planteamientos en el diseño, desarrollo y evaluación del mismo (Rodríguez-Gómez et al., 2018) donde la responsabilidad de la evaluación deje de estar solo en el docente y se distribuya dando participación activa al alumnado (Gargallo-López et al., 2017). La participación de los alumnos en la evaluación ya puede ser una valiosa oportunidad para motivar, mejorar y consolidar el aprendizaje, favoreciendo así el aprendizaje a lo largo de la vida y para la vida (Gargallo-López et al., 2020). Moreno et al. (2014), en este mismo Grado, cede la responsabilidad de la evaluación al alumnado y obtiene que este tipo de intervención incrementó la percepción de apoyo a la autonomía, la motivación intrínseca y el valor y rol concedido a la cesión de responsabilidad en la evaluación. Los participantes describieron este programa como un buen sistema de enseñanza-aprendizaje, novedoso y motivador.

Esta perspectiva más progresista ayudará a formar ciudadanos responsables y críticos, ya que la capacidad para evaluar va a ser una habilidad imprescindible a desarrollar en un futuro empleo, y más aún en el contexto de este trabajo realizado en el Grado de Ciencias de la Actividad Física y del Deporte donde se forma a los futuros profesionales de la Educación Física del Sistema Educativo Español.

Referencias

1. Álvarez, J. (2011). *Los deportes colectivos. Teoría y realidad: Desde la iniciación al rendimiento*. Zaragoza, Prensas Universitarias de Zaragoza.
2. Álvarez, J., Murillo, V., Casterad. J., & Nuviala, A. (2020). Validación de la escala del proceso enseñanza de la técnica deportiva por pares en la educación superior (ETEPES). *Retos: Nuevas tendencias en educación física, deporte y recreación*, *37*, 284-290. Recuperado de: https://recyt.fecyt.es/index.php/retos/article/view/73002/45230
3. Alvarez-Valdivia, I. (2017). Evaluar para contribuir a la autorregulación del aprendizaje. *Electronic journal of research in educational psychology*, 7(19), 1007-1030. https://doi.org/10.25115/ejrep.v7i19.1362
4. Boud (2010). Assessment 2020: Seven propositions for assessment reform in higher education. Sydney: Australian Learning and Teaching Council. Recuperado de: https://www.uts.edu.au/sites/default/files/Assessment-2020_propositions_final.pdf
5. Cañadas, L., Castejón, F. J., & Santos-Pastor, M. L. (2018). Relación entre la participación del alumnado en la evaluación y la calificación en la formación inicial del profesorado de educación física. *Revista Cultura, Ciencia y Deporte*, *13*, 291-300.
6. Chiva, Ò., Capella, C., & Pallarès, M. (2018). Investigación-acción sobre un programa de aprendizaje-servicio en la didáctica de la educación física. *Revista de Investigación Educativa*, *36*(1), 277-293.
7. Del Arco-Bravo, I., Flores-Alarcia, O., & Silva, P. (2019). El desarrollo del modelo flipped classroom en la universidad: Impacto de su implementación desde la voz del estudiantado. *Revista de Investigación Educativa*, 37(2), 451-469. https://doi.org/10.6018/rie.37.2.327831
8. Duran, D. (2010). Cooperative Interactions in Peer Tutoring: Patterns and Sequences in Paired Writing. *Middle Grades Research Journal*, *5*(1), 47-60. Recuperado de: http://grupsderecerca.uab.cat/grai/sites/grupsderecerca.uab.cat.grai/files/cooperativeinteractions.pdf
9. Gargallo-López, B., Jiménez-Rodríguez, M. Á., Martínez-Hervás, N., Giménez-Beut, J. A., & Pérez-Pérez, C. (2017). Métodos centrados en el aprendizaje, implicación del alumno y percepción del contexto de aprendizaje en estudiantes universitarios. *Educacion XX1*, *20*(2), 161-187. https://doi.org/10.5944/educXX1.15153
10. Gargallo-López, B., Pérez-Pérez, C., Garcia-Garcia, F.J., Giménez-Beut, J.A., & Portillo- Poblador, N. (2020). La competencia aprender a aprender en la universidad: Propuesta de modelo teórico. *Educación XX1*, *23*(1), 19-44. https://doi.org/10.5944/educXX1.23367
11. Gessa, A. (2011). La coevaluación como metodología complementaria de la evaluación del aprendizaje. Análisis y reflexión en las aulas universitarias. *Revista de Educación*, *354*, 749-764. Recuperado de: http://www.revistaeducacion.educacion.es/re354/re354_30.pdf
12. Gómez, P., & Gil, A.J. (2018). El estilo de aprendizaje y su relación con la educación entre pares. *Revista de Investigación Educativa*, *36*(1), 221-237. https://doi.org/10.6018/rie.36.1.233731
13. Gómez-Gonzalvo, Fernando & Molina, Pere & Martínez-Baena, Alejandro. (2017). El uso de materiales curriculares en Educación Física: racionalidad y desarrollo profesional del profesorado. *VIREF. Revista de Educación Física*, 6, 9-28.
14. Ibarra, M.S., Rodríguez, G., & Gómez, M.A. (2012). La evaluación entre iguales: Beneficios y estrategias para su práctica en la Universidad. *Revista de Educación*, *359*, 206-231. https://doi.org/10.4438/1988-592X-RE-2011-359-092
15. Izquierd, T., Asensi, E., Escarbajal, A., & Rodríguez, J. (2019). El aprendizaje cooperativo en la formación de maestros de Educación Primaria. *Revista de Investigación Educativa*, 37(2), 543-559. https://doi.org/10.6018/rie.37.2.369731
16. León, B., Mendo-Lázaro, S., Felipe-Castaño, E., Polo, M.I., & Fajardo-Bullón, F. (2017). Team Potency and Cooperative Learning in the University Setting. *Revista de Psicodidáctica*, 22(1), 9-15. https://doi.org/10.1387/RevPsicodidact.14213
17. Marteniuk, R.G (1976). Information processing in motor skills. New york: Holt, Rinehart, and Winston.
18. Martínez-Otero, Pérez, V., & Gaeta, L. (2018). Estudio del discurso educativo en una muestra de docentes

mexicanos. *Revista Iberoamericana de Educación*, *76*(1), 169-186. Recuperado de: https://rieoei.org/RIE/article/view/2855/3837

19. Méndez-Giménez, A., Fernández-Río, J., Rolim Marques, R. J., & Calderón, A. (2016). Percepciones de estudiantes de máster en Educación Física acerca de los materiales autoconstruidos. Una mirada desde la teoría construccionista de Papert [Physical education master program student perceptions on self-made materials. A reflection from Papert's constructionist theory]. *Educación XX1*, 19(1), 179-200. https://doi.org/10.5944/educXX1.15583
20. Moreno, J.A., Aracil, A., & Reina, R. (2014). Assignment of responsibility in evaluation: a strategy adapted to the European Higher Education Area. *Educación XX1*, 17(1), 183-200. https://doi.org/10.5944/educxx1.17.1.10710
21. Muñoz-San Roque, I., Martín-Alonso, J. F., Prieto-Navarro, L., & Urosa-Sanz, B. (2016). Autopercepción del nivel de desarrollo de la competencia de aprender a aprender en el contexto universitario: Propuesta de un instrumento de evaluación. *Revista de Investigación Educativa*, *34*(2), 369-383. https://doi.org/10.6018/rie.34.2.235881
22. Otero, F., Calvo, Á., & González-Jurado, J. (2014). Análisis de la evaluación de los deportes de invasión en Primaria. (Analysis of the assessment of invasion sports in elementary school). *Revista Cultura, Ciencia y Deporte*, *9*(26), 139-153. https://doi.org/10.12800/ccd.v9i26.432
23. Prins, F. J., Sluijsmans, D. M. A., Kirschner, P. A., & Strijbos, J. W. (2005). Formative peer assessment in a CSCL environment: A case study. *Assessment and Evaluation in Higher Education*, *30*(4), 417-444. https://doi.org/10.1080/02602930500099219
24. Rodríguez-Gómez, G., Ibarra-Saiz, M. S., & Cubero-Ibáñez, J. (2018). Competencias básicas relacionadas con la evaluación. Un estudio sobre la percepción de los estudiantes universitarios. *Educación XX1*, *21*(1), 181-208. https://doi.org/10.5944/educXX1.20184
25. Salmerón, L. (2013). Actividades que promueven la transferencia de los aprendizajes: Una revisión de la literatura. *Revista de Educación*, Extraordin, 34-53. https://doi.org/10.4438/1988-592X-RE-2013-EXT-253
26. Tejedor, F. (2014). Investigación educativa: su desarrollo en el ámbito de la tecnología educativa. En A. García-Valcárcel (Coord.), Investigación y tecnología de la información y comunicación al servicio de la innovación educativa (pp. 176-208). Salamanca: Ediciones Universidad de Salamanca.
27. Tejedor, F.J. (2018). Investigación educativa: La utilidad como criterio social de calidad. *Revista de Investigación Educativa*, *36*(2), 315-330. https://doi.org/10.6018/rie.36.2.326311
28. Vernetta, M., López, J., & Robles, A. (2009). Evaluación compartida con fichas de observación durante el proceso de aprendizaje de las habilidades gimnásticas. Un estudio experimental. *Revista Iberoamericana de Educación*, *50*(2), 1-7. Recuperado de: https://rieoei.org/historico/expe/2864Santana.pdf.
29. Vera-Lacarcel, J.A., Moreno-González, R., & Moreno-Murcia., J. A. (2008). Relaciones entre la cesión de responsabilidad en la evaluación y la percepción de igualdad en la enseñanza de la educación física escolar. *Revista Cultura, Ciencia y Deporte*, *4*, 25-31.
30. Villardón-Gallego, L., Yániz, C., Atxurra, C., IIraurgi, I., & Aguilar, M.C. (2013). La competencia para aprender en la universidad: Desarrollo y validación de un instrumento de medida. *Revista de Psicodidáctica*, *18*(2), 357-374. https://doi.org/10.1387/RevPsicodidact.6470

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CULTURA, CIENCIA Y DEPORTE

Efecto de la experiencia del árbitro de fútbol en la competición deportiva

Effect of the soccer referee's experience in sports competition

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Resumen

Los objetivos fueron analizar la relación entre las variables psicológicas pre-competición de árbitros de fútbol semiprofesionales y sus respuestas físico-fisiológicas durante la competición y comparar estas respuestas atendiendo a su nivel de experiencia. Participaron 153 árbitros (edad *M* = 23.21; *DT* = 4.80 años; experiencia *M*= 6.07; *DT* = 4.53 años). Se utilizaron los cuestionarios CSAI-2 (ansiedad competitiva; Martens et al., 1990) y RSES (autoestima; Rosenberg, 1965) antes de la competición y se recogieron datos del rendimiento del partido con dispositivos GPS (Owen et al., 2017). Los resultados mostraron que los árbitros experimentados presentaron menores puntuaciones en respuestas psicológicas negativas y mayores en positivas (p< .01). Este grupo desarrolló mayores valores en distancia recorrida y frecuencia cardíaca superior al 95 % de su frecuencia cardíaca máxima (p< .05; d> .70). Se hallaron correlaciones entre autoestima, ansiedad cognitiva y autoconfianza con respuestas físico-fisiológicas. Como conclusión, los árbitros experimentados poseen menores respuestas psicológicas negativas (ansiedad) y mayores positivas (autoconfianza y autoestima) que los árbitros no experimentados. Además, la experiencia podría explicar hasta un 13% de la varianza explicada en variables relacionadas con el rendimiento físico y hasta un 12% en las respuestas psicológicas. Se recomienda aplicar programas de intervención para ayudar a los árbitros menos experimentados a afrontar la competición y la introducción del VAR en categorías nacionales no profesionales para corregir errores claros. Se espera que estas medidas ayuden a los árbitros a mejorar sus capacidades psicofísicas y fisiológicas y aumentar sus niveles de éxito.

Palabras clave: Experiencia, ansiedad, autoestima, autoconfianza, GPS, árbitros.

Abstract

The objectives were to analyze the relationship between semi-professional soccer referees. pre-competition psychological variables and physical-physiological responses during the competition; and to compare these responses according to their experience. A total of 153 referees (age *M* = 23.21; *SD* = 4.80 years; experience *M*= 6.07; *SD* = 4.53 years) completed CSAI-2 (competition anxiety; Martens et al., 1990) and RSES test (self-esteem; Rosenberg, 1965) before the match. Physical performance data was collected with GPS devices (Owen et al., 2017). The results showed that experienced referees presented lower scores in the negative psychological responses and higher in positive ones (p< .01). This group developed higher values in distance covered and in heart rate greater than 95 % of their maximum heart rate (p< .05; d> .70). Various correlations were found between self-esteem, cognitive anxiety and self-confidence with physical-physiological responses. In conclusion, experienced referees have lower negative psychological responses (anxiety) and higher positive responses (self-confidence and self-esteem) than inexperienced referees. In addition, experience could explain up to 13% of the variance explained in variables related to physical performance and up to 12% in psychological responses. . Intervention programs to help less experienced referees in facing the competition and VAR introduction in non-professional national categories to correct clear errors are recommended. These measures are expected to help referees improving their psycho-physical-physiological capacities and increasing their success levels.

Keywords: Experience, anxiety, self-esteem, self-confidence, GPS, referees.

Introducción

El fútbol es un deporte de naturaleza sumamente compleja, en el que intervienen múltiples factores, e.g., físicos, biomecánicos, fisiológicos, nutricionales, psicológicos, … (Castillo-Rodríguez et al., 2020; Jafarigilandeh et al., 2021). Muchos analistas, entrenadores e investigadores dedican un tiempo considerable en el estudio del aumento del rendimiento físico (RF), ofreciéndose a día de hoy, numerosas investigaciones contrastadas (Walker et al., 2019). Por ende, los árbitros de fútbol (AF) evidentemente son una pieza fundamental en el correcto desempeño de la competición, lo cual ha propiciado el interés de la comunidad científica en las últimas décadas (Mellalieu et al., 2006; Muñoz-Arjona & Castillo-Rodríguez, 2020). Además, en los últimos años, ha aumentado sustancialmente la exigencia física en competición, requiriendo un mayor nivel condicional de los jugadores para poder competir en el alto nivel (Bradley et al., 2016) y por tanto, también de los AF como parte del juego (Medina-Cantalejo, 2017), i.e., el aspecto físico y la composición corporal (Ade et al., 2016), el cuidado alimenticio (Jenner et al., 2019; López-Gil et al., 2020; Montesano et al., 2019), el entrenamiento regulado y personalizado (Randers et al., 2010) o el control de las variables psicológicas (Jafarigilandeh et al., 2021; Kais & Raudsepp, 2005; Montesano et al., 2019; Muñoz-Arjona & Castillo-Rodríguez 2020), entre otros. Estos condicionantes influyen de forma diferente en la toma de decisiones de los AF durante la competición, siendo el control emocional uno de los más relevantes (Weinberg & Richardson, 1990). Diversas investigaciones concluyen incidiendo en la necesidad de implementar programas de intervención para la mejora de las capacidades psicológicas (Loghmani et al., 2018; Muñoz-Arjona & Castillo-Rodríguez, 2020), las cuales podrían obtener un mayor índice de acierto en el campo, situado actualmente entre el 90 y 95 % (Medina-Cantalejo, 2017).

Desarrollar una buena planificación y periodización del entrenamiento podría ayudar a una mejora de la composición corporal (Fernández-García et al., 2019), una reducción de lesiones durante la temporada (Bradley & Ade, 2018), mejora de estados psicosociales (Onetti-Onetti et al., 2019) y por ende, se estima que reporte un mayor RF, el cual propicie unos índices de acierto superiores en la toma de decisiones de los partidos, al igual que ocurre en los jugadores de fútbol (Castillo-Rodríguez et al., 2020). El estudio de las variables psicológicas, e.g. motivación, atención, estrés, ansiedad, autoconfianza (CF), estados de ánimo, autoestima (AE), miedo a la evaluación social, entre otros (Coudevylle et al., 2011; Mesagno et al., 2012) y su incidencia en el RF, ha sido unos de los principales objetos de estudio de la Psicología del Deporte (Dosil, 2002), llegando a la conclusión de que la evaluación y el estudio de dichas variables podrían llegar a garantizar el éxito del deportista (García et al., 2004).

La ansiedad es uno de los constructos más relacionados con el RF (Junge & Feddermann-Demont, 2016), dividiéndose en ansiedad cognitiva (AC) y ansiedad somática (AS) (Grossbard et al., 2009). El primero de ellos, hace referencia a la dificultad de mantener la concentración; en cambio el segundo, se refiere a las percepciones de los síntomas corporales usados por la activación del sistema nervioso autónomo, como la aceleración del ritmo cardiaco, sudoración, etc. (Martens et al., 1990). Ambos tipos de ansiedad influyen en el RF de forma distinta (Kaplan, 2021; Muñoz-Arjona & Castillo-Rodríguez, 2020). Por un lado, diversos estudios en fútbol no hallaron influencia entre AC y RF (Kais & Raudsepp, 2005); otros, sin embargo, observaron una relación lineal negativa y una relación de U-invertida entre AS y RF (RF óptimo en caso de valores de AS medios y menor RF en caso de AS baja y alta) (Craft et al., 2003; Woodman & Hardy, 2003); y otros, cuyas investigaciones dieron como resultados una relación directa, entre AC y RF (Mellalieu et al., 2004) e inversa entre AS y RF (r = -.42) (Muñoz-Arjona & Castillo-Rodríguez, 2020).

Por otro lado, la AE es una variable relacionada con la personalidad, en la que una persona se valora a sí misma (Molina et al., 2014). Se encuentra relacionada con la salud física y psicológica (Sandín et al., 2012), asociándose positivamente con el bienestar mental de deportistas, por su relación con características psicológicas positivas (resiliencia, etc.) y emocionales (miedos, ansiedad, depresión, etc.), así como también, con la evaluación en situaciones estresantes (Sandín et al., 2012). Los deportistas con niveles reducidos de AE tendían a percibir la competición deportiva de una forma más amenazante, mientras que aquellos con unos niveles elevados percibían la competición como una actividad más exigente, obteniendo una fuerte relación entre AE y RF (Muñoz-Arjona & Castillo-Rodríguez, 2020). En el caso de la CF, definida como el grado de certeza que los deportistas poseen en relación a su capacidad para tener éxito en el deporte (Guillén y Feltz, 2011), numerosas investigaciones han revelado el impacto sobre la práctica deportiva (Bačanac, 2014), hallándose relación positiva entre CF y RF (Chamberlain & Hale, 2007).

Por otro lado, la experiencia es otro factor que podría modular los estados emocionales de los deportistas, la cual parece estar relacionada positivamente con el dominio de diversas respuestas psicológicas (Rosnet, 2000), siendo los deportistas más experimentados quienes menores puntuaciones presentan en respuestas psicológicas negativas (e.g., melancolía, ansiedad, estrés) y mayores en las positivas (e.g., motivación, confianza, concentración; Hanton et al., 2008). En AF semi-profesionales existe una relación negativa entre experiencia y AC o AS (Muñoz-Arjona & Castillo-Rodríguez, 2020), aunque este estudio se centró en las pruebas anuales que tienen los AF para poder promocionar o descender de categoría. Por otro lado, los AF nóveles ofrecen mayores índices de motivación y CF, por lo que podemos afirmar que la experiencia podría influir en el deportista (r = .64; p = .045; Bačanac, 2014). Se plantea una hipótesis de partida, estimándose que los AF experimentados ofrecerán un mayor dominio de las respuestas psicológicas (mayores índices de AE y CF y menores en ansiedad), las cuales, podrían propiciar mayor RF (mayor distancia recorrida, mayor distancia recorrida a velocidades más elevadas, mayor velocidad máxima…) como fisiológicos (mayor tiempo en umbrales de frecuencia cardiaca por encima del 80-90 %, mayor frecuencia cardiaca máxima, entre otros). Es necesario destacar, que los AF de una misma categoría poseen una condición física similar, ya que dependiendo del rendimiento de las pruebas anuales, un AF podría arbitrar en una u otra categoría.

Por otro lado, la monitorización, control y programación de los parámetros físico-fisiológicos son determinantes con el fin de optimizar el RF y prevenir la aparición de lesiones (Ade et al., 2016; Bradley et al., 2016). Actualmente, la herramienta de monitorización más fiable y utilizada para el control de la carga externa son los sistemas de posicionamiento global (GPS) (Malone et al., 2015; Owen et al., 2017), ofreciendo

una información muy detallada, e.g. distancia total recorrida, sprints de alta intensidad, diferentes umbrales de velocidad, frecuencia cardiaca (HR), entre otros. De igual forma, el análisis de la HR viene determinada por el tipo de esfuerzo físico realizado, (aceleraciones, desaceleraciones, cambios de dirección, entre otros) incidiendo en el metabolismo anaeróbico, fundamental en el deporte del fútbol (Woolf et al., 2009).

Por estos motivos, el primer objetivo de este estudio, es fue analizar las respuestas psicológicas (AE, AC, AS y CF) pre competición de los AF y sus respuestas físico-fisiológicas durante la misma, en función de la su nivel de experiencia. El segundo objetivo es fue hallar relaciones psico-físico-fisiológicas en AF durante la competición donde confluyen dichas variables.

Material y método

Participantes

Ciento cincuenta y tres AF hombres adscritos a las distintas categorías de la Real Federación Española de Fútbol y Federación Andaluza de Fútbol fueron los participantes del estudio (edad *M* = 23.21; *DT* = 4.80 años; experiencia *M* = 6.07; *DT* = 4.53 años). Los AF fueron elegidos al azar entre las plantillas arbitrales confeccionadas por el Comité de Árbitros durante las temporadas 2017-2018 y 2018-2019. Los criterios de inclusión del estudio fueron que los AF evaluados estén compitiendo en la Liga de Tercera División o División de Honor del fútbol español, que hayan pasado los pertinentes test médicos (se han excluido los AF con lesiones en los últimos seis meses) y condición física del comité, que el partido evaluado sea completo (90 minutos o más) y sin incidentes (lesiones o situaciones no normales que tenga la competición interrupciones largas o no habituales) y que el AF esté de acuerdo con los objetivos del estudio completando todas las fases del mismo (respuestas psicológicas previas y grabación de datos físicos con GPS incorporado).

Instrumentos

En primer lugar se cumplimentó un cuestionario ad-hoc para la recogida de datos sociodemográficos: edad, años de experiencia, lesiones, categoría y años en la categoría. La experiencia se clasificó en dos grupos, el primero en 10 años o más, grupo de experimentados y menos de 10 años en el grupo de no experimentados (Muñoz-Arjona & Castillo-Rodríguez, 2020). En segundo lugar, y teniendo en cuenta las aportaciones de Chamberlain & Hale (2007) o de Junge & Feddermann-Demont (2016), para la obtención de los datos asociados a las variables psicológicas, se utilizó:

- El cuestionario *Competitive State Anxiety Inventory*-2 (CSAI-2) de Martens et al. (1990), se usó para determinar los niveles de AC, AS y CF. Está compuesto por un total de 27 ítems cuya valoración está comprendida entre nada (1), algo (2), bastante (3) y mucho (4). Para la determinación del valor de cada subescala, se atenderá a la medida suma de los nueve ítems correspondientes a cada variable. De esta forma, para la valoración de la AC se tuvieron en consideración los ítems: 1, 4, 7, 10, 13, 16, 19, 22 y 25. En el caso de la AS se valoró a través de los ítems: 2, 5, 8, 11, 14 (valorado de forma negativa), 17, 20, 23 y 26. Por último, la CF, se ha medido a partir de los ítems: 3, 6, 9, 12, 15, 18, 21, 24 y 27. Por consecuente, en las variables AC y CF las puntuaciones oscilarán entre 0 y 36 puntos, mientras que para la AS fue entre – 4 y 32 puntos. Ejemplos de ítems son: «me siento nervioso» y «mi cuerpo está tenso» (AS), «me preocupa no alcanzar mi objetivo en la carrera» y «me preocupa no hacerlo en esta carrera todo lo bien que podría» (AC), «confío en rendir bien a pesar de la presión» y «tengo confianza» (CF).

- El cuestionario Rosenberg Self-Esteem Scale (RSES) determina el nivel de AE (Atienza et al., 2000; Rosenberg, 1965). Está compuesto por un total de 10 ítems (cinco positivos y cinco negativos), en el que se le asigna una calificación: muy de acuerdo (A), de acuerdo (B), en desacuerdo (C) y muy en desacuerdo (D), teniendo cada uno de estos una puntuación de uno a cuatro en función de la respuesta empleada dependiendo de si se trata de un ítem positivo o negativo. Al obtener la puntuación total se categoriza al deportista con baja autoestima si posee menos de 25 puntos, existiendo problemas significativos de AE; entre 26 y 29, autoestima media, no presentando problemas de AE graves, aunque resulta conveniente mejorarla; y, entre 30 y 40 puntos, AE elevada, considerándose esta AE adecuada.

Por otro lado, los parámetros de carga externa fueron obtenidos a través de dispositivos de sistemas de posicionamiento global (GPS) de cinco Hz (SPI-PRO, GPSport, Canberra, Australia). Estos dispositivos fueron incorporados a través de un chaleco ajustado diseñado específicamente, los cuáles no impiden ningún tipo de movimiento y fueron validados para la práctica de deportes de interacción como el fútbol (Petersen et al., 2009): durante los sprints, el rango de fiabilidad fue alto y varió entre el 2 y el 13 %, con una subestimación o error de precisión de hasta un 4% en las distancias. Los movimientos de los AF se codificaron en cinco categorías y umbrales de velocidad (Casamichana et al., 2012): caminar (0.1–6.9 $km \cdot h^{-1}$), correr a baja velocidad (7.0-12.9 $km \cdot h^{-1}$), correr a velocidad media (13.0–17.9 $km \cdot h^{-1}$), correr a alta velocidad (18.0–20.9 $km \cdot h^{-1}$) y sprint (>21.0 $km \cdot h^{-1}$). El número promedio de satélites durante las mediciones fue 8±1. Para el hallazgo de la HR se utilizó el dispositivo Polar S610i (Polar Electro Oy®, Helsinki, Finland). La HR fue clasificada en distintas zonas, realizando una sensible adaptación de los porcentajes de la HRMax (Fernández-Elías et al., 2017): HR60 (<59.9 %), HR70 (60-69.9 %), HR80 (70-79.9 %), HR90 (80-89.9 %), HR95 (90-94.9 %) y HR96 (> 95 %). La HRMax fue hallada mediante la fórmula predeterminada de Tanaka et al. (2001). Para la valoración subjetiva de la carga interna post-esfuerzo (RPE) se utilizó la escala CR-10 de Börg (Scherr et al., 2013).

Procedimiento

Se llevó a cabo un diseño de estudio de carácter transversal, no experimental (no se manipulan variables independientes) y de tipo descriptivo e inferencial. En primer lugar, se informó a los AF sobre los objetivos y acciones a llevar a cabo en este estudio, y se solicitó consentimiento voluntario firmado antes de iniciar la investigación. Se siguieron las indicaciones establecidas en la Declaración de Helsinki (2013) sobre investigación humana, siendo este estudio aprobado por el Comité de ética de la Universidad de Granada (471/CEIH/2018). Seguidamente, la obtención de las variables psicológicas se realizó diez minutos antes del calentamiento para la competición. Finalizados los mismos, al equipo arbitral se le incorpora dispositivos GPS para la medición del calentamiento y partido. Concluido este, se pregunta sobre la escala de RPE. Cada AF fue evaluado una vez. Para conseguir un tamaño de la muestra adecuado, se evaluaron durante dos temporadas tanto las características psicológicas previas

a la competición como los datos grabados durante el partido sobre el rendimiento físico y fisiológico.

Análisis estadístico

Se utilizó el programa estadístico SPSS para Windows (SPSS Inc., Chicago), versión 25.0. Se realizaron análisis de Kolmogorov-Smirnov para evaluar la normalidad de las variables. Los resultados mostraron que estas variables seguían una distribución normal, excepto en AC, AS, CF, AE, HR95, HR96 y las carreras a alta velocidad (18.0–20.9 $km \cdot h^{-1}$) y sprint (>21.0 $km \cdot h^{-1}$). Posteriormente, se llevaron a cabo análisis comparativos (*t*-test y U-Mann Whitney) utilizando la experiencia como variable independiente, un análisis correlacional (test de Pearson y Spearman) y test de regresión lineal (*stepwise*) de las respuestas psico-físico-fisiológicas y la experiencia con la edad como covariable. El tamaño del efecto (d de Cohen) se usó para cuantificar el tamaño de la diferencia que se encontró entre ambos grupos. Para el caso de la prueba t de muestras independientes, la d de Cohen se ejecutó como tamaño del efecto utilizando los siguientes criterios: efecto pequeño (d < .20), efecto moderado (.20 ≤ *d* <.80) y efecto grande (*d* ≥ .80) (O 'Donoghue, 2013). Se definió una significancia estadística del 5 % ($p < .05$).

Resultados

En la tabla 1 se muestran los resultados de las respuestas psicológicas previas a la competición oficial teniendo en cuenta la experiencia del AF. Se observan múltiples diferencias significativas (con tamaños del efecto elevados). Los AF experimentados poseen menor AC ($p< .01$; $d = .60$) y AS ($p< .001$; $d = .62$) y mayor AE ($p< .001$; $d = .96$) y CF ($p< .001$; $d = .77$).

Tabla 1. Media ± desviación típica de las respuestas psicológicas previas a la competición según la experiencia.

		Experimentados (n=63)	No experimentados (n=90)	*p*	*d*
AE	(puntos)	36.73 ± 3.19	33.21 ± 3.94	.000***	.96
AC	(puntos)	16.38 ± 4.73	19.26 ± 4.82	.002**	.60
AS	(puntos)	8.08 ± 2.91	10.59 ± 4.61	.000***	.62
CF	(puntos)	30.68 ± 3.84	27.59 ± 4.13	.000***	.77

***** P < .05
****** P < .01
******* P < .001
AE: Autoestima; AC: Ansiedad cognitiva; AS: Ansiedad somática; CF: Autoconfianza.

En la tabla 2 se exponen las respuestas fisiológicas medias atendiendo a la división antes mencionada de la experiencia del AF. Hay que destacar una mayor demanda fisiológica en el grupo experimentado, cuyos valores de las variables HR95 con el 11.3 % y 7.58 % del tiempo de los AF experimentados en la primera y segunda parte respectivamente, frente al 4.80 % ($d = .70$) y 2.64 % ($d = .75$) de los AF no experimentados en la primera y segunda parte respectivamente; y en la variable HR96 con el 7.7 % del tiempo de los AF experimentados en la primera parte, frente al 0.73 % ($d = .93$) de los AF no experimentados en la misma parte del partido. Por el contrario, los AF no experimentados se encuentran mayor tiempo en HR80 (primera parte: 29.2 %; segunda parte: 31.2 %) que los AF experimentados (primera parte: 20.9 %; segunda parte: 23.9 %), aunque dichas diferencias no fueron significativas ($d = .49$ y .43, respectivamente).

Tabla 2. Media ± desviación típica de las respuestas fisiológicas en la competición según la experiencia.

			Experimentados (n=63)	No experimentados (n=90)	*P*	*d*
Partido	RPE	(puntos)	13.65 ± 2.33	12.57 ± 2.41	.115	.45
	HRMin	(%)	51.90 ± 10.9	51.96 ± 8.25	.984	
	HRMed	(%)	72.29 ± 15.7	71.06 ± 11.3	.762	
	HRMax	(%)	89.67 ± 18.9	89.14 ± 10.9	.907	
Primera parte	HRMin	(ppm)	102.9 ± 20.6	105.2 ± 18.8	.684	
	HRMed	(ppm)	142.7 ± 28.4	143.7 ± 22.2	.899	
	HRMax	(ppm)	175.7 ± 33.1	175.7 ± 21.1	.999	
	HR60	(%)	18.61 ± 32.8	20.70 ± 33.7	.839	
	HR70	(%)	18.16 ± 20.0	21.91 ± 14.6	.498	
	HR80	(%)	20.94 ± 16.3	29.24 ± 17.5	.117	.49
	HR90	(%)	23.54 ± 18.9	23.12 ± 17.4	.978	
	HR95	(%)	11.32 ± 12.5	4.795 ± 6.68	.034*	.70
	HR96	(%)	7.696 ± 12.0	0.732 ± 1.25	.009**	.93
Segunda parte	HRMin	(ppm)	99.72 ± 15.9	99.41 ± 15.3	.946	
	HRMed	(ppm)	140.2 ± 21.7	139.3 ± 23.2	.889	
	HRMax	(ppm)	173.2 ± 24.7	175.2 ± 21.4	.771	
	HR60	(%)	20.46 ± 30.1	23.60 ± 34.0	.753	
	HR70	(%)	23.63 ± 21.5	24.64 ± 15.6	.865	
	HR80	(%)	23.89 ± 14.4	31.15 ± 18.5	.087	.43
	HR90	(%)	23.86 ± 20.6	17.15 ± 14.8	.248	.
	HR95	(%)	7.577 ± 8.75	2.642 ± 4.76	.029*	.75
	HR96	(%)	2.504 ± 3.96	0.847 ± 1.81	.080	.58

***** P < .05

****** P < .01

RPE: Carga interna post-esfuerzo; HRMin: Frecuencia cardiaca mínima; HRMed: Frecuencia cardiaca media; HRMax: Frecuencia cardiaca máxima; HR60: Frecuencia cardiaca inferior a 59.9 %; HR70: Frecuencia cardiaca entre 60 y 69.9 %; HR80: Frecuencia cardiaca entre 70 y 79.9 %; HR90: Frecuencia cardiaca entre 80 y 89.9 %; HR95: Frecuencia cardiaca entre 90 y 94.9 %; HR96: Frecuencia cardiaca superior de 95 %.

Además, en las respuestas físicas en estos AF no se observaron diferencias significativas, aunque se apreciaron unos efectos moderados en la distancia total, y en la primera parte del partido, en las variables de distancias recorridas a partir de 18.0 $km \cdot h^{-1}$. Los AF experimentados demandan mayores distancias en dichas variables (*d* > .32).

Tabla 3. Media ± desviación típica de las respuestas físicas en la competición según la experiencia.

			Experimentados (n=63)	No experimentados (n=90)	*P*	*d*
Partido	DT	(metros)	7770.0 ± 2662.9	6589.7 ± 2330.7	.103	.48
Primera parte	VMed	(km/h)	4.96 ± 1.71	4.50 ± 1.55	.315	
	VMax	(km/h)	25.04 ± 4.1	24.97 ± 4.5	.952	
	DT	(metros)	3921.1 ± 1304.4	3536.9 ± 1173.6	.277	
	D1	(metros)	1740.1 ± 300.9	1620.7 ± 206.2	.109	.48
	D2	(metros)	1248.6 ± 539.9	1137.3 ± 500.6	.451	
	D3	(metros)	675.1 ± 465.0	589.7 ± 454.9	.512	
	D4	(metros)	225.1 ± 426.7	135.2 ± 125.2	.325	
	D5	(metros)	106.0 ± 121.7	68.10 ± 81.1	.193	.
	TiempoSP1	(%)	76.78 ± 11.7	78.96 ± 11.1	.501	
	TiempoSP2	(%)	15.88 ± 6.5	14.83 ± 6.2	.561	
	TiempoSP3	(%)	5.74 ± 3.97	4.91 ± 3.96	.454	
	TiempoSP4	(%)	0.99 ± 0.77	0.88 ± 0.83	.617	
	TiempoSP5	(%)	0.57 ± 0.64	0.39 ± 0.50	.259	
Segunda parte	VMed	(km/h)	4.50 ± 1.59	4.16 ± 1.32	.416	
	VMax	(km/h)	24.48 ± 2.9	24.53 ± 2.9	.950	
	DT	(metros)	3856.8 ± 1341.2	3492.4 ± 1106.1	.302	
	D1	(metros)	1853.0 ± 354.9	1695.2 ± 226.5	.066	.56
	D2	(metros)	1175.7 ± 521.7	1081.2 ± 487.3	.512	
	D3	(metros)	585.0 ± 414.6	500.0 ± 347.4	.438	
	D4	(metros)	141.8 ± 132.7	133.4 ± 103.8	.805	
	D5	(metros)	100.2 ± 118.7	82.63 ± 98.9	.573	
	TiempoSP1	(%)	80.20 ± 10.0	82.00 ± 9.5	.520	
	TiempoSP2	(%)	13.81 ± 5.8	13.16 ± 5.5	.687	
	TiempoSP3	(%)	4.60 ± 3.21	4.00 ± 2.8	.479	
	TiempoSP4	(%)	0.86 ± 0.81	0.83 ± 0.62	.877	
	TiempoSP5	(%)	0.51 ± 0.59	0.44 ± 0.52	.640	

DT: Distancia total; VMed: Velocidad Media; VMax: Velocidad Máxima; D1: Distancia recorrida entre 0.1–6.9 $km \cdot h^{-1}$; D2: Distancia recorrida entre 7.0-12.9 $km \cdot h^{-1}$; D3: Distancia recorrida entre 13.0–17.9 $km \cdot h^{-1}$; D4: distancia recorrida entre 18.0–20.9 $km \cdot h^{-1}$; D5: distancia recorrida >21.0 $km \cdot h^{-1}$; TiempoSP1: Tiempo entre 0.1–6.9 $km \cdot h^{-1}$; TiempoSP2: Tiempo entre 7.0–12.9 $km \cdot h^{-1}$; TiempoSP3: Tiempo entre 13.0–17.9 $km \cdot h^{-1}$; TiempoSP4: Tiempo entre 18.0–20.9 $km \cdot h^{-1}$; TiempoSP5: Tiempo >21.0 $km \cdot h^{-1}$.

Por otro lado, se han analizado diversas correlaciones entre respuestas psicológicas previas a la competición y las físico-fisiológicas desarrolladas durante el primer tiempo y durante la totalidad del partido (tabla 4). De esta forma, se observan correlaciones bajas-moderadas positivas entre AC y HRMed, HRMax y RPE (r = .30 a .34; p < .05) y negativas entre CF y HRMed, HRMax, distancias superiores a 13.0 $km \cdot h^{-1}$, HR95 y HR96, sucedidas todas ellas en la primera parte (r = .32 a .58; p < .05).

Tabla 4. Correlación bilateral entre respuestas psicológicas previas a la competición y las respuestas físico-fisiológicas sucedidas en el primer tiempo y el total del partido, controladas por la experiencia.

		AE	AC	AS	CF
	HRMin	-.060	.097	.048	-.048
	HRMed	.019	**.298***	.143	**-.353***
	HRMax	-.051	**.336***	.185	**-.344***
	DT	-.083	.037	.122	-.198
	D1	-.188	.014	.075	-.119
	D2	-.024	.060	.138	-.222
	D3	.127	.091	.262	**-.376***
	D4	-.008	.224	.158	**-.576****
	D5	.164	.060	.149	**-.315***
Primera	SP1	.189	**.332***	.293	-.234
parte	SP2	.281	.213	.202	-.269
	SP3	**.340***	.035	.141	-.274
	SP4	**.299***	.075	.164	-.291
	SP5	.227	.072	.129	**-.348***
	HR60	-.185	-.058	.015	-.036
	HR70	-.263	.010	.119	-.039
	HR80	-.038	.211	.263	-.021
	HR90	.227	.201	.082	-.206
	HR95	.048	.175	.042	**-.375***
	HR96	-.056	.186	-.033	**-.359***
	RPE	.006	**.327***	.081	.012
	HRMin	-.183	.096	.010	.081
Partido	HRMed	-.122	**.335***	.120	-.180
completo	HRMax	-.019	**.344***	.136	-.199
	DT	.260	.084	.129	-.199
	Σ _HR_85_100	-.190	**.293***	.103	-.082

***** P < .05

****** P < .01

AE: Autoestima; AC: Ansiedad cognitiva; AS: Ansiedad somática; CF: Autoconfianza; DT: Distancia total; VMed: Velocidad Media; VMax: Velocidad Máxima; D1 y SP1: Distancia y sprints recorridos entre 0.1–6.9 km·h^{-1}; D2 y SP2: Distancia y sprints recorridos entre 7.0-12.9 km·h^{-1}; D3 y SP3: Distancia y sprints recorridos entre 13.0–17.9 km·h^{-1}; D4 y SP4: distancia y sprints recorridos entre 18.0–20.9 km·h^{-1}; D5 y SP5: distancia y sprints recorridos >21.0 km·h^{-1}; ∑ _HR_85_100: Sumatorio de frecuencia cardíaca entre 85 y 100% de la frecuencia cardíaca máxima.

Finalmente, se llevaron a cabo diferentes regresiones lineales (*stepwise*) entre las variables de experiencia (como variable continua) y las respuestas psico-físico-fisiológicas (tabla 5). Las respuestas psicológicas son predichas por la experiencia del AF entre un 3.4 – 12.4 % (p < .05) de la varianza explicada y las respuestas físicas como distancia total (tanto del partido como de la primera parte), velocidad media, distancia caminando entre 0.1–6.9 km·h^{-1} , sprints superiores a 21.0 km·h^{-1} y sumatorio de distancias a partir de 13.0 km·h^{-1} son predichas por esta experiencia entre un 7.2 – 13.1 % de la varianza explicada (p < .05).

Tabla 5. Modelos de regresión lineal con la experiencia como variable independiente y la edad como covariable.

	Variables dependientes	R^2ajustado	*p*	SEE	Ecuación
Modelo 1	AE %	.112	.000	9.58	AE = 80.588 + (.759·Experiencia)
Modelo 2	AC %	.046	.008	13.45	AC = 55.528 - (.660·Experiencia)
Modelo 3	AS %	.034	.023	13.52	AS = 34.568 + (.563·Experiencia)
Modelo 4	CF %	.124	.000	11.11	CF = 73.107 + (.935·Experiencia)
Modelo 5	DT (Partido completo)	.106	.021	2439.3	DT = 5442.27 + (194.822·Experiencia*)
Modelo 6	Σ _D_345	.090	.036	1265.9	Σ _D_345= 890.51 + (91.564·Experiencia)
Modelo 7	VMed	.085	.038	1.58	VMed = 3.731 + (.111·Experiencia)
Modelo 8	DT (Primera parte)	.092	.030	1200.7	DT = 2937.20 + (87.70·Experiencia)
Modelo 9	D1 (Primera parte)	.089	.034	255.56	D1 = 1516.27 + (18.31·Experiencia)
Modelo 10	D1 (Segunda parte)	.131	.010	289.80	D1 = 1541.5 + (26.09·Experiencia)
Modelo 11	SP5 (Primera parte)	.072	.050	8.76	SP5 = 4.266 + (.558·Experiencia)

AE: Autoestima; AC: Ansiedad cognitiva; AS: Ansiedad somática; CF: Autoconfianza; DT: Distancia total recorrida; ∑_D_345: Suma de distancias mayores de 13.0 km·h^{-1}; VMed: Velocidad media; D1: Distancia recorrida entre 0.1–6.9 km·h^{-1}; SP5: sprints recorridos entre >21.0 km·h^{-1}.

Discusión

El objetivo del presente estudio fue analizar las respuestas psicológicas (AE, AC, AS, CF) en partidos de competición, y las respuestas físicas y fisiológicas de AF semi-profesionales en función de la experiencia. Los resultados mostraron que los AF tienen respuestas psicológicas diferentes en los momentos previos de la competición, en base a su experiencia en el arbitraje. Los AF experimentados poseen menor ansiedad y mayor CF y AE, tanto en valores absolutos como relativos, estando en consonancia con los estudios de Hanton et al. (2008), Muñoz-Arjona y Castillo-Rodríguez (2020) y Rosner (2000), y quienes afirman que los deportistas experimentados ofrecen un mayor control emocional. Estos hallazgos permitirán al AF encontrarse en mejores condiciones para la competición (García et al., 2004), llegando a tomar decisiones con más tranquilidad y seguridad (Weinberg, & Richardson, 1990) y además, evitando que las respuestas fisiológicas próximas al partido (15 primeros minutos) puedan elevarse, provocando una fatiga muscular y un descenso del RF (Mallo-Sainz et al., 2006). En este sentido, los AF no experimentados, desarrollaron menor distancia total en el partido (*d* = .48), lo cual pudiera ser debido a una menor AE (*d* = .96) y CF (*d* = .77), así como un mayor AS (*d* = .64) y AC (*d* = .60). Por ende, este estudio ratifica la conexión entre las respuestas psicológicas y el RF, tal y como afirman Jones y Hanton (1996). Además, los AF no experimentados, tienen escasos registros de AE, estando en coherencia con el estudio de Guillén y Feltz (2011).

Es destacable que los AF experimentados se encuentran más tiempo, realizando más metros y sprints en umbrales superiores a 13.0 km·h^{-1} . Estos hallazgos podrían explicar un mayor RF, al tratarse variables de media-alta intensidad (Mohr et al., 2003) y que la HRMed y HRMax (tanto en el partido como en ambas partes) hayan sido más elevadas, al igual que en HR95 y HR96, en ambas partes. Estos datos fortalecen el efecto producido en la RPE según la experiencia, estando en coherencia con el estudio de Impellizzeri et al. (2004).

Por otro lado, la correlación positiva del primer tiempo entre AE y la cantidad de sprints entre 18.0–20.9 km·h^{-1} , ratifica la importancia de dicha respuesta psicológica en los AF para dirigir partidos, como demostraron anteriormente en el estudio de Muñoz-Arjona y Castillo-Rodríguez (2020), quienes hallaron una alta relación entre AE y RF (*r* = .67; *p*< .01) en el contexto competitivo. Del mismo modo, se observa una correlación positiva entre CA y HRMax tanto en el primer tiempo (*r* = .336) como en el partido (*r* = .344) y entre AC y RPE en el tiempo total (*r* = .327), lo cual invita a pensar que no solo la AS produce alteraciones en los síntomas corporales por la activación del sistema nervioso autónomo (aceleración del ritmo cardiaco, sudoración, etc.), sino que también la AC caracterizada por la capacidad de mantener la concentración, propicia indirectamente por su relación con la AS, cambios fisiológicos, debido a la continua atención demandada por los AF en los partidos. En cambio, se puede podemos observar una correlación negativa entre CF y HRMax, así como con las distancias superiores a 13.0 km·h^{-1} y los sprints realizados por encima de 21.0 km·h^{-1} , es decir, a mayor CF, menores respuestas físico-fisiológicas demandan. Esto puede ser debido a que los AF con CF elevada, realizan una menor exigencia física y fisiológica, debido a su mejor colocación en el terreno de juego siendo esta fundamental para tomar las decisiones correctamente (Mallo & Navarro, 2009). En el mismo sentido, los coeficientes de determinación hallaron una participación reducida de la experiencia (con la edad como covariable) sobre las variables psicológicas y físicas de los AF. Por tanto, esta puede modular mínimamente, el importante estrés físico y alta carga emocional a la que están expuestos los AF en competición (Castagna et al., 2007). De esta forma, nuestros resultados están en consonancia con las aportaciones de Hanton et al. (2008), quienes revelan que la experiencia deportiva propicia un mejor control emocional. No obstante, siguiendo los cauces de Weston et al. (2010), la incidencia de la experiencia en las variables físicas de los AF, puede ser debida a que los árbitros experimentados realizan una mejor gestión de los movimientos y su veteranía le permite estar mejor posicionados.

Este estudio presenta diversas limitaciones. En primer lugar, la ausencia de técnicas cinemáticas antes mencionadas y del Video Arbitraje (VAR). Estas tecnologías son utilizadas únicamente en el fútbol profesional durante estos últimos años. Esto imposibilita que se pueda llevar a cabo una amplia base de datos de registros de temporadas, ya que se trata de un sistema vanguardista y que podría afectar a las respuestas psicológicas en los AF. A tenor

de lo expuesto y como futuras líneas de investigación, se propone la inclusión de metodologías de análisis biomecánico para los AF en la totalidad de competiciones nacionales, con el fin de optimizar su RF y su nivel de acierto. Este último incrementaría con la combinación de técnicas de Scouting para el estudio del sistema de juego de equipos y jugadores (Payyappalli & Zhuang, 2019) y con la implementación de las nuevas tecnologías del VAR a los partidos de las categorías no profesionales del fútbol nacional. La introducción de esta tecnología podría hacer fluctuar las respuestas psicológicas de los AF, en beneficio de la toma de decisiones que se podrían llevar a cabo en la competición oficial, teniendo además un efecto disuasorio que provocará una disminución de faltas y tarjetas, tal y como se analizó en partidos de la Serie A italiana y de la Bundesliga de Alemania (Lago-Peñas et al., 2019). De igual modo, la eficacia de dicha tecnología queda retractada en la Primera División Española, donde se incrementó el índice de acierto un 4.79 % en penaltis (situándose en un 98.24 %) y un 1.11 % en fuera de juego, (obteniéndose un 94.64 %). Dichos datos fueron ofrecidos por el Comité Técnico de Árbitros de la RFEF el 15 de enero de 2019. Por otro lado, la introducción de metodologías biomecánicas y cinemáticas, permitirían realizar un autoanálisis a los AF de su posicionamiento ante la toma de cada una de sus decisiones. Por todo ello, se deduce que ambas herramientas tecnológicas son primordiales para el aumento del nivel de acierto, y la reducción de los índices de ansiedad. Finalmente, se incluye también como limitaciones, la no existencia de información fisiológica previa a la competición, el cual, podría haber ofrecido una aclaración o relación entre las respuestas psicológicas y el estado fisiológico del AF (por ejemplo, 10 minutos antes del calentamiento del partido); se podría haber utilizado la versión de 18 ítems del CSAI-2 (CSAI-2R) recomendado en el estudio de Andrade Fernández et al. (2007); y en el cuestionario sociodemográfico se debería haber incluido información relativa a las ocupaciones laborales y/o académicas.

Como aplicación de este estudio, se recomienda la aplicación de programas de intervención tanto psicológica por parte de psicólogos deportivos como a nivel de preparación física para que ayuden a los árbitros más noveles afrontar la competición, de forma que se pueda coordinar un trabajo psicológico que aborden un RF similar a AF experimentados. Además, teniendo en cuenta la información hallada en este estudio, el Comité de asignación de partidos de competición podría determinar la experiencia como factor a considerar en fases finales o bien en partidos donde compitan por la permanencia o ascenso de categoría, en nuestro caso concreto a 2ª División B.

Conclusión

Los principales hallazgos del estudio mostraron que los AF experimentados poseen mejores características psicológicas (menor respuesta de ansiedad y mayor respuesta en autoconfianza y autoestima) previas a la competición, y además, la experiencia explica hasta un 13% algunas respuestas relacionadas con el RF desarrollado en la competición. La experiencia también predice diversas respuestas psicológicas del AF (hasta un 12% de la varianza explicada)

Referencias Bibliográficas

Ade, J., Fitzpatrick, J., & Bradley, P. S. (2016). High-intensity efforts in elite soccer matches and associated movement patterns, technical skills and tactical actions. Information for position-specific training drills. *Journal of Sports Sciences, 34*(24), 2205–2214. doi:10.1080/02640414.2016.1217343

Andrade Fernández, E. M., Lois Río, G., & Arce Fernández, C. (2007). Propiedades psicométricas de la versión española del Inventario de Ansiedad Competitiva CSAI-2R en deportistas. *Psicothema,19*(1), 150-155.

Atienza, F. L., Moreno, Y., & Balaguer, I. (2000). An Analysis of the Dimensionality of the Rosenberg Self-Esteem Scale in a sample of Valencian Adolescents. *Revista de Psicología, 22(*12), 29-42.

Bačanac, L., Milićević-Marinković, B., Kasum, G., & Marinković, M. (2014). Competitive anxiety, self-confidence and psychological skills in top athletes with and without disabilities: pilot study. *Facta Universitatis, Series: Physical Education and Sport*, 59-70. doi:10.1080/10413209708406488

Bradley, P. S., & Ade, J. (2018). Are Current Physical Match Performance Metrics in Elite Soccer Fit for Purpose or is the Adoption of an Integrated Approach Needed? *International Journal of Sports Physiology and Performance*, 1–23. doi:10.1123/ijspp.2017-0433

Bradley, P. S., Archer, D. T., Hogg, B., Schuth, G., Bush, M., Carling, C., & Barnes, C. (2016). Tier-specific evolution of match performance characteristics in the English Premier League: it's getting tougher at the top. *Journal of Sports Sciences, 34*(10), 980–7. doi:10.1080/02640414.2015.1082614

Casamichana, D., Castellano, J., & Castagna, C. (2012). Comparing the physical demands of friendly matches and small-sided games in semiprofessional soccer players. *Journal of Strength and Conditioning Research, 26*, 837–843. doi:10.1519/JSC.0b013e31822a61cf

Castagna, C., Abt, G., & D'Ottavio, S. (2007). Activity profile of international-level soccer referees during competitive matches. *The Journal of Strength & Conditioning Research, 18*(3), 486-490. doi:10.1519/1533-4287(2004)18<486:APOISR>2.0.CO;2

Castillo-Rodríguez, A., López-Aguilar, J., & Alonso-Arbiol, I. (2020). Relación entre respuestas físico-fisiológicas y psicológicas en árbitros de fútbol amateur. *Revista de Psicología del Deporte*, a head of print.

Chamberlain, S. T., & Hale, B. D. (2007). Competitive state anxiety and selfconfidence: Intensity and direction as relative predictors of performance on a golf putting task. *Anxiety, Stress & Coping, 20*(2), 197-207. doi:10.1080/10615800701288572

Coudevylle, G. R., Gernigon, C. y Martin, K. A. (2011). Self-esteem, self-confidence, anxiety and claimed self-handicapping: A mediational analysis. *Psychology of Sport and Exercise, 12*, 670-675. doi:10.1016/j.psychsport.2011.05.008

Craft, L. L., Magyar, T. M., Becker, B. J., & Feltz, D. L. (2003). The relationship between the competitive state anxiety inventory-2 and sport performance: A meta-analysis. *Journal of Sport and Exercise Psychology, 25*(1), 44-65. doi:10.1123/jsep.25.1.44

Dosil, J. (2002). *The sports psychologist. Advice and intervention.* Madrid: Síntesis

Fernández-Elías, V. E., Gómez-López, M. De la Vega, R., & Clemente-Suárez, V. J. (2017). Physical demands, heart rate response and performance of talent football referees. *Medicina dello Sport, 70*(4), 447-456. doi:10.23736/S0025-7826.17.03076-9

Fernández-García, J. C., Castillo-Rodríguez, A., & Onetti-Onetti, W. (2019). Influencia del sobrepeso y la obesidad sobre la fuerza en la infancia. *Nutrición Hospitalaria, 36*(5), 1055-1060. doi:10.20960/nh.02596

García, A., Estrany, B., & Cruz, J. (2004). How to collect information in psychology of physical activity and the sport: three examples and some considerations? *Cuadernos de Psicología del Deporte, 4*(1-2), 129-151.

Grossbard, J. R., Smith, R. E., Smoll, F. L., & Cumming, S. P. (2009). Competitive anxiety in young athletes: Differentiating somatic anxiety, worry and concentration disruption. *Anxiety, Stress and Coping, 22*(2),153-166. doi:10.1080/10615800802020643

Guillén, F., & Feltz, D. L. (2011). A conceptual model of referee efficacy. *Frontiers in Psychology, 2*, 25. doi:10.3389/fpsyg.2011.00025

Hanton, S., Neil, R., Mellaliu, S. D., & Fletcher, D. (2008). Competitive experience and performance status: An investigation into multidimensional anxiety and coping. *European Journal of Sport Science, 8*(3), 143-152. doi:10.1080/17461390801987984

Impellizzeri, F. M., Rampinini, E., Coutts, A. J., Sassi, A. L. D. O., & Marcora, S. M. (2004). Use of RPE-based training load in soccer. *Medicine & Science in sports & exercise, 36*(6), 1042-1047. doi:10.1249/01.MSS.0000128199.23901.2F

Jafarigilandeh, L., Madani, Y., Khabiri, M., & Golamali Lavasani, M. (2021). The Impact of" Psychological Skills Training" on Sport Success perception of Football Players. Sport Psychology Studies, in press. doi:10.22089/SPSYJ.2021.8890.2022

Jenner, S. L., Devlin, B. L., Forsyth, A. K., & Belski, R. (2019). Dietary intakes of professional Australian football league women's (AFLW) athletes during a preseason training week. *Journal of Science and Medicine in Sport, 22*(11), 1266-1271. doi:10.1016/j.jsams.2019.06.014

Jones, G. (1995). More than just a game: research developments and issues in competitive anxiety in sport. *British Journal of Psychology, 86*(4), 449-478. doi:10.1111/j.2044-8295.1995.tb02565.x

Junge, A., & Feddermann-Demont, N. (2016). Prevalence of depression and anxiety in top-level male and female football players. *BMJ Open Sport & Exercise Medicine, 2*(1), e000087. doi:10.1136/bmjsem-2015-000087

Kais, K., & Raudsepp, L. (2005). Intensity and direction of competitive state anxiety, self-confidence and athletic performance. *Kinesiology, 37*(1). 13-20.

Kaplan, E. (2021). Investigation of heart rate variability parameters and anxiety status of active individuals. *European Journal of Physical Education and Sport Science, 6*(10). doi:10.46827/ejpe.v6i10.3578

Lago-Peñas, C., Rey, E., & Kalén, A. (2019). How does Video Assistant Referee (VAR) modify the game in elite soccer?. *International Journal of Performance Analysis in Sport, 19*(4), 646-653. doi:10.1080/24748668.2019.1646521

Loghmani, M., Taylor, T., & Ramzaninejad, R. (2018). Job characteristics and psychological states of football referees: implications for job enrichment. *Managing Sport and Leisure, 1*, 1-16. doi:10.1080/23750472.2018.1426488

López-Gil, J. F., Camargo, E., & Yuste, J. L. (2020). Adherencia a la dieta mediterránea en escolares de Educación Primaria partícipes en actividad física: una revisión sistemática. *Cultura, ciencia y deporte: revista de ciencias de la actividad física y del deporte de la Universidad Católica de San Antonio, 15*(44), 267-275.

Mallo, J., & Navarro, E. (2009). Análisis biomecánico aplicado a la evaluación del rendimiento técnico de los árbitros y árbitros asistentes de fútbol. *Revista Kronos, 8*(15).

Mallo-Sainz, J., García-Aranda-Encinar, J. M., & Navarro-Cabello, E. (2006). Análisis del rendimiento físico de los árbitros de fútbol durante partidos de competición oficial. *European Journal of Human Movement, 17*, 25-40.

Malone, J. J., Di Michele, R., Morgans, R., Burgess, D., Morton, J. P., & Drust, B. (2015). Seasonal training-load quantification in elite English premier league soccer players. *International Journal of Sports Physiology and Performance, 10*(4), 489–97. doi:10.1123/ijspp.2014-0352

Martens, R., Vealey, R. S., & Burton, D. (1990). *Competitive Anxiety in Sport.* Human Kinetics.

Medina-Cantalejo, L. (2017). Visión del arbitraje profesional en España. En Jiménez-Soto, I. (Eds), *Los retos del deporte profesional y profesionalizado en la sociedad actual* (pp. 173-192). Editorial Reus.

Mellalieu, S. D., Hanton, S., & O'Brien, M. (2004). Intensity and direction of competitive anxiety as a function of sport type and experience. *Scandinavian Journal of Medicine & Science in Sports, 14*(5), 326-334. doi:10.1111/j.1600-0838.2004.00389.x

Mellalieu, S. D., Neil, R., & Hanton, S. (2006). Self-Confidence as a Mediator of the Relationship Between Competitive Anxiety Intensity and Interpretation. *Research Quarterly for Exercise & Sport, 77*(2), 263-270. doi:10.1080/02701367.2006.10599359

Mesagno, C., Harvey, J. T. y Janelle, C. M. (2012). Choking under pressure: The role of fear of negative evaluation. *Psychology of Sport and Exercise, 13*, 60-68. doi:10.1016/j.psychsport.2011.07.007

Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences, 21*(7), 519-528. doi:10.1080/0264041031000071182

Molina, J., Chorot, P., Valiente, R. M., & Sandín, B. (2014). Fear of negative evaluation and self-esteem as predictors of sport performance: The mediational role of anxiety and selfconfidence states. *Cuadernos de Psicología del Deporte, 14*(3), 57-66. doi:10.4321/S1578-84232014000300007

Montesano, P., Di Silvestro, M., Cipriani, G., & Mazzeo, F. (2019). Overtraining syndrome, stress and nutrition in football amateur athletes. *Journal of Human Sport and Exercise, 14*(4), 957-969. doi:10.14198/jhse.2019.14.Proc4.58

Muñoz Arjona, C. & Castillo-Rogríguez, A. (2020). Attitude vs. Aptitude. Effect of psychological responses on soccer referees. *International Journal of Sport Psychology, 51*(1), 69-81. doi:10.7352/IJSP.2019.50

O'Donoghue, P. (2013). *Statistics for sport and exercise studies: An introduction.* New York: Routledge. doi:10.4324/9780203133507

Onetti-Onetti, W., Álvarez-Kurogi, L., & Castillo-Rodríguez, A. (2019). Adherence to the Mediterranean diet pattern and self-concept in adolescents. *Nutrición Hospitalaria, 36*(3), 658-664. doi:10.20960/nh.2214

Owen, A. L., Lago-Peñas, C., Gómez, M. Á., Mendes, B., & Dellal, A. (2017). Analysis of a training mesocycle and positional quantification in elite European soccer players. *International Journal of Sports Science and Coaching, 12*(5), 665–676. doi:10.1177/1747954117727851

Payyappalli, V. M., & Zhuang, J. (2019). A data-driven integer programming model for soccer clubs´decision making on player transfers. *Environment Systems and Decisions, 39*(4), 466-481. doi:10.1007/s10669-019-09721-7

Petersen, C., Pyne, D., Portus, M., & Dawson, B. (2009). Validity and reliability of GPS units to monitor cricket-specific movement patterns. *International Journal of Sports Physiology and Performance, 4*(3), 381-393. doi:10.1123/ijspp.4.3.381

Randers, M. B., Nielsen, J. J., Krustrup, B. R., Sundstrup, E., Jakobsen, M. D., Nybo, L., & Krustrup, P. (2010). Positive performance and health effects of a football training program over 12 weeks can be maintained over a 1#year period with reduced training frequency. *Scandinavian Journal of Medicine & Science in Sports, 20*, 80-89. doi:10.1111/j.1600-0838.2010.01091.x

Rosenberg, M. (1965). *Society and the adolescent self image*. Princeton NJ: Princeton University Press. doi:10.1515/9781400876136

Rosnet, E. (2000). Coping strategies and performance in fencing. *International Journal of Psychology, 35*(3-4), 232-232

Sandín, B., Chorot, P., Lostao, L. y Valiente, R.M. (2012). *Screening del cáncer de mama: Afectación psicológica.* UNED.

Scherr, J., Wolfarth, B., Christle, J. W., Pressler, A., Wagenpfeil, S., & Halle, M. (2013). Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. *European Journal of Applied Physiology, 113*(1), 147-155. doi:10.1007/s00421-012-2421-x

Tanaka, H., Monahan, K. D., & Seals, D. R. (2001). Age-predicted maximal heart rate revisited. *Journal of American College of Cardioly, 37*(1), 153-156.

Walker, A., Arent, M., McFadden, B., & Arent, S. (2019). Physical Performance Testing in Soccer. *Elite Soccer Players: Maximizing Performance and Safety*, 137. doi:10.4324/9780429465536-8

Weinberg, R. S., & Richardson, P. A. (1990). *Psychology of Officiating.* Champaign, IL.: Leisure Press. doi:10.1037/0003-066X.45.12.1325

Weston, M., Castagna, C., Impellizzeri, F. M., Rampinini, E., & Breivik, S. (2010). Ageing and physical match performance in English Premier League soccer referees. *Journal of Science and Medicine in Sport, 13*(1), 96-100. doi:10.1016/j.jsams.2008.07.009

Woodman, T., & Hardy, L. (2003). The relative impact of cognitive anxiety and self-confidence upon sport performance: A meta-analysis. *Journal of Sports Sciences, 21*(6), 443-457. doi:10.1080/0264041031000101809

Woolf, K., Bidwell, W. K., & Carlson, A. G. (2009). Effect of caffeine as an ergogenic aid during anaerobic exercise performance in caffeine naive collegiate football players. *Journal of Strength & Conditioning Research, 23*(5), 1363-1369. doi:10.1519/JSC.0b013e3181b3393b

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CULTURA, CIENCIA Y DEPORTE

Las políticas deportivas en la provincia de Barcelona. La visión de los gestores deportivos municipales

Sport policies in the province of Barcelona. The vision of municipal sports managers

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Resumen

Las actividades físicas y deportivas han sido identificadas por los gobiernos como una prioridad social. Asimismo, las diferentes organizaciones y territorios han sido objeto de estudio para lograr una mayor comprensión de sus procedimientos de actuación. Esta investigación tiene como objetivo analizar la opinión de los gestores deportivos sobre la gestión que se realiza en la provincia de Barcelona, así como identificar posibles vías de progreso. El trabajo empírico se realizó mediante entrevistas cualitativas con un guion preestablecido. El procedimiento de muestreo fue no probabilístico y de conveniencia, y siguiendo el criterio de redundancia, dio como resultado 15 entrevistas a gestores deportivos municipales. Tras el análisis de las entrevistas se ha podido observar cómo se articula la gestión deportiva municipal en el territorio, así como las posibles mejoras a desarrollar en un futuro próximo. Entre ellas destacan la necesidad de una mayor planificación de gestión deportiva, el desarrollo de herramientas de control y seguimiento, la mejora en la fluidez de los procesos administrativos, el incremento en la inversión en infraestructuras deportivas, la regulación de las actividades al aire libre, una mayor dotación de ayudas a los colectivos más desfavorecidos y la colaboración con otras áreas del propio ayuntamiento.

Palabras clave: Gestión deportiva, Políticas deportivas, Barcelona, entrevistas en profundidad.

Abstract

Physical and sports activities have been identified by governments as a social priority. Likewise, the different organisations and territories have been the object of study to achieve a better understanding of their operating procedures. This research aims to analyze the opinion of sports managers about the management carried out in the province of Barcelona, as well as to identify possible ways of progress. The empirical work was carried out through qualitative interviews with a pre-established interview outline. The non-probabilistic and convenience sampling procedure, and following the redundancy criterion, resulted in 15 interviews with municipal sports managers. After analyzing the interviews, it has been possible to observe how municipal sports management is articulated in the territory, as well as the possible improvements to be developed in the near future. Such as the need for a greater use of sports management plans, the development of control and monitoring tools, the improvement in the fluidity of administrative processes, the increase in investment in sports infrastructure, as well as the regulation of the outdoor activities, the greater provision of aid to the most disadvantaged groups and collaboration with other areas of the council itself.

Keywords: Sports management, Sports policies, Barcelona, Interviews in depth.

Introducción

Es ampliamente reconocido que la práctica de actividades físicas y deportivas tienen beneficios físicos, psicológicos y sociales (Rasciute & Downward, 2010; World Health Organization, 2019). En base a estos beneficios, la gestión de las actividades físicas y deportivas (promoción, inversión y evaluación) han sido y serán una prioridad social que han recogido en su normativa los diferentes gobiernos centrales y locales (Downward & Rasciute, 2010), así como la propia Unión Europea (García, 2006; Husting, 2006).

Desde el punto de vista de la investigación social, el deporte y la actividad física han sido objeto de estudio para interpretar la propia realidad social, las interrelaciones entre las diferentes variables del sistema deportivo y de los mecanismos que explican los cambios de la población con respecto al deporte y a los hábitos de una actividad física y recreativa (Alexander & Bossio, 2006).

En términos generales, Dallmeyer et al. (2018) advirtieron como la mayoría de las investigaciones se han centrado en las políticas públicas deportivas y la participación en el deporte. Asimismo, respecto a las políticas públicas, aunque en menor medida, los servicios deportivos municipales también han sido objeto de estudio desde diferentes perspectivas (Arboledas & Puig, 2012).

En ese marco, dada la relación directa entre el servicio deportivo municipal y sus gestores (Auré, 2015), se cree que una comprensión directa de sus procedimientos de actuación puede contribuir a establecer diagnósticos que ayuden a mejorar su gestión.

De esta manera y atendiendo al objeto teórico de este estudio desde una perspectiva interna, en el presente artículo se plantea una investigación cualitativa y exploratoria que involucra a los gestores deportivos de los servicios deportivos municipales de la provincia de Barcelona, para que transmitan su visión sobre la gestión deportiva municipal que se desarrolla en el territorio.

En consecuencia, y gracias a esta visión de los expertos, se espera que los resultados del estudio puedan contribuir a una mejor y más profunda comprensión de la gestión deportiva pública en la provincia de Barcelona, así como apuntar elementos para su mejora. Entendemos pues, que por las características del territorio y su tradición deportiva dicho análisis pueda ser una referencia o, si más no, de utilidad para otros gestores deportivos que desarrollan su responsabilidad de gestión en otros servicios municipales. En este sentido, Hartley (2008) apuntaba que el intercambio de conocimiento es fundamental para la mejora de los servicios públicos, ya que el objetivo del conocimiento es agregar valor en el ámbito público.

Contextualización

La implementación de las políticas deportivas municipales se conoce como "un proceso en continua interacción en el que la administración local realiza una actuación mediante la puesta en práctica o implementación de unas decisiones tomadas por el poder político, las cuales conducirán a unos resultados y, en consecuencia, a un impacto social determinado" (Burriel, 1994, p.1).

En España, los ayuntamientos, con el apoyo de instituciones supramunicipales (Diputaciones y gobiernos autónomos principalmente), se han esforzado a lo largo de los años para promover el deporte entre la población (García & Barata, 2016). Gracias a estos esfuerzos, en el periodo 1995-2005 se estabilizaba el crecimiento de la práctica deportiva en el conjunto de España y se atendía a las diferencias en función de las variables de género, edad, nivel de instrucción y clase social (Puig & Camps, 2020, p. 112).

Si bien es difícil atribuir dicha responsabilidad únicamente a las instituciones, dando un repaso a la legislación vigente española, llegaremos a la conclusión de que los municipios gozan de una autonomía absoluta en cuanto al fomento de la práctica deportiva se refiere, sin más limitaciones que su voluntad política y sus recursos (Lacoba, 2006). Este principio que ya se recoge en la Constitución Española y que las leyes desarrollan después (Ley de Bases del Régimen Local, Leyes autonómicas municipales y del deporte, etc..) queda lo suficientemente abierto en su desarrollo normativo como para que cada municipio pueda adaptarse a su realidad en función de su cultura, sus prioridades o sus recursos (Lacoba, 2006).

De esta manera, los gestores deportivos tienen la doble misión de hacer que la organización deportiva en la que trabajan sea eficiente y promueva actividades físicas y deportivas de calidad para el mayor número de personas de forma inclusiva (Freitas et al., 2017). Así pues, estos se postulan como uno de los principales responsables de la gestión de las actividades físicas y deportivas municipales (Avila et al., 2019; Freitas et al., 2017).

Como se mencionaba en la introducción, en los últimos años no únicamente se han descrito las políticas deportivas públicas, sino que se analizan, se comparan y se proponen alternativas que las hagan más eficientes en su ámbito de actuación. "En relación con el estudio de las organizaciones públicas, se han observado dos clases de investigaciones. Por un lado, aquellas investigaciones que intentan extraer una serie de conclusiones sobre el cómputo general de la organización, analizando las diferentes áreas claves para su gestión bajo el mismo objeto de estudio. Por otro lado, aquellas que profundizan en aspectos concretos sobre un área de su gestión" (Arboledas & Puig, 2012, p. 2).

Respecto a las investigaciones que han analizado las principales variables del sistema deportivo, se observa como este análisis se ha llevado a cabo desde multitud de dimensiones o áreas como la dotación de instalaciones deportivas, la oferta deportiva, los recursos humanos y económicos (Gallardo, 2002), la información y la comunicación, la cultura organizativa, los antecedentes a la creación del servicio, las medidas relativas al desarrollo sostenible y las relaciones que los servicios municipales mantienen con otras organizaciones (Diputación de Barcelona, 2011).

A este respecto, Burriel (1994), Celma (2003) y Senlle et al. (2004) anticipaban que los principales elementos y factores que se han de tener en cuenta al analizar el sistema deportivo municipal son, por un lado, los factores internos del propio sistema: entidades, practicantes, infraestructura deportiva, ordenamiento jurídico-deportivo, recursos humanos y económicos, servicios y actividades; y por otro lado, se debe considerar aquellos sistemas que se relacionan con el deporte y condicionan su desarrollo, tales

como el sistema económico, social, demográfico, político, cultural y legal (adaptado de Arboledas & Puig, 2012).

En el presente trabajo se pretende analizar la opinión de los gestores deportivos sobre la gestión que se realiza en la provincia de Barcelona, así como la identificación de posibles caminos para su progreso. En consecuencia, y de manera más especifica se pretende:

(1) identificar los ejes fundamentales en que se asienta la gestión deportiva municipal,

(2) determinar la existencia y la utilización de elementos básicos de planificación,

(3) conocer cómo se da la participación ciudadana en la gestión,

(4) reconocer como se realiza la gestión de la información y la comunicación,

(5) averiguar su opinión respecto a los marcos normativos,

(6) conocer los criterios para el control de las entidades y la evaluación de servicios,

(7) identificar las acciones implementadas para la popularización del deporte,

(8) conocer lo que puede o necesita mejorar.

Diseño del estudio

Con la intención de abordar los objetivos anteriormente expuestos se adoptó un enfoque cualitativo, exploratorio y descriptivo.

Participantes y ámbito de estudio

El estudio que se presenta se ha desarrollado en Cataluña (la segunda comunidad autónoma más poblada de España según el Instituto Nacional de Estadística (2018). Se ha centrado en 15 municipios de la provincia de Barcelona. Se decidió llevar a cabo la investigación en la provincia de Barcelona debido a que esta y sus alrededores son una referencia deportiva, pues después de los Juegos Olímpicos de Barcelona en 1992, la ciudad ha sido frecuentemente citada como un ejemplo del legado y del modelo de gestión (Solanellas et al., 2017). Además, Barcelona, a lo largo de los años ha sido una ciudad líder en hábitos deportivos. Por ejemplo, fue la tercera ciudad a nivel mundial en práctica deportiva (Elasri et al., 2015), y la ciudad europea con más ciudadanos apuntados a un centro deportivo (Soler, 2012).

Para llevar a cabo el estudio se decidió por un procedimiento de muestreo no probabilístico y de conveniencia (Kotler & Keller, 2015). Además, el número de gestores entrevistados fue establecido de acuerdo al criterio de redundancia o saturación, es decir, las entrevistas fueron realizadas hasta que se percibió que las ideas se repetían, sin añadir nuevas informaciones al estudio (Guest et al., 2006). Con la intención de contemplar las diferentes realidades de la gestión deportiva de la provincia de Barcelona se tuvieron en cuenta distintos criterios para seleccionar a los gestores deportivos a entrevistar. Entre estos criterios se tuvo en cuenta las características de los municipios, como, por ejemplo, el tamaño de población (municipios con hasta 20.000 habitantes, de 20.001 a 50.000, de 50.001 a 100.000, de 100.001 a 900.000 y municipios con más 900.001 habitantes), diferentes modelos de gestión y municipios que han desarrollado buenas prácticas (que hayan recibido premios y certificaciones reconocidas).

El desenlace del procedimiento de muestreo y del trabajo de campo dio como resultado un tamaño de muestra de 15 gestores deportivos – *directores del departamento del servicio municipal*. Todos hombres, entre 41 y 65 años (2 de ellos no informaron de su edad). 11 de ellos tenían más de 20 años de experiencia en gestión deportiva, 2 tenían entre 12 y 20 años y 1 tenía cuatro años de experiencia (1 de los gestores no informó de su tiempo de experiencia).

En la Tabla 1 se muestra los municipios seleccionados, así como información sobre la superficie (Km^2), la población (nº habitantes) y la comarca a la que pertenecen.

Tabla 1. Municipios seleccionados

	Municipio	Superficie (Km²)	Población	Comarca
1	Barcelona	101,4	1.664.182	Barcelonès
2	L'Hospitalet de Llobregat	12,4	269.382	Barcelonès
3	Sabadell	37,8	216.520	Vallès Occidental
4	Mataró	22,5	129.661	Maresme
5	Sant Cugat del Vallès	48,2	92.977	Vallès Occidental
6	Viladecans	20,4	67.197	Baix Llobregat
7	Castelldefels	12,8	67.460	Baix Llobregat
8	Granollers	14,9	62.419	Vallès Oriental
9	Esplugues de Llobregat	4,6	47.150	Baix Llobregat
10	Barberà del Vallès	8,3	33.334	Vallès Occidental
11	Premià de Mar	2,1	28.531	Maresme
12	Sant Vicenç dels Horts	9,1	28.268	Baix Llobregat
13	Les Franqueses del Vallès	29,1	20.364	Vallès Oriental
14	Calella	8	19.277	Maresme
15	Torrelles de Llobregat	13,5	6.073	Baix Llobregat

Fuente: Instituto de Estadística de Cataluña (Idescat). Densidad de población.

Disponible en https://www.idescat.cat/pub/?id=aec&n=925&lang=es. Acceso el 29.03.21

Instrumento y procedimientos para el registro de datos

Se realizaron entrevistas semiestructuradas en profundidad (Flick, 2009) puesto que una de las más destacadas ventajas de este método es que no se somete a limitaciones espacio temporales (Heinemann, 2008) es decir, permite preguntar por hechos pasados, comportamientos típicos, y también por situaciones planificadas para el futuro, así como por previsiones profesionales.

Las entrevistas se dividieron en dos partes. La primera parte consistía en obtener datos de los municipios (entidad responsable de la gestión deportiva, número de instalaciones deportivas, número de trabajadores que actúan en el área de gestión deportiva y número de eventos realizados en 2017, así como datos del propio gestor). En la segunda parte de la entrevista se utilizó un guion de entrevista semiestructurado compuesto por 17 preguntas. Las dimensiones del estudio fueron fijadas previamente a la realización de las entrevistas, y su selección se hizo bajo el criterio de los investigadores, puesto que se consideró que permitirían abordar los objetivos de la investigación. Además, en algunos casos, fue necesario complementar los argumentos con preguntas secundarias con la intención de ampliar la comprensión sobre los temas abordados.

Las entrevistas fueron realizadas por el segundo autor entre el 21 de noviembre de 2018 y el 22 de febrero de 2019, programadas y realizadas en lugares escogidos por los entrevistados y de acuerdo con la conveniencia de sus agendas. Con el consentimiento de los participantes (Creswell, 2007), todas las entrevistas fueron grabadas en audio.

Las entrevistas tuvieron una duración aproximada de 50 minutos. Considerando lo previsto en el Consentimiento Informado, y para proteger la identidad de los gestores, serán identificados de ahora en adelante por letras y números, por ejemplo, G1, G2, ... G15 (la secuencia de la numeración de los gestores no es la misma utilizada en los municipios de la Tabla 1).

El enfoque de análisis de datos se basó en los procedimientos metodológicos recomendados por (Bardin, 2009):

a) Pre-análisis: Todas las grabaciones fueron transcritas utilizando el Software *VoiceMeeter* y posteriormente pasadas por una conferencia de confianza para evitar distorsiones. Tras la transcripción de las entrevistas, las informaciones fueron cuidadosamente organizadas, extrayendo los resultados más relevantes para la investigación. En este proceso se identificaron las unidades de significado presentes en los discursos de los gestores.

b) Explotación del material: se realizó a partir de la codificación, enumeración y clasificación de los datos. Posteriormente se realizó el aislamiento de los temas extraídos de las entrevistas, para abordar los objetivos del estudio.

c) Tratamiento de los datos: se realizó la inferencia e interpretación, es decir, a partir de los datos válidos más significativos, se buscó indicar tendencias, generalizaciones y destaques.

Resultados

El examen de las 8 dimensiones objeto de estudio permitió elaborar la (Tabla 2) en la que se presentan los principales resultados obtenidos de la investigación. En esta, se muestran las principales prácticas que se llevan a cabo desde el servicio de deportes municipal de los municipios de la muestra, así como los posibles elementos de mejora identificados por los gestores deportivos. En el resto de esta sección se describe con mayor detalle los discursos de los gestores deportivos con el objetivo de lograr una mayor comprensión de los temas abordados.

Tabla 2. Principales prácticas llevadas a cabo en lo Servicio Municipales de Deportes y los posibles elementos de mejora.

Dimensiones de estudio	Procedimientos comunes		(8) Elementos de mejora destacados por los gestores
(1) Ejes fundamentales de la gestión deportiva municipal.		• Deporte para todos. • Apoyo a entidades locales. • Instalaciones deportivas.	• Mayor mantenimiento y ampliación de las instalaciones deportivas. • Regulación del deporte al aire libre.
(2) Elementos básicos de planificación.	Sí (9 gestores):	• De acuerdo a los Planes de Actuación Municipal y el Plan de Equipamientos Deportivos. • Disponibilidad en la página web con el objetivo de cumplir con la Ley 19/2013, de 9 de diciembre de transparencia, acceso a la información pública y buen gobierno.	• Desarrollo de herramientas de control y seguimiento de la gestión operativa vinculado con la planificación estratégica. • Mayor comunicación del plan estratégico tanto interna como externamente.
	No (6 gestores):	• En elaboración y en compromiso con el Plan de Actuación Municipal.	• Creación, actualización y/o mayor utilización de planes de gestión deportiva.
(3) Participación ciudadana en la gestión.	Mecanismos principales:	• Contacto directo con las entidades. • Consejos y mesas de trabajo.	• Mejora en la formalidad de la participación ciudadana. • Cooperación entre entidades.
	Mecanismos secundarios:	• Encuestas de evaluación. • Barómetro. • Buzón de quejas y sugerencias. • Reuniones con gobernantes. • Comisiones de participación ciudadana.	
(4) Gestión de la información y la comunicación.	Mecanismos principales:	• Página web del ayuntamiento. • Redes Sociales (twitter, Facebook e Instagram).	• Explotación de otros canales (por ejemplo: televisión y radio municipales). • Ruedas de prensa para actividades puntuales. • Mejora de la comunicación corporativa y la exclusividad del servicio de deportes municipal.
	Mecanismos secundarios:	• Revistas impresas. • Impresos. • Calendarios o agendas de deportes.	
(5) Marcos normativos.		• Formación a los diferentes agentes implicados. • Facilitación mediante personal de apoyo. • Flexibilización de procedimientos.	• Adaptación a las nuevas normativas (falta de profesionalización en las entidades deportivas). • Disminución de la burocracia. • Mejora de la fluidez en los procesos.
(6) Control de las entidades y la evaluación de servicios.		• Comisiones de seguimiento. • Convenios y normativas para las subvenciones. • Indicadores. • Supervisión personal. • Baremos que determinan la cantidad de subvención a recibir.	• Control más exhaustivo de las entidades. • Desarrollo de un sello de calidad. • Falta de regulación legal de las profesiones del deporte.
(7) Popularización del deporte.	Mecanismos principales:	• Política de precios sociales. • Política de becas o cuotas subvencionadas.	• Desarrollo de un programa de tarificación social. • Mayor colaboración con otras áreas del propio ayuntamiento (como por ejemplo los Servicios Sociales).
	Mecanismos secundarios:	• Equipamientos públicos al aire libre. • Subvenciones a entidades para programas de inclusióon de escolares con dificultades socioeconómicas. • Programas y actividades de otros sectores (Centros Cívicos y Asociaciones de Vecinos) y cooperación con Fundaciones. • Programas y actividades propios.	

(1) Ejes fundamentales de la gestión deportiva

Tras el análisis del contenido de los discursos de los gestores deportivos entrevistados, en referencia a los ejes fundamentales en los que se asienta la gestión deportiva municipal, se observó una clara tendencia hacia tres temas principales: el deporte para todos, el apoyo a las entidades locales y las instalaciones deportivas.

En el eje deporte para todos se incluyeron todas las menciones de los gestores hacia la facilitación de acceso al deporte, como, por ejemplo: deporte como instrumento de cohesión social, el deporte en los barrios y en la calle, equidad territorial, promoción del deporte al aire libre, actividades no competitivas, deporte gratuito y accesible para todos, inclusión y la integración de personas discapacitadas.

Respecto al apoyo a las entidades, el G12 expuso: "*Con las entidades es una relación prácticamente diaria y cotidiana, es un trato muy directo*". Este hecho fue identificado en los discursos de prácticamente todos los gestores, conforme se ejemplifica seguidamente:

> *"Somos una ciudad muy activa, todos los clubs colaboran en las actividades, a menudo lo que nosotros hacemos es coorganizar con ellos las actividades que ellos quieren hacer y les ayudamos".* (Gestor 10)

A pesar de algunos problemas, los gestores apuntaron a la red de instalaciones como uno de los pilares del sistema deportivo, el G8 sostuvo que: "*la red de instalaciones deportivas es fundamental, hay que seguir manteniéndola*", incluyendo más recientemente los equipamientos al aire libre:

> *"Deporte al aire libre cada día coge más importancia" … "No es tan importante tener un gran pabellón deportivo, un gran campo de fútbol, si la ciudad permite la práctica deportiva en la orilla del mar y tienes espacios para caminar con garantías, conocer la montaña… la idea un poco es darle valor a todo esto".* (Gestor 11)

Concordando con lo mencionado por el G11, vemos como actualmente, el deporte ha quebrado las fronteras, ha salido de las instalaciones deportivas y ha ocupado las calles, parques, plazas y la misma naturaleza.

> *"Crecer en instalaciones deportivas es difícil, no hay dinero, las instituciones no te dan subvenciones, no podemos comprometer millones para hacer grandes actuaciones deportivas, pero sí que podemos poner en orden el contexto al aire libre…".* (Gestor 11)

En lo expuesto hasta el momento, de alguna forma, el G6 expresó la integración de los 3 pilares fundamentales (deporte para todos, entidades e instalaciones) en su discurso: "*Los programas que hacen la Oficina son muy accesibles y democratizados, las instalaciones deportivas convencionales están todas cedidas en los horarios de máximo uso a las entidades desde las 5 de la tarde hasta las 12 de la noche*".

(2) Utilización de elementos básicos de planificación

Cuando los gestores deportivos fueron preguntados sobre la existencia de un plan de gestión en materia de actividad física y deporte, nueve gestores indicaron que sí y seis que no. En esta pregunta se trató también del período de cobertura, de quién participó en la elaboración, y si el documento está publicado y disponible para el público en general en la web.

Conforme lo expresado por el G11, los Planes de Equipamientos Deportivos, documento por el cual se rigen los gestores deportivos para elaborar la estrategia del Servicio de Deportes Municipal, no tratan tan solo de equipamientos y en general también tienen la finalidad de conocer y analizar el sistema deportivo municipal.

"*Es un documento que gobierne quien gobierne sirve de referencia para el futuro*"

G1 – "*Se llama Plan de Gestión Municipal. Cada 4 años, cuando hay elecciones, se elabora un plan de actuación municipal en el cual se fijan los ejes de gobierno municipal. A partir de ahí elaboramos una serie de indicadores que vamos comprobando conforme se van cumpliendo cada uno de los objetivos, el Plan de Actuación Municipal, el PAM. Este se lleva en paralelo al PIM, que es el Plan de Inversión Municipal*".

Otro aspecto relevante es que la mayoría de los gestores que utilizan planes mencionaron que los mantienen disponibles en la página-web del ayuntamiento. Por ejemplo, el G1 mencionó que en estos momentos están trabajando para seguir las directrices de la Ley 19/2013, de 9 de diciembre, de transparencia, acceso a la información pública y buen gobierno.

Sin embargo, como se ha mencionado anteriormente, el 40% de los gestores entrevistados mencionaron no tener disposición de un plan estratégico. No obstante, como ejemplifica el discurso del G10, la gran mayoría de Servicios de Deportes Municipales se encontraban en fase de revisión y desarrollo.

> G10 - *"Por la parte política, cuando nosotros entramos al gobierno nuestro compromiso es con el Programa de Actuación Municipal, que presentamos en las elecciones" … "La parte técnica tiene su planificación, a veces es más caótica de lo que parece, pero bueno, nosotros sabemos lo que queremos hacer, lo que debemos hacer y cuando lo debemos hacer…".*

Asimismo, del 60% de municipios que disponían de un plan de gestión deportiva, se pudo comprobar como no existiría un único criterio de presentación de este e incluso no quedaba claro la comunicación que se realizaba del mismo. En este sentido, parece una clara línea de mejora el establecer un único criterio de presentación de planes de gestión que permita compararlos entre municipios al mismo tiempo que les ayude a avanzar en sus políticas deportivas.

(3) Participación ciudadana en la gestión

Preguntados sobre la manera que los ciudadanos participan en la gestión municipal de deportes, los gestores evidenciaron primeramente el contacto directo con las entidades, los consejos y las mesas de trabajo (sectoriales y mesa general de entidades). Las otras vías de participación mencionadas fueron: encuesta de evaluación, el barómetro, buzón de quejas y sugerencias, reuniones con los gobernantes, comisiones de participación ciudadana, existencia de un órgano en el ayuntamiento y el voluntariado. El G4 enfatizó algunos factores clave de la participación, destacando el papel de la ciudadanía en la nueva gobernanza:

> *"La ciudadanía no solo opina el día que votan el día de las elecciones, sino que hay diversidad de líneas e instrumentos para participar en la gestión, es la nueva gobernanza, es la idea de que la ciudadanía, a través de los consejos, a través de las quejas, de las sugerencias, de las reuniones con los gobernantes, van modelando poco a poco esos 4 años"* (Gestor 4)

Respecto al proceso participativo, G8 indicó que aún necesita de avances, cuando lo compara a países como Suiza. Este entrevistado añadió que *"es un tema que nos preocupa e intentamos mejorar", pero destaca que "la participación es un desafío"*.

Tratando el papel de las entidades, G6 evidenciaba que *"el gran peso es la participación de las entidades, que son muchas"* y G15 destacó el papel de las mesas directivas de deportes, que tienen la participación de representantes de las entidades.

Una de las formas institucionalizadas de participación en la gestión ocurre a través de los consejos sectoriales de políticas deportivas, sobre esta afirmación, el G8 afirmaba que: *"hay un conjunto, que configuran el consejo municipal de deportes"* y G6 destaca que el consejo de participación está desequilibrado, muchas entidades, y por ejemplo pocas escuelas.

Otros mecanismos de participación elementales fueron citados. El G15 mencionó que *"dentro de cada instalación tenemos un buzón de quejas y sugerencias"* y G1, como ejemplo, citó el barómetro, que es una encuesta de evaluación de uso para saber la apreciación que el ciudadano tiene.

El G9 apuntó que existe un órgano del ayuntamiento con participación de civiles, destacando que "*el reglamento de uso de las instalaciones se creó a través de un proceso participativo con usuarios, con trabajadores y con entidades*". El G7 enfatizó un resultado importante obtenido en su municipio a partir de procesos de intercambio y participación de la ciudadanía:

> *"Por ejemplo, en el ámbito del fútbol…, hemos conseguido que las 13 entidades que trabajan el fútbol en la ciudad firmen un decálogo de actuación conjunto… y esto lo han pactado entre ellos, con nosotros como mediadores".*

Algunos gestores resaltaron que la participación ciudadana es un tema que merece más atención, como por ejemplo el G12, cuando mencionaba que el Consejo Municipal

Deportivo tiene una reunión al año, que *"es más bien formal y me parece poco efectiva"*.

(4) Gestión de la información y la comunicación

En síntesis, respecto esta dimensión, se observó una predominancia del uso de la página-web del ayuntamiento, seguido de la utilización de redes sociales, con mayor mención al Twitter, Facebook e Instagram, respectivamente. Las Revistas (municipales o locales) impresas o disponibles en la página web, los impresos en general y los calendarios y agendas de deportes aparecen como un segundo bloque de opciones en materia de comunicación. Fueron mencionadas apenas una vez a la televisión y la radio municipal, así como, las ruedas de prensa para actividades más puntuales e importantes.

El proceso de difusión de la información fue descrito como sigue:

> *"Las entidades, por ejemplo, cuando hacen alguna actividad extraordinaria, también nos envían la programación y nosotros ya nos encargamos de ponerlo en internet, de ponerlo a las pantallas, de ponerlo en las carteleras y luego en las Redes Sociales del Ayuntamiento, tiene el Facebook, Twitter y el Instagram y esto lo tenemos centralizado en un Departamento de Comunicación, nosotros no lo gestionamos, les pasamos a ellos la información y ellos la publican"*. (Gestor 12)

De modo similar el G1 indicó que hay un equipo de especialistas en comunicación e imagen del ayuntamiento, y que *"toda imagen es consensuada desde alcaldía como una imagen única para no separarnos de la imagen municipal"*, este procedimiento no fue consensuado entre los demás gestores.

Analizados los discursos de los gestores, sintéticamente indican la necesidad de mejora, especialmente respecto a la utilización de las redes sociales, debido a la necesidad de adaptación a la realidad actual.

(5) El marco normativo

Los gestores deportivos señalaron la existencia de las muchas dificultades con las que se encuentran debido al marco normativo. En síntesis, pudimos comprobar que la preocupación se haya principalmente en la lentitud de los procesos y en las quejas de las entidades, especialmente de las pequeñas.

> *"Una locura... cada vez tenemos marcos más restrictivos"... "Ha cambiado la Ley de Contratos, tenemos que asumirlo y adaptarnos a la nueva legislación y esto es una locura para nosotros"... "Somos muy lentos en la implantación de cualquier cosa"* (Gestor 1)

De hecho, esto parecía un tema crítico y que preocupa a la mayoría de los gestores. Muchos atribuyeron las debilidades a un momento de transición y adaptación a las nuevas normativas, y adicionalmente al espíritu aficionado de algunas entidades ya que muchas son administradas por voluntarios.

> *"Ahora por ejemplo estamos cerrando todo el proceso de la convocatoria de subvenciones, para una entidad pequeña, que son la gran mayoría de las 200 que tenemos en el municipio. Rellenar y cumplir todos los requisitos es muy costoso y muchas dicen que tienen que perder demasiado tiempo y esfuerzo para cumplir todo lo que estáis pidiendo y para tener una subvención de 500 euros".* (Gestor 7)

Por otra parte, con la intención de cumplir con todas las normativas, se buscan alternativas, como, por ejemplo: la formación de los principales agentes involucrados, la facilitación y la flexibilización de procedimientos.

> *"Pero los trámites hay que hacerlos. Es lo que está marcado por las normativas" ... "Intentamos facilitarlos poniendo profesionales que les ayuden. Además, hemos abierto una oficina de atención a las entidades para facilitar estos procedimientos"* (Gestor 7)

Este gestor, atribuía el exceso de normativas al pasado de corrupción: "*Nos quejamos continuamente de la burocracia de la gestión de la administración ... quizás por los antecedentes que tenemos en este país de corrupción*".

Al comentar sobre problemas a nivel de trámites administrativos el G15 adicionalmente destacó la lentitud de los procedimientos:

> *"Cuando hay algún incumplimiento de alguna normativa y hay que sancionar alguna entidad o alguna persona" ... "Hay un proceso administrativo que es muy lento, son unos trámites que son muy largos y eso para mí es lo más complicado".*

(6) Criterios de control de las entidades y la evaluación de servicios

Cuando los gestores fueron preguntados sobre los ejes fundamentales en los que se asienta la gestión deportiva municipal, apuntaron claramente el apoyo a las entidades. Así, cuando preguntamos respecto a qué criterios se siguen en el control de las entidades, los gestores mencionaron que lo hacen principalmente mediante: comisiones de seguimiento, normativas para subvenciones, manual de cuadro de mandos (indicadores), sello de calidad (en desarrollo), supervisión personal y baremos. Según lo observado en el contenido de las entrevistas, se observa similitud en algunos procedimientos adoptados, como se ejemplifica con el discurso de algunos gestores:

> *"Tenemos las normativas de las subvenciones que delinea bastante los criterios que se valoran para poder conceder las subvenciones"* (Gestor 9)

> *"Firmamos convenios con entidades y los participantes deben seguir las normativas de la ordenanza municipal de instalaciones"* (Gestor 3)

En algunos municipios se observa una preocupación con este tema, con especial mención a las comisiones de seguimiento y supervisión, por ejemplo:

> *"Nosotros tenemos por un lado comisiones de seguimiento de lo que realmente está estipulado en contrato"* ... (Gestor 1)

Sin embargo, se trata de una parcela que algunos de los entrevistados revelaron tener una menor preocupación hacia este tema o indican dejarlo a cuenta del mercado:

> *"De hecho es una asignatura pendiente" ... "Ahora mismo tenemos pendiente de cómo fiscalizar el trabajo deportivo de los clubes, no creemos que tenga que pasar que cada club pague lo que quiera"* (Gestor 11)

En relación con las exigencias, los gestores mencionaron que las entidades deben estar registradas (Registro

Municipal de Entidades), deben tener una sede social, una infraestructura básica, una póliza de responsabilidad civil y un arraigo en el municipio. Los deportistas han de tener un seguro y, en pocos casos, fue mencionado que los entrenadores tienen que estar titulados. En algunos casos, fueron mencionadas exigencias que pueden determinar la cantidad de subvención que la entidad va a recibir.

> *"Nosotros tenemos un baremo, que analiza cuantas fichas federativas, cuantas fichas femeninas, en que categoría está, cuantos entrenadores con titulación, y eso determina la cantidad de euros (subvención) que la entidad va a recibir"* (Gestor 14)

La falta de regulación legal de las profesiones del deporte puede representar una amenaza para la calidad del sistema deportivo. Cuando fueron preguntados respecto la exigencia de formación de los profesionales, no se identificó un consenso en el discurso de los gestores:

> *"Si quieren recibir subvenciones los entrenadores tienen que estar titulados"* (Gestor 2)

> *"¿Formación básica? … no, no, eso va a posterior"* (Gestor 12)

Si partimos de la premisa del deporte como un bien colectivo y un servicio público, es imprescindible que existan mecanismos de control y combate contra las prácticas corruptas. Así, los gestores apuntaron que este tema suscita mayor preocupación por parte del sector.

> "*Hay mucha trampa" … "Lo que no se puede hacer es que, bajo el paraguas de entidad deportiva, camuflar una actividad económica con ánimo de lucro… "Sí que tienen ánimo de lucro" … "Hay que ser muy cuidadoso, pues muchos clubes son verdaderas empresas" … "Hay que ser muy escrupuloso para saber realmente qué beneficios aporta esto y a quién, o qué coste tiene realmente y si se revierte los beneficios de esta práctica deportiva"* (Gestor 13)

Los discursos de los gestores evidencian la necesidad de que el control de las entidades sea objeto de debate colectivo del sector, especialmente con la intención de mantener el sentido público del servicio deportivo.

En cuanto a la evaluación de los servicios, la mayoría de los gestores apuntó que utilizan mecanismos para evaluar la satisfacción de los usuarios. Los instrumentos y mecanismos más utilizados son: encuestas y cuestionarios de satisfacción, la detección de problemas a partir de la relación directa con usuarios, la encuesta de satisfacción de la DIBA (Diputación de Barcelona), el Barómetro y reclamos en la WEB.

> *"Utilizamos cuestionarios de satisfacción, pero nuestro indicador principal es que las actividades están todas llenas" … "También tenemos los cuestionarios de la Diputación de Barcelona que manda aleatoriamente y son respondidos por internet"* (Gestor 6)

Sin embargo, en cuatro de los quince municipios, cuando los gestores fueron cuestionados sobre cómo son evaluados los servicios, actividades y programas, indicaron no tener un sistema de evaluación establecido o que estuviese en desarrollo.

(7) Acciones implementadas para la popularización del deporte

En este apartado, los gestores indicaron dos factores principales, la primera es la política de precios, que según estos es muy popular (cursos de natación con precios bajos, precios sociales para personas con discapacidad funcional, jubilados (tercera edad), para jóvenes e inmigrantes. La segunda mención más significativa fue la política de becas o cuotas subvencionadas. Como ejemplo a estos dos factores podemos citar lo expresado por el G2 *"La política de precios es muy popular, a los casos más complicados, les damos becas o subvenciones"*.

En otro bloque con incidencia mediana entre los argumentos de los gestores está la política de equipamientos públicos al aire libre y las subvenciones a entidades a partir de los programas de inclusión de escolares con dificultades socioeconómicas. También fueron mencionadas la tarificación social (en desarrollo), los programas y actividades de otros sectores (Centros Cívicos y Asociaciones de Vecinos) y programas y actividades propios, como, por ejemplo, los destinados a la tercera edad y las Ligas de Ocio. Finalmente, otros mecanismos indirectos para la popularización de deporte también fueron identificados, como las acciones de los Servicios Sociales del Ayuntamiento y la cooperación con fundaciones.

En síntesis, se pudo comprobar que existe una gama de mecanismos adoptados por los servicios deportivos en favor de la promoción del deporte para todos. No obstante, la respuesta de algunos enfatiza que aún hay mucho trabajo por realizar:

> *"Pero, siempre hay colectivos a los que no consigues llegar"* (Gestor 10)

Discusión

Downward & Rasciute (2010) y Espinal et al. (2019) anticipaban como el deporte es un ámbito de la actividad humana que se ve afectado por la participación del Estado a través de las políticas deportivas. En España, son las Comunidades Autónomas quienes tienen la competencia y los recursos más importantes –junto con las entidades locales– para impulsar, mejorar y dotar de mayor calidad la práctica deportiva de la ciudadanía (Puig & Camps, 2020). De esta manera, el presente estudio contribuye a la literatura existente sobre gestión deportiva pública al examinar las opiniones de los gestores deportivos sobre la gestión que se realiza en los servicios deportivos municipales de la provincia de Barcelona, así como explicar algunos de los problemas y posibles elementos de mejora.

Szczepaniak (2020) argumentaba como fomentar la participación en la actividad deportiva es un tema importante para las políticas públicas, ya que existen beneficios en términos de salud y bienestar tanto para las personas como para la sociedad. En la presente investigación, se comprobó cómo en la provincia de Barcelona estas políticas se articulan a través de lo que los gestores deportivos identificaron como los pilares fundamentes en los que se asienta la gestión deportiva municipal: el deporte para todos, el apoyo a las entidades locales y las instalaciones deportivas.

En referencia al deporte para todos, Hoekman (2017) apuntaba como las políticas deportivas públicas (gastos gubernamentales en el deporte) se consideran necesarias para mantener el deporte accesible para aquellos colectivos

que se quedan atrás en participación deportiva. En esta línea, entre los principales mecanismos adoptados para la popularización del deporte, los gestores deportivos señalaban las políticas de becas o cuotas subvencionadas, así como las subvenciones a entidades deportivas. De hecho, que los entes locales desarrollen acciones de fomento del deporte mediante subvenciones para responder a las necesidades sociales y económicas de personas y entidades no es algo nuevo, si no que, como identificaba Calvet (2015), se trata de una técnica de intervención administrativa muy extendida que ocupa un peso importante en los presupuestos municipales. Sin embargo, elementos de mejora, como la posibilidad de desarrollar un programa de tarificación social, fueron apuntados por los diferentes gestores entrevistados.

Por otra parte, si el estado se involucra en la operación o el apoyo de las instalaciones para actividades deportivas y recreativas, las personas tendrán mayor facilidad de acceso a las actividades deportivas (Szczepaniak, 2020). Por tanto, que los gestores deportivos identificasen las instalaciones como un eje fundamental de la gestión deportiva municipal para la popularización del deporte no sorprende, pues La Ley Reguladora de Bases de Régimen Local (Artículo 25.2.m, de la Ley 7/1985, del 2 de abril, Reguladora de las Bases del Régimen Local), establece que es a los municipios a quien les corresponde el ejercicio de la competencia relativa a la prestación de servicios deportivos mediante la organización de actividades, así como de la construcción y gestión de los equipamientos deportivos. Sin embargo, como apuntaban los entrevistados, y en concordancia con estudios como el llevado a cabo por Arboledas y Puig (2012), la mayoría de los ayuntamientos indicaban que el presupuesto destinado a deportes es bajo, hecho que repercute en una falta de instalaciones deportivas públicas.

No obstante, y sin perder de vista el objetivo de hacer accesible el deporte para todos, uno de los retos a afrontar que los gestores deportivos identificaron en sus discursos fue el de la regulación de las prácticas deportivas al aire libre. Los gestores respaldaron la necesidad de implementación y regulación de este tipo de prácticas en crecimiento (Sánchez et al., 2013) ya que han sido asociadas a diversos beneficios para la salud (Twohig-Bennett & Jones, 2018), así como coadyuvantes al aumento de la satisfacción de las personas en sus actividades de ocio (Rosa et al., 2019). De hecho, en el contexto actual del Covid-19, y en el que probablemente nos encontraremos en la era Post-Covid-19, las prácticas deportivas al aire libre están cobrando mayor interés y probablemente consolidarán dicha tendencia en los próximos meses, y quizás años, como consecuencia de la pandemia.

El tercer pilar fundamental al que los gestores deportivos apuntaban fue el apoyo y la necesidad de salvaguardar una buena relación con los clubes deportivos, pues son estos los que actúan como complemento a la oferta pública dentro del servicio deportivo municipal. Vínculo al que Puig et al. (2010) hacían referencia un tiempo atrás y que hoy en día sigue siendo parte vertebral de las políticas deportivas municipales. No obstante, si bien gran parte de la práctica deportiva organizada se realiza a través de una amplia red de clubes y una gama de programas y servicios deportivos estructurados, todavía se sabe muy poco sobre las estrategias de conocimiento de dichas organizaciones deportivas (Girginov et al., 2015). Algunos gestores entrevistados hicieron referencia a la corrupción en las organizaciones deportivas, pues es un fenómeno global que amenaza la integridad de la industria del deporte, lo que representa un gran desafío para los administradores deportivos (Kihl et al., 2017). En este sentido, la mayoría de los entrevistados evidenciaron la necesidad de llevar un control más exhaustivo de las entidades, así como de llevar a cabo la evaluación de los servicios que brindan, como, por ejemplo, mediante el desarrollo de un sello de calidad. Además, la aparición de nuevas plataformas tecnológicas debería simplificar y mejorar el control de las entidades deportivas que se relacionan con las entidades públicas.

Sin embargo, no parece de fácil solución la mayor burocratización de los diferentes procedimientos administrativos que afecta de manera directa a los propios gestores. Entre los entrevistados, se añadieron argumentos de apoyo a la necesidad de profesionalización de las entidades deportivas, las que mediante modificaciones en la gestión deben buscar mejoras en la eficiencia (Nagel et al., 2015).

Por lo que se refiere a la adopción de planes de gestión, se pudo comprobar que el 40% de los gestores entrevistados evidenciaron la no utilización de elementos básicos de planificación. Hallazgos que se encuentran en línea con estudios anteriores donde se argumentó la necesidad de creación, actualización y/o mayor utilización de planes de gestión deportiva por parte de los servicios de deporte municipales (Avila et al., 2019; Puig et al., 2010). Girginov et al. (2015) destacaban como, a lo largo de los años, la importancia del conocimiento organizacional en la consecución de los objetivos estratégicos se ha ignorado en gran medida.

Al mismo tiempo, los gestores entrevistados indicaron como un aspecto de mejora a considerar la implementación de una orientación coordinada de los diferentes actores del ente público. No obstante, cabe destacar que "si bien los beneficios del trabajo interinstitucional son ampliamente reconocidos, la creación de asociaciones colaborativas es una tarea plagada de dificultades" (Greasley et al., 2008, p. 307).

Respecto a la línea de comunicación que podrían trabajar los municipios de la provincia de Barcelona, la investigación sugiere que hay un gran margen de mejora. Autores como Coalter (2013) o Piggin et al. (2009) destacaban la importancia de la comunicación porque cómo las agencias crean y difunden información y conocimiento sobre la participación deportiva tiene serias implicaciones para la prestación de servicios deportivos y cómo estos se utilizan. El hecho de que las políticas públicas municipales no tengan una competencia directa como servicios deportivos, ha podido conllevar a que en muchas ocasiones no se hayan desarrollado las estrategias de marketing necesarias para poder llegar a un porcentaje de población mucho mayor que permitiría abordar de mejor manera la popularización de la actividad física y el deporte. Autores como García y Barata (2016) o Puig et al. (2010) identificaban en sus estudios diversas estrategias utilizadas, como por ejemplo, el uso de los medios de comunicación locales, impresos, webs o puntos de distribución, aunque, al mismo tiempo señalaban algunas carencias como las apuntadas por los entrevistados en cuanto al bajo uso de las redes sociales propias, la existencia de páginas webs exclusivas del servicio de deportes o la baja explotación de otros canales.

Asimismo, cabe considerar que una mayor digitalización de los servicios deportivos municipales podría ayudar al aumento de la participación ciudadana en la gestión e incentivar la implicación de ciudadanos individuales y de asociaciones en la toma de decisiones sobre asuntos de interés general. Para lograr tal objetivo, los gestores identificaron cómo se articulan

diferentes mecanismos (encuestas de valoración, barómetro, comisiones de participación, etc.) aunque, según sus discursos, poco eficaces. A este respecto, Solanellas y Fanega (2019) avanzaban como la valoración de los servicios públicos debería ser una constante para investigadores y especialmente para aquellos que desarrollan responsabilidades en la gestión de estos servicios. "De hecho, una gestión deportiva sana es sin duda una que se cuestiona y desafía constantemente a sí misma" (Amis & Silk, 2005, p. 355).

Conclusiones

Este artículo examina la opinión de los gestores deportivos municipales sobre la gestión deportiva pública en la provincia de Barcelona y pone de manifiesto que el enfoque de los gestores en la popularización del deporte, el apoyo a las entidades deportivas y la gestión de instalaciones deportivas son aspectos que han podido influir en el notable éxito de la gestión deportiva del territorio.

En los discursos de los gestores deportivos se ha podido identificar el esfuerzo para ofrecer servicios deportivos de calidad para la población, así como la búsqueda de caminos para el continuo desarrollo. Se han identificado posibilidades de mejora como son la necesidad de creación, actualización y mayor uso de planes de gestión deportiva, el desarrollo de herramientas de control y seguimiento de la gestión operativa y de las entidades deportivas, la mejora en la fluidez de los procesos administrativos, el incremento en la inversión en infraestructura deportiva, así como la regulación de las actividades al aire libre, la mayor dotación de ayudas a los colectivos más desfavorecidos y conseguir una mayor colaboración con otras áreas del propio ayuntamiento.

Algo que, bajo nuestro punto de vista, debe destacarse es la necesidad de afrontar estos retos de manera colectiva y coordinada. Sin lugar a duda, ello permitiría mayores avances, crear sinergias, reducir costes y facilitar la comparativa entre los diferentes municipios. Como apuntábamos en la introducción, el intercambio de conocimiento es fundamental para la mejora de los servicios públicos y es aquí donde creemos que esta investigación puede contribuir como marco de referencia sobre el estado de la cuestión para que entidades públicas como la Diputación de Barcelona o la Generalitat de Catalunya puedan abrir una vía de acción a corto y medio plazo con los municipios de la muestra de estudio y de la población en general.

No obstante, sería deseable la realización de nuevos trabajos que analicen los municipios de la provincia de Barcelona restantes. La ampliación del estudio a todo el territorio permitiría considerar las posibles diferencias existentes entre los municipios en función de sus habitantes, densidad poblacional, extensión, recursos económicos o incluso en base al recorrido político de los últimos años. En este sentido, y como se ha podido comprobar, no ha sido un objetivo de esta investigación hacer una discusión profundizada de las diferencias entre municipios respecto a su gestión deportiva.

Por otra parte, cabe considerar que estos hallazgos no pueden generalizarse más allá de la población objeto de estudio. Así, futuros estudios pueden presentar propuestas para mejorar los problemas aquí presentados y reforzar el trabajo en común de los diferentes agentes que suponga un verdadero aprendizaje colectivo que redunde en una mejora de la calidad de los servicios ofertados.

Referencias

Alexander, M., & Bossio, R. (2006). Política deportiva: factores reales del sistema deportivo. *Liberabit Revista Peruana de Psicologia, 12: 87–94*.

Amis, J., & Silk, M. (2005). Promoting critical and innovative approaches to the study of sport management. *Journal of Sport Management, 19(4), 355–366.*

Arboledas, D., & Puig, N. (2012). Análisis de los servicios deportivos municipales en poblaciones mayores de 30.000 habitantes de cinco provincias andaluzas. *Revista de Estudios Regionales, 107, 35–61.*

Avila, M., Bahia, C., & Rosa, C. (2019). Gestão esportiva e de lazer uma análise de sites oficiais de 59 municípios baianos.*Motrivivência, 31(58), 01–17.*

Bardin, L. (2009). *Análise de conteúdo (5th ed.)*. Edições 70.

Burriel, J. C. (1994). Análisis y diagnóstico del sistema deportivo local: punto de partida para el diseño de políticas deportivas municipales. *Apunts: Educación Física y Deportes, 1994(36), 38–45.*

Calvet, J. A. i. (2015). Les subvencions de l'administració local en matèria d'esport a Catalunya. *Apunts Educació Física i Esports, 120, 58–66.*

Celma, J. (2003). *ABC del gestor deportivo*. Barcelona: INDE.

Coalter, F. (2013). *Sport for development*. London: Routledge.

Creswell, J. (2007). Qualitative Inquiry and Research Design: Choosing Among Five Approaches. *In Health Promotion Practice (Vol. 16, Issue 4).*

Dallmeyer, S., Wicker, P., & Breuer, C. (2018). The relationship between sport-related government spending and sport and exercise participation: the role of funding size, period, and consistency. *International Journal of Health Promotion and Education, 56(4–5), 237–247.*

Diputació de Barcelona, & Observatori Català de l'Esport (2011). *Els ajuntaments i l'esport a les comarques de Barcelona*, Barcelona, Diputació de Barcelona, Observatori Català de l'Esport.

Downward, P., & Rasciute, S. (2010). The relative demands for sports and leisure in England. *European Sport Management Quarterly, 10(2), 189–214.*

Elasri, A. E., Triadó, X. M. I., & Aparicio, P. C. (2015). La satisfacció dels clients dels centres esportius municipals de Barcelona. *Apunts Educació Física i Esports, 119, 109–117.*

Espinal, D., Medina, J., & Da Cunha, F. (2019). Teorías, tensiones y convergencia del desarrollo deportivo. Cultura, Ciencia Y Deporte, 14(42), 203-212.

Flick, U. (2009). *Introdução à pesquisa qualitativa (3rd ed.)*. Artmed.

Freitas, D., Girginov, V., & Teoldo, I. (2017). What do they do? Competency and managing in Brazilian Olympic Sport Federations. *European Sport Management Quarterly, 17(2), 193–209.*

Gallardo Guerrero, L. (2002). Características generales de los servicios deportivos municipales en Castilla-La Mancha. *European Journal of Human Movement, 9, 165–191.*

García, B. (2006). The European Union and Sport, rescuing the nation-state? *Representation, 51(1), 93–106.*

García, D. A., & Barata, N. P. (2016). Análisis de los servicios deportivos municipales en poblaciones mayores de 30.000 habitantes de cinco provincias andaluzas. *Revista de Estudios Regionales, 107, 35–61.*

Greasley, K., Watson, P., & Patel, S. (2008). The formation of public-public partnerships: A case study examination of collaboration on a 'back to work' initiative. *The International Journal of Public Sector Management, 21(3), 305–313.*

Guest, G., Bunce, A., & Johnson, L. (2006). How Many Interviews Are Enough? An Experiment with Data Saturation and Variability. *Field Methods, 18(1), 59–82.*

Hartley, J. (2008). The innovation landscape for public service organizations. In J. Hartley, C. Skelcher, C. Donaldson, & M. Wallace (Eds.), *Managing to improve public services (pp. 197–216).* Cambridge: Cambridge University Press.

Heinemann, K. (2008). *Introducción a la metodología de la investigación empírica en las ciencias del deporte*. Editorial Paidotribo.

Hoekman, R., Breedveld, K., &Kraaykamp, G., (2017). Providing for the rich? The effect of public investments in sport on sport (club) participation of vulnerable youth and adults. *European Journal for Sport and Society, Vol. 14, Issue 4.*

Husting, A. (2006) 'European Sports Regulation. Between Preservation of Public Interest, Interests of the Spectators, Sport Interests and Conciliation of Commercial Interests', *paper presented at the ECPR Joint Sessions of Workshops, Nicosia, Cyprus, 25–30 April.*

Instituto Nacional de Estadística. (2018).

Kihl, L. A., Skinner, J., & Engelberg, T. (2017). Corruption in sport: understanding the complexity of corruption. *European Sport Management Quarterly, 17(1), 1–5.*

Kotler, P., & Keller, K. L. (2015). *Direccion de Marketing*. In Pearson Educación (Vol. 1).

Lacoba, C. D. (2006). *Modulo I: las políticas deportivas ¿Por qué políticas deportivas en el sector público local? ¿Qué políticas?* Consejo Superior de Deportes.

Nagel, S., Schlesinger, T., Bayle, E., & Giauque, D. (2015). Professionalisation of sport federations – a multi-level framework for analysing forms, causes and consequences. *European Sport Management Quarterly, 15(4), 407–433.*

Piggin, J., Jackson, S., & Lewis, M. (2009). Knowledge, power and politics: Contesting 'evi- dence-based' national sport policy. *International Review for the Sociology of Sport, 44(1), 87–101.*

Puig, N., & Camps, A. (2020). *Diálogos sobre el deporte, 1975-2020*. Inde.

Puig, N., Viñas, J., Pérez, M. (2010). *Els Ajuntaments i l 'Esport a Catalunya.* Itik, Consultoria Esport I Lleure.

Rasciute, S., & Downward, P. (2010). Health or happiness? what is the impact of physical activity on the individual? *Kyklos, 63(2), 256–270.*

Rosa, C. D., Collado, S., Profice, C. C., & Larson, L. R. (2019). Nature-based recreation associated with connectedness to nature and leisure satisfaction among students in Brazil. *Leisure Studies.*

Sánchez, J. A., Segado, F., & Giménez, L. (2013). Valoración del uso recreativo en los Espacios Naturales Protegidos de la Región de Murcia. Cultura, Ciencia Y Deporte, 8(24), 223-230.

Senlle, A., Galllardo, L., y Dorado, A. (2004). *Calidad en las organizaciones deportivas: todo lo que se necesita saber para implantar un sistema de gestión de calidad y medio ambiente*. Barcelona: Gestión 2000.

Solanellas, F., & Fanega, L. (2019). Análisis comparativo sobre la percepción de la calidad de los servicios deportivos municipales del Baix Llobregat. *Revista de Psicología Del Deporte, 28(1), 105–114.*

Solanellas, F., Camps, A., & Ferrand, A. (2017). The Barcelona Olympic Games: Looking Back 25 Years On (2). *Apunts. Educación Física y Deporte, 128(2), 127–147.*

Soler, A. (2012). *Inteligencia deportiva (1st ed.)*. Romanyà-Valls S.A.

Szczepaniak, M. (2020). Public sport policies and health: Comparative analysis across European union countries. *Journal of Physical Education and Sport, 20(2), 1022–1030.*

Twohig-Bennett, C., & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environmental Research, 166, 628–637.*

Vassil Girginov, Kristine Toohey & Annick Willem (2015) Creating and leveraging knowledge to promote sport participation: the role of public governing bodies of sport. *European Sport Management Quarterly, 15:5, 555-578.*

World Health Organization. (2019). *Physical inactivity: a global public health problem*. WHO.

CULTURA, CIENCIA Y DEPORTE

Origin, evolution and influence on the game of water polo rules

Origen, evolución e influencia de las reglas de waterpolo sobre la dinámica del juego

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Abstract

The aim of this study was to describe the origin and evolution of the different regulations in water polo that have existed throughout its almost one hundred and fifty years of history and their possible influence on the game dynamics. A content analysis of the texts published on paper by the Fédération Internationale de Natation was carried out, focusing on semantics, based on some key categories of this sport. The main conclusion is that many regulatory changes have been made over the years. However, there is no scientific evidence of their effects on the game dynamics.

Keywords: team sport, game action, rule modification.

Resumen

El objetivo de este estudio fue describir el origen y evolución de sus diferentes reglamentos a lo largo de sus casi ciento cincuenta años de historia y su influencia en la dinámica del juego. Se llevó a cabo un análisis de contenido de los textos publicados en papel por la Federación Internacional de Natación Amateur, centrándose en la semántica, a partir de algunas categorías clave de este deporte. Se concluye que han existido numerosos cambios normativos a lo largo de los años. Sin embargo, sigue sin existir evidencia científica de sus efectos en la dinámica del juego.

Palabras clave: deporte de equipo, acción de juego, modificaciones reglamentarias.

1. Introduction

The water polo is a young team sport product of Industrial Revolution (Lloret, 1994). In the beginning, the water polo was approximately a rugby like game played in the water, without any official rules established, in which everything was valid and everyone solved the situations on their own. It was played without goalpost or with the biggest goalpost ever seen, and the players had to deposit the ball behind the other team's bottom line. No shot could be taken, having to reach the target with the ball in their arms.

So why the name water polo? It is clear the first part of the word, water, where there is no clear agreement is on the second part, polo. According to Delahaye (1929, pp. 2-3), "*the name water polo comes from polo aquatic and is reminiscent of a water game imagined in England around 200 years ago. In this game, the horses are replaced by empty barrels, in which the players are placed. Each one of them is equipped with a kind of stick that serves, at the same time, as a paddle to move and direct the device, and a stick to hit the ball*". Although there is no study on the relationship between horse polo and water polo, which derives in the current water polo, Vigarello (1988, pp. 46-48) points out: *"the confirmation of countless imitations of gentlemen... like the confrontations of the oarsmen piloting the barrels-horses*". From there, according to Lloret (1998, p. 22): "*it is possible to think that, during the first half of the 19th century, the precursor game of water polo was this polo aquatic... for natural reasons because we understand that, in such practices, the players should often fall from the barrels to play the ball from the water, forcing them, in their evolution, to get rid of a heavy and impractical material. As they master the medium, they start a game in which they must swim with the ball into the liquid medium*".

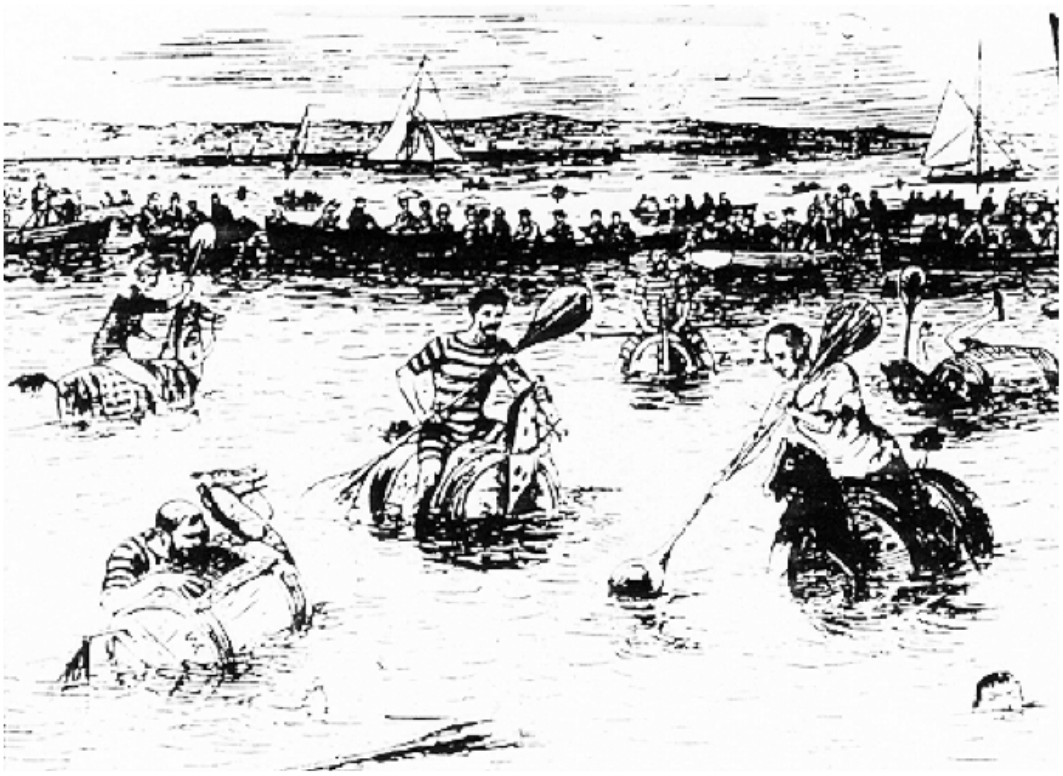

Figure 1. Origin of Polo Aquatic according to Vigarello (1988, p. 48)

As with the name of polo, controversy arises in the development of the rules of the game. According to Delahaye (1929), it was Baxter who made the first rules of the sport. While Iguarán (1972) and Cuddon (1980), claim that Wilson, president of the Swimming Association, made the rules that gave birth to the sport (Table 1). The former gave the game some basic rules, but it was the latter who established the rules.

The first match took place in 1869 in London, without any regulation. As a result of this, rules were drawn up in 1870, which led to the names "Football in the water". At first, the number of players varied between 7 and 20, and the width of the goal was between 3 and 6 meters. These were demarcated by flags, and the goalkeeper could use a paddle or stick, about whose size there are some doubts. Finally, according to Rajki (1958, pp. 13-16), in 1876: "*the Bournemouth Rowing Club played the first water polo match with regulated boundaries under the careful supervision of a referee and two goal judges. Each team consisted of seven players. There were no goals, and for the completion of the attack, the ball had to be placed in a raft, which meant the achievement of a goal or goal for the team that had deposited it. This first match was short lived as the fragile balls could not withstand the vigorous play and burst*". The first official regulations were drawn up in Glasgow in 1877, with goals appearing two years later and a series of matches between English and Scottish teams taking

place three years later. Finally, in 1885, the English Swimming Association officially recognised water polo, providing it with a set of eleven articles (Table 1), according to Rajki (1958).

Table 1. First water polo regulation of the English Swimming Association (Rajki, 1958).

1. Duration of the match: 20 minutes.
2. The captains agree or draw lots to choose the goalposts.
3. At the start of the match, the referee throws the ball into midfield. All players enter the water immediately, except the goalkeeper, on their respective sides. The goalkeeper must stay out of the water and defend his goal in the best possible way.
4. The ball must be passed from one player to another, and driven over or under the surface of the water towards the opponent's goal.
5. No player may interfere with the goalkeeper, whether in or out of the water or hold his opponents in any way, except if the goalkeeper or an opponent is in possession of the ball. In the event of a player violating this rule, a free kick shall be awarded at the place where the offence occurred.
6. A goal shall be scored when the ball is placed by hand on the floating platform or barge intended for that purpose.
7. If, during the match, the ball goes out of bounds, the referee shall award a kick against the team that has moved it out of bounds, but if it goes over or onto the barge, a goal kick shall be indicated, to be taken by the goalkeeper, from his floating platform.
8. The referees, or one of them, shall whistle immediately after a goal has been scored, and the match shall then cease (to be restarted once the teams are reorganised).
9. The teams will change their goalposts (of field) to the half.
10. When a competitor who has been called to take part in a water polo match fails to show up, he loses any possible prizes in the event of winning the match. Nor can he return to the match once it has started.
11. The referees have full powers. In case of doubt, the referee decides all those circumstances not foreseen in these rules.

At the height of the expansion, according to Rajki (1958, pp. 14-15): "*in 1890 water polo spread to the United States, where the rules were changed to convert it to indoor and small pools. These essential changes were not to allow a goal to be scored, but to allow a goal to be scored by touching a mark with the ball in your hand. In 1897 there was a restructuring of the rules unifying them with the European ones*". In Germany, the first water polo match was played in Berlin in 1894, with the problem of not being able to play matches on a large scale, given that each club had its own rules. On 19 July 1908 the Fédération Internationale de Natation Amateur (FINA) was founded in London. In 1911, according to Rajki (1958, p. 15): "*the FINA made it obligatory to revise the rules thoroughly, defining more precisely the boundaries of the field, the goals, the ball, the duration of the match, the characteristics of the game and the composition of the teams*". Its aim was to unify regulations and that in every country there would be the same. Since then, FINA has been responsible for all the regulatory changes that have taken place in the almost 150-year history of water polo.

In relation to the studies that have analysed the regulatory changes that have been applied in water polo in recent years, the research of Donev & Aleksandrović (2008) and Madera et al. (2017) should be highlighted. Emphasising the results of Lozovina & Lozovina (2019b), who find no difference in their influence on the outcome of the game in terms of the number of possessions and estimate that only a third of the fouls are useful. Based on previous studies, it is proposed to regain the 4-meter line for penalty shots and to introduce a "bonus" when receiving more than 7 fouls per quarter. It also allows two-handed shots to be blocked, and adds that the midfield must be passed within 20 seconds, with a penalty if the ball returns to the goalkeeper (Hraste, Bebić, & Rudić, 2013; Lozovina & Lozovina, 2019a). Finally, mention should be made of the studies on the effects of the change of distance in the penalty shot (Argudo, Ruiz-Barquín, & Borges, 2016) and the use of time out by coaches (Ruiz-Lara, Borges-Hernández, Ruiz-Barquín, & Argudo, 2018). Although these have remained a mere description of existing regulations or very superficial analyses of the game, they are not interested in knowing how these changes have affected the development of the game, its actions and transfers to training (Ávila-Moreno et al., 2018).

For all these reasons and in view of the scarcity of scientific studies, the aim of this study was to describe the origin and evolution of the different regulations in water polo that have existed throughout its almost one hundred and fifty years of history and its possible influence on the game dynamics.

2. Materials of study and procedure

The present study is a content analysis (Bardin, 1986; Krippendorff, 1997), in particular an analysis of the regulatory modifications of water polo throughout its 150 years history. As it is a documentary material, it has been chosen to analyse what is written, but this does not prevent subsequent works from including other types of empirical analyses as the only study on the subject that is known, carried out by Madera et al. (2017). In this, they study the minutes of international matches according to the regulations in force in order to describe how these modifications have affected the game as a way of extending this study. Both, the literal part and the modifications observed in the game are considered the source of information for this study, although in our case, we have considered analysing only the text and comparing it with

results of previous notational analysis of the sport in order to explain what changes have taken place in water polo.

For the analysis of the prevailing regulations, the official regulations published by FINA and the various authors who have studied this sport have been used (Madera et al, 2017; Lozovina & Lozovina, 2019a b). In this sense, and knowing that content analysis is not exclusively a qualitative technique (Flick, 2004), in this case, we will focus more on the semantic and pragmatic (Navarro & Díaz, 1995), and the relationships established between the content of the documents studied.

In order to carry out this analysis, a set of categories have been defined which correspond to the key aspects of the sport: materials, duration of the match, players and permitted actions and technical-tactical actions. This set of categories has been selected, to explain the development of the game as a whole and to be the classic analysis categories that have been used in the literature (Castejón et al., 2011). Each one of the documents has been analysed, applying the described categories, by all the members of this work individually, and later on a joint sharing, has been done in order to check the differences and similarities in the analysis. In those cases where wide differences appear between the researchers, this would be pointed out, discussing the suitability of the same.

3. Results

As in many other sports, throughout its 150 years of history, almost all aspects of the game have changed. Therefore, as can be seen in Table 2, rules, objectives and results achieved are explained.

Table 2. Evolution of water polo rules trough the history.

Source	Rule	Inferred objective	Game transfer
1876	Aquatic Handball - 7 players each side - Length of field 50 yards - goals marked by four flags		
1879	9 players, width of the goalpost at 14 feet		
1883-84	No interference with the goalkeeper. 20 min Ball maybe passed or carried either on o below surface - Free throw to be given where the foul occurred	Making the game more dynamic	
1885 (London Swimming Association)	Playing time at 20 min, were prevented from holding an opponent without possession of the ball and a goal was scored by "rehearsing" in a boat placed for this purpose. 6 players. Ball size (8 inches). Players stood up with the referee's whistle	First rules	
1888	Touching the bottom, catching an opponent without a ball and the goalkeepers passing from the ½ field. 27x20 m. Ball size 9 inches. Set up a goal to score the goals (10 feet) with crossbar 6 feet above surface. Players to swim when passing ball	Regulating different actions observed	
1892	2x7 min		

1908 (FINA)	Anglo-Scottish Rules	Unify the regulations of different countries	1920's During this decade three major facts occurred: 1. Larger and deeper pools came into use, increasing the importance of swimming proficiency. 2. Béla Komjádi introduced the idea of passing the ball back and forth in the air ••This new technique was a radical departure from the old style of play and immediately made ball handling a vital part of the game. The extended arm throw was abandoned and gradually gave way to passing with the use of the elbow and the wrist
1919	In 1905, the rule dealing with the free throw was not too detailed. The rule of 1919 describes the manner in which the free throw is to be executed. The depth of the pool to be at least 90 cm and not 1,4 m as previously. Disobedience was considered to be a foul If a free throw was awarded to the goalkeeper, it could be executed by the closest team-mate		
1929-1934	Fouls were sub-divided into well-defined categories under the headings Ordinary, Major and Penalty fouls. 30x20 m. Weight of the ball 400-450 g. If the defending player splashes the face of the opponent inside the 4 m area, this is to be considered a major personal foul. The player at foul is to be barred from play and a 4 m penalty is to be awarded	Delimiting fouls	
1936	The ball, passing from the original leather ball to a red rubber ball and then in 1956 to the current yellow ball that improved visibility	Improving ball grip	The new synthetic balls allowed better ball handling than before
1949	2x10 min. "Throwing directly at goal from a free throw" which then has been abandoned in 1949. Obligatory to pass after foul	The rule of standing on the referee's whistle is eliminated	1949 physical revolution, promoted by the evidence of the game considered by many as too static Thanks to various revisions of the regulations over time, there have been, in the words of Lloret (1998), three revolutions: "the physical revolution (1949), the technical revolution (1966) and the tactical revolution (1976)". The first took place when the article referring to statism, from which travel was permitted, was removed. The consequence was a faster game where physical power was imposed. Logically, it brought about a change in the "training systems" of the time
1961	4x5 min (real life game). 11 players (4 substitutes)	Reducing the harshness of the game makes it "more enjoyable and fair"	Splitting the game to 4 periods of 5 min and having 4 substitutes offered conditions to reduce the roughness *With the ideas to make the game "nicer" and "fairer" the "penalty point" regulation was introduced on 1967
1964	Cancelling the exclusion of the players	Balancing the matches	
1967	3 fouls a penalty	Giving continuity to the game	1966 technical revolution. After a period of developing skills and physical abilities, where teams with strong and resilient players were triumphing, the lack of technical skill with the ball became apparent. The second one brings with it the penalty (with three additions a maximum foul is thrown) and forces a technical improvement, since with this revision situations of game appear where it is necessary a good basic positioning, correct offensive and defensive displacements, it is possible to throw better, it is necessary to pass and to receive correctly and to possess

			a strong and skilful buoy. An example of this is the game that was developed in Mexico-68, much richer from the technical point of view (passes, movements, feints, shots, etc.). The game apparently rough and is full off fouls, devoid of combinatory, beauty and attractiveness
1969	Exclusions 1 min. Possessions 45 s. 3 exclusions (definitive).		1970 – The rule of three major fouls is cancelled
1977	2 referees. Exclusions 45 s. Possessions 35 s. The foul is taken out by the nearest. Missing with time out (exclusion). They clarified the term of offside. They determined that behind the line of the ball, there was no offside even in the two meter area. The substitution of players after goals has been introduced. Re-entry zone 2 m. The goalkeeper can pass the ball beyond the midfield	Making sport more colourful, quicker and balancing refereeing decisions	1977 tactical revolution promoted by the need to change the situations of disadvantage, generated by the innumerable fouls that the players considered technically and physically "good" received. The third one, the double refereeing was introduced, changes the concept of "three or more fouls" for the one of "reiteration of fouls" and fundamentally the zonal or mid-zonal defences appear. The game changed pace, becoming considerably faster The two Referee system, introduced in 1977, rendered necessary the need to promote uniform interpretation. Any visible clocks should show time in a descending manner indicating the time remaining in a period
1981	4x7 min. 13 players (7+6). 3 fouls in the middle (exclusion). A uniform code for the signalling of referees was introduced, ensuring the greater	Making refereeing decisions more understandable in order to reduce protests	The level of water polo teams began to be equalized
	understanding of the decisions of the referees. Sinking the ball is considered a foul or penalty		
1984	2 m replacement area	Bringing freshness to the game	
1986	Exclusions 35 s. Re-entry on the referee's signal when his team recovers the ball	Balancing differences in performance against the advantage of exclusion	
1991	Exclusions 20 s. 3 exclusion fouls are eliminated		Goalkeeper, who has not allowed direct shot on the opponent's goalpost can be achieved by the opposing goalpost
1997	4 m and 7 m line and free throw. Replacements at any time. 2 Time out. Change of bench at rest	To create a balance between the countries by allowing the use of more pools to meet the requirements for Water polo. Make the game more spectacular – a better product for TV Speed up the game and increase the number of counterattacks Create more action in front of the goal	
2001	Goal judges are to use arm movements instead of flags. Teams are to change ends before the start of 1st period of extra time. Teams are not restricted to wearing white and blue caps only, but caps may use contrasting colours		
2005	30x20 m y 25x20 m. 4x8 min. Possession 30 s.	Making the game faster Increase the number of shots and goals Avoiding excessive center forward fouls	Contact between the center forward and the defender is allowed and referees are allowed to judge the quality of the pass to the center forward in order to award exclusion or penalty.

	5 m line. Both arms cannot be raised. Third time out in extra time 2 m out of play. Corner if thrown by the goalkeeper, not the player. 4 min exclusion for brutality	Rewarding defensive blocks	Speeding up considerably the game
2009	Time-wasting is eliminated. Yellow and red cards for players	Making sanctions understandable to the public	
2013	Diving at a center forward to gain position is not allowed, but a penalty will be awarded if the defender pushes or grabs it with both hands	Reducing violence at the center forward position	
2017	11 + 2 goalkeepers. The obligation for the team to have two goalkeepers is introduced	Balancing matches by reducing the number of outfield players available	
2019	Shooting is allowed after a foul, even if it is not directly. Second attack reduces possession to 20 s. Goalkeeper can exceed the line of ½ field. Substitution from the side of the field	Increase the number of goals and with it the show	

4. Discussion

The aim of this study was to describe the origin and evolution of the different regulations in water polo that have existed throughout its almost one hundred and fifty years of history and its possible influence on the game dynamics.

However, to do so, it would be relevant to know whether the regulatory changes in this sport differ from or are similar to those in other modalities. Therefore, if we look at the existing literature, regulatory changes in different sports have occurred, as in water polo, throughout history, for several reasons. The first regulations were born to be able to play matches between different populations, to safeguard the integrity of the sportsmen and women, as well as to limit the actions and possibility of cheating in sport. Especially with the appearance of sports betting and the purchase of results such as those reported, in football matches by Liu, Dai, & Wang (2019), athletic races and other modalities. Other modifications arose to avoid or prevent what athletes, trainers and spectators understood as injustices (Kerr & Obel, 2015), as was the case of the modification of the score and composition of judges in gymnastics after a bad score for a great exercise and giving value to the show as a precursor of new regulatory modifications. Also increasing the participation of athletes at school age by modifying some rules such the triple line in minibasket (Arias, Argudo, & Alonso Roque, 2012) or the score in Basque pelota (Usabiaga & Castellano, 2014). As well as the demilitarisation of certain sports such as pentathlon (Heck, 2013). While other regulatory changes have emerged thanks to technical advances, such as improved materials, the case of the implemented mobile. For example, with the improvement of the leather of water polo balls, increased resistance and manageability. After their appearance, changes were seen in the game, leading to the implementation of regulatory changes that allowed players to pass the ball to each other (Rajki, 1958). Similar changes in football led to changes in team play and the need to implement new rules such as offside (Olivós, 1992). Finally, and thanks to technological advances, such as electronic scoreboards in fencing or taekwondo (Moenig, Cho, & Song, 2012), improved protectors, the introduction and comfort of boxing gloves (Vamplew, 2007), etc., made it possible to modify training systems and therefore competition, so that scores had to be adapted and previously banned actions allowed in pursuit of the integrity of the contestant.

If we look specifically at the field of water polo, there is evidence of a previous study by Madera et al. (2017), who analysed the influence of the rules on the game according to the types of structural and functional changes in the rules. They found a higher number of total goals and winning teams by increasing the duration of the match from 28 to 32 minutes, although the losers continued to score (probably the losing teams did not adapt as well to these changes in the duration of the game). However, total goals' difference, goals' difference/total goals ratio, and goals' difference/winners' goals ratio only showed increases when the length of the match increased from 20 to 28 min. Just as they appreciated that the greatest increase in goals scored occurred when implementing a possession time in attack.

In this sense, the present study tries to overcome, extending to the analyses made by Madera et al. (2017), the influence on the uncertainty generated in the game, and considering the technical-tactical aspects of the game, which gives this sport greater motor richness, increasing the equality in the game among the contenders, and therefore causing an increase in the spectacle. Therefore, the results presented here show differences in terms of the different systems and models of play used by the teams depending on the regulations in force and their implications in the game. Also, can be said that modern water polo is characterized by rapid circulation of the ball, with rapid counterattacks, powerful and precise shots to the goal, and tight duel between players play which requires that player abilities, skills, knowledge and habits are extremely high (Hraste et al., 2013). Although further research is still needed.

While these studies have always been done with the intention of finding out, which aspects of the game have the greatest bearing on performance and offering the ability to discern the situations that set successful teams apart from the rest. In this way, they provide technical managers with objective data to add to the training of the situations that are most conducive to obtaining greater performance. There is no evidence of any previous study that has analysed how the game has changed over time and the influence of regulatory changes on it. However, based on the analysis of throwing efficiency, considering the final classification of the Championship and comparing two competitions with different regulations, it is not possible to infer the existence of significant differences (Argudo et al., 2020, Argudo et al., 2021). Therefore, it is possible to infer that the regulations

affect all teams equally and the differences observed in this case are due to the level of the teams, their adaptation and not to regulatory modifications. This should serve to ensure that future regulatory changes are based on studies showing the suitability of the equipment.

Therefore, like the findings of previous studies, it is possible to state that throughout the history of this sport and its regulatory modifications (Lozovina & Lozovina, 2009). Three phases have been developed according to Lloret (1994): 1-Physical Pre-dominance (1948); 2-Technical Pre-dominance (1963), 3-Tactical Pre-dominance (1977), adding during these last years a last phase that can be called of economic/spectacle predominance (Lozovina & Lozovina, 2009). Although other authors such as Hraste et al., (2013) propose three more phases, each one of them standing out in terms of play:

1- The first stage of the development of the water polo is from 1869 to 1907. This stage can be marked as the search for identity and unifying the rules of water polo games. This stage is characterized by severe regulatory changes that delimited the progress of this sport. The number of players participating in the game was changed from playing without goals to including them, as well as the implements that were used, so it is not possible to provide data on the game that can be used to compare it with later regulations. This phase is the consolidation of the sport and the assimilation of the regulations by all athletes.

2- The second stage of the sport's development the period from 1908 to 1949. This stage can be marked as a period of restructuring and internationalization of the game. The new rules contributed to a faster game (Juba, 2008). In which the players had to be physically strong and good swimmers (Lord, 2008). According to Bonačić (personal communication, November 4, 2009, mentioned in Hraste et al., 2013) the most common game system in this period was 2-1-2-1, which consisted of a defence with two central defenders in line and with one midfield defender. The primary position of midfield defender was at a distance of 7-8 m from his goalpost. During this period, with the unification of the Anglo-Scottish regulations, the use of balls that did not absorb water and deep pools, forced the appearance of the air pass and gave an advantage to swimmers (by eliminating the rule of stopping when a foul was sanctioned in 1928), so the defensive section on the attack was improved above all. This led to an increase in the number of developed throws, which made it necessary to reduce the size of the goals. In this sense, although there are no studies on the subject, we understand that the modifications in the size of the goals (of which we have evidence) were produced by the disparity of results and the excessive ease of scoring a goal. Reducing its size by improving the speed of the game and preventing the goalkeeper from touching the ground, finding a measure that maintained the balance between offensive and defensive efficiency (3 m x 0.9 m), as well as the proliferation of the sport in the USA where the pools were smaller (Rajki, 1958).

3- In the third period (1950-1969) the standardization of the ball that does not absorb water and its characteristics, allowed players to have better visibility and handling, resulting in a faster game with more goals. The new rules eliminated slow players from the game. The center forward became the organizer of the attack with an additional role of ball distributor to teammates who tried driving towards the opponent's goalpost to gain an advantage over the opposing team and ensure favourable conditions for ball reception and shooting. This stage is characterised by balancing the matches with an increase in the penalties for fouls and giving the "little ones" (skilful and fast players) an advantage over the bigger and more powerful players. The current four period's system was introduced to reduce effort and increase rest, which led to an increase in the number of offensive situations and therefore in the number of goals scored (by both winners and losers).

4- The fourth stage covers the period from 1970 to 1986. The game tactics model changed in this stage because the new rules limited the time of possession of one team to 45 seconds. The new rule of re-entry after one minute of exclusion influenced the development of tactics in this type of situation, both offensive and defensive, especially in certain positions. This stage is characterised by an attempt to make the rules easier and more understandable or interpretable (a circumstance that was favoured by the introduction of double arbitration). Likewise, and once the physical primacy has been overcome, the game becomes much more colourful. The skill of the players develops technical aspects such as feinting, dribbling, etc. With the increase of the mobility of the players in attack, the first tactical defensive situations (zone) and offensive ones begin. At the beginning of the 70, the duration of the matches is increased to 4x7 min and the time of attack of the teams is limited, appreciating a drastic increase of the goals scored and reducing initially the difference between winners and losers. However, with the introduction of possession time at 35 s (1977) the difference in goals scored between winners and losers (4.79) according to Madera et al. (2017) increases . This fact is not appreciated again until the next modification of the possession time to 30 s. This fact may have been due to the modification in the duration of the temporary exclusion situations in which the reduction of their duration has caused a greater efficiency in them among the winning teams (Argudo , Ruiz, & Abraldes , 2010).

5- The fifth stage covers the period from 1987 to 2012. This stage can be marked as a high intensity game. Professionalism of water polo at this stage increased the volume and intensity of training. The physical workout is dry for strength development and the daily double training sessions. At this stage the development of the game of water polo, as it is understood today, began to be consolidated by the appearance of new tactical situations and by the definitive establishment of double refereeing. The balance between the teams increases and therefore there is a decrease in offensive situations, which is why all the subsequent changes in recent years have sought to increase the spectacular nature of the sport, the television interest and the entry of sponsors that increase the economic resources of the clubs and the professionalization of the current sport. Initially there was an increase in the importance in the game of temporary exclusions, reaching at least 80% of the goals scored per game. During the last years of this stage, scoring efficiency has decreased, as has the difference between winners and losers (García-Marín, 2009; Madera et al., 2017).

6- The sixth stage of changing rules will cover the period from 2013 to 2020. During this period, the rule changes will probably improve the structure of the water polo game with the aim of trying to establish equilibrium between attack and defence phases. During the last few years, some aspects of the game have been modified, leading to an increase in the penalty (Argudo, Ruiz-Barquín, & Borges, 2016), a greater number of shots, a decrease in the efficiency of the counterattacks and a decrease in the influence of temporary exclusions on the final results of the matches. However, a

significant change in the nature of the game has not been appreciated until the current changes to which time should be left to check their influence on the game (Argudo, Ruiz, & Abraldes, 2010, García-Marín, 2009; García-Marín & Argudo 2017a, 2017b).

It is also important to note that the regulatory changes that have taken place over the last 7 years aim to reduce the roughness of the game and the number of fouls penalised, which according to Hraste et al. (2013) are three times those penalised in football, four times those in basketball and twelve times those in hockey. What is the aim of this reduction? Simply because there is evidence that 60% of fouls in elite matches are provoked with the intention of wasting time in the transition phase. Therefore, in some international competitions (European Junior Championship 2014), FINA tried to convert ordinary fouls into simple temporary exclusions, but the idea did not prosper and this modification was abolished before it was approved.

Once we know the changes made to date as shown in Table 2, we can say that the normative changes have always lagged behind what is happening in the game. For example, the sanction of the penalty shot was regulated when Francesc Castillo in the 1973 World Cup in Yugoslavia sank the goal to avoid an opponent's goal. As well as adding the sanction of a penalty against when requesting a time-out when the ball is not in possession, after the 2003 World Championship several coaches tried to take advantage of this gap in the regulations.

In this sense, and always according to the interpretation made by Lozovina & Lozovina (2009), on the fact that the regulatory modifications do not allow the game to develop it is true and full potential. Future studies could make use of predictive statistical models similar to those presented by Saavedra et al. (2020), who correctly classify 83.9% of the teams with the variables GB shots, action goals, time out and thefts and highlight the important work of the goalkeeper in achieving final sporting success. On the other hand, the perceptions of athletes, managers, referees, spectators (sponsors) and coaches on how changes have affected the game and its training process should be considered. Based on these contributions and on the notational analyses developed by Argudo et al. (2000, 2005a, 2005b, 2009, 2020), Lozovina et al. (2009, 2019a, 2019b), Lupo et al. (2010, 2012, 2014), García-Marín et al. (2015, 2017a, 2017b) Graham and Mayberry (2014, 2016), etc., propose new modifications that are adapted to the current sports reality. For example, proposing that if a goal is scored beyond the 7 m line it is worth double or that if a team receives more than 7 fouls in a quarter it is given a penalty (Lozovina & Lozovina, 2019b).

5. Conclusions

The evolution of a sport is closely related to regulatory changes over time. Any change in them affects the work of coaches, readapting training systems, and players, assimilating the possible variations that these imply on the game dynamics in order to remain competitive. Likewise, these modifications must seek a greater showiness that attracts more practitioners and spectators and, therefore, greater income from sponsorship for official institutions, clubs and athletes.

Many regulatory changes have been made over the years in Water polo. However, there is no scientific evidence of their effects on the game dynamics. There are hardly any studies that have analysed the before and after of a regulation modification. Therefore, it would be very interesting to be able to discuss the suitability of the modifications to be proposed and to collaborate with the federative technical managers for their possible application and thus, to be able to empirically validate the consequences of these new rules on the playing action in water polo.

In any case, we can say that the rules of water polo are alive and well and that they adapt to the changes in the game as time goes by. The current rules are in line with the health situation, trying to reduce the exposure and contact of players and officials to the merely sporting, thus adapting the refereeing to these facts (De Ara, personal communication, 3 November 2020). Referees also believe that the future of water polo will be associated with video refereeing, the law of advantage (which allows for fluid, fast, dynamic play with many chances to score) and the protection of offensive play from defensive play (De Ara, personal communication, 3 November 2020).

Disclosure statement

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References

Argudo, F. M. (2000). *Modelo de evaluación táctica en deportes de oposición con colaboración. Estudio práxico del waterpolo*. Tesis doctoral, Universidad de Valencia, Valencia, España.

Argudo, F. M., Alonso, J. I., Fuentes, F. & Ruiz, E. (2005a). *Polo Análisis v1.0 Banquillo. Software para la cuantificación de las acciones de los jugadores de waterpolo en tiempo real*. En F. M. Argudo, S. Ibáñez, E. Ruiz y J. I. Alonso, Softwares aplicados al entrenamiento e investigación en el deporte (pp. 187-194). Sevilla: Wanceulen.

Argudo, F. M., Alonso, J. I., & Fuentes, F. (2005b). *Computerized registration for tactical quantitative evaluation in water polo. Polo partido v1.0*. In: Proceedings of the 5th International Symposium Computer Science in Sport. Croatia.

Argudo, F. M., García, P., Borges, P. J., & Sillero, E. (2020). Effects of rules changes on shots dynamics in Water polo World Championship 2003 -2013. *Journal of Physical Education and Sport, 20*(2), 800-809. doi:10.7752/jpes.2020.02114

Argudo, F. M., García-Marín, P., Borges-Hernández, P. J., & Ruiz-Lara, E. (2021). Influence of rule changes on shooting performance in balanced matches between two European Water polo Championship. *International Journal of Performance analysis, 21*(1), 61-73. doi:10.1080/24748668.2020.1846111

Argudo, F. M., Ruiz, E., & Abraldes, A. (2010). Influencia de los valores de eficacia sobre la condición de ganador o perdedor en un mundial de Waterpolo. *Retos. Nuevas tendencias en Educación Física, Deporte y Recreación, 17*, 21-24.

Argudo, F. M., Ruiz, E., & Alonso, J. I. (2009). Were differences in tactical efficacy between the winners and losers teams and the final classification in the 2003 water polo World Championship? *Journal of Human Sport and Exercise, 4*(2), 142-153. doi:10.4100/jhse

Argudo, F. M., Ruiz-Barquín, R., & Borges, P. (2016). The Effects of Modifying the Distance of the Penalty Shot in Water Polo. *Journal of Human Kinetics , 54*(1), 127 -133 . doi:10.1515 / hukin-2016-0041

Arias, J. L., Argudo , F. M., & Alonso , J. I. (2009). Influencia del diseño de la línea de tres puntos sobre el número de jugadoras que participan en posesión del balón y las zonas de lanzamiento en minibasket femenino . *Cultura, Ciencia y Deporte*, 4(10), 49-54.

Bardin, L. (1986). *El análisis de contenido*. Madrid: Aka

Castejón, F. J., Martínez, L. F., Del Campo, J., & Argudo, F. M(2011). Análisis de la documentación para la formación de entrenadores de base en baloncesto. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte, 11*(42), 255-277. https://cdeporte.rediris.es/revista/revista 42/artanalisis200.html

Cuddon, J. A. (1980). *The Macmillan Dictionary of Sports and Games*. Ed. Macmillan Press Ltd. U.S.A.

De Ara, O. (2020). Personal comunication , November 3, 2020.

Delahaye, A. (1929). *Le waterpolo*. Anvers: Imprenta Van Montfort.

Donev, Y., & Aleksandrović, M. (2008). History of rule changes in water polo. *Sport Science, 1*(2), 16-22.

Flick, U. (2004). *Introducción a la investigación cualitativa* . Madrid: Morata.

García -Marín , P . (2009). *Evaluación cuantitativa de la desigualdad numérica temporal simple con posesión mediante observación sistemática en waterpolo* . Tesis doctoral . Universidad Autónoma de Madrid , Madrid , España.

García -Marín , P ., & Argudo , F. M . (2017 a). Water polo : Technical and tactical shot indicators between winners and losers according to the final score of the game . *International Journal of Performance Analysis in Sport, 17*(3), 334–349. doi:10.1080/24748668. 2017.1339258

García -Marín , P ., & Argudo , F. M. (2017 b). Water polo shot indicators according to the phase of the championship : Medallist versus non -medallist players . *International Journal of Performance Analysis in Sport, 17*(4), 642–655. doi:10.1080/24748668.2017.1382215

García-Marín, P., Argudo, F. M., & Alonso, J. I. (2015). The game action of the power play in water polo by periods . *RETOS . Nuevas Tendencias en Educación Física, Deporte y Recreación, 27*, 14-18.

Graham , J., & Mayberry , J. (2014). Measures of tactical effi ciency in water polo . *Journal of Quantitative Analysis in Sports, 10*(1), 67-79. doi:10.1515/jqas-2013-0127

Graham , J., & Mayberry , J. (2016). The ebb and flow of official calls in water polo. *Journal of Sports Analytics , 2*(2), 61-71. doi:10.3233/JSA-160019

Heck, S. (2013). Modern Pentathlon at the London 2012 Olympics: Between Traditional Heritage and Modern Changes for Survival . *The International Journal of the History of Sport , 30*(7), 719-735. doi:10.1080 /09523367 . 2013.782485

Hraste, M., Bebić, M., & Rudić, R. (2013). Where is today's water polo heading? An analysis of the stages of development of the game of water polo . *NAŠE MORE : znanstveno -stručni časopis za more i pomorstvo, 60*(1-2), S17-22.

Iguarán, J. (1972). *Historia de la natación antigua y moderna de los Juegos Olímpicos*. Tolosa: Industria gráfica Valverde.

Juba, K. (2008). *A short history of water polo*. Luxembourg: LEN

Kerr, R., & Obel, C. (2015). The disappearance of the perfect 10: Evaluating rule changes in women's artistic gymnastics. *The International Journal of the History of Sport, 32*(2), 318-331. doi:10.1080/09523367.2014.974031

Krippendorff, K. (1997). *Metodología de análisis de contenido: teoría y práctica*. Barcelona: Paidós.

Liu, Z., Dai, J., & Wang, B. (2019). Bribing Referees : The History of Unspoken Rules in Chinese Professional Football Leagues, 1998–2009. *The International Journal of the History of Sport , 36*(4-5), 359 -374 . doi :10.1080 /09523367 .2019 . 1581173

Lloret , M. (1994). *Análisis de la acción de juego en el Waterpolo durante la Olimpiada de Barcelona -92* . Tesis Doctoral . Universitat de Barcelona, Barcelona, España.

Lloret, M. (1998). *Waterpolo. Técnica, táctica y estrategia* . Barcelona: Gymnos.

Lord, C. (2008). *Aquatic 1908-2008*. Lausanne: Federation Internationale de Natation.

Lozovina, M., & Lozovina, V. (2009). Attractiveness lost in the water polo rules. *Sport Science, 2*(2), 85-89.

Lozovina , M., & Lozovina , V. (2019 a). Why introduce a bonus for ordinary offense in water polo . *Sport Science , 12*(Suppl) 7-13.

Lozovina, M., & Lozovina, V. (2019b). Proposal for changing the rules of water polo. *Sport Science, 12*(Suppl) 14-26.

Lupo , C., Capranica , L., & Tessitore , A. (2014). The validity of the session -RPE method for quantifying training load in water polo . *International Journal of Sports Physiology and Performance, 9*(4), 656-660. doi:10.1123/ijspp.2013-0297

Lupo , C ., Condello , G ., & Tessitore , A. (2012). Notational analysis of elite men ´ s water polo related to speci fic margins of victory . *Journal of Sports Sciences & Medicine, 11*(3), 516-525.

Lupo, C., Tessitore , A., Cortis, C., Minganti , C., & Capranica , L. (2010). Notational analysis of elite and sub-elite water polo matches . *Journal of Strength & Conditioning Research , 24*(1), 223-229. doi:10.1519/JSC.0b013e3181c27d36

Madera , J., Tella , V., & Saavedra , J. M . (2017). Effects of rule changes on game -related statistics in men 's water polo matches. *Sports, 5*(4), 84. doi:10.3390/sports5040084

Moenig , U., Cho , S., & Song , H. (2012). The Modi fications of Protective Gear, Rules and Regulations during Taekwondo' s Evolution –From its Obscure Origins to the Olympics . *The International Journal of the History of Sport , 29*(9), 1363 - 1381. doi:10.1080/09523367.2012.691474

Navarro , P . & Díaz , C . (1995). Análisis de contenido . En Delgado , J. M ., & Gutiérrez , J. (Eds .). *Métodos y técnicas cualitativas de investigación en ciencias sociales* (pp. 177-224). Madrid: Síntesis.

Olivós, R. (1992). *Teoría del fútbol*. Sevilla: Wanceulen.

Rajki, B. (1958). *Waterpolo*. London: Museum Press.

Ruiz-Lara , E., Borges-Hernández, P., Ruiz-Barquín, R., & Argudo -Iturriaga , F. M. (2018). Analysis of time -out use in female water polo. *Journal of Human Sport and Exercise, 13*(1), 1-8. doi:10.14198/jhse.2018.131.01

Saavedra, J. M., Pic, M., Lozano, D., Tella, V., & Madera, J. (2020). The predictive power of game-related statistics for the final result under the rule changes introduced in the men 's world water polo championship : a classi fication -tree approach . *International Journal of Performance Analysis in Sport, 20*(1), 31-41. doi:10.1080/24748668.2019.1699767

Usabiaga , O. & Castellano , J. (2014). Efecto del cambio de reglas en pelota vasca escolar . (Effect of rule changes in school -league basque pelota). *Cultura , Ciencia y Deporte* , 9(27), 243-250.

Vamplew, W. (2007). Playing with the rules: Influences on the development of regulation in sport . *The International Journal of the History of Sport, 24*(7), 843-871. doi:10.1080/09523360701311745

Vigarello, G. (1988). *Une histoire culturelle du sport. Techniques d'hier et d'aujourd'hui*. Paris: Revue EPS - Robert Laffont.

Effects of active exergames training on physical functional performance in older females

Efectos del entrenamiento de exergames activos sobre el rendimiento físico funcional en mujeres mayores

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Abstract

Objective: To analyze the effects of 8 weeks of an active exergames training program on walking speed, static balance, timed up-and-go test, and sit-to-stand performance in older females. Methods: Two groups of participants were formed by block-design randomization as follows: (i) control group (n=12; age, 74.1±7.9 years); (ii) 8 week exergames training group (n=13; age, 75.6±9.1 years). Training was undertaken three times per week, including athletic, bowling and table tennis exergames. Each exergame had a duration of 8 min, with 2 min of recovery between exergames. The intensity of the training sessions was controlled using the 10-point rating of perceived exertion scale. Results: Group×time interactions were observed for the 4 m walking speed test, static balance test, timed up-and-go test and the 5-repetition sit-to-stand test (all p<0.01; d=0.46–0.80). Conclusion: Exergames training improve physical functional performance in older females. These results should be considered when designing appropriate and better training programs for older adults, since active exergames training it is an affordable and low-cost alternative for community centres and preventive health units working with this population.

Keywords: physical fitness, resistance training, frail elderly, aged, video games, exercise, musculoskeletal and neural physiological phenomena.

Resumen

Objetivo: Analizar los efectos de 8 semanas de un programa de entrenamiento de exergames activos sobre la velocidad de la marcha, el equilibrio estático, la prueba de levantarse caminar y volver a sentarse en mujeres mayores. Métodos: Se formaron dos grupos de participantes mediante aleatorización de diseño de bloques de la siguiente manera: (i) grupo de control (n = 12; edad, 74,1 ± 7,9 años); (ii) grupo de entrenamiento de exergames de 8 semanas (n = 13; edad, 75,6 ± 9,1 años). El entrenamiento se llevó a cabo tres veces por semana, incluidos ejercicios de atletismo, bolos y tenis de mesa. Cada exergame tuvo una duración de 8 min, con 2 min de recuperación entre exergames. La intensidad de las sesiones de entrenamiento se controló mediante la calificación de 10 puntos de la escala de esfuerzo percibido. Resultados: Se observaron interacciones de grupo x tiempo para la prueba de velocidad de caminata de 4 m, la prueba de equilibrio estático, la prueba de levantamiento y marcha cronometrada y la prueba de sentarse y pararse de 5 repeticiones (todas p <0,01; d = 0,46-0,80). Conclusión: El entrenamiento con exergames mejora el rendimiento físico funcional en mujeres mayores. Estos resultados deben ser considerados a la hora de diseñar programas de formación adecuados y mejores para los adultos mayores, ya que el entrenamiento en exergames es una alternativa asequible y de bajo costo para los centros comunitarios y unidades de salud preventiva que trabajan con esta población.

Palabras clave: condición física, entrenamiento de resistencia, anciano frágil, envejecido, videojuegos, ejercicio, fenómenos fisiológicos neurales y musculoesqueléticos.

INTRODUCTION

The population of older adults is increasing, with an estimated increase from 11% to 22% worldwide between years 2000 and 2050 (WHO, 2015). The aging process brings with it changes in the physical functional performance of the population, as a decrease in balance and muscle strength, leading to a deterioration in mobility, increased risk of falling, hospitalization, thus adversely affecting their quality of life and health, and may lead to functional dependence (Frontera, 2017; Smee et al., 2012).

Therefore, it is important to consider interventions to counteract the decline of physical functional performance in older adults. Physical exercise based on active exergames has emerged as a means not only of entertainment, but also as a strategy to improve the physical functional performance of older adults (Fang et al., 2020). A study by Maillot et al. (2012) demonstrated that 12 weeks of active exergames training, including two sessions per week of 70 min each, improved older males and females physical functional performance in the 6 m walk test (14%) compared to the control group (0.7%). Interventions through active exergames can offer an alternative to traditional training programs (e.g., balance training) in older adults. In a study it was observed that 6 weeks of exergames training, including five sessions of 30 min per week, improved balance (10%) and the physical functional performance in the timed up-and-go test (8.2%) in older males and females. In addition, participants reported greater pleasure during exergames training sessions compared to a group of older adults who performed traditional balance exercises (Karahan et al., 2015). In another study with older females (Szanton et al., 2016), 4 weeks (3 sessions per week) of active exergames improved balance, walking speed, and the ability to stand-up from a chair.

Furthermore, Shin et al. (2016) in an 8 week active exergames training intervention, with two sessions per week, observed improvements in the Berg balance scale (4.5%) and the timed up-and-go test (8.4%) in older males and females. In addition, improvements in the quality of life have been observed at the physical (15.1%), social (17.5%) and psychological levels (9.8%) (Keogh et al., 2012), with improvements in sociability (4.3%), decreased feelings of loneliness (6.3%) and social anxiety 2.6% (Xu et al., 2016).

While there is evidence of the favorable effects of active exergames interventions on the physical function of older adults, it is important to replicate the aforementioned findings, in order to confirm or refute results, exploring the limits of the theories and, ultimately, to help in the progression of science and society (Earp, 2015; Forstmeier et al., 2017), specially for older adults. In addition, although adequately planned active exergames interventions usually have demonstrated a significant effect on the improvement of several key outcomes in older females, the high inter-individual variability in the response to exercise training among older adults should be considered (Barbalho et al., 2017; Bouchard & Rankinen, 2001). In this sense, familial factors (shared environment and genetic factors) may affect the response to exercise training (Bouchard & Rankinen, 2001). Active exergames interventions have collected data predominantly from non-Latin-American countries, with findings potentially differencing from those that may be obtained in participants with different genetic component background (Ross et al., 2019). Therefore, the objective of this study was to replicate results previously observed in active exergames interventions in older adults from non-Latin American countries, through an 8 week active exergames training program applied to female Latin American older adults, including Amerindians (the Mapuche), to analyse its effects on physical functional performance, including walking speed, static balance, timed up-and-go test, and sit-to-stand performance. Based on relevant literature (Karahan et al., 2015; Szanton et al., 2016), it was hypothesized that 8 weeks of training with active exergames would improve the physical functional performance of older females.

METHODS

To analyze the effects of 8 weeks of an exergames training program on the physical functional performance in older females (≥60 years of age), two groups of participants were randomly formed. A block-design randomization sequence was generated electronically at https://www.randomizer.org and concealed until interventions were assigned. This procedure was established according to the "CONSORT" statement (https://www.consort-statement.org), as graphically described in Figure 1.

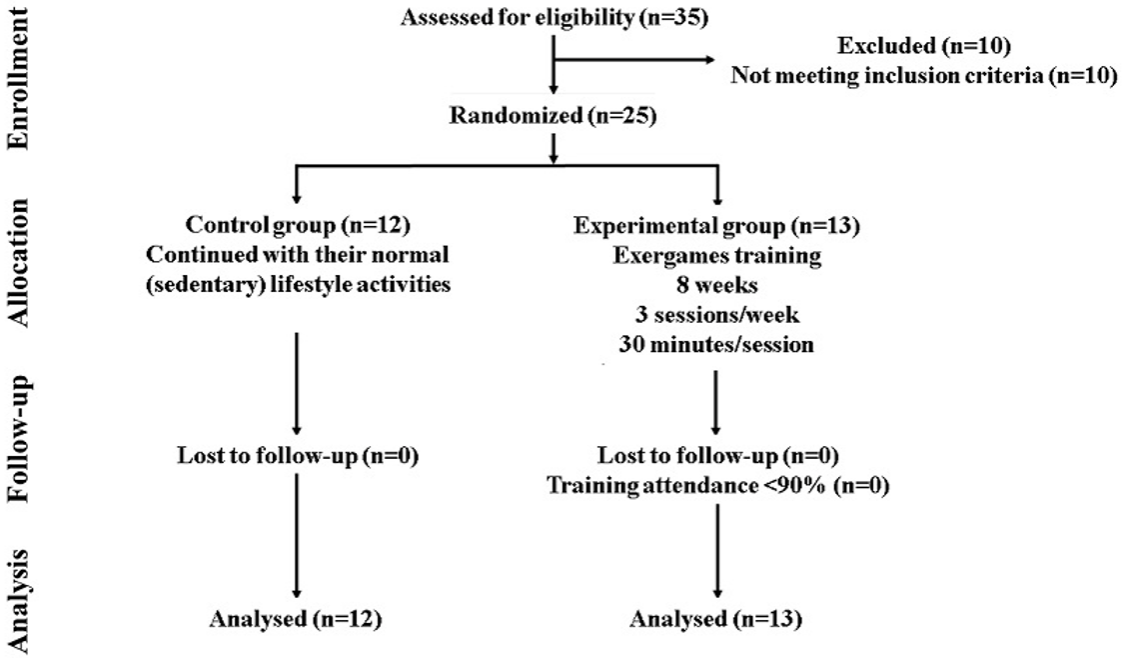

Figure 1 . CONSORT diagram of recruitment and randomization process.

One group of females was deemed the control group (CG, n=12; age 74.1±7.9 years; age range, 65–89 years; body mass, 69.5±14.4 kg; height, 147.6±6.8 cm; body mass index, 31.4±5.6 kg•m-2). A second group completed 8 weeks of an active exergames training program, with three sessions per week (ExG, n=13; age, 75.6±9.1 years; age range, 60–89 years; body mass, 73.4±18.2 kg; height, 149.1±4.6 cm; body mass index, 33.1±6.7 kg•m-2).

Participants

Initially, 35 older females of Hispanic descent (including Amerindians -the Mapuche), were considered for participation in the study. Participants with similar (<600 METs-1.min-1.week-1) physical activity levels were recruited, and females from the two groups were periodically asked (i.e., three times per week) to notate their habitual physical activity levels throughout the intervention. Participants met the following inclusion criteria: (i) healthy by self-report (i.e., completion of the revised physical activity readiness questionnaire for older adults); (ii) free (by self-report) of a history of heart disease, osteoarthritis, severe visual impairment, neurological disease, pulmonary disease requiring the use of oxygen, uncontrolled hypertension, hip fracture, or lower extremity joint replacement in the past six months, and no current participation in structured training exercise or previous participation in exercise training in the past six months. Participants taking medications considered to affect dependent variables (e.g., conjugated estrogen) were excluded from the study. To be included in the final analyses, participants who met the inclusion criteria also needed to complete ≥90% of all training sessions (≥21 of 24 sessions) and attend all assessment sessions. Of the 35 females initially considered for inclusion in the study, one was excluded due to a history of heart disease, one due to a pre-existing diagnosis of osteoarthritis, and eight females did not attend all baseline measurement sessions. Therefore, 25 females were finally included and randomly divided into the CG and ExG. All females from the CG and ExG attend all measurement sessions after the intervention, and all females from the ExG attend ≥90% of all training sessions. Therefore, 25 older females were included in the final analyses. The sample size was deemed adequate for statistical power based on recommendations in previous research (Bieryla, 2016; Padala et al., 2017) examining the effects of exergames in older adults (alpha=0.05; beta=0.80).

Apart from routine daily tasks of the two groups included in the study, the ExG underwent an active exergames training program (i.e., three sessions per week over 8 weeks). All participants were carefully informed about the experimental procedures and possible risks and benefits associated with participation in the study, and each signed an informed consent document before any of the tests were performed. The study protocol was reviewed and approved by the Scientific Ethics Committee of the Universidad Autónoma de Chile (No. 06-2016) and the principles of the Declaration of Helsinki were followed for its development.

Testing procedures

Testing procedures were applied to all groups at baseline and after 8 weeks of training. The participants followed a familiarization session of 90 min before testing to reduce the effects of any differences in learning. The standardized tests were completed in one session. All tests were administered at the same location, in the same order, at the same time of day (i.e., 10:00–13:00 h), and by the same investigator, whom was blinded to the training group of the participants. Females were asked to wear the same athletic clothing during each testing session and were motivated to give their maximum effort during performance testing.

Anthropometric measures. Standing height (m) and body mass (kg) were assessed according to international standards for anthropometric assessment. To evaluate height and body mass, a stadiometer/mechanical scale (SECA, model 220, Hamburg, Germany) with accuracy of 0.1 cm and 0.1 kg, respectively, was used. These parameters were assessed

before any physical performance test. Participants were tested while wearing light clothing (shoes were removed). Body mass index was calculated (kg•m-2).

4 m walking speed test. Participants were instructed to perform two maximum-effort walking for 4 m. Participants were instructed to walk as fast as possible, without running. The time was measured to the nearest 0.01 s using single-beam infrared photoelectric cells (Brower Timing System, Salt Lake City, UT, USA). Participants had a standing start with the toe of the preferred foot forward and just behind the starting line. The test started when participants voluntarily initiate the test, which triggered timing. The timing gates were positioned at the beginning (0.3 m in front of the starting line) and at 4 m and set ~0.7 m above the floor (i.e., ~hip level). This system ensures to capture trunk movement rather than a false trigger from a limb. Participants performed the trials separated by 3 min of rest, on an indoor wooden track. The best result was chosen for analysis.

Static balance. This protocol followed previous published instructions for tandem stance (Guralnik et al., 1994). An evaluator assistant was positioned on the right side of the participant, another on the left, one behind and another ahead of the participant until felt stable in the tandem position, with one foot directly in front of and touching the other foot. Participants self-selected the forward foot. Support provided was the minimum needed to prevent loss of balance and was not recorded on the data collection form or otherwise factored into the score. Timing began as support was released and continued for 10 seconds or until participants moved out of tandem or contacted external support. A stopwatch recorded the time. Two attempts were allowed and the best performance was recorded for analysis, with 2 min of rest between attempts. Instructions were given to position the arms, bend at the knees, or move the body as needed to maintain balance. The test was completed on an indoor wooden surface.

Timed up-and-go test. The test consisted of standing up from a chair (50 cm off the floor) with armrest, walking 3 m, and turning and returning to the initial seated position. The test was administered according to previously described instructions (Podsiadlo & Richardson, 1991). Participants performed three trials, with 3 min of rest between them, on an indoor wooden track. The time was measured to the nearest 0.01 s using single-beam infrared photoelectric cells (Brower Timing System, Salt Lake City, UT, USA), as indicated above. The best result was chosen for analysis.

5-repetition sit-to-stand test. The test consisted of standing up from a chair (50 cm off the floor) and returning to the initial seated position, completing five repetitions as fast as possible, administered according to previously described instructions (Guralnik et al., 1994). Time was controlled by using a stopwatch. Participants performed two trials with at least 4 min of rest between them. The best result was chosen for analysis.

Training Protocol

Training was undertaken three times per week (usually between 11:00 and 11:40), on non-consecutive days, based on previous interventions (Sadeghi et al., 2016). Exergames training sessions were conducted using an X-box® Kinect sensor containing an infrared camera that can distinguish body parts in the environment through mathematical algorithms. As the camera recognizes the joints and body parts, the avatar on the screen reflects the individual movements in real time. Participants completed the training sessions at 1.8-2.4 m in front of a big screen television, with the Kinect sensor placed ~1.5 m over the floor surface. The games selected for training sessions had three levels of intensity (difficulty): easy, moderate, and hard. In this sense, to accomplish the training principle of overload, the participants started training sessions using the easy level, increasing the difficulty according to individual progression. The intensity of the training sessions was controlled using the 10-point rating of perceived exertion (RPE) scale. However, if the training intensity was over an RPE of 4-5, the difficulty of the game was reduced. A familiarization session was held where the older females were shown how to carry out the sports games (i.e. bowling, athletics and table tennis) that would be included in their exergames training. After this, he was asked if there was any doubt to explain again. Continuing with older adults playing these games in a recreational way so they can adapt to this technology.

Training sessions begun with a warm-up of 5 min, including a lateral step to the right and then to the left, four times in each direction, walking forward and energetically, raising the left and right knee upwards, and mild stretching. The main part of the training sessions included athletic, bowling and table tennis exergames, each with a duration of 8 min, with 2 min of recovery between games. All training sessions finished with a cool-down of 5 min, including breathing deeply while carrying both arms above the head and letting out the air while bringing the arms back down, walking slowly, and performing some mild stretching exercises (Sadeghi et al., 2016). Training sessions were performed under the direct supervision of strength and conditioning coaches to ensure safety and the maintenance of the exercise protocol. A supervisor-to-participant ratio method of 1:1 was used. The strength and conditioning coaches were oriented to: (i) control training attendance and administration (i.e., check participants' training logs after each training session and help them to complete the logs); (ii) provide technical instruction, feedback, and motivation to assure adequate training intensity; (iii) provide social and mental support; and (iv) exhibit a supportive attitude and avoid over-expectation. None of the coaches was aware of the purpose of the study. On the other hand, intensity was increased in table tennis and athletics games by growing the speed of movements, while for bowling, the game's complexity was increased. Figure 2 presents the summary of the intervention.

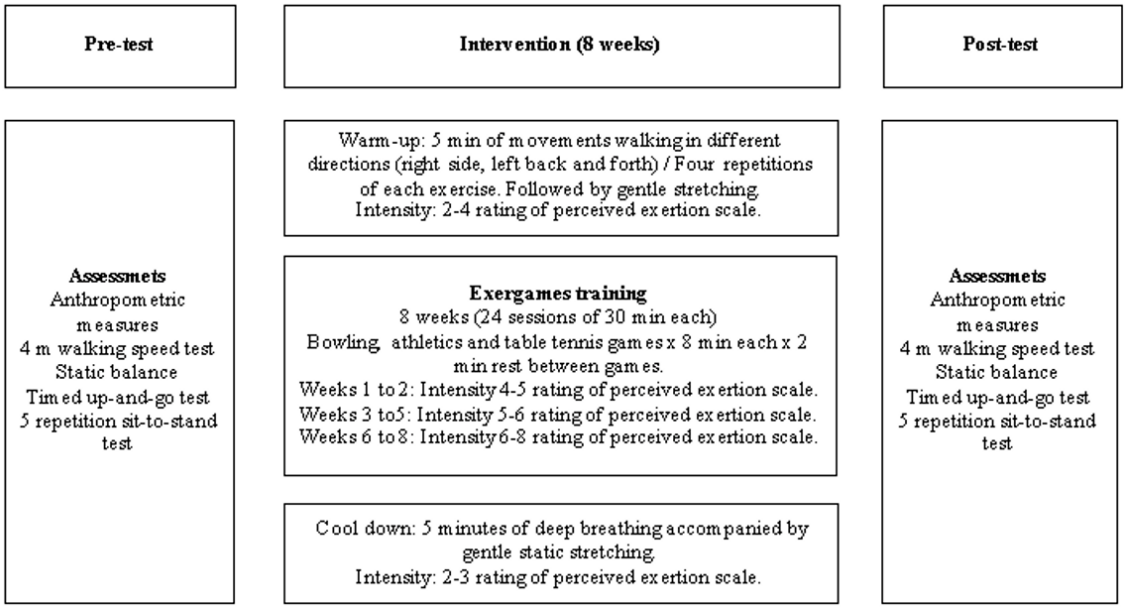

Figure 2. Intervention program

Statistical analysis

Data are presented as group mean values ± standard deviations. Normality and homoscedasticity assumptions for all data before and after intervention were checked with Shapiro-Wilk and Levene tests, respectively. Differences between groups at baseline were investigated using one-way ANOVA test. To establish the effects of the intervention on the outcomes, ANOVA with repeated measures (two groups [Control and Experimental] × two time points [pre- and post-test]) were performed. Post-hoc tests with a Bonferroni-adjusted α were conducted to identify comparisons that were statistically significant. Effect sizes for main effects of group, time, as well as group × time interactions were taken from the ANOVA output (partial eta squared). Within-group Cohen's d effect sizes were computed, using the following equation: effect sizes = (mean_post - mean_pre)/pooled standard deviation. Statistical analyses were conducted using STATISTICA statistical package (Version 8.0; StatSoft, Inc, Tulsa). Significance level was set at α = 5%. Tests' reliability was determined using the intra-class correlation coefficient, with threshold set at ≥0.80 in order to include data for analysis.

RESULTS

No injuries occurred in any of the females during the completion of this study. Moreover, although participants described mild levels of muscle soreness after the initial testing and training sessions, none of them suspended training or their normal daily live activities due to muscle soreness.

There were no significant (all p>0.05, d=0.01–0.11) baseline differences between-groups for all dependent variables (Table 1).

Table 1. Baseline pre and changes post in dependent variables after 8 weeks of intervention

Variables	Experimental group (n=13)	Control group (n=12)	ANOVA outcomes		
			Group F(1, 23), p-value (d)	Time F(1, 23), p-value (d)	Group x Time F(1, 23), p-value (d)
4-m walking speed test (s)			F=2.1, p=0.2 (0.09)	F=2.8, p=0.11 (0.11)	F=19.7, p<0.001 (0.46)
Pre	2.5±0.6	2.6±0.5			
Post	2.4±0.5*	2.8±0.5			
Static balance (s)			F=0.1, p=0.7 (0.01)	F=45.1, p<0.001 (0.66)	F=60.1, p<0.001 (0.72)
Pre	3.0±2.6	4.7±2.3			
Post	6.7±2.0*	4.4±2.3			
Timed up-and-go test (s)			F=0.1, p=0.7 (0.01)	F=8.4, p<0.01 (0.27)	F=26.9, p<0.01 (0.54)
Pre	7.9±0.7	7.3±0.9			
Post	7.2±0.7*	7.5±0.9			
5-repetition sit-to-stand test (s)			F=0.1, p=1.0 (0.00)	F=40.0, p<0.001 (0.64)	F=88.9, p<0.001 (0.80)
Pre	15.0±2.5	13.5±2.3			
Post	12.5±1.8*	14.0±2.2			

Group × time interactions were observed for the 4 m walking speed test, static balance, timed up-and-go test, and 5-repetition sit-to-stand test (all p<0.01; d=0.46–0.80). For the ExG, the improvements in the 4 m walking speed test was Δ4.1% (d=0.22), static balance Δ199% (d=1.42), timed up-and-go test Δ8.5% (d=0.85), and 5-repetition sit-to-stand test Δ16% (d=1.07). Aside from trivial (ES <0.2) changes in the CG for the static balance, timed up-and-go test, and 5-repetition sit-to-stand test, a detrimental change was detected in the 4 m walking speed test after 8 weeks (Δ10.9%, d=0.5).

DISCUSSION

The objective of this study was to replicate results previously observed in active exergames interventions in older adults from non-Latin-American countries, through an 8 week active exergames training program applied to female Latin American older adults, including Amerindians (the Mapuche), to analyze its effects on walking speed, static balance, timed up-and-go test, and sit-to-stand performance. The main results suggest that an 8-week active exergames training program induced meaningful improvements in the 4 m walking speed test, static balance, timed up-and-go test, and 5-repetition sit-to-stand test, as compared to a control group.

Walking is an essential part of daily living, and even a performance increase of 0.1 m.s-1 in walking speed has been associated with increased survival, especially in older females (Studenski et al., 2011). Additionally, improvements in this physical capability may reduce the difficulty with which older females perform their daily living activities, giving them the possibility of better walking habits and, hence, improved health (Mosallanezhad et al., 2013). In this sense, current results show that the ExG, after an exergames training program intervention, improved in the 4 m walking speed test (d=0.22), similar to previous exergames training interventions in older females. According to Garcia et al. (2016) improvements in walking speed (29%) were observed after an intervention with twelve weeks and three sessions per week in older females and males. Szanton et al. (2016), after a 4-week intervention, with three sessions per week, induced a 19.4% improvement in walking speed in older adults. Improvements may be associated with greater neuromuscular activation and muscle power (Clark et al., 2011; Suzuki et al., 2001).

Alterations in the proprioceptive, sensory and vestibular systems occur frequently during aging (Clark et al., 2015), leading to a loss of control of the knee joint and balance (Relph & Herrington, 2016). Such changes may be counteracted by appropriate interventions. In this sense, current results show that the ExG, after an exergames training program, improved in the static balance test (d=1.42). Similar to the current results, Karahan et al. (2015) after 6 weeks and 5 sessions per week, observed improvements (10.2%) in the Berg balance scale in older adults. Changes in balance after exergames training might be related to an improvement in the proprioception of the knee joint (Sadeghi et al., 2016). After 8 weeks of exergames training, with 3 sessions per week (as in the current study), an improvement in knee proprioception was observed in the dominant and non-dominant leg in older participants (Sadeghi et al., 2016). Exergames training programs combines sensory stimulation with cognitive stimulation (Saposnik et al., 2009) including multisensory feedback (Pichierri et al., 2011) which may be related to the aforementioned proprioception and balance improvement. Therefore, to counteract the falls during aging due to poor proprioception and postural stability (Sohn & Kim, 2015) the sensorial motor-control stimulation induced by exergames training, especially in the lower-limbs, may be important for balance.

Limitations in the mobility of the lower limbs, such as walking or getting up from a chair are also indicators of a marked decline in functional health (Verbrugge & Jette, 1994). In this sense, a key finding in this study was the improvement in the timed up-and-go test (Δ8.5%, d=0.85) in the ExG, corroborating previous results. For example, after 12 weeks of exergames training, with 3 sessions per week, improvements

(13%) were observed in the timed up-and-go test in older adults (Garcia et al., 2016). In addition, Grigorova et al. (2015) observed improvements (6.8%) in the timed up-and-go test after 4 weeks. Interventions with exergames may lead to an increase in the strength of the lower limbs and balance, potentially related to improvements in the timed up-and-go test (Grigorova et al., 2015; Lee, 2013). Such adaptations may lead to decreased fear and risk of falling.

Improvements in the 5-repetition sit-to-stand test (Δ16%, d=1.07) was also observed in this study. Similarly, Sato et al. (2015) after 24 active exergames training sessions, observed improvements (37.1%) in standing and sitting from a chair in older adults. As some of the games included in the current intervention required that participants perform movements similar to the sit-to-stand test, this may have contributed to the observed changes in physical functional performance. For example, during bowling, table-tennis and the long jump in athletics exergames the participants frequently adopted a ~90° knee angle, similar to the knee angle that may be considered key for the performance of the sit-to-stand test. In this line, a previous study in older adults also observed improvements in the sit-to-stand test after an exergames intervention that included games with a similar pattern of movement (Sato et al., 2015). Improvements in the sit-to-stand test may be considered key for the physical autonomy of older adults to carry out their activities of daily living.

A possible limitation of the present study was the absence of more physiological measurements, which may have helped in better understanding the underlying mechanisms of active exergames training. Moreover, further studies should aim to replicate current results with greater samples sizes of older females, and older males, including long-term assessments. Despite of these limitations, this study provides support for using active exergames training as an accessible alternative to promote active aging.

CONCLUSION

An 8-week active exergames training program induced meaningful improvements in the physical functional performance of older females, including improvements in the 4 m walking speed test, static balance, timed up-and-go test, and the 5-repetition sit-to-stand test, as compared to a control group of females that continued with their habitual non-active lifestyle.

PRACTICAL APPLICATIONS

Active exergames training approaches may be an effective and safe strategy to achieve significant and clinically relevant improvements in physical functional performance relevant to activities of daily living and the quality of life of older females. These results should be considered when designing appropriate and better training programs for older adults, since active exergames training it is an affordable and low-cost alternative for community centers and preventive health units working with this population.

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REFERENCES

Barbalho, M., Gentil, P., Izquierdo, M., Fisher, J., Steele, J., & Raiol, RA. (2017). There are no no-responders to low or high resistance training volumes among older women. *Experimental Gerontology*, 99:18-26. doi: 10.1016/j.exger.2017.09.003.

Bieryla, KA. (2016). Xbox Kinect training to improve clinical measures of balance in older adults: a pilot study. *Aging Clinical and Experimental Research*, 28(3):451-7. doi: 10.1007/s40520-015-0452-y.

Bouchard, C., & Rankinen, T. (2001). Individual differences in response to regular physical activity. *Medicine & Science in Sports and Exercise*, 33(6):S446-51. doi: 10.1097/00005768-200106001-00013

Clark, D.J., Patten, C., Reid, K.F., Carabello, R.J., Phillips, E.M., & Fielding, R.A. (2011). Muscle performance and physical function are associated with voluntary rate of neuromuscular activation in older adults. *The Journal of Gerontology. Series A, Biological Science and Medical Sciences*, 66(1):115-21. doi: 10.1093/gerona/glq153

Clark, N.C., Roijezon, U., & Treleaven, J. (2015). Proprioception in musculoskeletal rehabilitation. Part 2: Clinical assessment and intervention. *Manual Therapy*, 20(3):378-87. doi: 10.1016/j.math.2015.01.009.

Earp, B.D., & Trafimow, D. (2015). Replication, falsification, and the crisis of confidence in social psychology. *Frontiers in Psychology*, 6: 621. doi: 10.3389/fpsyg.2015.00621

Fang, Q., Ghanouni, P., Anderson, S.E., Touchett, H., Shirley, R., Fang, F., & Fang, C. (2020). Effects of exergaming on balance of healthy older adults: a systematic review and meta-analysis of randomized controlled trials. *Games for health journal, 9*(1), 11-23. doi: 10.1089/g4h.2019.0016.

Forstmeier. W., Wagenmakers, E.J., & Parker, T.H. (2017). Detecting and avoiding likely false-positive findings - a practical guide. *Biological Reviews*, 92(4):1941-1968. doi: 10.1111/brv.12315.

Frontera, W.R. (2017). Physiologic Changes of the Musculoskeletal System with Aging: A Brief Review. *Physical Medicine and Rehabilitation Clinics of North America*, 28(4):705-711. doi:10.1016/j.pmr.2017.06.004.

Garcia, J.A., Schoene, D., Lord, SR., Delbaere, K., Valenzuela, T., & Navarro, K.F. (2016). A Bespoke Kinect Stepping Exergame for Improving Physical and Cognitive Function in Older People: A Pilot Study. *Games for Health Journal*, 5(6), 382–388. doi: 10.1089/g4h.2016.0070

Grigorova, K, Dimitrova, A, Lubenova, D, Zaharieva, D., & Vasileva, D. (2015). Feasibility of interactive video games for influence on balance in institutionalized elderly people. *Journal of Physical Education and Sport*, 15(31): 429-43. doi: 10.7752/jpes.2015.03064.h

Guralnik, J.M., Simonsick, E.M., Ferrucci, L., Glynn, R.J., Berkman, L.F., Blazer, D.G., Scherr, P.A., & Wallace R.B. (1994). A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *Journal Gerontology*, 49(2):M85-94. doi: 10.1093/geronj/49.2.m85.

Karahan AY., Tok F., Taskin H., Kucuksarac S., Basaran A., & Yildirim P. (2015). Effects of Exergames on Balance, Functional Mobility, and Quality of Life of Geriatrics Versus Home Exercise Programme: Randomized Controlled Study.

Central European Journal of Public Health, 23 Suppl:S14-8. doi: 10.21101/cejph.a4081.

Keogh, J.W., Power, N., Wooller, L., Lucas, P., & Whatman, C. (2014). Physical and psychosocial function in residential aged-care elders: effect of Nintendo Wii Sports games. *Journal of Aging Physical Activity*, 22(2):235-44. doi: 10.1123/japa.2012-0272.

Lee, G. (2013). Effects of training using video games on the muscle strength, muscle tone, and activities of daily living of chronic stroke patients. *Journal of Physical Therapy Science*, 25(5): 595–597. doi: 10.1589/jpts.25.595.

Maillot, P., Perrot, A., & Hartley, A. (2012). Effects of interactive physical-activity video-game training on physical and cognitive function in older adults. *Psychology and Aging*, 27(3):589-600. doi: 10.1037/a0026268.

Mosallanezhad, Z., Salavati, M., Sotoudeh, G.R., Nilsson W.L., & Frandin, K. (2014). Walking habits and health-related factors in 75-year-old Iranian women and men. *Archives of Gerontology and Geriatrics,* 58(3):320-6. doi: 10.1016/j.archger.2013.11.008.

Padala, K.P., Padala, P.R., Lensing, S.Y., Dennis, R.A., Bopp, M.M., Parkes, C.M., Garrison M.K., Dubbert, P.M., Roberson, P.K., & Sullivan, D.H. (2017). Efficacy of Wii-Fit on Static and Dynamic Balance in Community Dwelling Older Veterans: A Randomized Controlled Pilot Trial. *Journal of Aging Research*, 4653635. doi: 10.1155/2017/4653635.

Pichierri, G., Wolf, P., Murer, K., & de Bruin, E.D. (2011). Cognitive and cognitive-motor interventions affecting physical functioning: a systematic review. *BMC Geriatrics*, 11-29. doi:10.1186/1471-2318-11-29.

Podsiadlo, D., & Richardson, S. (1991). The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *Journal of the American Geriatrics Society*, 39(2):142-8. doi: 10.1111/j.1532-5415.1991.tb01616.x.

Relph, N., & Herrington, L. (2016). The effects of knee direction, physical activity and age on knee joint position sense. *The Knee*, 23(3):393-8. doi: 10.1016/j.knee.2016.02.018.

Ross, R., Goodpaster, B.H., Koch, L.G., Sarzynski, M.A., Kohrt, W.M., Johannsen, N.M., Skinner, J.S., Castro, A., Irving, B.A., Noland, R.C., Sparks, L.M., Spielmann, G., Day, A.G., Pitsch, W., Hopkins, W.G., & Bouchard, C. (2019). Precision exercise medicine: understanding exercise response variability. *British Journal of Sports Medicine*, 53(18):1141-1153. doi: 10.1136/bjsports-2018-100328.

Sadeghi, H., Hakim, M.N., Hamid, T.A., Amri, S.B., Razeghi, M., Farazdaghi, M., & Shakoor, E. (2017). The effect of exergaming on knee proprioception in older men: A randomized controlled trial. *Archives of Gerontology and Geriatrics* 2017, 69:144-150. doi: 10.1016/j.archger.2016.11.009.

Saposnik, G., Mamdani, M., Bayley, M., Thorpe, K.E., Hall, J., Cohen, L.G., & Teasell, R. (2010). Effectiveness of Virtual Reality Exercises in STroke Rehabilitation (EVREST): rationale, design, and protocol of a pilot randomized clinical trial assessing the Wii gaming system. *International Journal of Stroke*, 5(1):47-51. doi: 10.1111/j.1747-4949.2009.00404.x.

Sato, K., Kuroki, K., Saiki, S., & Nagatomi, R. (2015). Improving Walking, Muscle Strength, and Balance in the Elderly with an Exergame Using Kinect: A Randomized Controlled Trial. Randomized Controlled Trial. *Games for Health Journal*, 4(3):161-7. doi: 10.1089/g4h.2014.0057.

Shih, M.C., Wang, R.Y., Cheng, S.J., & Yang, Y.R. (2016). Effects of a balance-based exergaming intervention using the Kinect sensor on posture stability in individuals with Parkinson's disease: a single-blinded randomized controlled trial. *Journal Neuroengineering and Rehabilitation*, 27:13(1):78. doi: 10.1186/s12984-016-0185-y.

Smee, D.J., Anson, J.M., Waddington, G.S., & Berry, H.L. (2012). Association between Physical Functionality and Falls Risk in Community-Living Older Adults. *Current Gerontology and Geriatrics Research*, 864516. doi: 10.1155/2012/864516

Sohn, J., & Kim, S. (2015). Falls study: Proprioception, postural stability, and slips. *Biomedical Materials and Engineering*, 26 Suppl 1:S693-703. doi: 10.3233/BME-151361.

Studenski, S., Perera, S., Patel, K., Rosano, C., Faulkner, K., Inzitari, M., Brach, J., Chandler, J., Cawthon, P., Connor, E.B., Nevitt, M., Visser, M., Kritchevsky, S., Badinelli, S., Harris, T., Newman, A.B., Cauley, J., Ferrucci, L., & Guralnik, J. (2011). Gait speed and survival in older adults. *JAMA*, 305(1): 50–58. doi: 10.1001/jama.2010.1923.

Suzuki, T., Bean, J.F., & Fielding, R.A. (2001). Muscle power of the ankle flexors predicts functional performance in community-dwelling older women. *Journal of the American Geriatrics Society*, 49(9):1161-7. doi: 10.1046/j.1532-5415.2001.49232.x.

Szanton, SL., Walker, R.K., Lim, J.H., Fisher, L., Zhan, A., Gitlin, L.N., Thorpe, R.J., & Terzis, A. (2016). Development of an Exergame for Urban-dwelling Older Adults With Functional Limitations: Results and Lessons Learned. *Progress in community health partnerships: research, education, and action*, 10(1):73-81. doi: 10.1353/cpr.2016.0005.

Verbrugge, L.M., & Jette, A.M. (1994). The disablement process. *Social science & medicine*, 38(1):1-14. doi: 10.1016/0277-9536(94)90294-1.

WHO (World Health Organization). World report on ageing and health. World Health Organization, ed.: World Health Organization, 2015. URL: https://apps.who.int/iris/handle/10665/186463.

Xu, X., Li, J., Pham, T.P., Salmon, C.T., & Theng, Y.L. (2016). Improving Psychosocial Well-Being of Older Adults Through Exergaming: The Moderation Effects of Intergenerational Communication and Age Cohorts. *Games for health journal*, 5 (6):389-397. https://doi.org/10.1089/g4h.2016.0060.

CULTURA, CIENCIA Y DEPORTE

Effect of physical activity and fitness on executive functions and academic performance in children of elementary school. A systematic review

Efectos de la actividad física y condición física sobre funciones ejecutivas y rendimiento académico en niños de Educación Primaria. Una revisión sistemática

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Abstract

This systematic review sought to investigate the influence of physical activity and physical fitness on cognitive functions and academic performance. Studies were identified in four databases from January 2010 through January 2021. A total of 26 studies were selected after meeting the established criteria. Nine studies showed an association between physical activity and physical fitness variables and academic performance. Cardiorespiratory fitness, speed-agility, motor coordination, and perceptual-motor skill had the strongest association with executive function, including attention, memory, inhibition and shifting in 17 studies. High levels of physical activity and physical fitness are associated with higher academic performance and executive function. More hours of Physical Education are needed to more effectively develop the cognitive aspects and physical fitness of children in elementary school.

Keywords: Physical performance, cognitive functions, academic achievement, school-aged children..

Resumen

Esta revisión sistemática buscó investigar la influencia de la actividad física y la aptitud física en las funciones cognitivas y el rendimiento académico. Los estudios se identificaron en cuatro bases de datos desde enero de 2010 hasta enero de 2021. Se seleccionaron un total de 26 estudios después de cumplir con los criterios establecidos. Nueve estudios mostraron una asociación entre la actividad física y las variables de aptitud física y el rendimiento académico. La aptitud cardiorrespiratoria, la velocidad-agilidad, la coordinación motora y la habilidad perceptivo-motora tuvieron la asociación más fuerte con la función ejecutiva, incluida la atención, la memoria, la inhibición y el cambio en 17 estudios. Los altos niveles de actividad física y aptitud física están asociados con un mayor rendimiento académico y función ejecutiva. Se necesitan más horas de Educación Física para desarrollar de manera más efectiva los aspectos cognitivos y la aptitud física de los niños en la escuela primaria.

Palabras clave: Desempeño físico, funciones cognitivas, rendimiento académico, niños en edad escolar.

Introduction

The importance of physical activity (PA) for health and quality of life is well known and researched. Children experience both physical and psychological benefits when participating in PA (Ahn and Fedewa, 2011; Janssen and Leblanc, 2010; Lobelo et al., 2020). Moreover, previous studies have shown that PA influences cognitive functions (Ellemberg and St-Louis-Deschênes, 2010; Gallotta et al., 2014; Gunnell et al., 2019; Verburgh et al. 2014). A recent review showed that physical fitness (PF), single bouts of PA, and PA interventions benefit children's cognitive functioning (Donnelly et al., 2016). Children who demonstrated to have high physical aptitudes exhibited greater cortical activation and corresponding cognitive functions than less fit children (Álvarez-Bueno et al., 2017; Latorre Román et al., 2017; Lemes et al., 2021). Chaddock, Pontifex, Hillman and Kramer (2011) demonstrated how PA improved brain health and cognitive functions during child development. Chang et al. (2012) and Gallotta et al. (2014) showed that several variables associated with PA such as PA duration, PA intensity and specific types of PA performed during a training programme were significant moderators in the association between cognitive functions and PA.

The terms PA and PF are often confused. Although these terms are closely related, they should not be treated as synonyms. PA refers to any bodily movement produced by skeletal muscle which requires consumption of energy. PF in turn is interpreted as a measure of the capacity to perform PA that include the majority of the physical functions (skeletomuscular, CRF, hematocirculatory, endocrine-metabolic, and psycho-neurological) involved in PA. PF is made up of 3 components: cardiorespiratory fitness (CRF), strength, and agility (Martínez-Vizcaíno and Sánchez-López, 2008). The close relationship between these terms is what justifies attending to both in this systematic review.

Previous studies have found several associations between PA and cognitive functions on specific factors such as academic performance (AP), executive function (EF), memory, intellectual maturity, concentration, and creativity in children (Donnelly et al., 2016; Latorre-Román et al., 2016; Lees and Hopkins, 2013; Soga, Shishido and Nagatomi, 2015). These studies analysed both acute and chronic effects of PA on cognitive actions. In addition, literature reviews (e.g. Marques et al., 2018) show how higher cardiorespiratory fitness (CRF) may be important to enhance academic performance.

Academic performance can be improved through PA at school (Carriedo and González, 2019). Wittberg et al. (2012) demonstrated how students who have healthy PF had significantly higher scores in different school subjects than students who had a low level of PF. In addition, current research has shown that AP was higher when children completed an intervention dedicated to doing more PA at school (Resaland et al., 2015; Donnelly et al., 2013).

Aerobic exercises have the potential to promote multiple facets of development through its direct impact on EF (Best, 2010). The term EF makes reference to capabilities we utilise when we formulate our goals and objectives, organise and plan, and when we carry out a series of adjusted and effective behaviours to achieve a goal (Lezak, Howieson and Loring, 2004). Multiple cognitive functions such as inhibiting dominant responses, updating working memory representations, shifting between task sets and attention are included in EF (Friedman et al., 2008). Working memory is an important element which belongs with EF. Pesce et al. (2009) investigated the effects of PA on memory performance in children through two sessions immediately following a PE class (aerobic circuit training vs. team games). They found that memory improved in both experimental groups compared to the control group. In addition, Berrios Aguayo et al. (2019) demonstrated the effectiveness of two PE classes (team game exercise and aerobic exercise) on memory. Additionally, attentional control and selective attention are other components of EF (Anderson, 2002). Mahar (2011) showed how after a break from a PE class, attention on a task was better. Syväoja et al. (2014) found that sedentary behaviour was associated with weaker flexibility of attention.

Different variables for PA have been associated with childhood neurocognition, however how cognitive aspects in children are developed through their physical development are still poorly understood. Further research is necessary to understand the relationship between PA and cognition performance during development. Mahar et al. (2006) claimed opportunities to be physically active at school are limited by pressure on scholastic performance. The incorporation of PA time into the school day is needed (Kibbe et al., 2011; Segura-Martínez et al., 2020).

Considering all previous evidence about how the practice of PA is related to greater cognitive and academic development in school-aged children, the research question focuses on: is there enough research literature that analyse this issue? Therefore, the objective of this systematic review was to analyse research that investigated the relationship and/or influence of PA and the level of PF on AP and EF in school-age children.

Method

The study was designed following the structure and recommendation of other systematic reviews (Ruiz-Ariza et al., 2017; García-Pinillos et al., 2016), the protocol used by PRISMA guidance for reports and studies (Moher, Liberati, Tetzlaff, Altman and PRISMA Group, 2009) and the Cochrane Manual of systematic reviews of interventions (Higgins and Green, 2011).

Search strategy

A comprehensive search of 4 databases (Medline, Pubmed, Eric ProQuest and Web of Science) from January 2010 through to January 2021 was undertaken. The principal categories of search terms were identified and employed in different combinations using "AND" (combining terms by retrieving the records in which all the searched terms appear) and "OR" (joining different terms by retrieving the records in which any of the terms appear) (Table 1).

Table 1. *Searcher strategy in databases*

Databases	Research Strategy	Limits	Filters
Medline (EBSCO)	(physical education OR physical fitness OR physical activity) AND (cognitive performance OR academic performance OR attention OR executive function OR memory) AND (children OR childhood)	Publication date: 2010-2021 English language Age: 6-12 years Free full text	5623
Pubmed	(physical education OR physical fitness OR physical activity) AND (cognitive performance OR academic performance OR attention OR executive function OR memory) AND (children OR childhood)	Publication date: 01/01/2010-01/01/2021 Humans Age: 6–12 years. English language Linked full text	2343
Eric Proquest	(physical fitness OR physical education OR physical activity) AND (cognitive performance OR academic performance OR attention OR executive function OR memory) AND (children OR childhood)	Publication date: 01/01/2010-01/01/2021 English language Journal Articles Elementary education	143
Web of Science	((physical education' OR' physical activity' OR 'physical fitness') (cognitive performance' OR 'academic performance' OR attention OR executive function OR memory) (children OR childhood))	Publication date: 2010-2021 English language Articles Open access	1783

Inclusion and exclusion criteria

The relevant papers selected for inclusion in the review were checked against the following criteria:

(1) There were no exclusion criteria with regard to sex or ethnic origin; (2) There was exclusion with children with physical or intellectual disabilities. (3) Age: children aged between 6-12 years old; (4) Language: English; (5) Year of publication: 2010-2021; (6) The systematic review uses cross-sectional, repeated measures or interventional studies; (7) Review articles were not included in this systematic review.

Reliability and data extraction

Based on the inclusion and exclusion criteria, two independent reviewers screened the citations of potentially relevant publications. If the citation showed any potential relevance, it was screened at the abstract level. When abstracts indicated potential inclusion, full-text articles were reviewed. A third-party consensus meeting was held with a third author (APV) if the 2 reviewers were not able to reach agreement. In conclusion, authors reviewed the studies resulting from the systematic review and agreed on their inclusion.

Quality assessment and level of evidence

The quality assessment of the study has carried out on the basis of other standardised assessment lists. Cross-sectional studies were assessed using the modified version of the Quality Index developed by Downs and Black (Downs and Black, 1998) (Table 2). The original scale was reported to have good test-retest (. = 0.88) and inter-rater (. = 0.75) reliability and high internal consistency (Kuder-Richardson Formula 20 (KR-20) = 0.89). Reliability of the subscales varied from good to poor validity. The Quality Index correlated highly with an existing, established instrument for assessing randomised studies r = 0.90. The modified version of the Downs and Black Quality Index is scored from 1 to 14, with higher scores indicating higher-quality studies. Those items that corresponded to the selected studies were selected based on the needs of the study, as well as relevant systematic reviews already published, such as the one by Ruiz-Ariza et al. (2017).

Table 2. *List of included studies with quality score (Down and Black scale modified)*

Authors and variables	Item 1	Item 2	Item 3	Item 6	Item 7	Item 10	Item 12	Item 15	Item 16	Item 18	Item 20	Item 22	Item 23	Item 25	Total Score (out of 14)
Wittberg, Northrup and Cottrell (2012)	1	1	1	1	1	1	1	1	1	1	1	1	0	0	12
Lambourne et al. (2013)	1	1	1	1	1	1	1	1	1	1	1	1	0	1	13
Hansen et al. (2014)	1	1	1	1	1	1	1	1	1	1	1	1	0	1	13
Haapala et al. (2014)	1	1	1	1	1	1	0	1	1	1	1	1	1	1	13
Syväoja et al. (2014).	1	1	1	1	1	1	0	1	1	1	1	1	1	1	13
van der Niet et al. (2015)	1	1	1	1	1	1	0	1	1	1	1	1	1	0	12
van den Berg et al. (2016)	1	1	1	1	1	0	0	1	1	1	1	1	1	0	11
Pontifex et al. (2012)	1	1	1	1	1	1	0	1	1	1	1	1	1	1	13
Gallotta et al. (2015)	1	1	1	1	1	1	0	1	1	1	1	1	1	1	13
Ma, Le Mare and Gurd (2015)	1	1	1	1	1	1	0	1	1	1	1	1	1	1	13
Raine et al. (2013)	1	1	1	1	1	1	0	1	1	1	1	1	1	1	13
Jäger et al. (2015)	1	1	1	1	1	1	0	1	1	1	1	1	1	0	12
Schmidt et al. (2015)	1	1	1	1	1	1	0	1	1	1	1	1	1	0	12
Pirrie and Lodewyk (2012)	1	1	1	1	1	1	0	1	1	1	1	1	1	1	13
Schmidt et al. (2017)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14

Note: 0 = no; 1 = yes; Item 1: clear aim/hypothesis; Item 2: outcome measures clearly described; Item 3: patient characteristics clearly described; Item 6:main findings clearly described; Item7:measures of random variability provided; Item10: actual probability values reported; Item12: participants prepared to participate representative of entire population; Item 15: Blinding of outcome measures; Item 16: analysis completed was planned; Item 18: appropriate statistics; Item 20: valid and reliable outcome measures; Item 22: participants recruited over same period; Item 23: Randomised; Item 25: adjustment made for confounding variables.

The methodological quality of interventional studies was assessed using the Physiotherapy Evidence Database (PEDro) scale (Maher et al., 2003) (Table 3). This 11-item scale rates randomised controlled trials from 0 to 10, with 6 representing the cut off score for high-quality studies. Studies scoring 9-10 on the PEDro scale were considered to be of "excellent" methodologically quality, 6-8 of "good" quality, 4-5 of "fair" quality, and below 4 of "poor" quality.

Table 3. *List of included longitudinal studies with quality scores (PEDro scale)*

Authors and variables	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Total Score	Quality level
Mullender-Wijnsma et al. (2015)	1	1	0	1	1	0	0	1	1	1	1	8	GQ
Erwin, Fedewa and Ahn (2012)	1	0	0	1	1	0	0	1	1	1	1	7	GQ
Käll, Nilsson & Lindén (2014)	1	0	0	1	1	0	0	1	1	1	1	7	GQ
Sardinha et al. (2016)	1	0	0	1	1	0	0	1	1	1	1	7	GQ
Hillman et al. (2014)	1	1	0	1	1	0	0	1	1	1	1	8	GQ
Fisher et al. (2011)	1	0	0	1	1	0	0	1	1	1	1	7	GQ
Kamijo et al. (2011)	1	1	0	1	1	0	0	1	1	1	1	8	GQ
Ou et al. (2016)	1	1	0	1	1	0	0	1	1	1	1	8	GQ
de Greeff et al. (2016)	1	1	0	1	1	0	0	1	1	1	1	8	GQ
Kvalø et al. (2017)	1	1	0	1	1	0	0	1	1	1	1	8	GQ
Lind et al. (2018)	1	1	1	1	1	0	0	1	1	1	1	9	EQ
Chaddock-Heyman et al. (2020)	1	1	1	1	1	0	0	1	1	1	1	9	EQ
Layne et al. (2021)	1	1	1	1	1	0	0	1	1	1	1	9	EQ

Note. 0 = item was not satisfied; 1 = item was satisfied Excellent quality (EQ)= 9-10; Good quality (GQ)= 6-8; Fair quality(FQ)= 4-5; Poor quality (PQ)= <4; Item 1: eligibility criteria were specified; Item 2: subjects were randomly allocated to groups; Item 3: allocation was concealed; Item 4:The groups were similar at baseline regarding the most important prognostic indicators; Item 5:There was blinding of all subjects; Item 6:There was blinding of all therapists who administered the therapy; Item 7: There was blinding of all assessors who measured at least one key outcome; Item 8: measurements of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; Item 9: all subjects for whom outcome measuments were available received the treatment or control condition as allocated, or where this was not the case, data for at least one key outcome were analyzed by "intention to treat"; Item 10: the results of between groups statistical comparisons are reported for at least one key outcome; Item 11: the study provides both point measurements and measurements of variability for at least one key outcome.

Result

The flow of search results through the systematic review process is shown in Figure 1. Firstly, 9892 papers from the different databases were extracted based on the language, type of document, age and date. Secondly, duplicate papers were excluded (4562 duplicate papers). Then, the titles of the articles were read to exclude those that were not related with our bibliographical search (123 papers were selected). Specifically, population, age, language, design, variables, and other excluding factors were meticulously inspected. Finally, 123 papers were read in full in order to select the final sample (28 papers) (Table 4).

A meticulous analysis was conducted with the final papers. Nine papers (32,14%) were cross-sectional studies (Wittberg et al. 2012; Lambourne et al., 2013; Hansen et al., 2014; Haapala et al., 2014; Syväoja et al., 2014; van der Niet et al., 2015; Pontifex et al., 2012; Raine et al., 2013; Schmidt et al. 2017); six papers (21,42%) were repeated measures studies (van den Berg et al., 2016; Gallotta et al., 2015; Ma et al., 2015; Jäger et al., 2015; Schmidt et al., 2015; Pirrie and Lodewyk, 2012). Both cross-sectional studies and repeated measures studies were methodologically assessed through the *modified Down and Black scale* providing an adequate assessment of the articles based on the scale scores. Finally, 13 papers (46.42%) were interventional studies (Mullender-Wijnsma et al., 2015; Käll et al., 2014; Erwin et al., 2012; Hillman et al., 2014; Fisher et al., 2011; Kamijo et al., 2011; Ou et al., 2016; de Greeff et al., 2016; Sardinha et al., 2016; Kvalø et al. 2017; Lind et al., 2018; Chaddock-Heyman et al., 2020; Layne et al., 2021) . These articles were assessed through the PEDro scales obtaining an evaluation of *Good Quality* or *Excellent Quality*.

The main findings of the studies analyzed in the systematic review agree that PA has an acute and chronic effect on the cognitive and academic performance of primary school children. The results will mainly depend on the intensity and the time of development of the PA.

Table 4. Characteristic of the studies analysed

Authors	Physical/ Cognitive Variables	Study design/ Duration Sample/ Age/ Country	Procedure and physical activities measures.	Cognitive function measures	Result
Wittberg et al. (2012)	CRF/AP	Cross-sectional study/ 1725 students/ 5th grade and 7th grade/ Virginia, USA	Cardiorespiratory fitness: Students did the Progressive Aerobic Cardiovascular Endurance Run (PACER) used in FitnessGram. This test measures the time it takes the child to run or walk 1 mile. With the PACER assessment, the student is expected to run back and forth across a 20-metre space at a pace defined on a beep-only or music audiotape, which gets faster each minute.	Academic performance: WESTEST (West Virginia Educational Standards Test) 4 test areas: mathematics, science, social studies, and reading and language arts.	Students who had better marks on the CRF test obtained significantly higher WESTEST scores than students who had lower CRF capacity.
Lambourne et al. (2013)	PA and CRF/AP	Cross-sectional study/ 687 students/ 2nd and 3rd grades/ Kansas, USA	Daily PA assessed: Children wore a portable Accelerometer on a belt over the non-dominant hip for at least 10 hours on 3 days or more. Cardiovascular fitness: children did the PACER.	Academic performance: Weschsler Individual Achievement Test-Third Edition (WIAT-III). It assessment reading comprehension and oral reading fluency, spelling, and mathematics problem solving and numerical operations.	Findings showed a direct effect of PA on AF ($b = 0.009$, $p < 0.001$) and an indirect effect (mediation) of PA via fitness on math achievement ($b = 0.003$, $p < 0.01$). However, PA nor AF were correlated with WIAT-III reading or spelling scores.

Note: PA = Physical activity; PF = Physical fitness; PE = Physical education; MVPA = moderate to vigorous physical activity; AF = Aerobic fitness; CRF = Cardiorespiratory fitness; PLACER = Progressive Aerobic Cardiovascular Endurance Run; BMI = Body mass index; AP = Academic performance; EF = Executive function

Table 4 (cont.) Characteristic of the studies analysed

Hansen, at al. (2014)	CRF/AP	Cross-sectional study/ 687students/ Mean age = 7.8 ± 0.6 years from 2nd and 3rd grades/ Kansas USA	Physical activity: To measure PA, children wore an ActiGraph GT3X+ portable accelerometer on a belt over the non-dominant hip for 4 consecutive days (including 1 weekend day) Cardiorespiratory fitness: To measure progressive cardiovascular fitness, PACER was used.	Academic performance: The WIAT-III is comprised of 16 subtests. For this study, five subtests were selected: reading comprehension, oral reading fluency, spelling, mathematics problem solving, and numerical operations.	Multilevel regression results for AF indicated there was no significant linear or non-linear association between fitness and reading achievement ($p > 0.05$), but a significant quadratic association between fitness and both spelling and math achievement (both p's < 0.01).
Haapala et al. (2014)	Motor performance, cardiovascular performance/AP	Cross-section study/ 341 students/ 6-8 years from 1st and 3rd grades/ Kuopio, Finland	Body composition: Body fat mass was assessed using a Lunar dual-energy x-ray absorptiometry device. Body weight was measured using a calibrated InBod. BMI (body weight (kg) divided by height (m) squared). Cardiorespiratory fitness: The PA test protocol included a 3-min warm-up period, a 1-min steady-state period, a PA period with a workload increase every 6 s until exhaustion, and a 4-min cooldown period. Motor performance: The shuttle run test was used to assess speed and agility. The flamingo balance test was used to assess static balance. The box and block test was used to assess manual dexterity.	Academic performance: Reading fluency and reading comprehension were assessed using a group-administered timed subtest of the nationally normed reading achievement battery (ALLU). Arithmetic skills were assessed using a basic arithmetic test, with a set of visually presented addition and subtraction tasks.	A worse overall motor performance in grade 1, was associated with poorer reading fluency ($F2,161 = 5.94$, $p = 0.003$), reading comprehension ($F2,161 = 3.95$, $p = 0.021$), and arithmetic skills ($F2,161 = 10.01$, $p = 0.001$) in grades 1–3 after adjustment for age. Children who had lower motor performance in grades 1-3 had poorer reading fluency ($p = 0.003$) and reading comprehension ($p = 0.025$).

Table 4 (cont.) Characteristic of the studies analysed

Syväoja et al. (2014)	PF/EF (visual memory, working memory, attention).	Cross-sectional study/ 224 children/ Mean age 12.2 years/ Jyväskylä, Finland	Physical activity and sedentary time: The ActiGraph GT1M/GT3X accelerometers with vertical axel were used to measure children's MVPA and sedentary time. The accelerometer was worn on the right hip with an elastic waistband during waking hours for seven consecutive days.	Visual memory: Pattern Recognition Memory test (PRM) assessed recognition memory and visual patterns. Executive functions Spatial Span (SSP) and Intra-Extra Dimensional Set Shift (IED) tests assess the length of the visuospatial working memory span based on the Corsi blocks task. Attention: Reaction Time (RT) and Rapid Visual Information Processing (RVP) measured children's reaction time and speed of response to a visual target.	Girls spent more of their waking hours being sedentary than boys. Objectively measured MVPA was negatively associated with the RTI five-choice test score (ms), whereas sedentary time was not associated with the RTI five-choice test score. Sedentary time was positively associated with RVPA, whereas objectively measured MVPA was not associated with RVPA. Self-reported playing of computer/video games was negatively associated with SSP span length.
van der Niet et al. (2015)	PF/EF (inhibition, working memory, cognitive flexibility and planning)	Cross-sectional study/ 80 students/ 8-12 years old	Physical activity: An accelerometer was used (The ActiGraph GT1M/GT3X) over seven consecutive days.	Executive functions: Inhibition: Was measured with Stroop test. Working memory: Was measured with the Visual Memory Span test. Cognitive flexibility: Was measured with Trailmaking. Planning: Children used Tower of London test in order to measure planning.	More time spent in sedentary behaviour was related to worse inhibition ($r = -0.24$). A higher total volume of PA was associated with better planning ability ($r = 0.24$) and a shorter total execution time ($r = -0.29$). A significant correlation was found between time spent in MVPA and the total execution time of the Tower of London ($r = -0.29$).
Pontifex et al. (2012)	Poor CRF/ EF(attention)	Cross-sectional study/ 62 students/ 9-10 years old/ East-central Illinois region, USA	Cardiorespiratory fitness: Maximal oxygen consumption (VO_2max) was measured using a computerised indirect calorimetry system with averages for oxygen uptake (VO_2) and respiratory exchange ratio (RER; $VC0_2\backslash V0_2$) assessed every 20 seconds.	Poor attention: The ADHD Rating Scale IV is an 18-item inventory completed by the parent/legal guardian based upon the diagnostic criteria for attention deficit hyperactivity disorder Pubertal status: The Tanner Pubertal Timing Scales use self-ratings based upon schematic drawings of secondary sexual characteristics. Intelligent: The K-BIT assessed the verbal and nonverbal intelligence in individuals.	Findings showed that lower-fit children exhibited poorer overall response accuracy during a task requiring aspects of cognitive control relative to their higher-fit counterparts, with a disproportionately greater number of errors of omission, and longer, more frequent sequential errors of omission.

Table 4 (cont.) Characteristic of the studies analysed

Table 4 (cont.) Characteristic of the studies analysed

Raine et al. (2013)	CRF/AP and EF (way of learning and memory)	Cross-sectional study/ 3 days/ 48 students/ children 7-9 years old/ Illinois, USA	Day 1: participants completed maximal oxygen consumption (VO2max) test to assess their level of AF. Cardiorespiratory fitness: Sessions occurred on consecutive days and involved a mobile application on an iPad (Apple Inc., Cupertino, CA). The task involved remembering names of specific regions comprised of four letters each from a map	Learning and recall: Day 2: children learned the names and locations of the regions. Participants learned two different maps using two different learning strategies: a study only (SO) strategy and a test study (TS) strategy. Day 3: Participants returned one day after studying the maps to complete the recall test.	There were no differences in performance at initial learning between higher fit and lower fit participants. However, during the retention session higher fit children outperformed lower fit children, particularly when the initial learning strategy involved relatively poor recall performance. Fitness can boost learning and memory of children and these fitness-associated performance benefits are largest in conditions in which initial learning is the most challenging.
Schmidt et al. (2017)	Motor ability(aerobic endurance, motor coordination, muscular strength)/EF (updating, inhibitions, shifting) and academic performance	Cross-sectional study/10 week/236 students/children 10-12 years old/Magglingen, Switzerland	The first 4 week the motor ability was evaluated. Aerobic endurance: The Shuttle run test was used to assess cardiorespiratory endurance. Next 6 week the motor coordination and muscular strength was assessed Motor coordination: Motor coordination was measured by jumping sideways, a subtest of the Körperk oordinations test für Kinder Muscular strength The standing long jump was used to measure strength	Executive function Updating A non-spatial n-back task was used to assess updating Inhibition A child-adapted Eriksen flanker task was used Shifting An additional block ("mixed" block) included in the flanker task was employed Academic performance Math	A mediation analysis was used to show how EF was a mediator variable for the three physical variables . However, there was only one direct path from motor coordination and the AP. It concludes by showing an indirect path of physical skills and the AP through the EF

Table 4 (cont.) Characteristic of the studies analysed

				Arithmetic, geometry, and solving written math problems Task was considered Reading The Salzburger Lese-Screening für die Klassenstufen 5–8 was used Spelling Hamburger Schreib-Probe test was employed	
Jäger et al. (2015)	Team games and aerobic exercise /EF (inhibition and shifting)	Repeated measure study/ acute effect/ 12 years old/ Bern, Switzerland	Team games group (floorball and basketball): These two team games were chosen because they are appropriate to induce MVPA intensity. Both control and complex eye-hand coordination and require goal-directed behaviour. Third, these team games were suitable for combining sport-specific skill development. Aerobic exercise group: Children were instructed to run a marathon as an entire class, whereby each child was allowed to cross off one box from a joint list after each circuit. With a circuit of 200 m. Control group: normal classes of PE	Executive functions Inhibition Was measured by means of a child-adapted Flanker task consisting of a block with 20 congruent trials ("pure" block) and a block with 20 congruent and 20 incongruent trials in a randomised order ("standard" block). Shifting Was assessed by an additional block ("mixed" block) included in the Flanker task.	Both interventions (team games and aerobic exercise) have a positive acute effect on children's AF (4–5% increase in estimated VO2 max). Importantly, an improvement in shifting performance was found only in the team games and not in the aerobic exercise or control condition. Thus, the inclusion of cognitive engagement in PA seems to be the most promising type of chronic intervention to enhance EF in children.

Table 4 (cont.) Characteristic of the studies analysed

van den Berg et al. (2016)	Aerobic, coordination, and strength classes/EF (information processing speed and selective attention)	Repeated measures study / acute effect/ 195 students/ 10-13 years old/ The Netherlands	Three types of exercises in the classroom 12 minutes for each (the first 1½ min warming-up and last 30 s cooling-down were equal for all exercise types). Heart rates: during the exercise session, students wore a HR monitor: Aerobic exercise: Various well-known, easy and repetitive movements Coordination exercise: More complex movements that stressed coordinative skills, including bilateral movements and movements in which the body mid line was crossed Strength exercise: Dynamic and static body-weight exercises Control group Normal sessions in the classroom	Information processing speed: The Letter Digit Substitution Test (LDST) requires students to match letter-number pairs according to a key, which is presented on top of the sheet. The key contains nine boxes with letters and associated numbers, between 1-9. Selective attention: Students performed the D2 test. It consists of one page with 14 lines, each consisting of 47 letters 'd' and 'p'. Above and/or below each letter are 1–4 dashes displayed, either individually or in pairs.	There were no significant acute effects of exercise on information processing speed [$F(1,174) = 0.71$, $p = 0.40$, $\eta 2p = 0.00$] and selective attention [$F(1,172) = 0.91$, $p = 0.34$, $\eta 2p = 0.01$]. Likewise, type of PA did not moderate effects on information processing speed [$F(1,174) = 1.75$, $p = 0.18$, $\eta 2p = 0.02$] and selective attention [$F(1,172) = 0.60$, $p = 0.55$, $\eta 2p = 0.01$]. Pre- and post-test scores showed similar patterns on the exercise and control day, and did not differ between exercise types.
Gallotta et al. (2015)	Physical exertion, cognitive exertion, mixed cognitive and physical exertion/EF (attention)	Repeated measures study / acute effect/ 116 students/ 8-11 years old from 3rd-5th grades/ Rome, Italy.	Physical exertion (PE): The PE consisted of continuous aerobic circuit training followed by a submaximal shuttle run exercise. This lesson was focused on the improvement of cardiovascular endurance by performing different types of gaits (fast walking, running…) without any specific coordinative request	Attention: Children, before the intervention classes and just after these, used the D2 test in order to assess pre- and post selective attention.	Exertion type × time interaction indicates the likely presence of differential effects of the exertion type on TR (total responses) and E% (precision index) variables change after intervention. Children improved their performances from pre- to post-, and to 50′ post-intervention to a lower degree when exerted in CPE condition as compared with both CE and PE conditions. These results revealed that CPE exertion type led to a

Table 4 (cont.) Characteristic of the studies analysed

			Cognitive exertion (CE): It consisted of a 50-min academic class about humanistic subject matters. Mixed physical and cognitive exertion (CPE): Basketball was used in the context of mini-games. The basketballs were used in unconventional ways with varying game rules (use of foot-eye coordination techniques with basketballs)		lower improvement of CP values over time than the two other exertion conditions
Ma et al. (2015)	A 4-minute high-intensity exercise/EF (attention).	Repeated measures study/ 3 weeks/ 168 students/ Children 9-11 years old from 3rd -5th grades/ South eastern Ontario, Canada	FUNterval activity intervention: This physical technique requires only 4 min to complete. Consists of 20 s of high-intensity activity separated by 10 s of rest, repeated 8 times. FUNterval is performed in the classroom before the academic lessons. Control group: normal academic lessons	Attention: Children did a pre-test and a post-test using the D2 test to assess selective attention.	A comparison of the D2 test performance on no-activity days demonstrated that males made a higher number of total errors (E) and E Omission than females. The effect of the intervention on attention was good. All measures of the D2 test improved from week 1 to week 2 ($p < 0.05$).

Table 4 (cont.) Characteristic of the studies analysed

Schmidt et al. (2015)	Physical games, aerobic exercise and cognitive games sessions/EF (updating, inhibition and shifting)	Repeated measures study / Acute effect/ 219 students/ children 10-12 years/ Bern, Switzerland	Physical games session: Children played three different cooperative and competitive physical games that required the activation of one or more EF dimensions. Aerobic exercise condition: PA without cognitive engagement. This condition consisted of short tasks and games requiring different forms of running Cognitive games group: The games required the activation of all EF dimensions and the level of difficulty was increased twice during the game by introducing new rules. Control group: Children made themselves comfortable on a mat and listened to an age-appropriate story.	Executive function: Updating Was assessed by a non-spatial n-back task. Several pictures of fruits were presented one after another on the screen. Inhibition Was measured by a Flanker task consisting of a block with 20 congruent and 20 incongruent trials in a randomised order. Shifting Was assessed by an additional block (shifting block) included in the Flanker task. In this block, again 20 congruent and 20 incongruent trials were shown with additional rule cued.	No significant effect was found in children with lower academic achievement. In children with higher academic achievement, a significant main effect for PA (F (1,104) = 12.55, $p < .01$) and also for cognitive engagement (F (1, 104) = 4.86, p = .03) emerged indicating that children with higher academic achievement benefitted from all interventions relative to the control condition. Post-tests showed that children with higher academic achievement in the physical games ($p < .01$, d = 1.12), in the aerobic exercise ($p < .01$, d=.89), and in the cognitive games group (p = .02, d = .57) improved significantly more than children in the control group.

Table 4 (cont.) Characteristic of the studies analysed

Pirrie and Lodewyk (2012)	MVPA/EF (planning, attention, simultaneous process and successive process).	Repeated measures study / 2 weeks/ 40 students/ Children from 4th grade/ Southwestern Ontario, Canada	Experimental group: They completed the cognitive function tests after an hour MVPA lesson. Testing began approximately 10 min after the end of the PE lesson and all students were tested within one hour after the end of the PE class. Control group: This group was tested first after PA and eight days later after no activity. Cardiorespiratory fitness measurement: Heart rate monitors were used to measure the intensity of PA for a randomly selected, gender-matched group of ten students in each class.	Children completed an independent reading task assigned by their regular teacher. Executive function: The PASS theory has been operationalised using the Cognitive Assessment System (CAS) which measures planning, attention, simultaneous processing, and successive processing.	Performance on the planning test significantly improved after PA ($p <$ 0.001), controlling for sequence and habituation/retesting effects. No improvement was observed for attention, simultaneous processing, or successive processing.
Sardinha et al. (2016)	CRF/AP	Interventional study/ 3 years/ 1286 students/ Mean age=11.3 from 5th, 6th and 7th grades/ Portugal	Participants were part of the PA and Family-Based Intervention in Paediatric Obesity Prevention in the School Settings (PESSOA project). This intervention lasted 3 years. CRF measurement: The CRF was assessed by PACER Body mass index (BMI): Was calculated by the Quetelet index (weight (kg)/height (m)2)	Academic performance Children were assessed at baseline and at the end of 3 years by student marks (Mathematic, Portuguese, English and Science)	Being persistently fit (fit–fit), compared with those classified unfit–unfit, increased the odds of having high levels of academic achievement in Portuguese (odds ratio (OR) = 3.49; 95% CI, 1.97–6.20; p = 0.001) and foreign language (OR = 2.41; 95% CI, 1.39–4.14; p = 0.01) at follow-up. Students that improved their CRF and became fit (unfit–fit) also had higher odds of achieving better marks than those persistently unfit–unfit in Portuguese (p = 0.01) and foreign language (p = 0.01).

Table 4 (cont.) Characteristic of the studies analysed

Käll et al. (2014)	Increasing PE classes/AP	Interventional study / 1965 students/ elementary school/ Sweden	Experimental group: Children were carrying out a Swedish government programme (Handslaget), using group play, and other activities. Control group: Student did not increase PA sessions.	Academic performance: National goals in Swedish, Mathematics, and English. Academic results from the years prior to and during the intervention programme were analysed.	Higher proportions of students in the experimental group achieved the national goals in all 3 subjects compared with the control group which obtain lower results.
Mullender-Wijnsma et al. (2015)	Active academic lesson/AP	Interventional study/ 1 year/ 228 children (122 boys and 106 girls) /Mean age: 8.1 from 2nd or 3rd grades/ Netherlands	Experiment group: Children have to do MVPA during F&V lessons (Fit & Vaardig op school; Fit and academically proficient at school) in the classroom (jumping while spelling words, moving around the class saying exercise results, etc.) Control group: Normal lesson without PA	Academic performance: Observations were done during the lesson. Investigators observed whether children performed the basic exercise (on-task), the specific exercise (on-task) or no/other exercise (off-task) of maths and languages.	The third-grade children in the intervention group scored significantly higher on both mathematics ($F[1,99] = 11.72$, $p < .05$) and reading ($F[1,98] = 6.97$, $p < .05$) in comparison with the third-grade children in the control group. On the other hand, the second-grade children in the intervention group scored significantly lower on mathematics in comparison with the second-grade children in the control group ($F[1,109] = 12.40$, $p < .05$). No differences were found on the reading test in grade 2 ($F[1,109] = 0.72$, $p = .40$)
Erwin et al. (2012)	Active academic lessons/AP	Interventional study/ 20 week/ 29 students/ Mean age: 8.87 from 3rd grade/ Kentucky, USA	Experimental group: Intervention children had PA breaks for 20+ minutes per day. Children combined different PA like teacher-directed instruction, partner or group exercises around the classroom, etc. To measure school day PA, participants wore a pedometer for five consecutive school days Control group:	Academic performance Reading fluency was curriculum-based while mathematical fluency was assessed with short progress measures designed to assess children's reading and mathematical abilities. At the beginning and end of the intervention, students carried out the Test of Primary Reading Outcomes (T-PRO), which	The intervention group ($M = 24.56$, $SD = 2.21$) scored significantly higher in mathematics than the control group ($M = 13.69$, $SD = 2.45$). The scores in reading were statistically higher than standardised test scores ($p < .001$).

Table 4 (cont.) Characteristic of the studies analysed

			They did normal academic classes in the classroom	assesses phonics, vocabulary, comprehension, and research skills.	
Hillman et al. (2014)	Afterschool PA/ Behaviour (accuracy and reaction time) and EF (modulated attentional, inhibition and cognitive flexibility).	Interventional study/ 9 months/ 221 students/ 7-9 years old/ East Central Illinois	Aerobic fitness: A test of maximal oxygen consumption (VO2max) was used to measure AF. Afterschool PA programme: The 2-hour PA intervention occurred after each school day, and focused on improvement of AF. Children intermittently participated in at least 70 minutes of MVPA. The intervention included 30-40 minutes at PA stations. Next, a healthy snack and educational component were provided as a rest period, and children then engaged in low organisational games (45–55 minutes) centred on a skill theme.	Attentional inhibition Assessed using a modified flanker task. Cognitive flexibility was assessed by using a colour-shape switch task. A modified flanker task is a method to measure inhibition in which children are engaged in a series of trials that, in this case, have arrays of fish that either match (congruent arrays) or do not match (incongruent arrays).	Response accuracy increased in both groups, however, the intervention group demonstrated greater improvement from pre-test to post-test than the wait-list control group (3.2%, 95% CI: 0.0 to 6.5, $d = 0.27$ for group difference in pre-to-post change score. The improvement in performance on the heterogeneous task was greater among intervention participants (4.8%, 95% CI: 1.1 to 8.4, $d = 0.35$ for group difference in pre-to-post change score.
Fisher et al. (2011)	Increasing hours of PE/EF (spatial memory, working memory) and attention	Interventional study/ 10 week/ 185 students/ Mean age: 6.2/ Glasgow, Scotland	Physical activity: Data were collected at week 0 with the Actigraph GT1M accelerometer for 7 days. Actigraphs were worn over the right hip on a waist belt. Experimental group: It increased 2 classes per week of PE.	Cognitive function: The Cognitive Assessment System (CAS), the Cambridge Neuropsychological Test Battery (CANTAB). Attention:	Total PA was significantly greater during the intervention than control sessions (median difference 649 counts per minute; $p < 0.001$). There were no significant between group differences in any of the CAS scales (all $p > 0.05$). The CANTAB Spatial Working Memory Error rate was significantly reduced in the intervention group. Scores on subscales which measure the risk of

Table 4 (cont.) Characteristic of the studies analysed

			Control group: Only 1 class of PE per week	The Attention Network Test (ANT). Memory: The test of Spatial Memory Span (SSP) and the test of Spatial Working Memory (SWM).	suffering cognitive Problems/ Inattention, Hyperactivity and ADHD index were significantly lower post intervention than in the control group.
Kamijo et al. (2011)	Afterschool PA/EF (working memory)	Interventional study/ 9 months/ 43 students/ children 7-9 years old/ Illinois, USA	Physical activity intervention: It occurred for a 2-hour period following each school day, and focused on improvement of CRF. Muscle fitness was addressed at least 2 days a week, with the participants using their own Thera-bands®. The sessions were around 40 min, however there were lessons lasting 70 min. Cardiorespiratory fitness: Maximal oxygen consumption (VO_{2max}) was measured using a motor-driven treadmill and a modified Balke protocol.	Working memory: A modified Sternberg task asked participants to encode a memory set containing an array of one, three, or five letters and press one of two buttons with their thumbs corresponding to whether a single probe letter was present (right) or absent (left) in the encoded letter array.	The PA intervention led to increases in CRF and improved Sternberg task performance. Further, the beneficial effects of the PA intervention were greater for a task condition requiring greater working memory demands. In addition, the intervention group exhibited larger initial contingent negative variation (CNV) at the frontal electrode site, relative to the control group.
Ou et al. (2016)	Afterschool PA/EF(working memory)	Interventional study/ 10 weeks/ 71 students/ Mean age: 9.4 years/ Westphalia, Germany	The experimental groups had 3 afterschool sessions per week for 45 min. The cardiovascular exercise group (CE): Children focused on improvement of cardiovascular fitness through running and running-based games of MVPA (recorded on three occasions by F1 Polar HR monitors). The motor exercise group (ME):	Working memory: Children used The Letter Digit Span (LDS). The task involves a standardised auditory presentation of an increasing mixed series of alternating numbers and letters. After an acoustic signal, each participant was asked to respond by first writing the numbers in order from the smallest to the largest,	Improvements in working memory from pre- to post-test in the two exercise groups were found with large effect sizes (CE: $F(1,26) = 19.709$, $p = 0.001$, $r = 0.66$; ME: $F(1,22) = 62.718$, $p = 0.001$, $r = 0.86$), but not in the CO ($F(1,20) = 0.769$, $p = 0.391$, $r = 0.19$). In the post measurement, only the ME differed significantly from the CO ($t(68) = 2.521$, $p = 0.014$, $r = 0.29$), but not from the CE ($t(68) = 0.746$, $p = 0.458$, $r = 0.09$), nor did the CE

Table 4 (cont.) Characteristic of the studies analysed

			Children focused on the improvement the bilateral coordination, hand–eye coordination, and leg–arm coordination exercises as well as spatial orientation and reaction to moving objects/persons Control group (CO): normal PE classes	followed by writing the letters in alphabetical order.	differ significantly from the CO ($t(68) = 1.887$, $p = 0.063$, $r = 0.22$).
de Greeff et al. (2016)	Active academic lesson/EF (inhibition, cognitive flexibility and working memory).	Intervention study/ 2 years/ 499 students/ Mean age: 8.1 years from 2nd and 3rd grades/ Northern Netherlands	Intervention group: Three F&V lessons per week. The F&V lessons had a duration of 20–30 min, with 10–15 min spent on solving mathematical problems and 10–15 min spent on language. They had MVPA intensity. During the F&V lessons all children started with performing a basic exercise, such as jogging, hopping in place or marching. A specific exercise was performed when the children solved an academic task. Control group: Normal lesson in the classroom	Executive function measurement: Inhibition: The Golden Stroop test was used to measure inhibition. Cognitive flexibility: Measured using a modified version of the Wisconsin card sorting test (M-WCST) Working memory: The Digit span backward and Visual span backward were used.	A great improvement in speed-coordination ($B = -0.70$, $p = 0.002$) and a lower improvement in static strength ($B = -0.92$, $p < 0.001$) were found for the intervention group. There was no significant result between intervention group and EF.
Kvalø et al. (2017)	Active academic lesson/EF (inhibition, cognitive flexibility and working memory).	Intervention study/ 10 months/ 449 students/ children 10-11 years old/ Stavanger, Norway.	Aerobic fitness: A 10-minute interval running test was using to assess AF Interventional group:	Executive function measurement: Inhibition: This EF was measured by The Golden Stroop test.	No significant differences were found between aerobic capacity and EF $F(1,344)=3.64$, $P=.057$. However, the results were positive.

Table 4 (cont.) Characteristic of the studies analysed

			A weekly intervention was carried out of 2×45 minutes physically active academic lessons, 5×10 minutes physically active breaks and 5×10 minutes physically active homework. Control group: Children followed a normal routine	Cognitive flexibility: Measured using the Trail Making Test Working memory: The Digit span was used to measure attention capacity	
Lind et al. (2018)	Increasing hours of PE /Psychomotor function and EF (attention, working memory)	Intervention study/11 week / 931 children 10-11 years old/ Southern Denmark	Intervention group: Two weekly PE sessions based on The "FIFA 11 for Health" were added: a 45-minute "play football" session (teaching football skills and playing small-sided football) and a 45-minute "play fair" session (teaching a health message and health behaviours) Control group: This group performed the obligatory daily school-based PA (5 × 45 minutes per week).	Cognitive assessment: English version of the Cogstate® Brief Battery, which is an objective computer-based cognitive test battery addressing psychomotor function, attention, working memory and visual learning in children.	This study provided evidence that the school-based physical activity programme "FIFA 11 for Health" for Europe can improve cognitive performance in schoolchildren: psychomotor function (56, sx– = 22 ms, p < .001), attention (39, sx– = 17 ms, p = .012) and working memory (79, sx– = 35 ms, p = .020)
Chaddock-Heyman et al. (2020)	Afterschool PA/EF (cognitive flexibility) and AP	Intervention study / 9 months/ 150 children 8-9 years old / East-Central Illinois	Intervention group: Two hours daily afterschool development the FITKids2 program based on improving aerobic fitness through engagement in a variety of developmentally appropriate physical activities. Control group: They completed all facets of the baseline and post-intervention without carrying out the program.	Cognitive assessment: Children completed subtests from the Woodcock–Johnson III Tests of Cognitive Abilities. The cognitive performance clusters assess executive processes, thinking ability, cognitive efficiency and verbal ability. Academic performance: The scholastic performance was assessed with subtests from the	The Experimental group better outcomes than control group in cognitive and academic performance after intervention: Executive Processes: F=36.441, p<0.001; Cognitive Efficiency: F=23.764, p<0.001; Thinking Ability: F=35.564, p<0.001; Verbal Ability: F=7.595, p=0.007; Mathematics: F=9.022, p=0.003; Reading: F=2.566, p=0.111).

Table 4 (cont.) Characteristic of the studies analysed

				Kaufman Test of Educational Achievement School performance was assessed with subtests of the Kaufman Test for Educational Achievement evaluating word recognition, reading comprehension, math concepts, applications and math computation.	
Layne et al. (2021)	Active academic lesson/EF (reaction time, response inhibition) and AP.	Intervention study / 4 week / 40 children 8-9 years / mid-south United States	Intervention group The intervention group played FitNexx active video game 10-minutes daily before mathematics classes. Control group	Cognitive assessment: The Go/No-Go test for inhibitory control (reaction time, overall error, decision error, and omission error) were conducted. Academic performance: Mathematics test for performance for mathematics. This test were regularly scheduled given to the students each week to examine their knowledge obtainment of the material being learned.	The findings showed that the intervention had a positive effect on students' reaction time (F[2,39] = 29.98, p < .001, η2 = .45) and response inhibition control (F[2,39] = 21.02, p < .001, η2 = .36). No effect was found on mathematics performance (F[2, 35] = .51, p = .479, η2 = .02).

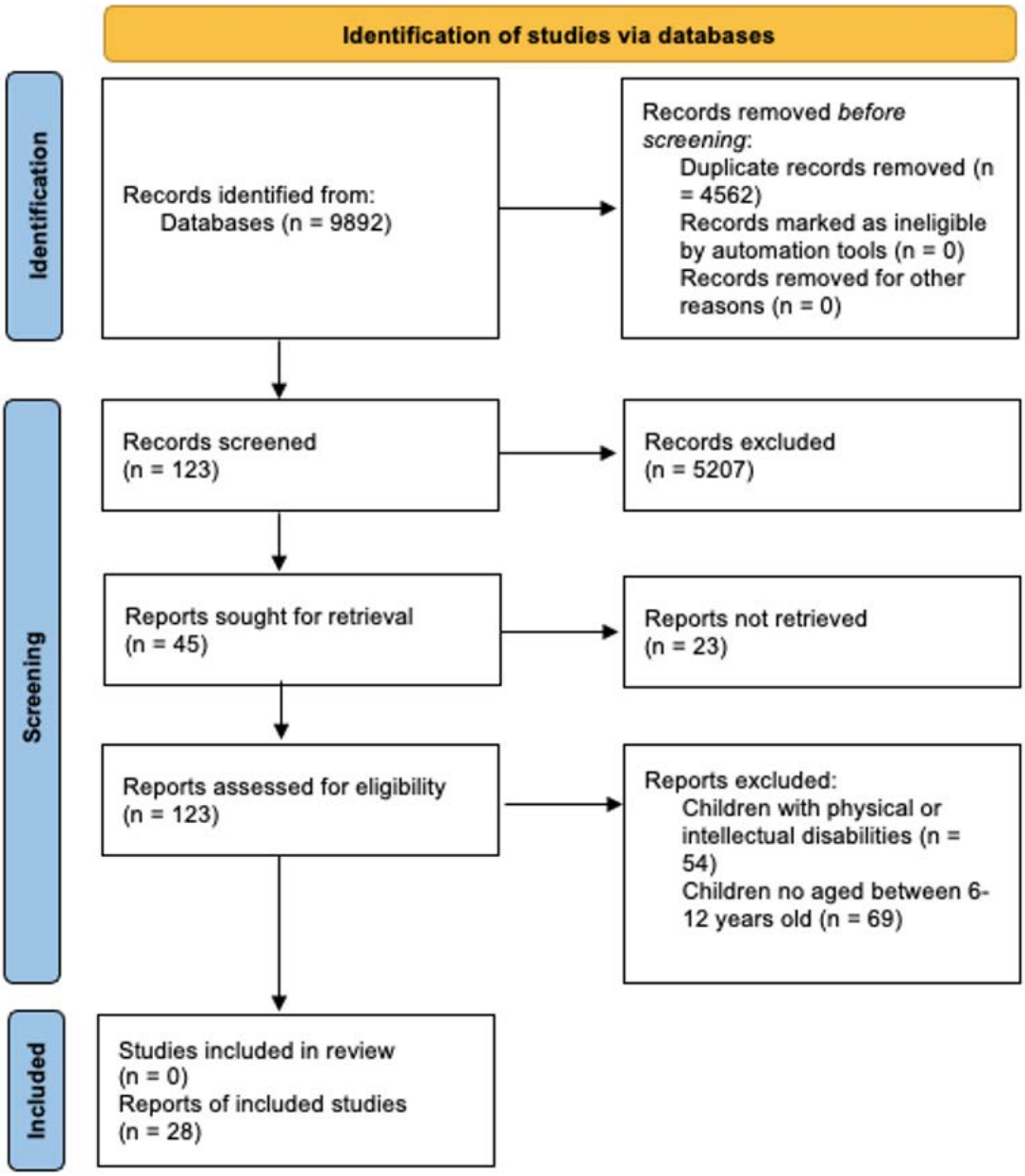

Figure 1. Flowchart illustrating the different phases of the search and selection of the studies
Note: PRISMA (2020) flow diagram for new systematic reviews which included searches of databases and registers only.

Discussion

This systematic review has explored the association between PA and PF on AP and EF in elementary school children (6-12 years old). Studies from January 2010 to January 2021 were obtained from 4 databases. A total of 26 articles met the inclusion criteria: 9 studies used a cross-sectional design, 6 were repeated measures studies and 11 were intervention studies. PA and levels of PF were assessed by CRF, muscular strength, speed-agility, motor coordination, perceptual-motor skill and other physical variables.

A large number of studies have examined, through cross-sectional designs, the association between the level of PF and various cognitive functions at school. The detailed analysis of the influence of each physical fitness component revealed that CRF has the greatest influence on AP and EF. To evaluate CRF, some studies used the 20-m shuttle run test PACER (Wittberg et al., 2012; Lambourne et al., 2013; Hansen, et al., 2014) and two studies used a formula to calculate the maximal oxygen consumption (VO.max) (Pontifex et al., 2012; Raine et al., 2013). Wittberg et al. (2012), Lambourne et al. (2013) and Hansen et al. (2014) found that children with more CRF had a higher AP. On the other hand, Pontifex et al. (2012) and Raine et al. (2013) used a computerised indirect calorimetry system with averages for oxygen uptake (VO.) and respiratory exchange ratio to assess CRF, showing how children with a high level of CRF had better memory ability. A suitable PF is an

possible condition for better inhibition, working memory and cognitive flexibility in children (Syväoja et al., 2014; van der Niet et al., 2015). In addition, a good CRF, an adequate body composition, and a higher motor performance are associated better AP (Haapala et al., 2014). However, Jansen et al. (2019) did not find relationship between PF (body coordination and speed) and working memory in school-aged children.

Some research has focused on determining the acute and chronic effect of PA on children's cognitive abilities. The type of effect depended on the duration of the intervention carried out. Several research has shown a acute effect when children perform PA before academic subjects on AP and EF. Different PE classes in which children have to activate their brain function, lead to they are more prone to obtain better scores on AP, memory, attention or concentration (Yanagisawa et al., 2010). MVPA performed in a PE session has an acute effect on different EF like planning, attention, simultaneous processing and successive processing and school performance in children during elementary school (Pirrie and Lodewyk, 2012). Moreover, short periods of aerobic exercise (20 seconds of high-intensity activity separated by 10 seconds of rest and repeated 8 times) have an important acute effect on attention in the next academic classes (Ma et al., 2015). Team game sessions, which demand control and complex eye-hand coordination and require goal-directed behaviour, and aerobic exercises, based on high-intensity cardiomyopathy, help students to better develop inhibition, shifting and memory update of themselves to face scholary activities in an appropriate way (Jäger et al., 2015). This was also supported by authors such as Mezcua et al. (2019) who showed that short-term training of C-HIIT has benefits in cognitive functions. However, a team game session had a better result in cognitive function than a class in aerobic exercise because it is producing a cognitive compromise when the frontal lobe is activated in the execution (Yanagisawa et al., 2010). This statement attempts to explain how PE sessions which include a cognitive compromise can have an acute effect on the cognitive capacities of children. Thus, Gallotta et al. (2015) demonstrated in an experiment that those sessions that require cognition exercises like playing mini-games with coordination, meant students were able to develop their cognitive skills more effectively. However, van den Berg et al. (2016) did not find any improvement on memory, attention or the PA in children who did aerobic, coordination or strength sessions in comparison with children who were in the control group.

On the other hand, current research has demonstrated the chronic effect of PA on AP and EF for elementary school children. Most of them have performed PA programmes in which children increased the time dedicated to PA at school (Lind et al., 2018). Käll et al. (2014) carried out a controlled interventional study in a Swedish government programme (Handslaget) based on group play and other activities which increased the proportion of students who achieved national learning compared with three reference schools. Higher proportions of students in the intervention school achieved the national goals in all three subjects compared with the reference schools after initiation of the intervention programme. Sardinha et al. (2016) also performed an intervention study to assess AP of children after a three-year intervention dedicated to avoiding childhood obesity. The result of this intervention was positive regarding the national goals. On the other hand, active lessons of MVPA in the classroom for several weeks improved the AP and EF of students due to the fact that they exercise not only the body but also the cognitive processes reflected in the AP (Mullender-Wijnsma et al., 2015; Erwin et al., 2012; Layne et al., 2021). Hillman et al. (2009) showed that an intervention over 9 months where children do short periods of moderate-intense aerobic exercise can improve cognitive control and attention. Increasing the number of hours of PE at school (two hours), over at least 10 weeks, is a suitable method to enhance the students' marks and cognitive aspects such as working memory and attention (Fisher et al., 2011). Children who have physical afterschool sessions for two hours per week (over 9 months) performing MVPA achieve better results on their behaviour (analysing accuracy and reaction time) and on executive control such as modulated attentional, inhibition and cognitive flexibility (Hillman et al., 2014). Moreover, afterschool sessions based on aerobic exercises (Kamijo et al., 2011; Chaddock-Heyman et al., 2020) and cardiovascular and motor exercises (Ou et al., 2016) showed improvements in some EF such as memory work or inhibitory control and AP. Continuing with afterschool sessions performing MVPA is a good way to enhance children's cognitive functions. In addition, it is relevant to determine not only whether team games and aerobic exercises have an acute effect on PA, but also whether it has a chronic effect if carried out for several weeks on EF such as inhibition, shifting and update (Schmidt et al., 2015). However, de Greeff et al. (2016) did not find improvements in mathematical and language activities for the experiment group after a two-year intervention dedicated to active MVPA classes.

Limitations of research and implications for research and practice

The limitations of the study are manifested in the selected databases. Although relevant databases were used, others such as Scopus were ignored. In addition, all types of studies that met the inclusion criteria were attended without paying attention to factors that could determine the quality of the study, such as the sample size.

Finally, based on the measurement instruments of the different variables, the suitability of the same can be confirmed in consideration of the context where the measurement was carried out and the age of the sample. All reflect an appropriate degree of reliability and are tailored to the sample. Certainly, more innovative and effective techniques such as image analysis could have been used, however, in the educational field, which has a fairly large sample, the use of such instruments is very complicated.

The literature suggests that cognitive and academic performance of children not improved by limiting the time allocated to PE and PA (Trudeau and Shephard, 2008). Therefore, increasing the amount of time devoted to PA and so improving their PF can promote acute and chronic cognitive benefits on EF such as working memory, attention, inhibition and shifting have important implications for AP (Fisher et al., 2011). In addition, activity breaks can produce positive, chronic cognitive response. This literature review serves as the basis for future research in the field of educational psychology that promotes PA programs in the school context in primary education.

Conclusion

The present review found a total of 26 articles that analysed the association between PA with AP and EF in children. Nine articles focused on AP and fifteen on EF. Thirteen of those focused on attention and working memory and two on other EF like inhibition, shifting, cognitive flexibility, update

or planning. Most studies showed a positive relationship between PA on AP and EF. In the nine studies which analysed the effect of PA and PF on AP, only one did not find an association. Regarding EF, in two studies PA did not produce any effects. CRF was the physical variable that was correlated with better AP and EF. On the other hand, active classes of MVPA and PE classes when children had to perform coordination exercises revealed a better acute effect. In addition, a large chronic effect was found mainly in children who carried out PE sessions over several weeks which involved cognitive compromises by means of coordination exercises. Finally, confounders could have played a pivotal role in these associations. Sex, age, BMI, sociodemographic factors, and previous marks must be taken into account. More research is needed to explain the effect of different types of PA on AP and EF to clarify the role of confounders and better predict the relationship between physical and cognitive variables. Intervention studies in which children have to move more at school or outside school are necessary in order to enhance cognitive processes which are used during the school day. Integrating educational departments, the school and the families can guarantee the cognitive and physical health of children. Promoting PA in children as a tool for improving cognitive aspects is everyone's responsibility.

References

Ahn, S., & Fedewa, A. L. (2011). A meta-analysis of the relationship between children's physical activity and mental health. *Journal of Pediatric Psychology, 36*(4), 385–397. https://doi.org/10.1093/jpepsy/jsq107

Álvarez-Bueno, C., Pesce, C., Cavero-Redondo, I., Sánchez-López, M., Martínez-Hortelano, J. A., & Martínez-Vizcaíno, V. (2017). The Effect of Physical Activity Interventions on Children's Cognition and Metacognition: A Systematic Review and Meta-Analysis. In *Journal of the American Academy of Child and Adolescent Psychiatry*. https://doi.org/10.1016/j.jaac.2017.06.012

Anderson, P. (2002). Assessment and Development of Executive Function (EF) During Childhood. *Child Neuropsychology, 8*(2), 71–82. https://doi.org/10.1076/chin.8.2.71.8724

Berrios Aguayo, B., Pantoja Vallejo, A., & Latorre Román, P. Á. (2019). Acute effect of two different physical education classes on memory in children school-age. *Cognitive Development*. https://doi.org/10.1016/j.cogdev.2019.03.004

Best, J. R. (2010). Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise. *Developmental Review, 30*(4), 331–351. https://doi.org/10.1016/j.dr.2010.08.001

Carriedo, A. & González, C. (2019).Rendimiento Académico en Educación Física: Aspectos Académicos versus Físico-deportivos. Cultura_Ciencia_Deporte, 14(42), 225-232.

Chaddock-Heyman, L., Weng, T. B., Kienzler, C., Weisshappel, R., Drollette, E. S., Raine, L. B., & Kramer, A. F. (2020). Brain network modularity predicts improvements in cognitive and scholastic performance in children involved in a physical activity intervention. *Frontiers in Human Neuroscience, 14*, 346. https://doi.org/10.3389/fnhum.2020.00346

Chaddock, L., Pontifex, M. B., Hillman, C. H., & Kramer, A. F. (2011). A review of the relation of aerobic fitness and physical activity to brain structure and function in children. *Journal of the International Neuropsychological Society#: JINS, 17*(6), 975–985. https://doi.org/10.1017/S1355617711000567

Chang, Y. K., Labban, J. D., Gapin, J. I., & Etnier, J. L. (2012). The effects of acute exercise on cognitive performance: A meta-analysis. In *Brain Research* (Vol. 1453, pp. 87–101). https://doi.org/10.1016/j.brainres.2012.02.068

de Greeff, J. W., Hartman, E., Mullender-Wijnsma, M. J., Bosker, R. J., Doolaard, S., & Visscher, C. (2016). Long-term effects of physically active academic lessons on physical fitness and executive functions in primary school children. *Health Education Research, 31*(2), 185–194. https://doi.org/10.1093/her/cyv102

Donnelly, J. E., Greene, J. L., Gibson, C. A., Sullivan, D. K., Hansen, D. M., Hillman, C. H., Poggio, J., Mayo, M. S., Smith, B. K., Lambourne, K., Herrmann, S. D., Scudder, M., Betts, J. L., Honas, J. J., & Washburn, R. A. (2013). Physical activity and academic achievement across the curriculum (A + PAAC): rationale and design of a 3-year, cluster-randomized trial. *BMC Public Health, 13*(1), 307. https://doi.org/10.1186/1471-2458-13-307

Donnelly, J. E., Hillman, C. H., Castelli, D., Etnier, J. L., Lee, S., Tomporowski, P., Lambourne, K., & Szabo-Reed, A. N. (2016). Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review. In *Medicine and Science in Sports and Exercise* (Vol. 48, Issue 6, pp. 1197–1222). https://doi.org/10.1249/MSS.0000000000000901

Downs, S. H., & Black, N. (1998). The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health, 52*, 377–384.

Ellemberg, D., & St-Louis-Deschênes, M. (2010). The effect of acute physical exercise on cognitive function during development. *Psychology of Sport and Exercise, 11*(2), 122–126. https://doi.org/10.1016/j.psychsport.2009.09.006

Erwin, H., Fedewa, A., & Ahn, S. (2012). Student academic performance outcomes of a classroom physical activity intervention: A pilot study. *International Electronic Journal of Elementary Education, 4*(3), 473–487.

Fisher, A., Boyle, J. M. E., Paton, J. Y., Tomporowski, P., Watson, C., McColl, J. H., & Reilly, J. J. (2011). Effects of a physical education intervention on cognitive function in young children: randomized controlled pilot study. *BMC Pediatrics, 11*(1), 97. https://doi.org/10.1186/1471-2431-11-97

Friedman, N. P., Miyake, A., Young, S. E., DeFries, J. C., Corley, R. P., & Hewitt, J. K. (2008). Individual differences in executive functions are almost entirely genetic in origin. *Journal of Experimental Psychology: General, 137*(2), 201–225. https://doi.org/10.1037/0096-3445.137.2.201

Gallotta, M. C., Emerenziani, G. P., Franciosi, E., Meucci, M., Guidetti, L., & Baldari, C. (2015a). Acute physical activity and delayed attention in primary school students. *Scandinavian Journal of Medicine & Science in Sports, 25*(3), e331-8. https://doi.org/10.1111/sms.12310

Gallotta, M. C., Emerenziani, G. P., Franciosi, E., Meucci, M., Guidetti, L., & Baldari, C. (2015b). Acute physical activity and delayed attention in primary school students. *Scandinavian Journal of Medicine & Science in Sports, 25*(3), e331–e338. https://doi.org/10.1111/sms.12310

García-Pinillos, F., Soto-Hermoso, V. M., & Latorre-Román, P. A. (2016). How does high-intensity intermittent training

affect recreational endurance runners? Acute and chronic adaptations: A systematic review. *Journal of Sport and Health Science*. https://doi.org/10.1016/j.jshs.2016.08.010

Gunnell, K. E., Poitras, V. J., LeBlanc, A., Schibli, K., Barbeau, K., Hedayati, N., Ponitfex, M. B., Goldfield, G. S., Dunlap, C., Lehan, E., & Tremblay, M. S. (2019). Physical activity and brain structure, brain function, and cognition in children and youth: A systematic review of randomized controlled trials. *Mental Health and Physical Activity*. https://doi.org/10.1016/j.mhpa.2018.11.002

Haapala, E. A., Poikkeus, A.-M., Tompuri, T., Kukkonen-Harjula, K., Leppänen, P. H. T., Lindi, V., & Lakka, T. A. (2014). Associations of motor and cardiovascular performance with academic skills in children. *Medicine and Science in Sports and Exercise, 46*(5), 1016–1024. https://doi.org/10.1249/MSS.0000000000000186

Hansen, D. M., Herrmann, S. D., Lambourne, K., Lee, J., & Donnelly, J. E. (2014). Linear/nonlinear relations of activity and fitness with children's academic achievement. *Medicine and Science in Sports and Exercise, 46*(12), 2279–2285. https://doi.org/10.1249/MSS.0000000000000362

Higgins, J. P. T., & Green, S. (2011). *Manual Cochrane de revisiones sistemáticas de intervenciones*.

Hillman, C. H., Buck, S. M., Themanson, J. R., Pontifex, M. B., & Castelli, D. M. (2009). Aerobic fitness and cognitive development: Event-related brain potential and task performance indices of executive control in preadolescent children. *Developmental Psychology, 45*(1), 114–129. https://doi.org/10.1037/a0014437

Hillman, C. H., Pontifex, M. B., Castelli, D. M., Khan, N. A., Raine, L. B., Scudder, M. R., Drollette, E. S., Moore, R. D., Wu, C.-T., & Kamijo, K. (2014). Effects of the FITKids randomized controlled trial on executive control and brain function. *Pediatrics, 134*(4), e1063-71. https://doi.org/10.1542/peds.2013-3219

Jäger, K., Schmidt, M., Conzelmann, A., & Roebers, C. M. (2015). The effects of qualitatively different acute physical activity interventions in real-world settings on executive functions in preadolescent children. *Mental Health and Physical Activity, 9*, 1–9. https://doi.org/10.1016/j.mhpa.2015.05.002

Jansen, P., Scheer, C., & Zayed, K. (2019). Motor ability and working memory in Omani and German primary school-aged children. *PLOS ONE, 14*(1), e0209848. https://doi.org/10.1371/journal.pone.0209848

Janssen, I., & Leblanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act., 7*(1479–5868), 40. https://doi.org/1479-5868-7-40[pii]\r10.1186/1479-5868-7-40

Käll, L. B., Nilsson, M., & Lindén, T. (2014). The Impact of a Physical Activity Intervention Program on Academic Achievement in a Swedish Elementary School Setting. *Journal of School Health, 84*(8), 473–480. https://doi.org/10.1111/josh.12179

Kamijo, K., Pontifex, M. B., O'Leary, K. C., Scudder, M. R., Wu, C.-T., Castelli, D. M., & Hillman, C. H. (2011a). The effects of an afterschool physical activity program on working memory in preadolescent children. *Developmental Science, 14*(5), 1046–1058. https://doi.org/10.1111/j.1467-7687.2011.01054.x

Kamijo, K., Pontifex, M. B., O'Leary, K. C., Scudder, M. R., Wu, C.-T., Castelli, D. M., & Hillman, C. H. (2011b). The effects of an afterschool physical activity program on working memory in preadolescent children. *Developmental Science, 14*(5), 1046–1058. https://doi.org/10.1111/j.1467-7687.2011.01054.x

Kibbe, D. L., Hackett, J., Hurley, M., McFarland, A., Schubert, K. G., Schultz, A., & Harris, S. (2011). Ten Years of TAKE 10! (®): Integrating physical activity with academic concepts in elementary school classrooms. *Preventive Medicine, 52 Suppl 1*, S43-50. https://doi.org/10.1016/j.ypmed.2011.01.025

Kvalø, S. E., Bru, E., Brønnick, K., & Dyrstad, S. M. (2017). Does increased physical activity in school affect children's executive function and aerobic fitness? *Scandinavian Journal of Medicine & Science in Sports, 27*(12), 1833–1841. https://doi.org/10.1111/sms.12856

Layne, T., Yli-Piipari, S., & Knox, T. (2021). Physical activity break program to improve elementary students' executive function and mathematics performance. *Education 3-13, 49*(5), 583-591. https://doi.org/10.1080/03004279.2020.1746820

Lambourne, K., Hansen, D. M., Szabo, A. N., Lee, J., Herrmann, S. D., & Donnelly, J. E. (2013). Indirect and direct relations between aerobic fitness, physical activity, and academic achievement in elementary school students. *Mental Health and Physical Activity, 6*(3), 165–171. https://doi.org/10.1016/j.mhpa.2013.06.002

Latorre-Román, P. Á., Mora-López, D., & García-Pinillos, F. (2016). Intellectual maturity and physical fitness in preschool children. *Pediatrics International, 58*(6), 450–455. https://doi.org/10.1111/ped.12898

Latorre Román, P. Á., Pinillos, F. G., Pantoja Vallejo, A., & Berrios Aguayo, B. (2017). Creativity and physical fitness in primary school-aged children. *Pediatrics International, 59*(11), 1194–1199. https://doi.org/10.1111/ped.13391

Lees, C., & Hopkins, J. (2013). Effect of aerobic exercise on cognition, academic achievement, and psychosocial function in children: a systematic review of randomized control trials. *Preventing Chronic Disease, 10*, E174. https://doi.org/10.5888/pcd10.130010

Lemes, V., Gaya, A. R., Sadarangani, K. P., Aguilar-Farias, N., Rodriguez-Rodriguez, F., de Lucena Martins, C. M., ... & Cristi-Montero, C. (2021). Physical fitness plays a crucial mediator role in relationships among personal, social, and lifestyle factors with adolescents' cognitive performance in a structural equation model. The cogni-action project. *Frontiers in pediatrics, 9*, 656916. https://doi.org/10.3389/fped.2021.656916

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment*. Oxford University Press.

Lind, R. R., Geertsen, S. S., Ørntoft, C., Madsen, M., Larsen, M. N., Dvorak, J., Ritz, C., & Krustrup, P. (2018). Improved cognitive performance in preadolescent Danish children after the school-based physical activity programme "FIFA 11 for Health" for Europe. A cluster-randomised controlled trial. *European Journal of Sport Science, 18*(1), 130–139. https://doi.org/10.1080/17461391.2017.1394369

Lobelo, F., Muth, N. D., Hanson, S., & Nemeth, B. A. (2020). Physical activity assessment and counseling in pediatric clinical settings. *Pediatrics, 145*(3), e20193992. https://doi.org/10.1542/peds.2019-3992

Ma, J. K., Le Mare, L., & Gurd, B. J. (2015). Four minutes of in-class high-intensity interval activity improves selective attention in 9- to 11-year olds. *Applied Physiology, Nutrition, and Metabolism, 40*(3), 238–244. https://doi.org/10.1139/apnm-2014-0309

Mahar, M. T. (2011). Impact of short bouts of physical activity on attention-to-task in elementary school children. *Preventive Medicine, 52*, S60–S64. https://doi.org/10.1016/j.ypmed.2011.01.026

Mahar, M. T., Murphy, S. K., Rowe, D. A., Golden, J., Shields, A. T., & Raedeke, T. D. (2006). Effects of a classroom-based program on physical activity and on-task behavior. *Medicine and Science in Sports and Exercise, 38*(12), 2086–2094. https://doi.org/10.1249/01.mss.0000235359.16685.a3

Maher, C. G., Sherrington, C., Herbert, R. D., Moseley, A. M., & Elkins, M. (2003). Reliability of the PEDro scale for rating quality of randomized controlled trials. *Physical Therapy, 83*(8), 713–721.

Marques, A., Santos, D. A., Hillman, C. H., & Sardinha, L. B. (2018). How does academic achievement relate to cardiorespiratory fitness, self-reported physical activity and objectively reported physical activity: A systematic review in children and adolescents aged 6-18 years. *British Journal of Sports Medicine, 52*(16), 1039. https://doi.org/10.1136/bjsports-2016-097361

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine, 6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Mullender-Wijnsma, M. J., Hartman, E., de Greeff, J. W., Bosker, R. J., Doolaard, S., & Visscher, C. (2015). Improving Academic Performance of School-Age Children by Physical Activity in the Classroom: 1-Year Program Evaluation. *Journal of School Health, 85*(6), 365–371. https://doi.org/10.1111/josh.12259

Ou, F. K., Wegner, M., Niemann, C., & Budde, H. (2016). *Effects of Motor versus Cardiovascular Exercise Training on Children_s Working Memory*. https://doi.org/10.1249/MSS.0000000000000869

Page, M.J., McKenzie, J.E., Bossuyt, PM, Boutron, I., Hoffmann, T.C., Mulrow, C.D., et al. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ, 71*. https://doi.org/10.1136/bmj.n71

Pesce, C., Crova, C., Cereatti, L., Casella, R., & Bellucci, M. (2009). Physical activity and mental performance in preadolescents: Effects of acute exercise on free-recall memory. *Mental Health and Physical Activity, 2*, 16–22. https://doi.org/10.1016/j.mhpa.2009.02.001

Pirrie, A. M., & Lodewyk, K. R. (2012). Investigating links between moderate-to-vigorous physical activity and cognitive performance in elementary school students. *Mental Health and Physical Activity, 5*(1), 93–98. https://doi.org/10.1016/j.mhpa.2012.04.001

Pontifex, M. B., Scudder, M. R., Drollette, E. S., & Hillman, C. H. (2012). Fit and vigilant: the relationship between poorer aerobic fitness and failures in sustained attention during preadolescence. *Neuropsychology, 26*(4), 407–413. https://doi.org/10.1037/a0028795

Raine, L. B., Lee, H. K., Saliba, B. J., Chaddock-Heyman, L., Hillman, C. H., & Kramer, A. F. (2013). The Influence of Childhood Aerobic Fitness on Learning and Memory. *PLoS ONE, 8*(9), e72666. https://doi.org/10.1371/journal.pone.0072666

Resaland, G. K., Moe, V. F., Aadland, E., Steene-Johannessen, J., Glosvik, Ø., Andersen, J. R., Kvalheim, O. M., McKay, H. A., Anderssen, S. A., & ASK study group. (2015). Active Smarter Kids (ASK): Rationale and design of a cluster-randomized controlled trial investigating the effects of daily physical activity on children's academic performance and risk factors for non-communicable diseases. *BMC Public Health, 15*(1), 709. https://doi.org/10.1186/s12889-015-2049-y

Ruiz-Ariza, A., Grao-Cruces, A., de Loureiro, N. E. M., & Martínez-López, E. J. (2017). Influence of physical fitness on cognitive and academic performance in adolescents: A systematic review from 2005–2015. *International Review of Sport and Exercise Psychology, 10*(1), 108–133. https://doi.org/10.1080/1750984X.2016.1184699

Sardinha, L. S., Marques, A., Minderico, C., Nio Palmeira, A., Martins, S., Santos, D. A., & Ekelund, U. (2016). Longitudinal Relationship between Cardiorespiratory Fitness and Academic Achievement. *Med . Sci . Sports Exerc, 48*(5), 839–844. https://doi.org/10.1249/MSS.0000000000000830

Schmidt, M., Egger, F., Benzing, V., Jäger, K., Conzelmann, A., Roebers, C. M., & Pesce, C. (2017). Disentangling the relationship between children's motor ability, executive function and academic achievement. *PLOS ONE, 12*(8), e0182845. https://doi.org/10.1371/journal.pone.0182845

Schmidt, M., Jäger, K., Egger, F., Roebers, C. M., & Conzelmann, A. (2015). Cognitively Engaging Chronic Physical Activity, but Not Aerobic Exercise, Affects Executive Functions in Primary School Children: A Group-Randomized Controlled Trial. *Journal of Sport and Exercise Psychology, 37*(6), 575–591. https://doi.org/10.1123/jsep.2015-0069

Segura-Martínez, P., Molina-García, J., Queralt, A., del Mar Bernabé-Villodre, M., Martínez-Bello, D. A., & Martínez-Bello, V. E. (2020). An Indoor Physical Activity Area for Increasing Physical Activity in the Early Childhood Education Classroom: An Experience for Enhancing Young Children's Movement. *Early Childhood Education Journal*, 1-15. https://doi.org/10.1007/s10643-020-01125-6

Soga, K., Shishido, T., & Nagatomi, R. (2015). Executive function during and after acute moderate aerobic exercise in adolescents. *Psychology of Sport and Exercise, 16*, 7–17. https://doi.org/10.1016/j.psychsport.2014.08.010

Syväoja, H. J., Tammelin, T. H., Ahonen, T., Kankaanpää, A., & Kantomaa, M. T. (2014). The Associations of Objectively Measured Physical Activity and Sedentary Time with Cognitive Functions in School-Aged Children. *PLoS ONE, 9*(7), e103559. https://doi.org/10.1371/journal.pone.0103559

Tomporowski, P. D., Davis, C. L., Miller, P. H., & Naglieri, J. A. (2008). Exercise and children's intelligence, cognition, and academic achievement. *Educational Psychology Review, 20*(2), 111–131. https://doi.org/10.1007/s10648-007-9057-0

Trudeau, F., & Shephard, R. J. (2008). Physical education, school physical activity, school sports and academic performance. In *International Journal of Behavioral Nutrition and Physical Activity* (Vol. 5, Issue 1, p. 10). https://doi.org/10.1186/1479-5868-5-10

van den Berg, V., Saliasi, E., de Groot, R. H. M., Jolles, J., Chinapaw, M. J. M., & Singh, A. S. (2016). Physical Activity in the School Setting: Cognitive Performance Is Not Affected by Three Different Types of Acute Exercise. *Frontiers in Psychology, 7*, 723. https://doi.org/10.3389/fpsyg.2016.00723

van der Niet, A. G., Smith, J., Scherder, E. J. A., Oosterlaan, J., Hartman, E., & Visscher, C. (2015). Associations between daily physical activity and executive functioning in primary school-aged children. *Journal of Science and Medicine in Sport, 18*(6), 673–677. https://doi.org/10.1016/j.jsams.2014.09.006

Verburgh, L., Königs, M., Scherder, E. J. a, & Oosterlaan, J. (2014). Physical exercise and executive functions in preadolescent children, adolescents and young adults: a meta-analysis. *British Journal of Sports Medicine, 48*(12), 973–979. https://doi.org/10.1136/bjsports-2012-091441

Wittberg, R. A., Northrup, K. L., & Cottrell, L. A. (2012a). Children's aerobic fitness and academic achievement: a longitudinal examination of students during their fifth and seventh grade years. *American Journal of Public Health, 102*(12), 2303–2307. https://doi.org/10.2105/AJPH.2011.300515

Wittberg, R. A., Northrup, K. L., & Cottrell, L. A. (2012b). Children's Aerobic Fitness and Academic Achievement: A Longitudinal Examination of Students During Their Fifth and Seventh Grade Years. *American Journal of Public Health, 102*(12), 2303–2307. https://doi.org/10.2105/AJPH.2011.300515

Yanagisawa, H., Dan, I., Tsuzuki, D., Kato, M., Okamoto, M., Kyutoku, Y., & Soya, H. (2010). Acute moderate exercise elicits increased dorsolateral prefrontal activation and improves cognitive performance with Stroop test. *NeuroImage, 50*(4), 1702–1710. https://doi.org/10.1016/j.neuroimage.2009.12.023

CULTURA, CIENCIA Y DEPORTE

Analysis of efficiency in under-16 basketball: A log-linear analysis in a systematic observation study

Análisis de la eficacia en baloncesto U16: aplicación del log-linear en metodología observacional

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Abstract

Within the framework of an observational methodology study, we used log-linear analysis to analyze efficiency in elite under-16 basketball from the perspective of three key dimensions: shot position, last pass position, and shot result. The reliability of the observational datasets was confirmed by analysis of interobserver agreement (Cohen's kappa statistic) and a generalizability theory analysis. The most parsimonious hierarchical model selected using backward elimination in the log-linear analysis was a conditional independence model where the association between last pass position and shot position was independent of shot result and the association between shot position and shot result was independent of last pass position. In this article, we discuss the results corresponding to the model's first- and second-order effects and show the possibilities offered by log-linear analysis within a systematic observation study to analyze efficiency in basketball.

Keywords: performance analysis, observational methodology, last pass position, shot position, shot result.

Resumen

En el seno de la metodología observacional se realiza un estudio de la eficacia en la élite del baloncesto sub 16. Mediante un análisis log-linear se analiza la asociación entre tres dimensiones claves en el estudio de la eficacia. En lo relativo a la calidad del dato, se ha garantizado la concordancia inter-observadores mediante el coeficiente kappa de Cohen. Además, en el seno de la teoría de la generalizabilidad, se ha garantizado una elevada fiabilidad de precisión de generalización de los resultados. Los resultados obtenidos a partir del análisis log-linear realizado muestran que el modelo jerárquico más parsimonioso seleccionado a través del procedimiento *backward* es el de independencia condicional: la asociación entre el lugar desde el que se realiza el último pase y el lugar desde el que se realiza el lanzamiento es independiente de consecuencia del lanzamiento; y la asociación entre el lugar desde el que se realiza el lanzamiento y la consecuencia del lanzamiento es independiente del lugar desde el que se realiza el último pase. A partir de la discusión de los resultados relativos a los efectos de primer y segundo orden se han constatado las posibilidades que el análisis log-linear brinda a la metodología observacional.

Palabras clave: análisis del rendimiento, metodología observacional, posición del último pase, posición en el lanzamiento, resultado del lanzamiento.

Introduction

Studies of efficiency and factors that influence efficiency are common in elite basketball (Gómez et al., 2013; Izquierdo et al., 2021; Sampaio et al., 2010; Simovic et al., 2012, 2021). The most common performance indicator in this setting is shot success (Erculj & Strumbelj, 2015; Ibáñez et al., 2009), which is analyzed in a wide range of contexts, including comparisons between winning and losing teams (Fernández & Piñar, 2017; Gómez et al., 2008), home and away teams (Ribeiro et al., 2016), and league and playoff matches (García et al., 2013).

To better understand what occurs during a game of basketball, it is important not only to determine how and where shots are taken, but also to study the actions leading up to these shots (Oudejans et al., 2012; Romaris et al., 2012)

Analyses of shots and favorable shooting conditions are also important for training purposes (Lapresa et al., 2013; Ortega et al., 2006; Piñar et al., 2014), as data from real-life situations can help coaches establish technical and tactical goals to ease the transition from amateur/youth basketball to professional /senior basketball (Alsasua et al., 2018). Under-16 (U16) basketball is a highly relevant category in this sense (Lorenzo et al., 2010; Monteiro et al., 2013; Ortega et al., 2007), as it is the bridge between categories where the focus is still very much on player development and categories where the focus is on preparing players for the transition to senior or professional basketball (e.g., U18 /senior amateur teams) (Ortega & Gómez, 2009; Parejo et al., 2013).

In match analysis that use observational methodology, the analysis techniques to be used are determined by the objectives pursued and the observational design that supports the study (Anguera et al., 2011). Although the true potential of the observational methodology is obtained from diachronic analysis with data that incorporate order and/or duration (Anguera & Hernández-Mendo, 2015), the usual synchronous statistical analysis, which look for association relationships between dimensions that provide data categorical, are also relevant to meet the objectives set (O'Donoghue, 2009). The chi-square type statistics have the limitation of contrasting two variables (two-dimensional contingency tables). This limitation, when relating more variables is needed, is usually overcome by repeating the analysis in pairs in the different contingency sub-tables that are generated. However, the loglinear analysis technique does allow the analysis of more than two dimensions, it is much more robust, and it is appropriate from multidimensional contingency tables (Agresti, 2002; Eom & Schutz, 1992).

The aim of this study was to study efficiency in boy's U16 basketball according to shot position (area of the court where the shot is taken) and last pass position (the position of the player who made the pass leading up to the shot). A second, methodological, aim, was to show how log-linear analysis performed within the framework of an observational methodology (Anguera, 1979) study is a useful tool for this purpose. In a previous study in elite basketball, Alsasua et al. (2019) successfully used log-linear analysis to analyze relationships between the three variables at the core of this study: a) shot position, b) last pass position, and c) shot result.

Method

We applied a nomothetic, intersessional/intrasessional follow-up, multidimensional observational design (N/F/M) (Anguera et al., 2011). The design was nomothetic as we observed eight teams; it is intersessional and intrasessional follow-up as we analyzed seven matches corresponding to the quarter-finals, semi-finals, and final of the Spanish U16 Basketball Club Championship as well as all relevant behaviors that occurred during each match; and it is multidimensional as different dimensions (criteria), all of which are included in the observation instrument, were studied. The behaviors were both proxemic (i.e., they occurred in different areas of the court) and gestural (i.e., they involved different technical-tactical actions).

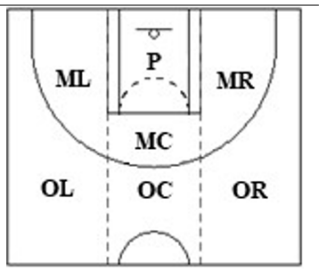
Participants

The participants were U16 boys who played the quarter-finals, semi-finals, and final of the Spanish U16 Basketball Club Championship (2012), which brings together the country's elite in this category. For each of the matches analyzed, we studied all offensive sequences that ended in a shot by the winning team.

Observation instrument

The observation instrument (Table 1) is an adaptation of the SOBL-2 instrument designed by Fernández et al. (2009) to analyze efficiency in basketball. It combines a field format and a category systems. To satisfy the objective of the work, and facilitate the didactic development of the application of the loglinear analysis technique, it has been considered suitable to develop a three-dimensional model. That is why we made two modifications to the original SOBL-2: we grouped all proxemic categories (codes) into a single dimension (area of the court) and classified each completion of sequence category as favorable (basket [Mk], foul received [FR], and basket and foul [A1]) or unfavorable (missed basket [Ms], offensive foul/violation [Vi], and block [Bl]).

Table 1. Observation Instrument

Dimension	Category (codes)
Area	Middle of left corridor (ML); Outer left corridor (OL); Middle of right corridor (MR); Outer right corridor (OR); Middle of central corridor (MC); Outer central corridor (OC); paint (P) 
Action	Ball recovery (BR); Defensive rebound (DR); Offensive rebound (OR); Penultimate pass (P1); Penultimate reception (R1); Last pass (P2); Last reception (R2); New possession (NP); Shot (Sh)
Completion of sequence	Favorable: Basket (Mk); Foul received (FR); Basket and foul (A1). Unfavorable: Missed basket (Ms); Offensive foul/violation (Vi); Block (Bl)
Initiation of sequence	Ball in play (BP); Offensive sideline throw-in (OST); Offensive baseline throw-in (OBT); Opening tip-off (OT); Defensive baseline throw-in (DBT); Defensive sideline throw-in (DST); Free throw (FT)

Procedure

The observation instrument was loaded into Match Vision Studio v.3 for data annotation and coding (Castellano et al., 2008). The observation sample was generated by annotating all sequences of play ending in a shot by the winning team. Each sequence comprised the shot and a maximum of five actions leading up to this shot. A maximum of six rows thus was created for each sequence in the dataset. Based on the criteria of Bakeman (1978), the data can be considered type IV, concurrent, and time-based.

Data quality control

Interobserver agreement

There have been two observers -with the academic degree of a doctor, proven experience in observational methodology and title of National Basketball coach- in charge of making the records in this study. The observer training process has been carried out from Anguera (2003): 1) Theoretical training in the observation instrument; 2) Theoretical-practical training: in relation to the recording procedure, once the observation instrument has been entered in the Match Vision Studio v.3 recording and coding instrument; 3) Practical training: supervised record of five plays (belonging to a match of the same competition but out of sampling); later autonomous recording of the observers of another five plays; and once a high degree of concordance was obtained (Cohen's kappa> 0.80) between the autonomous records of both observers, the training process was considered completed.

The first observer coded 100% of the sequences in the observation sample while the second observer coded 10% (Alsasua et al., 2019; Sastre et al., 2021). The agreement between the resulting datasets was measured using Cohen's kappa statistic (Cohen, 1968) in GSEQ (v. 5.1). The kappa statistics for the different match datasets were 0.89 for FC Barcelona-Torrelodones (the first team is the winning team, i.e., the team observed), 0.90 for Cajasol-Easo, 0.81 for Peixe-Joventut, 0.83 for Unicaja-Endesa, 0.86 for Cajasol-FC Barcelona, 0.89 for Peixe-Unicaja, and 0.82 for Cajasol-Peixe.

Generalizability of results

To further confirm the reliability of the data, we performed a generalizability theory analysis (Cronbach et al., 1972) in SAGT (v. 1.0) (Ramos et al., 2012), which involved estimating the generalizability coefficients obtained in the general linear model for the design categories/matches, where matches was the instrumentation facet.

Overall, 92.9% of the variability was explained by the categories facet, 1.4% by the matches facet, and 5.7% by the interaction between the two facets. The relative generalizability coefficient obtained (e2= 0.991) attests to the homogeneity of the datasets and the high level of generalizability of our results.

Data analysis

For the log-linear analysis, we analyzed the relationship between three dimensions: position of shot, position of pass leading up to the shot, and shot result. The purpose of log-linear analysis is to select the most parsimonious model capable of explaining the distribution of frequencies in the contingency table with the fewest effects possible (Agresti, 2002; López-Roldán & Fachelli, 2015).

The process involved three steps. In the first step, the most parsimonious model was selected using the backward elimination method in SPSS (v. 19.0). This procedure produces the simplest possible model by removing, one by one, nonsignificant effects while maintaining the hierarchy of the model (Pérez, 2013). In other words, if a model includes higher-order parameters, then all the lower-order parameters must be included (López-Roldán & Fachelli, 2015). The saturated model, i.e., the model containing all possible effects, is entered into SPSS, which progressively removes all nonsignificant higher-order interactions until the simplest model (i.e., the model in which the elimination of another effect would alter the goodness of fit) is achieved (Pérez, 2013). The second step was to estimate the parameters that comprised the most parsimonious model. SPSS (v. 19.0) contains a general log-linear feature that estimates the

magnitude of each effect in the selected model (Valldecabres et al., 2022). So that it can do this, it is necessary to select a dummy variable (reference category) for each dimension. In our case, we chose outer central corridor for last pass position, shot from paint position, and favorable outcome for shot result . The resulting parameters are expressed as neperian logs, and as such, the exponential function (or anti-logarithm) of the estimated parameters are the equivalent of odds and odds ratios for the different categories in the dimensions. These logs indicate the influence (magnitude) of the different effects. In the third and final step, the effects of significant parameters were interpreted in the context of our study.

Results

The simplest model generated in step 1 of the log-linear analysis was a conditional independence model (López-Roldán & Fachelli, 2015) in which two of the dimensions (last pass position and shot position) were associated independently of the third dimension (shot result). The interaction between shot position and result were not influenced by last pass position. Table 2 shows the estimations for the significant model parameters from step 2 of the log-linear analysis.

Table 2. Estimation of significant parameters in selected model

Parameter (variable/category)	Estimate (λ)	Sig. (>.005)	Exponential (λ)	1 / exp (λ)
Last pass from the outer right corridor	0.981	0.001	2.667	0.375
Last pass from paint	1.006	0.001	2.375	0.365
Shot from middle of left corridor	1.030	0.001	2.801	0.357
Shot from outer right corridor	-1.104	0.018	0.332	3.016
Shot from outer left corridor	-1.330	0.017	0.264	3.781
Shot from middle central corridor	-1.492	0.005	0.225	4.446
Last pass from paint * shot from outer right corridor	-4.395	0.002	0.012	81.045
Last pass from paint * shot from outer left corridor	-2.615	0.021	0.073	13.667
Shot from outer right corridor * unfavorable shot result	1.015	0.001	2.759	0.362
Shot from outer central corridor * unfavorable shot result	0.991	0.002	2.694	0.371
Shot from middle of left corridor * unfavorable shot result	2.358	0.027	10.570	0.0095

Results are interpreted using the exponential (λ) value shown in the third column of Table 2. Values >1 indicate that a given category is significantly more likely to occur than the reference category. For example, the exp (λ) value in the first row of Table 2, 2.667, indicates that a pass leading up to a shot is 2.667 times more likely to be made from the outer right corridor than from the outer central corridor. Values <1 indicate that extent to which a given category is less likely to occur compared with the reference category. As indicated by the value in the fifth row of Table 2, a shot from the outer right corridor is 0.332 times less likely to occur than one from the paint. To simplify matters in the discussion of results, we have inverted exp (λ) values <1 to 1/ exp (λ) (column 4 of Table 2). This inverse value indicates how more likely it is that the reference category will occur compared with a given category. Taking the previous example from the fifth row of Table 2, the exp (λ) indicates that a shot from the paint is 3.016 times more likely than one from the outer right corridor.

Discussion

The substantive objective of this work is to study the effectiveness in basketball sub 16 depending on the area of the court from where the last pass and the shot are made. The methodological aim of this study was to illustrate the possibilities offered by log-linear analysis within the framework of observational methodology (Anguera, 1979). Log-linear analysis permits the simultaneous exploration of higher-order interactions between dimensions formed by categorical variables (Agresti, 2002). It is therefore suitable for analyzing multidimensional contingency tables (Eom & Schutz, 1992), i.e., tables with >2 dimensions. In this study, we used log-linear analysis to analyze efficiency in U16 basketball from the perspective of three dimensions (last pass position, shot position, and shot result) and their respective categories. As a limitation of the loglinear analysis technique, it is stated that, as the number of incorporated dimensions increases, the interpretation of the results becomes more complex.

The results obtained from the log-linear analysis carried out show that the most parsimonious hierarchical model -capable of explaining the distribution of cell counts in this three-way model featuring the fewest effects possible (Lozares & López-Roldán, 1998)- selected through the backward procedure which is that of conditional independence: the association between the area of the court from which the last pass is made and the area from which the shot is made is independent from the consequence of the shot; and the association between the area from which the shot is made and the consequence of the shot is independent of the area from which the last pass is made.

The first-order effects show that passes immediately preceding a shot are more likely to come from the outer right corridor (-exp (λ)= 2.667), the paint (exp (λ)= 2.375), or the middle of the left corridor (exp (λ)= 2.801) than from the outer central corridor. In a recent study of top teams from the Spanish men's professional league (ACB), Alsasua et al. (2019) also found that shots were more likely to be preceded by a pass from the paint than from the outer central corridor. These results are consistent with findings showing that the outer central corridor is where passes are least likely to be made to a shooter (Fernández et al. 2009) and where other offensive strategies are more recommendable (Lamas et al., 2010). Some authors, however, recommend using this part of the court for distributing the ball and even for passing the ball to a player open for a shot (Ortega & Gómez 2009; Refoyo et al., 2009; Romaris et al., 2012). The lower use of the central pick and roll in sub 16 basketball may be behind the lower probability of the last pass being made from the outer central corridor.

Our results for first-order effects (Figure 1) also show that shots are more likely to taken from inside the paint than from the outer right corridor (1/exp (λ)= 3.016), the outer left corridor (1/exp (λ)= 3.781), or the middle of the central corridor (1/exp (λ)= 3.378). Alsasua et al. (2019) also found that ACB players were more likely to shoot from the paint than from either the left outer corridor or the middle of the central corridor. Most studies have found that the paint is where most shots are taken (Fernández et al., 2009; Ibáñez et al., 2009; Mexas et al., 2005). Exceptions include shots immediately following a direct screen (Muñoz et al., 2015). Nonetheless, Alsasua et al. (2019) found that shots taken from the paint by ACB players were more likely to be preceded by a pass from the outer central corridor than from the outer right corridor. The greater use of fast and counter play in formation categories (Monteiro et al., 2013) contributes to the greater probability that shots will be made near the basket.

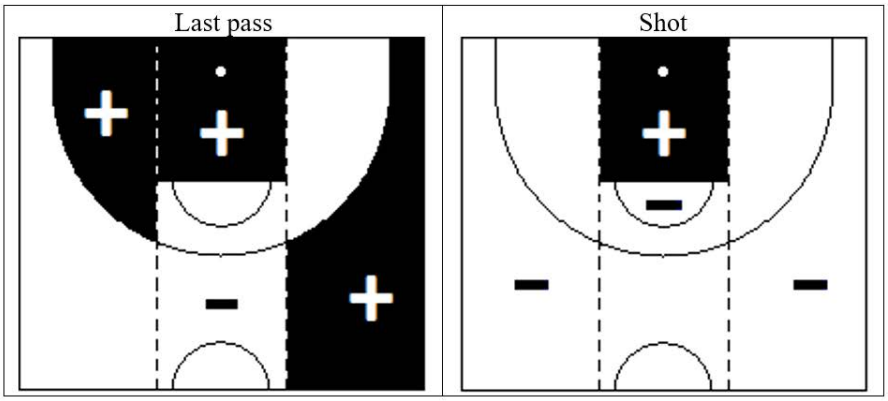


Figure 1. Graph showing first-order effects. Passes leading up to a shot are more likely to be made from the outer right corridor than from the middle of the left corridor and from the paint than from the outer central corridor (left). Shots, in turn, are more likely to be taken from the paint than from the outer left corridor, the outer right corridor, or the middle of the central corridor (right)

The second-order effects corresponding to the interaction between last pass position and shot position (Figure 2) also show that a pass from the paint is more likely to result in a shot from the same area than from either the outer right (1/exp (λ)= 81.045) or outer left (1/exp (λ)= 13.667) corridor. Similarly, Alsasua et al. (2019) found that shots within the paint were more likely to be preceded by a pass from the paint than from the outer right corridor in ACB matches. This association between passes and shots within the paint is interesting as it defies the minimum passer-receiver distance recommended by Ortega and Gómez (2009) and Fewell et al. (2012). In a T-pattern analysis of actions following direct screens in two ACB tournaments, Serna et al. (2017) detected a significant association between passes between players in the paint. Alsasua et al (2019) also found that passes from ACB players located in the outer left or right corridor or in the middle of the right corridor were more likely to end in a shot from the paint. The higher probability of this pass in U16 basketball may be related to drive and kick situations against less structured assist defenses that allow this type of inside pass after penetration.

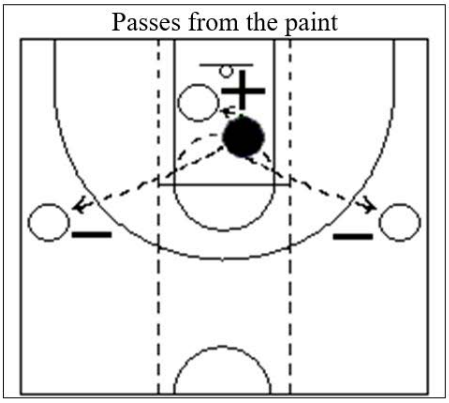


Figure 2. Second-order effects of the association between last pass position and shot position showing the likelihood of a shot according to where the pass was made from

Second-order effects corresponding to the interaction between shot position and shot result show that shots are more likely to have an unfavorable outcome when taken from the outer right corridor (exp (λ)= 2.759), the outer central corridor (exp (λ) = 2.694), or the middle of the central corridor (exp (λ)= 10.570). This finding partially coincides with reports by Alsasua et al. (2019) that shots taken by ACB players were more likely to be unsuccessful when taken from the outer right or outer central corridors. They are also consistent with reports that shots taken from the outer right corridor are most likely to have an unfavorable outcome (Fernández et al., 2009; Lapresa et al., 2014). Fernández and Piñar (2017), on comparing winning and losing U14 teams found that shots taken from the middle of the central corridor were missed more than shots taken elsewhere. Finally, it is worth noting that in their study of top-performing ACB teams, Alsasua et al. (2019) did not find that shots were more likely to have an unfavorable outcome in this part of the court. The less elaboration of the game in basketball sub 16 before increasingly organized defenses (Erculj & Strumbelj, 2015) may be behind the less effective shooting from the zones reflected in figure 3.

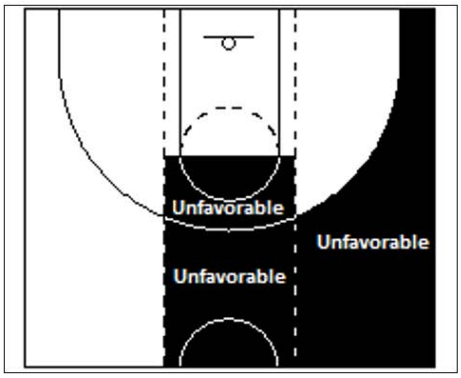


Figure 3. Second-order effects of the association between shot position and shot result showing (in black) where shots are more likely to have an unfavorable outcome

Conclusion

Relevant studies that contribute to a longitudinal programming of the content in the root sport -basketball in our case- are relevant, as milestones in a roadmap -extracted from reference teams of the corresponding age categories- that those involved in training basketball they should take into account (Lapresa et al., 2018). Log-linear analysis is a useful technique for analyzing successful and unsuccessful actions in basketball and in this particular case for detecting associations between last pass position, shot position, and shot result. In sub 16 basketball, the lower probability that the pre-throw pass is made from the outer right corridor than from the middle of the left corridor and from the paint than from the outer central corridor has been found. The pitches made in this category sub 16 are more likely to be taken from the paint than from the outer left corridor, the outer right corridor, or the middle of the central corridor. It has also been obtained that a pass from the paint is more likely to result in a shot from the same area than from either outer corridor. Finally, the middle of the left corridor, the outer central corridor and the outer right corridor have been characterized as the least effective positions for a successful shot in the sub 16 category.

References

Agresti, A. (2002). *Categorical data analysis*. New Jersey: John Wiley & Sons.

Alsasua, R., Lapresa, D., Arana, J., Anguera, M.T., & Garzón, B. (2018). Successful and unsuccessful offensive sequences

ending in a shot in professional and elite under-16 basketball. *Journal of Human Kinetics, 64*(1), 147-159. https://doi.org/10.1515/hukin-2017-0191

Alsasua, R., Lapresa, D., Arana, J., & Anguera, M.T. (2019). A log-linear analysis of efficiency in elite basketball applied to observational methodology. *International Journal of Sports Science & Coaching, 14* (3), 363-371. https://doi.org/10.1177/1747954119837819

Anguera, M.T. (1979). Observational Typology. *Quality & Quantity. European-American Journal of Methodology, 13*(6), 449-484.

Anguera, M.T. (2003). La observación. En C. Moreno Rosset (Ed.), *Evaluación psicológica. concepto, proceso y aplicación en las áreas del desarrollo y de la inteligencia* [Psychological evaluation. Concept, process and application in development and intelligence areas] (pp. 271-308). Madrid: Sanz y Torres.

Anguera, M.T. & Hernández-Mendo, A. (2015). Técnicas de análisis en estudios observacionales en ciencias del deporte [Data analysis techniques in observational studies in sport sciences]. *Cuadernos de Psicología del Deporte, 15*(1), 13-30. https://doi.org/10.4321/S157884232015000100002

Anguera, M.T., Blanco-Villaseñor, A., Hernández-Mendo, A., & Losada, J.L. (2011). Diseños observacionales: ajuste y aplicación en psicología del deporte [Observational designs: adjustment and application in sport psychology]. *Cuadernos de Psicología del Deporte, 11*(2), 63-76.

Bakeman, R. (1978). Untangling streams of behavior: Sequential analysis of observation data. En G.P. Sackett (Ed.), *Observing Behavior* (Vol. 2, pp. 63-78). Baltimore: University of Park Press.

Castellano, J., Perea, A., Alday, L., & Hernández-Mendo, A. (2008). Measuring and observation tool in sports. *Behavior Research Methods, 40*(3), 898-905. https://doi.org/10.3758/BRM.40.3.898

Cohen, J. (1968). Weighted Kappa: nominal scale agreement with provision for scaled disagreement or partial credit. *Psychological Bulletin, 70*, 213-220. https://doi.org/10.1177/001316446002000104

Cronbach, L.J., Gleser, G.C., Nanda, H., & Rajaratnam, N. (1972). *The dependability of behavioral measurements: theory of generalizability for scores and profiles*. New York: Wiley.

Eom, H.J., & Schutz, R.W. (1992). Transition play in team performance of volleyball: a log-linear analysis. *Research Quarterly for Exercise and Sport, 63*(3), 261-269. https://doi.org/10.1080/02701367.1992.10608741

Erculj, F., & Strumbelj, E. (2015) Basketball Shot Types and Shot Success in Different Levels of Competitive Basketball. *PLoS ONE, 10*(6). https://doi.org/10.1371/journal.pone.0128885

Fernández, J., Camerino, O., Anguera, M.T., & Jonsson, G.K. (2009). Identifying and analyzing the construction and effectiveness of offensive plays in basketball by using systematic observation. *Behavior Research Methods, 41*(3), 719-730. http://dx.doi.org/10.3758/BRM.41.3.719

Fernández, J.A., & Piñar, M.I. (2017). Estudio de las fases de ataque en baloncesto infantil masculino: diferencias entre ganadores y perdedores [Study of the attack phases in 14-and-under male basketball: differences between winners and losers]. *Cuadernos de Psicología del Deporte, 17*(3), 207-216.

Fewell, J.H., Armbruster, D., Ingraham, J., Petersen, A., & Waters, J.S. (2012). Basketball Teams as Strategic Networks. *PLoS ONE, 7*(11), e47445. https://doi.org/10.1371/journal.pone.0047445

García, J., Ibáñez, S.J., Martínez de Santos, R., Leite, N., & Sampaio, A.J. (2013). Identifying Basketball Performance Indicators in Regular season and Playoff Games. *Journal of Human Kinetics, 36,* 161-168. https://doi.org/10.2478/hukin-2013-0016

Gómez, M.A., Lorenzo, A., Barakat, R., Ortega, E., & Palao, J.M. (2008). Differences in Game-Related Statistics of Basketball Performance by Game Location for Men's Winning and Losing Teams. *Perceptual and Motor Skills, 106*(1), 43-50. https://doi.org/10.2466/pms.106.1.43-50

Gómez, M.A., Lorenzo, A., Ibáñez. S.J., & Sampaio, J. (2013) Ball possession effectiveness in men's and women's elite basketball according to situational variables in different game periods. *Journal of Sports Sciences, 31*(14), 1578-1587. https://doi.org/10.1080/02640414.2013.792942

Ibáñez, S.J., García, J., Feu, S., Parejo, I., & Cañadas, M. (2009). La eficacia del lanzamiento a canasta en la NBA: Análisis multifactorial [Shot efficacy in the NBA: A multifactorial analysis]. *Cultura, Ciencia y Deporte, 4*(10), 39-47. https://doi.org/10.12800/ccd.v4i10.132

Ibáñez, R., Lapresa, D., Arana, J., Camerino, O., & Anguera, M.T. (2018). Observational Analysis of the Technical-Tactical Performance of Elite Karate Contestants. *Cultura, Ciencia y Deporte*, 13(37), 61-70. https://doi.org/10.12800/ccd.v13i37.1039

Izquierdo, J.M., Pedauga, L.E., Pardo-Fanjul, A., & Redondo, J.C. (2021). Marginal contribution of game statistics to probability of playing playoff at elite basketball leagues. *Cultura, Ciencia y Deporte, 16*(49), 433-442. https://doi.org/10.12800/ccd.v16i49.1586

Lamas, L., De Rose, J., Santana, F., Rostaiser, E., Negretti, L., & Ugrinowitsch C. (2010). Space creation dynamics in basketball offence: validation and evaluation of elite teams. *International Journal of Performance Analysis in Sport, 11*(1), 71-84. https://doi.org/10.1080/24748668.2011.11868530

Lapresa, D., Anguera, M.T., Alsasua, R., Arana, J., & Garzón, B. (2013). Comparative analysis of T-patterns using real time data and simulated data by assignment of conventional durations: the construction of efficacy in children's basketball. *International Journal of Performance Analysis in Sport,13*(2), 321-339.

Lapresa, D., Alsasua , R., Arana , J., Anguera , M. T., & Garzón, B. (2014). Análisis observacional de la construcción de las secuencias ofensivas que acaban en lanzamiento en baloncesto de categoría infantil [Observational analysis of the construction of offensive sequences that end in a shot in youth basketball]. *Revista de Psicología del Deporte, 23*(2), 365-376.

Lapresa, D., Del Río, A., Arana, J., Amatria, M. & Anguera, M.T. (2018): Use of effective play-space by U12 FC Barcelona players: an observational study combining lag sequential analysis and T-pattern detection. *International Journal of Performance Analysis in Sport, 18*(2), 293-309. https://doi.org/10.1080/24748668.2018.1475195

López-Roldán, P. & Fachelli, S. (2015). *Metodología de la Investigación Social Cuantitativa* [Methodology of Quantitative Social Research]. Bellaterra: Universidad Autónoma de Barcelona.

Lorenzo, A., Gómez, M.A., Ortega, E., Ibáñez, S.J., & Sampaio, J. (2010). Game related statistics which discriminate between winning and losing under- 16 male basketball games. *Journal of Sports Science and Medicine*, 9, 664-668.

Lozares, C., & López-Roldán, P. (1998). La complementariedad del log-lineal y del análisis de correspondencias en la elaboración y el análisis de tipologías [Complementary use of loglinear and correspondence analyses in the development and analysis of typologies]. *Papers: Revista de Sociologia, 55*, 79-93.

Mexas, K., Tsitskaris, G., Kyriakou, D., & Garefis, A. (2005). Comparison of effectiveness of organized offences between two different championships in high level basketball. *International Journal of Performance Analysis in Sport, 5*(1), 72-82. https://doi.org/10.1080/24748668.2005.11868317

Monteiro, I., Tavares, F., & Santos, A. (2013). Comparative study of the tactical indicators that characterize the fast break in male and female under-16 Basketball teams. *Revista de Psicología del Deporte, 22*(1), 239-244.

Muñoz, V., Serna, J., Daza, G., & Hileno, R. (2015). Influence of Direct Blocking and One-on-one on Successful Shooting in Basketball. *Apunts. Educación Física y Deportes*, 119, 80-86. https://doi.org/10.5672/apunts.2014-0983.es.(2015/1).119.05

O'Donoghue, P. (2009). *Research methods for sports performance analysis*. London: Routledge.

Ortega, E., & Gómez, M.A. (2009). *Metodología observacional en baloncesto de formación* [Observational methodology in grassroots basketball]. Murcia: Diego Marín Librero-Editor.

Ortega, E., Palao, J.M., Gómez, M.A., Lorenzo, A., & Cárdenas, D. (2007). Analysis of the efficacy of possessions in boys' 16-and-under basketball teams: differences between winning and losing teams. *Perceptual and Motor Skills, 104*, 961-964. https://doi.org/10.2466/pms.104.3.961-964

Oudejans, R. R. D., Karamat, R. S., & Stolk, M. H. (2012). Effects of Actions Preceding the Jump Shot on Gaze Behavior and Shooting Performance in Elite Female Basketball Players. *International Journal of Sports Science & Coaching, 7*(2), 254-267. https://doi.org/10.1260/1747-9541.7.2.255

Parejo, I., García, A., Antúnez, A., & Ibáñez, S.J. (2013). Differences in performance indicators among winners and losers of group A of the spanish basketball amateur league (EBA). *Revista de Psicología del Deporte, 22* (1), 257-261.

Pérez, C. (2013). *Análisis multivariante de datos: aplicaciones con IBM SPSS, SAS y STATGRAPHICS* [Multivariate data analysis: applications with *IBM SPSS, SAS and STATGRAPHICS*]. Madrid: Ibergarceta.

Piñar, M.I., Estévez-López, F., Ortega, V., Conde, J., Alarcón, F., & Cárdenas, D. (2014). Characteristics of attack phases in boys' 14-and-under basketball competition. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte, 14*(54), 265-278.

Refoyo, I., Romaris, I.U., & Sampedro, J. (2009). Analysis of men's and women's basketball fast-breaks. *Revista de Psicología del Deporte, 18*(3), 439-444.

Ribeiro, H.V., Mukherjee, S., & Zeng, X.H. (2016). The Advantage of Playing Home in NBA: Microscopic, Team-Specific and Evolving Features. *PLoS ONE 11*(3). https://doi.org/10.1371/journal.pone.0152440

Romaris I.U., Refoyo, I., & Coterón, J. (2012). La finalización de las posesiones en baloncesto: estudio de la acción de finalización [The completion of the possessions in basketball: study of the completion action]. *Cuadernos de Psicología del Deporte, 12*(supple), 45-49.

Sampaio, J., Lago, C., & Drinkwater, E.J. (2010). Explanations for the United States of America's dominance in basketball at the Beijing Olympic Games (2008). *Journal of Sports Sciences, 28*(2), 147-152. https://doi.org/10.1080/02640410903380486

Sastre, V., Lapresa, D., Arana, J., Ibáñez, R. & Anguera, M.T. (2020). Observational analysis of technical-tactical performance in initiation to combat in karate, *International Journal of Performance Analysis in Sport, 21*(1), 126-138. https://doi.org/10.1080/24748668.2020.1853450

Serna, J., Muñoz, V., Hileno, R., Solsona, E., & Sáez, U. (2017). Patrones temporales iniciados con bloqueo directo o uno contra uno en baloncesto [T-Patterns initiated with ball screen or one-on-one in basketball]. *Revista de Psicología del Deporte, 26*(3), 81-86.

Simovic, S., Komic, J., Guzina, B., Pajic, Z., Karalic, T., & Pasic, G. (2021). Difference-based analysis of the impact of observed game parameters on the final score at the FIBA Eurobasket Women. *Journal of Human Sport and Exercise, 16*(2), 373-387. https://doi.org/10.14198/jhse.2021.162.12

Simovic, S., Matkovic, B., Mijanovi, M., Kocic, M., & Vojvodic, M. (2012). Structure of efficiency factor at XIII, XIV, XV and XVI World Championship in basketball. *Journal of Human Sport and Exercise, 7*(2), 527-543. https://doi.org/10.4100/jhse.2012.72.16

Valldecabres, R., de Benito, A.M., Losada, J.L., & Casal, C.A. (2022). Badminton World Championship stress zones and performance factors: The key to success through log-linear analysis . *Journal of Human Sport and Exercise , 17*(1), 10-21. https://doi.org/10.14198/jhse.2022.171.02

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Effects of the menstrual phase on the performance and well-being of female youth soccer players

Efectos de la fase menstrual en el rendimiento y bienestar de mujeres jóvenes futbolistas

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Abstract

The aim of the study was to analyze variations in performance and subjective perception of well-being in youth soccer players between menstrual (FM), follicular (FF) and luteal (FL) phases. Twelve female soccer players participated (age, 16.18 ± 1.68 years; height, 164 ± 7.27 cm; body mass, 61.90 ± 6.37 kg), all with 4 years of competitive experience, and 3.1 ± 1 years with a regular menstrual cycle. The maximum speed in 40-m, ability to change direction (25-m with 5 changes of direction of 45º every 5 m), explosive strength of the lower limbs with dominant, non-dominant, bipodal leg and vertical jump height were evaluated using Squat Jump into each phase, along with the Hooper's subjective well-being questionnaire. No differences between menstrual phases were obtained in any performance outcome, sleep, fatigue, stress, or muscle pain (all p> 0.05). However, a lower (worse) general well-being (p <0.01) was noted during FM and FL compared to FF. Youth female soccer players well-being perception between menstrual phases provides relevant information to take into account by practitioners working with such athletes.

Keywords: menstrual cycle, gender, football, women, menstruation.

Resumen

El objetivo del estudio fue analizar variaciones en rendimiento y percepción subjetiva del bienestar en jóvenes futbolistas entre fase menstrual (FM), folicular (FF) y lútea (FL). Participaron doce mujeres futbolistas (16.18 ± 1.68 años; 164 ± 7.27 cm; 61.90 ± 6.37 kg) con 4 años de experiencia competitiva y 3.1±1 años con ciclo menstrual regular. Se evaluó velocidad máxima en 40-m, habilidad de cambio de dirección (25-m con 5 cambios de dirección de 45º cada 5 m), fuerza explosiva del tren inferior con pierna dominante, no dominante, bipodal y altura de salto vertical mediante Squat Jump en cada fase, junto con el cuestionario de Hooper de bienestar subjetivo. No se obtuvieron diferencias significativas en ninguna variable de rendimiento ni de sueño, fatiga, stress y dolor muscular entre las fases del ciclo menstrual (p>0.05). Sí se obtuvo un estado de bienestar general significativamente peor (p<0.01) en FM y FL respecto a FF. Conocer la percepción subjetiva de bienestar puede ser una herramienta que aporte información relevante a los cuerpos técnicos de equipos femeninos.

Palabras clave: ciclo menstrual, género, futbol, mujer, menstruación.

Introduction

Soccer performance depends on multiple variables of physical, physiological, psychological, social, technical and tactical type (Reina-Gómez & Hernández-Mendo, 2012), providing a complex performance analysis scenario (Carling et al., 2014). Along with these aspects, women's soccer has the added feature of experiencing a menstrual cycle with hormonal changes that can condition performance (Constantini, et al., 2005). Within soccer as a sport predominantly practiced by men, we find more and more women practicing, both in grassroots soccer and in elite soccer (Oyón et al., 2016). According to the International Football Federation (FIFA), 30 million women practiced this sport in 2015 (FIFA, 2015). In 2019, ~60,000 female licenses were registered in Spain, 4,762 more compared to 2018. Despite the fact that there continues to be a clear imbalance between men (93.9% of licenses) and women (6.1% of licenses), it should be noted that the percentage increase in female licenses (7.89%) was higher than that of men (3.14%) between the years 2017 and 2018.

Sport performance between men and women is conditioned by differences at a physiological, biological, social, and cultural level, as well as by a different age of maturation (León, 2000; Ramírez-Balas, 2014). Moreover, women experience variations in their performance due to hormonal changes during their menstrual cycle (Seoane-Prado, 2013) and with modifications in the levels of endogenous sex steroid hormones (Constantini et al., 2005). The fertile and adult age of the menstrual cycle can be a determining factor of possible changes in performance, due to wide variations in the concentration of follicle-stimulating hormone (FSH) and luteinizing hormone (LH), and ovarian hormones such as estrogens and progesterone (Villa-del Bosque, 2016). Information regarding the menstrual cycle and its effects on performance may aid practitioners to adapt training and to better preper athletes for competitions during the different menstrual phases (Bruinvels et al., 2016; Datson et al., 2014).

The literature is contradictory regarding how menstrual phases can influence sports performance (Romero-Moraleda et al., 2019). Not only are there contradictory results, but also some investigations did not find clear differences in performance between the phases of the menstrual cycle (Fridén et al., 2003; Guijarro et al., 2009) while others have shown this aspect as a determining factor of performance (Dokumacı & Hazır, 2019; Julian et al., 2017). Previous studies have shown a significantly better performance in intermittent resistance (14%) (Julian et al., 2017) and in muscular strength (26%) (Pallavi et al., 2017) in the follicular phase (FF) over the luteal phase (FL). On the contrary, a better average power in repeated sprints (2.61%) has been obtained in the FL over the FF (Middleton & Wenger, 2006), together with a worse running economy in FF than in FL (Dokumacı & Hazır, 2019). On the other hand, no significant differences have been obtained in 30-second sprint power (Tsampoukos et al., 2010), 30-m sprint time (Julian et al., 2017), lower body strength under different loads (Romero-Moraleda et al., 2019), time to exhaustion (Matsuda et al., 2020), or VO2max depending on the phase of the menstrual cycle (Dokumacı & Hazır, 2019). Therefore, more research should clarify the effects of the menstrual phases on performance. In addition to effects on physical performance, it seems that menstrual phases affect the perception of energy levels (Cockerill et al., 1994), psychological stress (Oriol, 2006) and the state of well-being (Konovalova, 2013) seeing all of them harmed in FF over FL.

Elite female soccer matches entails running 10.3 km (range 9.7-11.3), 1.32 km at high intensity (range 0.71–1.70) (Krustrup et al., 2005), and 4.8 maximal-intensity actions per minute in each competition (Strauss et al., 2019), representing ~125 total maximal-intensity actions, each with an average duration of 2.3 seconds (range 2.0-2.4). Along with these actions, the players made approximately 700 changes of direction (Upton & Ross, 2011) all of them carried out at high intensity and considered the most influential actions in competition performance (Bangsbo et al., 2006). Speed and change of direction along with acceleration and deceleration are essential attributes for performance in women's football (Yap, 2000), so the training and assessment of these actions will be of vital importance for coaches and coaches. Studies analysing the effects menstrual phases on performance in the aforementioned variables are scarce and contradictory, with differences noted in speed (Paris & Jakeman 1987), although not in jumping 30-m sprint (Julian et al., 2017). Despite the popularity of female soccer, few studies addressed the influence of the menstrual cycle, age and years of sports practice in youth female soccer performance.

Therefore, the objective of this study was to analyze the effects of the different phases of the menstrual cycle on determinant variables of performance and well-being in youth soccer players. Our main hypothesis is that the phases of the menstrual cycle may have a conditioning effect on the performance of the lower body, showing better results in the menstrual phase (FM) and FF, also affecting the perception of well-being in youth soccer players.

Method

Participants

Twelve female soccer players (age, 16.18 ± 1.68 years; height, 164.01 ± 7.27 cm; body mass, 61.90 ± 6.37 kg) who competed in the regional category participated in the study. The inclusion criteria were i) perform three 90-minute sessions together with a weekly competitive game for at least three months prior to the study; ii) minimum experience of at least four years practicing federated football; iii) not having suffered any injury in the four months prior to the study. Athletes with menstrual cycle variation from 24 to 35 days in the last six months were excluded from the study (Lebrun et al., 1995). The athletes and their parents/guardians were informed of the risks and benefits of participating in the study and signed/approved the corresponding informed consent/ assent. The experimental design was carried out according to the Declaration of Helsinki.

Experimental design

One week before the start of data collection, the weight and height of the soccer players were recorded. A 100g precision scale (BC-418MA, TANITA®, Arlington Heights, IL) was used to measure weight and a 1mm precision Seca stadiometer (Seca 202, Seca®, Hamburg, Germany) for height. During three training sessions this week, the players performed the performance tests used in the study, requiring maximum effort at least in one repetition, and they completed the well-being questionnaire, in order to become familiar with them. Subsequently, the days to carry out the tests were assigned individually for each player, coinciding with a training day after

a rest session and with the second third of the cycle phase. Furthermore, the athletes were instructed to eat a dinner and breakfast rich in carbohydrates, and to be well hydrated the day before the test and during the testing sessions. They were also instructed to have a light snack with ingestion of about 300 ml of water 1 h before the session. On the day assigned for the measurements in each of the phases of the menstrual cycle, the players completed individually (19:00 ± 1h) the well-being perception scales, providing information on the state with which they faced the session. Subsequently and prior to performing the physical performance tests, the players performed a 15-minute warm-up that consisted of five minutes of continuous low intensity running and joint mobility, five minutes of dynamic stretching and five minutes of running races (progressive speed over different distances). After the warm-up, the players performed the different physical performance tests proposed for the study (20:00 ± 1h). After five minutes of passive rest, the tests began, which were carried out outdoors in an area sheltered from rain and air, in the extension of the artificial turf surface of the soccer field where the players performed their training sessions and games, with the usual clothes and footwear for the game. All the participants completed the tests in the afternoon at the same time of day and in similar environmental conditions (4.8 ± 0.83 ºC and 71.60 ± 5.07% relative humidity) and without previous fatigue. All data was saved into an Excel sheet (Microsoft Office 2017).

Determination of the phases of the menstrual cycle

The players completed a retrospective initial questionnaire regarding their menstrual cycle in the previous six months (Romero-Parra et al., 2020) as well as the date of the next period and whether they used any hormonal contraceptive and/or medication. Data was obtained using a mobile application (Menstrual Calendar and Cycle®, Period Tracker) that predicts the different menstrual phases. The application calculated possible days of registration taking into account the possible ovulation day (predicted by the app) and the period of menstruation, establishing three phases, FM, FF and luteal phase (FL) for each player (Figure 1) and from which the timing of the performance of the different assessment tests was established. Of the 16 players who completed the study, only 12 were selected (i.e., eumenorrheic athletes).

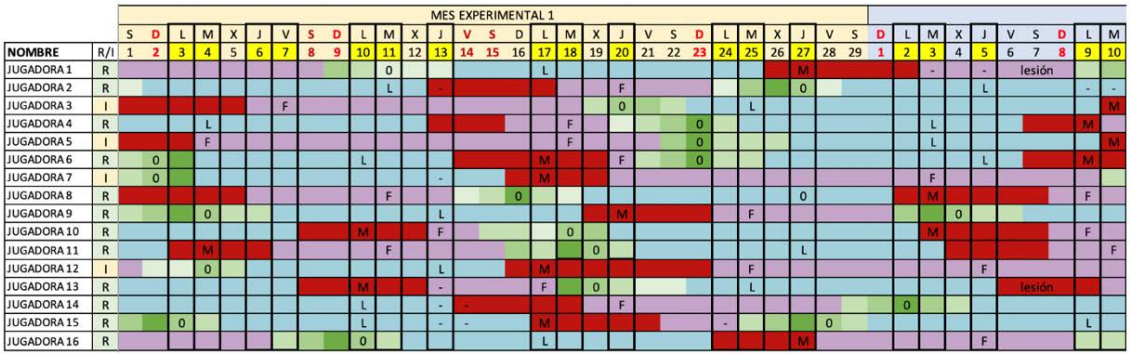

Figure 1. Calendar for the registration of the menstrual cycle of each player obtained from the data of the retrospective questionnaire

Note = Red = menstrual phase days; Pink = follicular phase; Blue = luteal phase; Green (0) = ovulation estimate; R = Regular cycle; I = Irregular cycle; Dark line and yellow background = weekly training; M = test performed in menstrual phase; F = Test performed in follicular phase; L = Test performed in the luteal phase.

Athletic Performance

40-m test. The maximum linear speed was determined by performing two linear sprints of 40 m separated by a passive rest of two minutes (Hernández et al., 2019). The best attempt of the two was selected for analysis. The players began the test standing from a bipedal position, located 0.3 meters from the first photocell. The height of the photocells was 1.40 m, at the height of the soccer players' chest (Cronin et al., 2007).

V-cut. To determine the speed in the change of direction, the V-Cut test was carried out (Gonzalo-Skok et al., 2015). For this, two 25-m sprints were executed, separated by a two-minute passive rest, with four direction changes (one every 5 m) with a 45º departure angle. For valid trials, the players had to pass the foot over the line marked on the ground (by two cones) at each change of direction point. The distance between cones was 0.7 meters. If a trial was not valid, the athlete repeated the trial after five minutes of recovery. The best time of the two repetitions performed was recorded for analysis. WittySEM, Microgate ® (Bolzano, Italy) photocells were used to measure linear speed and performance in direction changes.

Lower body strength. Two maximum horizontal jump tests (Hop Test) and one vertical jump test (Squat Jump) (Logerstedt, Snyder-Mackler, Ritter, Ax, & Godges, 2010) were performed to determine lower body strength. In the horizontal jump test, the Single Hop Test (SHT) was used, assessing the ability to do a maximum monopodal jump with left and right leg, identifying the dominant (D-SHT) and non-dominant (nD-SHT) leg and the Bipodal Hop Test (BHT). A mark was placed on the ground perpendicular to the starting line. The players supported on one leg (SHT) or on two (BHTD), with the foot on the line that marked the exit, executed a maximum horizontal jump receiving with the same leg or with both, respectively. The distance was measured from the starting line to the back of the heel. To count a jump as correct, the position had to be maintained after the jump for at least three seconds without losing balance or supporting the opposite leg in the case of SHT. If these quality criteria were not met in the execution, the jump was repeated after the established recovery time (Troule & Casamichana, 2016). In the vertical jump test, the Squat Jump (SJ) test was used to assess the explosive strength of the lower body (Bosco et al., 2000). From the squat position (knees bent) at 90º and the hands resting on the hips with the trunk and head perpendicular to the ground, the players performed a maximum vertical jump, keeping their knees extended throughout the aerial phase of the jump and landing with the forefoot of the jump. In all the tests, three jumps were made with a recovery of 30 seconds between each one, calculating the distance in cm with the software and selecting the jump with the greatest distance

or height reached in the case of the SJ. Jumping performance tests were measured with a Globus Ergo System R. contact platform (Codogne, Italy).

Subjective perception of well-being and fatigue. To know the subjective perception of well-being and fatigue of the players, the scales proposed by Hooper et al. (1995) known as the Hooper Index and whose reliability has been demonstrated in previous studies (Rabbani et al., 2019). This tool is made up of four items (sleep, fatigue, stress, muscle pain) to be evaluated from one to seven, where the value one corresponds to very, very low (very, very good in the case of sleep) and seven with very, very high. The athletes in each item had to assess: i) how they had perceived the quality of sleep the previous night; ii) what was the level of general fatigue they perceived; iii) perception of the level of stress and iv) perception of local muscle pain.

Statistical analysis

Results are presented as mean ± standard deviation (SD). The study of the variables showed a normal distribution according to the Shapiro Wilk test. To analyse the difference between variables as a function of the phase of the menstrual cycle, the mixed analysis test line ANOVA of repeated measures was used. When appropriate, the Bonferroni post hoc adjustment was applied to examine the differences. The coefficient of variation was determined as (SD · mean − 1) × 100 to evaluate the variability of each test (Atkinson & Nevill, 1998). Significant differences were considered when p <0.05. Additionally, the effect size (TE) was calculated through Cohen's d test (Cohen, 1988). The d value was interpreted according to the following ranges <0.1 (very small), from 0.1 to <0.2 (small), 0.2 to <0.5 (moderate), 0.5 to <0.8 (large) and ≥ 0.8 (very large). The Statistical Package for Social Sciences (SPSS, v. 21.0, SPSS, Inc., Chicago, IL, USA) was used for this analysis.

Results

Results are presented as mean ± standard deviation (SD). The study of the variables showed a normal distribution according to the Shapiro Wilk test. To analyse the difference between variables as a function of the phase of the menstrual cycle, the mixed analysis test line ANOVA of repeated measures was used. When appropriate, the Bonferroni post hoc adjustment was applied to examine the differences. The coefficient of variation was determined as (SD · mean − 1) × 100 to evaluate the variability of each test (Atkinson & Nevill, 1998). Significant differences were considered when p <0.05. Additionally, the effect size (TE) was calculated through Cohen's d test (Cohen, 1988). The d value was interpreted according to the following ranges <0.1 (very small), from 0.1 to <0.2 (small), 0.2 to <0.5 (moderate), 0.5 to <0.8 (large) and ≥ 0.8 (very large). The Statistical Package for Social Sciences (SPSS, v. 21.0, SPSS, Inc., Chicago, IL, USA) was used for this analysis.

Table 1 shows the results of the physical condition assessment tests in the different phases of the menstrual cycle. No differences (p> 0.05) were noted for 40-m sprint, V-Cut test, LSHT, RSHT, BHT, or SJ between the different phases of the menstrual cycle. The performance in the V-Cut test presents a large effect size (TE = 0.53) with a better mark (2.7%) during the FF than, in the FM, although without significant differences, observing the tendency to reach higher speed (linear and with changes of direction) and explosive force (vertical and horizontal, except in non-dominant leg).

Table 1. Performance in speed and explosive strength tests according to the phase of the menstrual cycle in youth soccer players

	40-m (s)	**V-Cut** (s)	**nD-SHT** (cm)	**D-SHT** (cm)	**BHT** (cm)	**SJ** (cm)
FM	6.18±0.38 (6.29)	7.27±0.39 (5.36)	159.96±13.66 (8.53)	152.72±11.48 (7.51)	182.03±14.63 (8.03)	27.94±4.49 (16.07)
FF	6.14±0.38 (6.18)	7.08±0.33 (4.66)	159.77±11.79 (7.37)	161.28±16.73 (10.37)	188.46±15.01 (7.96)	28.69±4.35 (15.16)
FL	6.12±0.51 (8.46)	7.19±0.36 (5.01)	161.41±19.96 (12.36)	158.09±16.87 (10.67)	186.36±15.86 (8.51)	27.45±5.43 (19.78)
			% change-TE			
FM vs FF	0.65%-0.11	2.68%-0.53	0.11%-0.01	5.30%-0.60	3.41%-0.43	2.61%-0.17
FM vs FL	0.98%-0.13	1.11%-0.21	0.89%-0.08	3.39%-0.37	2.32%-0.28	1.78%-0.10
FF vs FL	0.32%-0.04	1.52%-0.32	1.01%-0.10	2.01%-0.19	1.12%-0.14	4.51%-0.25

Mean values ± SD (CV). Note = 40-m = speed test time in 40 m; V-Cut = 25 m test time with changes of direction; nD-SHT = Non-dominant leg jump; D-SHT = Dominant leg jump; BHT = Bipodal jump; SJ = Squat Jump; FM = menstrual phase; FF = follicular phase; FL = luteal phase; TE = effect size. CV = coefficient of variation.

Figure 2 shows the results of the subjective perception of well-being scale, not observing significant differences (p> 0.05) between phases, neither in sleep assessment, nor in stress nor in muscle pain. In FM and FL, higher levels of Fatigue were obtained (large TE = 0.52 and 0.54, respectively) with a score of 19.93% higher in FM and FL, compared to FF. In addition, a significantly worse general well-being was obtained (p <0.01) in FM and FL compared to FF (large TE = 1.1 and 0.91, respectively), with a score 6.43% higher in FM and 7.11 % in FL compared to FF. The coefficient of variation (CV) of the general welfare state was 23.65 for FM, 29.35 for FF and 35.01 for FL. In the variables sleep, fatigue, stress and muscle pain, the CV values were: sleep (FM = 3.51; FF = 2.59; FL = 3.30); fatigue (FM = 37.15; FF = 42.69; FL = 39.58); stress (FM = 26.86; FF = 40.35; FL = 39.93); muscle pain (FM = 43.48; FF = 38.56; FL = 67.08).

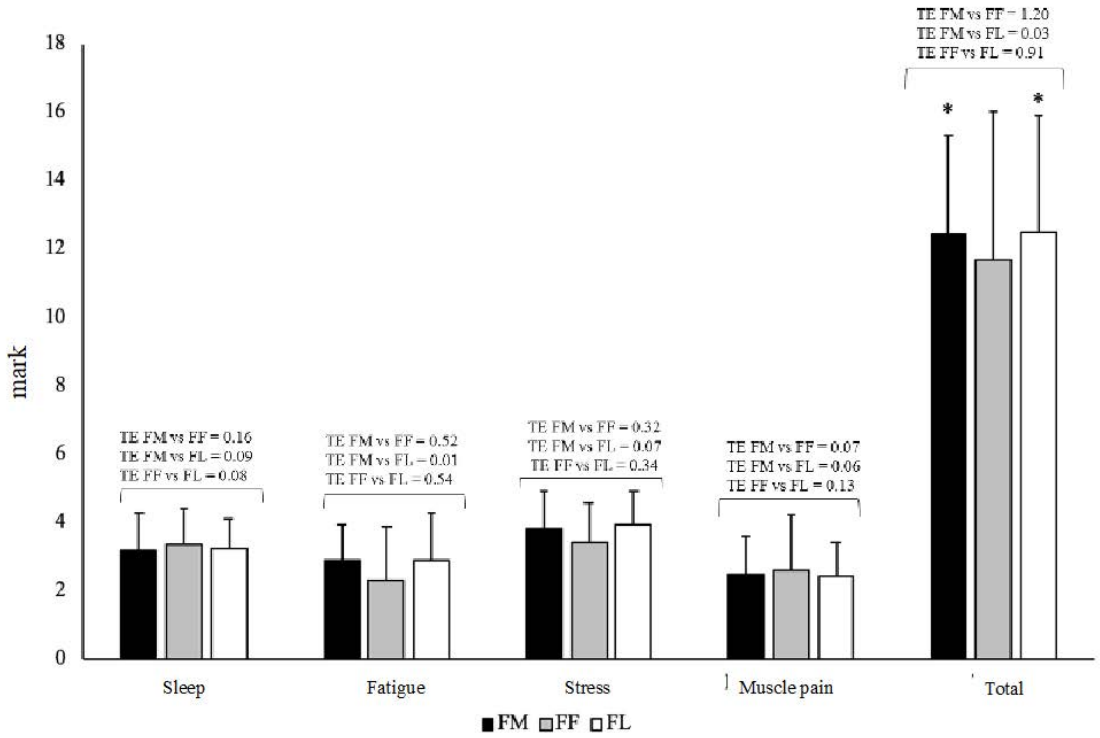

Figure 2. Results of the well-being perception scale in the different phases of the menstrual cycle in youth soccer players

*Note = FM = menstrual phase; FF = follicular phase; FL = luteal phase; TE = effect size. * = indicates significant differences with follicular phase (p <0.01).*

Discussion

The objective of this study was to analyse the effects of the different phases of the menstrual cycle (FM, FL, and FF) on performance determinants such as speed and horizontal and vertical jumping capacity, and well-being in youth soccer players. The data obtained show that the FF of the menstrual cycle of youth soccer players shows a significant (p <0.01) lower perception of fatigue (FM vs FF = 19.93% and TE 1.2; FL vs FF 19.93% and TE 0.91) and general well-being (FM vs FF = 6.43% and TE 0.52; FL vs FF 7.11% and TE 0.54) in the Hooper index, without significant differences (p> 0.05) in the performance in speed and explosive strength of the lower body between the three phases of the menstrual cycle. The absence of effects of the menstrual cycle on performance in speed and explosive strength of the lower body, suggests that performance in eumenorrheic women is not affected by the different phases of the menstrual cycle. These results are of great relevance in the design and quantification of the training and competition load since a greater load can be perceived differently depending on the phase of the menstrual cycle and increase the risk of injury. All the participants had a regular menstrual cycle, were active in the same sports category, with only three years of menarche, without medication or use of contraceptives, or diseases or conditions that could affect hormonal balance, and without having suffered previous injuries in the last 4 months, thus justifying the great control of the variables that can affect and influence the contradictory evidence of the results (Julian et al., 2017; Romero-Moraleda et al. 2019).

Sprinting and high intensity actions in soccer matches account for only 8% to 12% of the distance travelled, but these actions are considered the most important for performance along with horizontal (sprint) and vertical (jumping power) in women's soccer (Haugen et al., 2012). The results obtained did not show significant differences (p <0.05) in linear speed (40-m) or in speed with change of direction (V-Cut) as a function of the menstrual cycle. These results are in agreement with previous studies that show that performance in speed determined by a similar test (30-m) is not conditioned by the phase of the menstrual cycle (Villa-del Bosque, 2016; Julian et al., 2017). Hormonal changes caused by the menstrual cycle may not cause changes in sprint performance because naturally isolated 17b-estradiol concentrations with low progesterone have no effect on performance (Tsampoukos et al. 2010). Likewise, Wiecek et al. (2016) showed that hormonal changes in the menstrual cycle have no effect on anaerobic performance, speed, or anaerobic endurance. Julian et al. (2017) in a study with 9 soccer players carried out during early FF (where estrogen is at minimum values) and medium FL (where both estrogen and progesterone reach their highest magnitude), they did not obtain differences in speed (5 -m, 10-m and 30-m), between FF and FL. However, they did show a significant reduction (p = 0.07) in performance in aerobic endurance tests during the FL of the menstrual cycle, postulating that it may be due to the regulation of heat, the availability of substrates and metabolism.

The variation in basal body temperature of women during FL is attributed to the increase in progesterone, thus justifying the limitation in the ability to perform prolonged exercise in this phase (Janse de Jonge, 2003; Julian et al., 2017). However, Somboonwong et al. (2015) showed that the increase in core temperature after warming was associated

with an improvement in sprinting. The explosive strength performance of the lower body has not shown significant differences depending on the phase of the menstrual cycle, neither in the horizontal nor in the vertical jump. Arazi et al. (2019) report that the muscular strength and endurance and anaerobic power of young women do not vary in the different phases of the menstrual cycle, despite the fact that the levels of LH and FSH change. According to the results of our study, no significant differences (p> 0.05) were observed in any of the jump tests (D-SHT; nD-SHT; BHT; SJ) performed to measure lower body muscle strength. These results may hormonal changes may not cause an effect, and/or the effects of estrogen on muscle strength have been restricted during LF, a consequence of the predominant antagonistic effect of progesterone (Giacomoni et al. 2000; Julian et al., 2017). These results are in agreement with previous studies that show how, in trained women, lower-body muscle strength performance is not affected by the phase of the menstrual cycle (Fridén et al. 2003; Romero-Moraleda et al. 2019). The authors suggest that the individual responses of each athlete should be considered and taken into account if decisions are to be made regarding the phases of the menstrual cycle during training and matches, since this seems to affect the performance of each subject differently.

Performance in eccentric muscular actions will not be affected in the different phases of the cycle, as long as women do not suffer from premenstrual and menstrual symptoms (Lebrun, 1993), justifying that this absence of differences in the cycle could be related to specificity of the exercise they are familiar with (Giacomoni et al., 2000; Martínez-Lagunas et al., 2014; Tsampoukos et al., 2010; Villa-del Bosque, 2016). In fact, physical performance in elite women's soccer is closely related to training status and maximum capabilities (Krustrup et al., 2005; Julian et al., 2017), so maintaining an optimal level during the menstrual cycle is essential for athletic success.

The main finding of this study is that, while no significant differences were obtained in the variables of subjective well-being, sleep, stress, muscle pain and fatigue, the players showed a significantly worse (p <0.01) general well-being state (TE = 1.21 -0.91; very large) in FM and FL compared to FF. The menstrual and premenstrual symptoms such as fluid retention (causing bloating, congestion and discomfort), weight gain, mood swings (irritability, depression, loss of motivation), and dysmenorrhea (Villa-del Bosque, 2016) may be the reasons for the different wellness scores. Konovalova (2013), showed that stress, both psychological and physiological, or changes in mood caused in the premenstrual and menstrual phases, are associated with a decreased level of energy and / or a worse functioning of cognitive processes, being able to also establish an association between these and the menstrual phase (Guijarro et al., 2009). Pallavi et al. (2017) in a study carried out in the three phases of the menstrual cycle with 100 healthy volunteers aged between 18-24 years, showed a higher rate of fatigue during FM, followed by FL and FF, attributed to the psychological component, since bleeding has a negative effect on their performance due to their preconceived anguish; and it can even be related to physical performance, since blood loss can reduce oxygen transport.

This study is not without limitations, the main ones being the small sample size and the absence of evaluation of hormonal changes depending on the phase of the menstrual cycle. An analysis of the concentrations of hormones related to performance in each of the phases of the menstrual cycle could help us to interpret the reasons for the absence of changes in performance as a function of the menstrual cycle. Finally, it is important to point out that there are aspects related to mood that can influence the slowdown of motor responses, so this aspect could be a future line of research.

Conclusions

Soccer players in training with a regular menstrual cycle did not show significant differences in muscle performance in speed and explosive strength of the lower body between the menstrual cycle phases, but in the subjective perception of well-being. Recording data on subjective perception of well-being through scales such as the Hooper Index can be a complementary instrument, which provides relevant information to the technical bodies of women's teams, when it comes to knowing the predisposition towards competition on the part of the players.

References

Arazi, H., Nasiri, S., & Eghbali, E. (2019). Is there a difference toward strength, muscular endurance, anaerobic power and hormonal changes between the three phase of the menstrual cycle of active girls? *Apunts Medicina de l'Esport, 54*(202), 65-72. doi:10.1016/j.apunts.2018.11.001

Atkinson G, & Nevill, A.M. (1998). Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Medicine, 26*(4), 217# 238. doi:10.2165/00007256-199826040-00002

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *Journal of Sports Sciences, 24*(7), 665-674. doi:10.1080/02640410500482529

Bosco, C., Colli, R., Bonomi, R., von Duvillard, S.P., & Viru, A. (2000). Monitoring strength training: neuromuscular and hormonal profile. *Medicine and Science in Sports and Exercise, 32*(1), 202-208. doi:10.1097 / 00005768-200001000-00030

Bruinvels, G., Burden, R.J., McGregor, A.J., Ackerman K.E., Dooley, M., Richards T., et al. (2016). Sport, exercise and the menstrual cycle: where is the research? *British Journal of Sports Medicine, 51*(6). doi:10.1136 / bjsports-2016-096279.

Carling, C., Wright, C., Nelson, L. J., & Bradley, S. P. (2014). Comment on performance analysis in football: a critical review and implications for future research. *Journal of Sports Science, 32(*1), 2-7. doi:10.1080/02640414.2013.807352

Cockerill, I.M., Wormington, J.A., & Nevill, A.M. (1994). Menstrual-cycle effects on mood and perceptual-motor performance. *Journal of Psychosomatic Research, 38*(7), 763-771. doi:10.1016/0022-3999(94)90029-9.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Lawrence Earlbaum Associates. doi: 10.4324/9780203771587.

Constantini, N.W., Dubnov, G., & Lebrun, C.M. (2005). The menstrual cycle and sport performance, *Clinical Sports Medicine, 24*(2), 51-82. doi:10.1016/j.csm.2005.01.003

Cronin, J.B., Green, J.P, Levin, G.T., Brughelli, M.E., & Frost, D.M. Effect of starting stance on initial sprint performance. Journal of Strength and Conditioning Research, 21(3), 990-1002. doi:10.1519/R-22536.1

Datson, N., Hulton, A., Andersson, H., Lewis, T., Weston, M., Drust, B., et al. (2014). Applied physiology of female soccer: an update. *Sports Medicine, 44*(9), 1225-1240. doi:10.1007/s40279-014-0199-1

Dokumacı, B, Hazır, T. (2019). Effects of the Menstrual Cycle on Running Economy: Oxygen Cost Versus Caloric Cost. *Research Quarterly for Exercise in Sport, 90*(3), 318#326. doi:10.1080/02701367.2019.1599800

FIFA. (2015). Women's Football. Background information.

Fridén, C., Hirschberg, A.L., & Saartok, T. (2003). Muscle strength and endurance do not significantly vary across 3 phases of the menstrual cycle in moderately active premenopausal women. *Clinical Journal of Sport Medicine, 13*(4), 238-241. doi:10.1097/00042752-200307000-00007

Giacomoni, M., Bernard, T., Gavarry, O., Altare, S., & Falgairette, G. (2000). Influence of the menstrual cycle phase and menstrual symptoms on maximal anaerobic performance. *Medicine and Science in Sports and Exercise, 32*(2), 486-492. doi:10.1097/00005768-200002000-00034

Gonzalo-Skok, O., Tous-Fajardo, J., Suarez-Arrones, L., Arjol-Serrano, J.L., Casajús, J.A., & Méndez-Villanueva, A. (2015). Validity of the V-cut Test for Young Basketball Players. *International Journal of Sports Medicine, 36*(11), 893-899. doi:10.1055/s-0035-1554635.

Guijarro, E., de la Vega, R. y del Valle, S. (2009). Ciclo menstrual, rendimiento y percepción del esfuerzo en jugadoras de fútbol de élite. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte*, 9(34), 96-104. ISSN: 1577-0354

Haugen, T. A., Tønnessen, E., & Seiler, S. (2012). Speed and countermovement-jump characteristics of elite female soccer players, 1995-2010. *International Journal of Sports Physiology and Performance, 7*(4), 340-349. doi:10.1123/ijspp.7.4.340

Hernández, D., Martín, V., Villa-del Bosque, M., & Sánchez-Sánchez, J. (2019). Efecto del entrenamiento de pretemporada sobre la condición física de futbolistas jóvenes: análisis por demarcaciones. *Revista Andaluza de Medicina del Deporte, 12*(4), 348-353. doi:10.33155/%20j.ramd.2019.06.003

Hooper, S. L., Mackinnon, L. T., Howard, A. L. F., Gordon, R. D., & Bachmann, A. W. (1995). Markers for monitoring overtraining and recovery. Medicine y Science in Sports y Exercise. 27(1), 106-112. PMID: 7898325

Janse de Jonge, X.A. (2003). Effects of the Menstrual Cycle on Exercise Performance. *Sports Medicine, 33*, 833–851. doi:10.2165/00007256-200333110-00004

Julian, R., Hecksteden, A., Fullagar, H. H., & Meyer, T. (2017). The effects of menstrual cycle phase on physical performance in female soccer players. *Plos One, 12*(3), 1-13. doi:10.1371 / journal. pone.0173951

Konovalova, E. (2013). El ciclo menstrual y el entrenamiento deportivo: una mirada al problema. *Revista U.D.C.A Actualidad & Divulgación Científica, 16*(2), 293-302. doi: 10.31910/rudca.v16.n2.2013.900

Krustrup, P., Mohr, M., Ellingsgaard, H., & Bangsbo, J. (2005). Physical demands during an elite female soccer game: Importance of training status. *Medicine and Science in Sports and Exercise, 37*(7), 1242-1248. doi:10.1249/01.mss.0000170062.73981.94

Lebrun, C.M. (1993). Effect of the different phases of the menstrual cycle and contraceptives on athletic performance. *Sports Medicine, 16*(6), 400–430. doi:10.2165/00007256-199316060-00005.

Lebrun, C.M., McKenzie, D.C., Prior, J.C., Taunton, J.E. (1995). Effects of menstrual cycle phase on athletic performance. *Medicine and Science in Sports and Exercise, 27*(3), 437–44. doi: 10.1249/00005768-199503000-00022.

León, C. (2000). Influencia del sexo en la práctica deportiva. Biología de la mujer deportista. *Arbor CLXV, 165*(650), 249-263. doi:10.3989/arbor.2000.i650.968

Logerstedt, D.S.; Snyder-Mackler, L.; Ritter, R.C.; Axe, M.J., y Godges, J.J. (2010). Knee stability and movement coordination impairments: knee ligament sprains. *Journal of Orthopaedic and Sports Physical Therapy, 40*(4), A1-A37. doi:10.2519/ jospt.2010.0303.

Martínez-Lagunas, V., Niessen, M., & Hartmann, U. (2014). Women's football: Player characteristics and demands of the game. *Journal of Sport and Health Science, 3*(4), 258-272. doi:10.1016/j.jshs.2014.10.001

Matsuda, T., Furuhata, T., Ogata, H., Kamemoto, K., Yamada, M., & Sakamaki-Sunaga, M. (2020). Effects of the Menstrual Cycle on Serum Carnitine and Endurance Performance of Women. *International Journal of Sports Medicine* (ahead of print). doi:10.1055/a-1088-5555

Middleton, L.E., & Wenger, H.A. (2006). Effects of menstrual phase on performance and recovery in intense intermittent activity. *European Journal of Applied Physiology, 96*(1), 53-58. doi:10.1007/s00421-005-0073-9

Oriol, P.A. (2006). La importancia de corrección de los estados psicológicos en el kickboxing femenino. *Educación Física Estudiantil, 6,* 43-51.

Oyón, P., Franco, L., Rubio, F.J., & Valero, A. (2016). Fútbol femenino categorías inferiores. Características antropométricas y fisiológicas. Evolución a lo largo de una temporada. *Archivos de Medicina del Deporte, 33*(1), 24-28. ID: ibc-152179

Pallavi, L. C., Souza, U. J. D., & Shivaprakash, G. (2017). Assessment of musculoskeletal strength and levels of fatigue during different phases of menstrual cycle in young adults. *Journal of Clinical and Diagnostic Research, 11*(2), CC11-CC13. doi: 10.7860/JCDR/2017/24316.9408

Paris, H.C., & Jakeman, P.M. (1987). The effects of menstruation upon repeated maximal print performance. *Journal of Sports Sciences, 1*, 78.

Rabbani, A., Clemente, F. M., Kargarfard, M., & Chamari, K. (2019). Match Fatigue Time-Course Assessment Over Four Days: Usefulness of the Hooper Index and Heart Rate Variability in Professional Soccer Players. *Frontiers in physiology,* 19(*10)*, 109. doi:10.3389/fphys.2019.00109.

Ramírez-Balas, A. (2014). *Efectos de las fases del ciclo menstrual sobre la condición física, parámetros fisiológicos y psicológicos en mujeres jóvenes moderadamente entrenadas*. Tesis Doctoral. Universidad de Extremadura, Extremadura.

Reina-Gómez, A. y Hernández-Mendo, A. (2012). Revisión de indicadores de rendimiento en fútbol. *Revista Iberoamericana de Ciencias de la Actividad Física y el Deporte, 1*(1), 1-14. doi:10.24310/riccafd.2012.v1i1.1990

Romero-Moraleda, B., Del Coso, J., Gutiérrez-Hellín, J., Ruíz-Moreno, C., Grgic, J., & Lara, B. (2019). The Influence of the Menstrual Cycle on Muscle Strength and Power Performance. *Journal of Human Kinetics, 68*(1), 123-133. doi:10.2478/hukin-2019-0061

Romero-Parra, N., Barba-Moreno, L., Rael, B., Alfaro-Magallanes, V. M., Cupeiro, R., Díaz, Á. E., Calderón, F. J.,

& Peinado, A. B. (2020). Influence of the Menstrual Cycle on Blood Markers of Muscle Damage and Inflammation Following Eccentric Exercise. *International journal of environmental research and public health, 17*(5), 1618. doi: 10.3390/ijerph17051618

Seoane-Prado, A. (2013). Influence of menstrual cycle in synchronized swimming flexibility. *AGON, International Journal of Sport Sciences, 3*(2), 53-59. ISSN: 2254-2132

Somboonwong, J., Chutimakul, L., & Sanguanrungsirikul, S. (2015). Core temperature changes and sprint performance of elite female soccer players after a 15-minute warm-up in a hot-humid environment. *Journal of Strength and Conditioning Research, 29*(1), 262-269. doi:10.1097/JSC.0000000000000235.

Strauss, A., Sparks, M., & Pienaar, C. (2019). The Use of GPS Analysis to Quantify the Internal and External Match Demands of Semi-Elite Level Female Soccer Players during a Tournament. *Journal of sports science & medicine, 18*(1), 73–81. PMID: 30787654

Troule, S. & Casamichana, D. (2016). Application of functional test to the detection of asymmetries in soccer players. *Journal of Sport and Health Research. 8*(1), 53-64. ISSN: 1989-6239

Tsampoukos, A., Peckham, E. A., James, R., & Nevill, M. E. (2010). Effect of menstrual cycle phase on sprinting performance. *European Journal of Applied Physiology, 109*(4), 659-667. doi:10.1007/s00421-010-1384-z

Upton, D.E., & Ross, J.W. (2011). Assisted and Resisted Sprint Training: Effects on 13.7 M Speed, Speed with Direction Change, and Peak Power in Division I Female Soccer Athletes. *Journal of Strength and Conditioning Research*, 25, 83-84. doi:10.1097/01.JSC.0000395712.68999.f1

Villa-del Bosque, M. (2016). Influencia del ciclo menstrual en la capacidad anaeróbica en el fútbol femenino. *Papeles Salmantinos de Educación, 20*, 49-67.

Wiecek, M., Szymura, J., Maciejczyk, M., Cempla, J., & Szygula, Z. (2016). Effect of sex and menstrual cycle in women on starting speed, anaerobic endurance and muscle power. *Acta Physiologica Hungarica, 103*(1), 127-132. doi:10.1556/036.103.2016.1.13

Yap, C.W. (2000). Development of speed, agility, and quickness for the female soccer athlete. *Strength and Conditioning Journal, 22*, 1-9. doi:0.1519/1533-4295

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Efectos de la fase menstrual en el rendimiento y bienestar de mujeres jóvenes futbolistas

Effects of the menstrual phase on the performance and well-being of female young soccer players

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Resumen

El objetivo del estudio fue analizar variaciones en rendimiento y percepción subjetiva del bienestar en jóvenes futbolistas entre fase menstrual (FM), folicular (FF) y lútea (FL). Participaron doce mujeres futbolistas (16.18 ± 1.68 años; 164 ± 7.27 cm; 61.90 ± 6.37 kg) con 4 años de experiencia competitiva y 3.1±1 años con ciclo menstrual regular. Se evaluó velocidad máxima en 40-m, habilidad de cambio de dirección (25-m con 5 cambios de dirección de 45º cada 5 m), fuerza explosiva del tren inferior con pierna dominante, no dominante, bipodal y altura de salto vertical mediante Squat Jump en cada fase, junto con el cuestionario de Hooper de bienestar subjetivo. No se obtuvieron diferencias significativas en ninguna variable de rendimiento ni de sueño, fatiga, stress y dolor muscular entre las fases del ciclo menstrual ($p>0.05$). Sí se obtuvo un estado de bienestar general significativamente peor ($p<0.01$) en FM y FL respecto a FF. Conocer la percepción subjetiva de bienestar puede ser una herramienta que aporte información relevante a los cuerpos técnicos de equipos femeninos.

Palabras clave: ciclo menstrual, género, futbol, mujer, menstruación.

Abstract

The aim of the study was to analyze variations in performance and subjective perception of well-being in young soccer players between menstrual (FM), follicular (FF) and luteal (FL) phases. Twelve female soccer players participated (16.18 ± 1.68 years; 164 ± 7.27 cm; 61.90 ± 6.37 kg) with 4 years of competitive experience and 3.1 ± 1 years with regular menstrual cycle. Maximum speed in 40-m, ability to change direction (25-m with 5 changes of direction of 45º every 5 m), explosive strength of the lower body with dominant, non-dominant, bipodal leg and vertical jump height were evaluated using Squat Jump into each phase, along with Hooper's subjective well-being questionnaire. No significant differences were obtained in any variable of performance or sleep, fatigue, stress and muscle pain between the phases of the menstrual cycle ($p> 0.05$). If a significantly worse general well-being state ($p <0.01$) in FM and FL with respect to FF. Knowing the subjective perception of well-being can be a tool that provides relevant information to the technical bodies of women's teams.

Keywords: menstrual cycle, gender, football, women, menstruation.

Introducción

El rendimiento en fútbol depende de múltiples variables de tipo físico, fisiológico, psicológico, social, técnico y táctico (Reina-Gómez & Hernández-Mendo, 2012) por lo que su análisis a partir de indicadores de rendimiento es complejo (Carling et al., 2014). Junto con estos aspectos, el fútbol femenino presenta añadida la particularidad de experimentar un ciclo menstrual con cambios hormonales que pueden condicionar el rendimiento (Constantini, et al., 2005). Dentro del fútbol como deporte predominantemente practicado por hombres, cada vez encontramos más mujeres practicantes, tanto en el fútbol base como en el fútbol de élite (Oyón et al., 2016). Según la Federación Internacional de Fútbol (FIFA), 30 millones de mujeres practicaban este deporte en 2015 (FIFA, 2015). En este año se registraban unas 60.000 licencias femeninas en España, habiéndose incrementado este número en 2018 con 4.762 nuevas licencias. A pesar de que sigue existiendo un claro desequilibrio en el sector entre hombres (93,9% de licencias) y mujeres (6,1% de licencias), hay que destacar que porcentualmente el índice de aumento de licencias femeninas (7,89%) fue superior al de hombres (3,14%) entre los años 2017 y 2018.

El rendimiento deportivo entre hombres y mujeres está condicionado por diferencias a nivel fisiológico, biológico, social y cultural, así como por una edad de maduración diferente (León, 2000; Ramírez-Balas, 2014). Junto con estos factores las mujeres experimentan variaciones en su rendimiento, como consecuencia de cambios hormonales continuos, inherentes a su ciclo menstrual (Seoane-Prado, 2013) y con modificaciones en los niveles de hormonas endógenas esteroideas sexuales (Constantini et al., 2005). La edad fértil y adulta del ciclo menstrual puede ser un factor determinante de posibles cambios en el rendimiento, debido a amplias variaciones de concentración de las hormonas hipofisarias foliculoestimulante (FSH) y lunteinizante (LH), y ováricas como son los estrógenos y la progesterona (Villa-del Bosque, 2016). Conocer cómo afecta el ciclo menstrual al rendimiento es relevante para entrenadores y preparadores físicos, ya que las deportistas se verán sometidas a entrenamientos y competiciones durante las diferentes fases que lo componen (Bruinvels et al., 2016; Datson et al., 2014).

La literatura es contradictoria respecto a cómo pueden influir las fases del ciclo menstrual en el rendimiento deportivo (Romero-Moraleda et al., 2019). No solo existen resultados contradictorios, sino que además algunas investigaciones no encontraron diferencias claras en el rendimiento entre las fases del ciclo menstrual (Fridén et al., 2003; Guijarro et al., 2009) mientras otras han mostrado este aspecto como condicionante del rendimiento (Dokumacı & Hazır, 2019; Julian et al., 2017). Estudios previos han mostrado un significativamente mejor rendimiento en resistencia intermitente (14%) (Julian et al., 2017) y en fuerza muscular (26%) (Pallavi et al., 2017) en la fase folicular (FF) sobre la fase lútea (FL). Por el contrario, se ha obtenido una mejor potencia media en sprints repetidos (2.61%) en la FL sobre la FF (Middleton & Wenger, 2006), junto con una peor economía de carrera en FF que en FL (Dokumacı & Hazır, 2019). Por otra parte, no se han obtenido diferencias significativas en el rendimiento en la potencia en un sprint de 30 segundos (Tsampoukos et al., 2010) en el tiempo en un sprint de 30 m (Julian et al., 2017), en la fuerza del tren inferior ante diferentes cargas (Romero-Moraleda et al., 2019) o en el tiempo hasta la extenuación (Matsuda et al., 2020) o en el VO.max en función de la fase del ciclo menstrual (Dokumacı & Hazır, 2019). Dados estos resultados, más investigaciones son necesarias para aclarar los efectos de las fases en el rendimiento. Además de efectos sobre el rendimiento físico, parece que las fases del ciclo menstrual afectan a la percepción de los niveles de energía (Cockerill et al., 1994), al estrés psicológico (Oriol, 2006) y al estado de bienestar (Konovalova, 2013) viéndose todos ellos perjudicados en FF sobre FL.

El fútbol femenino demanda para sus practicantes recorrer 10.3 km (rango 9.7-11.3), 1.32 km a alta intensidad (rango 0.71–1.70) en futbolistas de élite (Krustrup et al., 2005) mientras que jugadoras con un menor nivel recorren unos 5.8 km y realizan 4.8 acciones a máxima intensidad por minuto en cada competición (Strauss et al., 2019). Estos esfuerzos a alta intensidad se reproducen unas 125 veces con una duración media de 2.3 segundos (rango 2.0-2.4). Junto con estas acciones, las jugadoras realizan aproximadamente 700 cambios de dirección (Upton & Ross, 2011) todas ellas realizadas a alta intensidad y consideradas las acciones más influyentes en el rendimiento en competición (Bangsbo et al., 2006). La velocidad y el cambio de dirección junto con la aceleración y deceleración son atributos esenciales para el rendimiento en el fútbol femenino (Yap, 2000), por lo que el entrenamiento y valoración de estas acciones será de vital importancia para entrenadores y cuerpos técnicos. Los efectos de las fases del ciclo menstrual en el rendimiento en estas variables son escasos y contradictorios ya que estudios previos muestran diferencias significativas en función de la fase del ciclo menstrual en el rendimiento en velocidad (Paris & Jakeman 1987) mientras que otros no obtienen diferencias en la capacidad de salto o el sprint en 30 metros (Julian et al., 2017). A pesar de que el fútbol es el deporte en el que más incrementa la participación de la mujer, paradójicamente pocos estudios, o en algunos de los existentes, no se han tenido en cuenta la influencia del ciclo menstrual, la edad y años de práctica deportiva en el rendimiento.

Por lo tanto, el objetivo de este estudio fue analizar los efectos de las diferentes fases del ciclo menstrual en variables determinantes del rendimiento y el bienestar en jóvenes futbolistas. Nuestra hipótesis principal es que las fases del ciclo menstrual pueden tener un efecto condicionante en el rendimiento del tren inferior mostrando mejores resultados en la fase menstrual (FM) y FF, incidiendo también en la percepción del bienestar en jóvenes futbolistas.

Método

Participantes

Participaron en el estudio 12 jugadoras de fútbol (16.18 ± 1.68 años de edad; 164.01 ± 7.27 cm de altura; 61.90 ± 6.37 kg de masa corporal) que competían en categoría regional. Los criterios de inclusión fueron i) realizar tres sesiones de 90 minutos junto con un partido de competición semanal durante al menos los tres meses previos al estudio; ii) experiencia mínima de al menos cuatro años practicando fútbol federado; iii) no haber sufrido lesión alguna en los cuatro meses previos al estudio. Aquellas jugadoras que presentaban una variación en el ciclo de 24 a 35 días en los últimos seis meses fueron excluidas del estudio (Lebrun et al., 1995). Todas las jugadoras y padres, madres, tutores y/o tutoras fueron informados de los riesgos y beneficios de la participación en el estudio y firmaron el correspondiente

consentimiento informado. El diseño experimental se realizó de acuerdo a la Declaración de Helsinki.

Diseño experimental

Una semana antes del comienzo de la recogida de los datos, se registró el peso y la altura de las futbolistas. Se utilizó una báscula de precisión de 100g (BC-418MA, TANITA®, Arlington Heights, IL) para medir el peso y un estadiómetro Seca de precisión 1mm (Seca 202, Seca®, Hamburg, Germany) para la altura. Durante 3 sesiones de entrenamiento de esta misma semana, las jugadoras realizaron los test de rendimiento utilizados en el estudio, requiriéndoles esfuerzo máximo al menos en alguna repetición, y completaron el cuestionario de bienestar, con el objetivo de familiarizarse con ellos. Posteriormente se asignaron de forma individualizada para cada jugadora los días para realización de los test, haciendo coincidir un día de entrenamiento posterior a una sesión de descanso y con el 2º tercio de duración de la fase del ciclo; además se indicó a las futbolistas que la cena y desayuno anterior fueran ricos en hidratos carbono complejos y que bebieran en torno a dos litros en las 24 h antes, con objeto de minimizar diferencias en estado de hidratación y repleción de glucógeno; igualmente se les indicaba realizar una leve merienda con ingesta de unos 300 ml de agua 1 h antes de la sesión. El día asignado para las mediciones en cada una de las fases del ciclo menstrual, las jugadoras cumplimentaron de forma individual (19.00 ± 1h) las escalas de percepción de bienestar, aportando información del estado con que afrontaban la sesión. Posteriormente y previo a la realización de los test de rendimiento físico, las jugadoras realizaron un calentamiento con una duración de 15 minutos que consistía en cinco minutos de carrera continua de baja intensidad y movilidad articular, cinco minutos de estiramientos dinámicos y cinco minutos de carreras de velocidad progresivas en diferentes distancias. Nada más finalizar el calentamiento las jugadoras realizaron los diferentes test de rendimiento físico propuestos para el estudio (20.00 ± 1h). Tras cinco minutos de descanso pasivo se comenzó la realización de los test, los cuales se llevaron a cabo al aire libre en una zona resguardada de lluvia y aire, en la prolongación de la superficie de césped artificial del campo de fútbol donde las jugadoras realizaban sus entrenamientos y partidos, con la ropa y calzado habitual de juego. Todas las participantes completaron las pruebas por la tarde a la misma hora del día y en condiciones ambientales similares (4.8 ± 0.83 ºC y 71.60 ± 5.07 % humedad relativa) y sin fatiga previa. Todos los resultados obtenidos en los diferentes test de rendimiento y en el cuestionario de percepción subjetiva de bienestar y fatiga, se volcaron en un documento Excel (Microsoft Office 2017), donde se trataron, recodificaron y prepararon para el análisis de datos.

Determinación de las fases del ciclo menstrual

Las jugadoras completaron un cuestionario inicial retrospectivo en el cual recordaban el inicio y final del ciclo menstrual en los seis meses previos (Romero-Parra et al., 2020) así como la fecha del próximo periodo y si utilizaban algún anticonceptivo hormonal y/o medicación. Este registro se realizó mediante una aplicación móvil (Calendario menstrual y Ciclo ®, Period Tracker) que permitía realizar una predicción de las diferentes fases calculándose los posibles días de registro teniendo en cuenta el posible día de ovulación (pronosticado por la app) y el período de menstruación, estableciéndose tres fases, FM, FF y fase lútea (FL) para cada jugadora (Figura 1) y a partir del cual se estableció la temporalización de la realización de las diferentes pruebas de valoración. De las 16 jugadoras que completaron el estudio, sólo 12 fueron seleccionadas por su carácter eumenorreico.

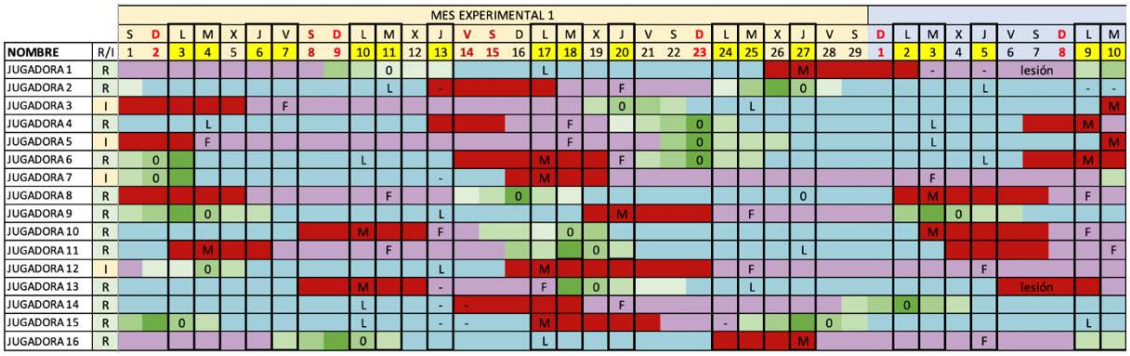

Figura 1. Calendario de registro de ciclo menstrual de cada jugadora obtenido a partir de los datos del cuestionario retrospectivo

Leyenda = Rojo = días de fase menstrual; Rosa = fase folicular; Azul = fase lútea; Verde (0) = estimación de la ovulación; R = Ciclo regular; I = Ciclo irregular; Línea oscura y fondo amarillo = entrenamiento semanal; M = test realizado en fase menstrual; F = Test realizado en fase folicular; L = Test realizado en fase lútea.

Valoración del rendimiento

Test 40-m. La velocidad lineal máxima se determinó realizando dos sprint lineales de 40 m separados por un descanso pasivo de dos minutos (Hernández et al., 2019). El mejor intento de los dos fue seleccionado para su análisis. Las jugadoras comenzaban el test paradas desde una posición bípeda, situadas a 0.3 metros de la primera fotocélula. La altura de las fotocélulas fue de 1.40 m, a la altura del pecho de las futbolistas (Cronin et al., 2007).

V-cut. Para determinar la velocidad en el cambio de dirección se llevó a cabo el test *V-Cut* (Gonzalo-Skok et al., 2015). Para ello se ejecutaron dos sprint de 25 m, separados por un descanso pasivo de dos minutos, con cuatro cambios de dirección (uno cada 5 m) con un ángulo de salida de 45º. Para que el intento realizado fuera válido, las jugadoras tenían que pasar completamente el pie de la línea marcada en el suelo dos conos en cada cambio de dirección. La distancia entre conos fue de 0.7 metros. Si una prueba de las dos era considerada como nula o fallida (i.e. no sobrepasar el cono en su totalidad) disponían de una nueva oportunidad tras cinco minutos de recuperación. El mejor tiempo de las dos repeticiones ejecutadas fue registrado para su análisis. Para medir la velocidad lineal y el rendimiento en los cambios

de dirección se utilizaron fotocélulas WittySEM, Microgate ® (Bolzano, Italia).

Fuerza del tren inferior. Se realizaron dos pruebas máximas de salto horizontal (*Hop Test*) y una de salto vertical (*Squat Jump*) (Logerstedt, Snyder-Mackler, Ritter, Axe, & Godges, 2010) para determinar la fuerza del tren inferior. En la prueba de salto horizontal se utilizaron el *Single Hop Test (SHT),* valorando la capacidad de hacer un salto monopodal máximo con pierna izquierda y derecha, identificándose la pierna dominante (*D-SHT*) y no dominante (*nD-SHT*) y el *Hop Test* bipodal (*BHT*). Se colocó una marca en el suelo perpendicular a la línea de salida. Las jugadoras apoyadas sobre una pierna (SHT) o sobre dos (*BHTD*), con el pie en la línea que marcaba la salida ejecutaron un salto horizontal máximo recepcionando con la misma pierna o con ambas, respectivamente. La distancia se midió desde la línea de salida hasta la parte posterior del talón. Para contabilizar un salto como correcto se debía mantener la posición tras el salto al menos tres segundos sin perder el equilibrio o apoyar la pierna contraria en el caso del *SHT*. De no cumplir dichos criterios de calidad en la ejecución, el salto era repetido tras el tiempo de recuperación establecido (Troule & Casamichana, 2016). En la prueba de salto vertical se utilizó la prueba de *Squat Jump .SJ*) para valorar la fuerza explosiva del tren inferior (Bosco et al., 2000). Desde la posición de squat (rodillas flexionadas) a 90º y las manos apoyadas en la cadera con tronco y cabeza perpendicular al suelo, las jugadoras realizaban un salto vertical máximo manteniendo las rodillas extendidas durante toda la fase aérea del salto y aterrizando con el antepié de nuevo sobre el lugar de impulsión. En todas las pruebas se realizaron tres saltos con una recuperación de 30 segundos entre cada uno, calculándose con el software la distancia en cm y seleccionando el salto con la mayor distancia o altura alcanzada en el caso del *SJ*. Los test de rendimiento de salto se midieron con una plataforma de contacto Globus Ergo System R © (Codogné, Italia).

Percepción subjetiva de bienestar y fatiga. Para conocer la percepción subjetiva de bienestar y fatiga de las jugadoras, se utilizaron las escalas propuestas por Hooper et al. (1995) conocidas como *Índice de Hooper* y cuya fiabilidad ha sido demostrada en estudios previos (Rabbani et al., 2019). Esta herramienta está formada por cuatro ítems (sueño, fatiga, stress, dolor muscular) a valorar de uno a siete, donde el valor uno se corresponde con muy, muy bajo (muy, muy bueno en el caso del sueño) y el siete con muy, muy alto. Los deportistas en cada ítem debían valorar: i) como habían percibido la calidad del sueño de la noche anterior; ii) cual era el nivel de fatiga general que percibían; iii) percepción del nivel de stress y iv) percepción de dolor muscular local.

Análisis estadístico

Los resultados se presentan como media ± desviación estándar (*DE*). El estudio de las variables mostró una distribución normal de acuerdo a la prueba de Shapiro Wilk. Para analizar la diferencia entre variables en función de la fase del ciclo menstrual, se utilizó la prueba de análisis mixto línea ANOVA de medidas repetidas. Cuando fue apropiado, el ajuste post hoc de Bonferroni fue aplicado para examinar las diferencias. El coeficiente de variación fue determinado como (DE·media^{-1}) × 100 para evaluar la variabilidad de cada test (Atkinson & Nevill, 1998). Se consideraron diferencias significativas cuando . < 0.05. Adicionalmente se calculó el tamaño del efecto (TE) a través de la prueba . de Cohen (Cohen, 1988). El valor . fue interpretado atendiendo a los siguientes rangos < 0.1 (muy pequeño), de 0.1 a < 0.2 (pequeño), 0.2 a < 0.5 (moderado), 0.5 a < 0.8 (grande) y ≥ 0.8 (muy grande). Para este análisis se utilizó el Paquete Estadístico para Ciencias Sociales (SPSS, v. 21.0, SPSS, Inc., Chicago, IL, EE.UU.).

Resultados

En la tabla 1 se observan los resultados de las pruebas de valoración de la condición física en las diferentes fases del ciclo menstrual. No se encuentran diferencias significativas (p>0.05) ni en la velocidad, ya sea lineal (*40-m*) o con cambios de dirección (*V-Cut*), ni en la fuerza explosiva, ya sea en el salto horizontal (*LSHT, RSHT, BHT*) o salto vertical (*SJ*) entre las diferentes fases del ciclo menstrual. El rendimiento en el test *V-Cut,* presenta un tamaño del efecto grande (TE = 0.53) con una mejor marca (2.7%) durante la FF que, en la FM, aunque sin diferencias significativas, observando la tendencia a alcanzar mayor velocidad (lineal y con cambios de dirección) y fuerza explosiva (vertical y horizontal, salvo en pierna no dominante).

Tabla 1. Rendimiento en los test de velocidad y fuerza explosiva en función de la fase del ciclo menstrual en jóvenes futbolistas

	40-m (s)	**V-Cut** (s)	**nD-SHT** (cm)	**D-SHT** (cm)	**BHT** (cm)	**SJ** (cm)
FM	6.18±0.38 (6.29)	7.27±0.39 (5.36)	159.96±13.66 (8.53)	152.72±11.48 (7.51)	182.03±14.63 (8.03)	27.94±4.49 (16.07)
FF	6.14±0.38 (6.18)	7.08±0.33 (4.66)	159.77±11.79 (7.37)	161.28±16.73 (10.37)	188.46±15.01 (7.96)	28.69±4.35 (15.16)
FL	6.12±0.51 (8.46)	7.19±0.36 (5.01)	161.41±19.96 (12.36)	158.09±16.87 (10.67)	186.36±15.86 (8.51)	27.45±5.43 (19.78)
			% cambio-TE			
FM vs FF	0.65%-0.11	2.68%-0.53	0.11%-0.01	5.30%-0.60	3.41%-0.43	2.61%-0.17
FM vs FL	0.98%-0.13	1.11%-0.21	0.89%-0.08	3.39%-0.37	2.32%-0.28	1.78%-0.10
FF vs FL	0.32%-0.04	1.52%-0.32	1.01%-0.10	2.01%-0.19	1.12%-0.14	4.51%-0.25

Valores medios ± DS (CV). *Leyenda* = 40-m = tiempo test velocidad en 40 m; V-Cut = tiempo test de 25 m con cambios de dirección; nD-SHT = Salto con pierna no dominante; D-SHT = Salto con pierna dominante; BHT = Salto bipodal; SJ = Squat Jump; FM = fase menstrual; FF = fase folicular; FL = fase lútea; TE = tamaño del efecto. CV = coeficiente de variación.

En la figura 2 se observan los resultados de la escala de percepción subjetiva de bienestar, no observándose diferencias significativas ($p>0.05$) entre fases, ni en la valoración del sueño, ni en estrés ni en dolor muscular. En la FM y FL se obtuvieron mayores niveles de Fatiga (TE grande = 0.52 y 0.54, respectivamente) con una puntuación 19.93% mayor en la FM y FL, en comparación con la FF. Además, se obtuvo un estado de bienestar general significativamente peor ($p<0.01$) en la FM y FL en comparación con la FF (TE grande = 1.1 y 0.91, respectivamente), con una puntuación un 6.43% mayor en la FM y un 7.11% en la FL en comparación con la FF. El coeficiente de variación (CV) del estado de bienestar general fue 23.65 para la FM, 29.35 para la FF y 35.01 para la FL. En las variables sueño, fatiga, stress y dolor muscular los valores del CV fueron: sueño (FM = 3.51; FF = 2.59; FL = 3.30); fatiga (FM = 37.15; FF = 42.69; FL = 39.58); stress (FM = 26.86; FF = 40.35; FL = 39.93); dolor muscular (FM = 43.48; FF = 38.56; FL = 67.08).

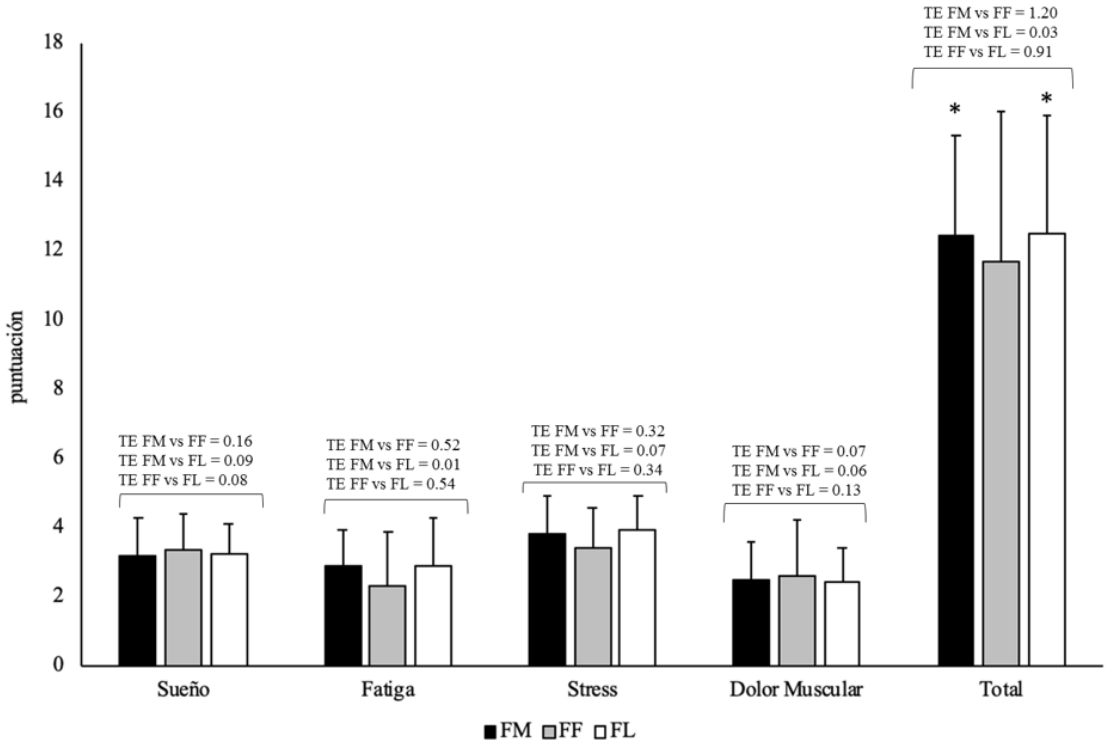

Figura 2. Resultados de la escala de percepción del bienestar en las diferentes fases del ciclo menstrual en jóvenes futbolistas
Leyenda = FM = fase menstrual; FF = fase folicular; FL = fase lútea; TE = tamaño del efecto. * = indica diferencias significativas con Fase folicular (p < 0.01).

Discusión

El objetivo de este estudio fue analizar los efectos de las diferentes fases del ciclo menstrual (FM, FL, y FF) en variables determinantes del rendimiento como la velocidad y la capacidad de salto horizontal y vertical, y el bienestar en jóvenes jugadoras de fútbol. Los datos obtenidos muestran que la FF del ciclo menstrual de futbolistas jóvenes cursa con significativa (p<0.01) menor percepción de fatiga (FM vs FF = 19.93% y TE 1.2; FL vs FF 19.93% y TE 0.91) y de bienestar general (FM vs FF = 6.43% y TE 0.52; FL vs FF 7.11% y TE 0.54) en el índice de Hooper, sin diferencias significativas (p>0.05) en el rendimiento en velocidad y fuerza explosiva del tren inferior entre las tres fases del ciclo menstrual. La ausencia de efectos del ciclo menstrual en el rendimiento en velocidad y fuerza explosiva del tren inferior, sugiere que el rendimiento en mujeres eumenorreicas no está afectado por las diferentes fases del ciclo menstrual. Estos resultados son de gran relevancia en el diseño y cuantificación de la carga de entrenamiento y competición ya que una mayor carga puede ser percibida de forma diferente en función de la fase del ciclo menstrual e incrementar el riesgo de lesión. Todas las participantes presentaban un ciclo menstrual regular, militaban en la misma categoría deportiva, con sólo tres años de menarquía, sin medicación para su regulación ni consumo de anticonceptivos, ni enfermedades o afecciones que pudieran afectar al equilibrio hormonal, y sin haber sufrido lesiones previas en los últimos 4 meses, justificando así, el gran control de las variables que pueden afectar e influir en la evidencia contradictoria de los resultados (Julian et al., 2017; Romero-Moraleda et al. 2019).

Las carreras de velocidad y las acciones de alta intensidad en los partidos de fútbol representan solo del 8% al 12% de la distancia recorrida, pero estas acciones se consideran las más importantes para el rendimiento junto con la aceleración horizontal (sprint) y vertical (poder de salto) en el fútbol femenino (Haugen et al., 2012). Los resultados obtenidos no mostraron diferencias significativas (p<0.05) en la velocidad lineal (40-m) o en la velocidad con cambio de dirección (V-Cut) en función del ciclo menstrual. Estos resultados están de acuerdo con estudios previos que muestran que el rendimiento en velocidad determinada mediante un test similar (30-m) no está condicionado por la fase del ciclo menstrual (Villa-del Bosque, 2016; Julian et al., 2017). Es posible que los cambios hormonales ocasionados por el ciclo menstrual no originen cambios en el rendimiento en el sprint debido a que las concentraciones de 17b-estradiol aisladas de forma natural con baja progesterona, no tengan ningún efecto en el rendimiento (Tsampoukos et al. 2010). Asimismo Wiecek et al. (2016) mostraron que los cambios hormonales en el ciclo menstrual no tienen ningún efecto sobre el rendimiento anaeróbico, la velocidad o la resistencia anaeróbica. Julian et al. (2017) en un estudio con 9 futbolistas llevado a cabo durante la FF temprana (donde el estrógeno se encuentra en valores mínimos) y la FL media (donde tanto estrógeno como progesterona alcanzan su mayor magnitud), no obtuvieron diferencias en la velocidad (5-m, 10-m y 30-m), entre FF y FL. Sin embargo, si mostraron una reducción significativa (p = 0.07) del rendimiento en pruebas de resistencia aeróbica durante la FL del ciclo menstrual, postulando que puede ser debido a la regulación del calor, la disponibilidad de sustratos y el metabolismo.

La variación de temperatura corporal basal de la mujer durante la FL es atribuida al aumento de la progesterona, justificando así la limitación en la capacidad de realizar un ejercicio prolongado en esta fase (Janse de Jonge, 2003; Julian et al., 2017). Sin embargo, Somboonwong et al. (2015) mostraron que el aumento de la temperatura central tras el calentamiento se asoció a una mejora del sprint. El rendimiento en fuerza explosiva del tren inferior no ha mostrado diferencias significativas en función de la fase del ciclo menstrual, ni en el salto horizontal ni en el vertical. Arazi et al. (2019) informan que la fuerza y resistencia muscular y la potencia anaeróbica de las mujeres jóvenes, no varían en las diferentes fases del ciclo menstrual, a pesar de que los niveles de LH y FSH vayan cambiando. Según los resultados de nuestro estudio, no se observaron diferencias significativas ($p>0.05$) en ninguna de las pruebas de salto (D-SHT; nD-SHT; BHT; SJ) realizadas para medir la fuerza muscular del tren inferior. Estos resultados pueden deberse a que los cambios hormonales no son suficientemente elevados como para causar efecto, y/o haberse restringido los efectos del estrógeno sobre la fuerza muscular durante la FL, consecuencia del efecto antagonista predominante de la progesterona (Giacomoni et al. 2000; Julian et al., 2017). Estos resultados están de acuerdo con estudios previos que muestran como en mujeres entrenadas, el rendimiento en fuerza muscular del tren inferior no se ve afectado por la fase del ciclo menstrual (Fridén et al. 2003; Romero-Moraleda et al. 2019). Los autores sugieren que se deben considerar y tener en cuenta las respuestas individuales de cada deportista si se quieren tomar decisiones respecto a las fases del ciclo menstrual durante entrenamientos y partidos, ya que este parece afectar de forma diferente al rendimiento de cada sujeto.

El rendimiento en acciones musculares excéntricas no se verá afectado en las diferentes fases del ciclo, siempre y cuando las mujeres no sufran los síntomas premenstruales y menstruales (Lebrun, 1993), justificando que esta ausencia de diferencias en el ciclo podría estar relacionada con la especificidad del ejercicio al que están familiarizadas (Giacomoni et al., 2000; Martínez-Lagunas et al., 2014; Tsampoukos et al., 2010; Villa-del Bosque, 2016). De hecho, el rendimiento físico en el futbol femenino de élite está muy relacionado con el estado de entrenamiento y sus capacidades máximas (Krustrup et al., 2005; Julian et al., 2017), por lo que el mantenimiento de un nivel óptimo durante el ciclo menstrual es esencial para el éxito deportivo.

El principal hallazgo de este estudio es que, mientras que no se obtuvieron diferencias significativas en las variables de bienestar subjetivo sueño, estrés, dolor muscular y fatiga, las jugadoras mostraron un significativamente peor ($p<0.01$) estado de bienestar general (TE = 1.21-0.91; muy grande) en la FM y FL en comparación con la FF. La existencia de síntomas menstruales y premenstruales como son la retención de líquidos (ocasionando hinchazón, congestión y malestar), el aumento de peso, los cambios de humor (irritabilidad, depresión, pérdida de motivación) y dismenorrea (Villa-del Bosque, 2016) pueden ser los motivos de estas diferentes puntuaciones de bienestar. Konovalova (2013), mostró que el estrés, tanto psicológico como fisiológico, o los cambios de estado de ánimo provocados en las fases premenstrual y menstrual, se asocian con un nivel disminuido de energía y/o un peor funcionamiento de los procesos cognitivos, pudiéndose además establecerse una asociación entre estos y la fase menstrual (Guijarro et al., 2009). Pallavi et al. (2017) en un estudio realizado en las tres fases del ciclo menstrual con 100 voluntarias sanas de edades entre 18-24 años, mostraron una tasa de fatiga más alta durante la FM, seguida de la FL y la FF, atribuyéndose al componente psicológico, ya que el sangrado tiene un efecto negativo en su rendimiento debido a la angustia preconcebida de este; e incluso puede relacionarse con el rendimiento físico, ya que la pérdida de sangre también puede afectar al mismo.

Este estudio no está exento de limitaciones, siendo las principales, el pequeño tamaño muestral y la ausencia de evaluación de los cambios hormonales en función de la fase del ciclo menstrual. Un análisis de las concentraciones de hormonas relacionadas con el rendimiento en cada una de las fases del ciclo menstrual, podría ayudarnos a interpretar los motivos de la ausencia de cambios en el rendimiento en función del ciclo menstrual. Por último, es importante señalar que hay aspectos relacionados con el estado de ánimo que pueden influir en la ralentización de las respuestas motoras, por lo que este aspecto podría ser una futura línea de investigación.

Conclusiones

Las jugadoras de fútbol en formación con un ciclo menstrual regular no presentaron diferencias significativas en el rendimiento muscular en velocidad y fuerza explosiva del tren inferior entre las fases ciclo menstrual, pero si en la percepción subjetiva de bienestar. Registrar datos de percepción subjetiva de bienestar a través de escalas como el Índice de Hooper puede ser un instrumento complementario, que aporta información relevante a los cuerpos técnicos de los equipos femeninos, a la hora de conocer la predisposición hacia la competición por parte de las jugadoras.

Referencias

Arazi, H., Nasiri, S., & Eghbali, E. (2019). Is there a difference toward strength, muscular endurance, anaerobic power and hormonal changes between the three phase of the menstrual cycle of active girls? *Apunts Medicina de l'Esport, 54*(202), 65-72. https://doi.org/10.1016/j.apunts.2018.11.001

Atkinson G, & Nevill, A.M. (1998). Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Medicine, 26*(4), 217#238. https://doi.org/10.2165/00007256-199826040-00002

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *Journal of Sports Sciences, 24*(7), 665-674. https://doi.org/10.1080/02640410500482529

Bosco, C., Colli, R., Bonomi, R., von Duvillard, S.P., & Viru, A. (2000). Monitoring strength training: neuromuscular and hormonal profile. *Medicine and Science in Sports and Exercise, 32*(1), 202-208. https://doi.org/10.1097/00005768-200001000-00030

Bruinvels, G., Burden, R.J., McGregor, A.J., Ackerman K.E., Dooley, M., Richards T., et al. (2016). Sport, exercise and the menstrual cycle: where is the research?. *British Journal of Sports Medicine, 51*(6). https://doi.org/10.1136/bjsports-2016-096279.

Carling, C., Wright, C., Nelson, L. J., & Bradley, S. P. (2014). Comment on performance analysis in football: a critical review and implications for future research. *Journal of Sports Science, 32(*1), 2-7. https://doi.org/10.1080/02640414.2013.807352

Cockerill, I.M., Wormington, J.A., & Nevill, A.M. (1994). Menstrual-cycle effects on mood and perceptual-motor performance. *Journal of Psychosomatic Research, 38*(7), 763-771. https://doi.org/10.1016/0022-3999(94)90029-9.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Lawrence Earlbaum Associates.

Constantini, N.W., Dubnov, G., & Lebrun, C.M. (2005). The menstrual cycle and sport performance, Clinical Sports Medicine, 24(2), 51-82. https://doi.org/10.1016/j.csm.2005.01.003

Cronin, J.B., Green, J.P, Levin, G.T., Brughelli, M.E., & Frost, D.M. Effect of starting stance on initial sprint performance. Journal of Strength and Conditioning Research, 21(3), 990-1002. https://doi.org/10.1519/R-22536.1

Datson, N., Hulton, A., Andersson, H., Lewis, T., Weston, M., Drust, B., et al. (2014). Applied physiology of female soccer: an update. *Sports Medicine, 44*(9), 1225-1240. https://doi.org/10.1007/s40279-014-0199-1

Dokumacı, B, Hazır, T. (2019). Effects of the Menstrual Cycle on Running Economy: Oxygen Cost Versus Caloric Cost. *Research Quarterly for Exercise in Sport, 90*(3), 318#326. https://doi.org/10.1080/02701367.2019.1599800

FIFA. (2015). Women's Football. Background information.

Fridén, C., Hirschberg, A.L., & Saartok, T. (2003). Muscle strength and endurance do not significantly vary across 3 phases of the menstrual cycle in moderately active premenopausal women. *Clinical Journal of Sport Medicine, 13*(4), 238-241. https://doi.org/10.1097/00042752-200307000-00007

Giacomoni, M., Bernard, T., Gavarry, O., Altare, S., & Falgairette, G. (2000). Influence of the menstrual cycle phase and menstrual symptoms on maximal anaerobic performance. *Medicine and Science in Sports and Exercise, 32*(2), 486-492. https://doi.org/10.1097/00005768-200002000-00034

Gonzalo-Skok, O., Tous-Fajardo, J., Suarez-Arrones, L., Arjol-Serrano, J.L., Casajús, J.A., & Méndez-Villanueva, A. (2015). Validity of the V-cut Test for Young Basketball Players. *International Journal of Sports Medicine, 36*(11), 893-899. https://doi.org/10.1055/s-0035-1554635.

Guijarro, E.; de la Vega, R. y del Valle, S. (2009). Ciclo menstrual, rendimiento y percepción del esfuerzo en jugadoras de fútbol de élite. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte*, 9(34), 96-104. ISSN: 1577-0354

Haugen, T. A., Tønnessen, E., & Seiler, S. (2012). Speed and countermovement-jump characteristics of elite female soccer players, 1995-2010. *International Journal of Sports Physiology and Performance, 7*(4), 340-349. https://doi.org/10.1123/ijspp.7.4.340

Hernández, D., Martín, V., Villa-del Bosque, M., & Sánchez-Sánchez, J. (2019). Efecto del entrenamiento de pretemporada sobre la condición física de futbolistas jóvenes: análisis por demarcaciones. *Revista Andaluza de Medicina del Deporte, 12*(4), 348-353. https://doi.org/10.33155/%20j.ramd.2019.06.003

Hooper, S. L., Mackinnon, L. T., Howard, A. L. F., Gordon, R. D., & Bachmann, A. W. (1995). Markers for monitoring overtraining and recovery. Medicine y Science in Sports y Exercise. 27(1), 106-112. PMID: 7898325

Janse de Jonge, X.A. (2003). Effects of the Menstrual Cycle on Exercise Performance. *Sports Medicine, 33*, 833–851. https://doi.org/10.2165/00007256-200333110-00004

Julian, R., Hecksteden, A., Fullagar, H. H., & Meyer, T. (2017). The effects of menstrual cycle phase on physical performance in female soccer players. Plos One, 12(3), 1-13. https://doi.org/10.1371/journal.pone.0173951

Konovalova, E. (2013). El ciclo menstrual y el entrenamiento deportivo: una mirada al problema. *Revista U.D.C.A Actualidad & Divulgación Científica, 16*(2), 293-302. https://doi.org/10.31910/rudca.v16.n2.2013.900

Krustrup, P., Mohr, M., Ellingsgaard, H., & Bangsbo, J. (2005). Physical demands during an elite female soccer game: Importance of training status. *Medicine and Science in Sports and Exercise, 37*(7), 1242-1248. https://doi.org/10.1249/01.mss.0000170062.73981.94

Lebrun, C.M. (1993). Effect of the different phases of the menstrual cycle and contraceptives on athletic performance. Sports Medicine, 16(6), 400–430.https://doi.org/10.2165/00007256-199316060-00005

Lebrun, C.M., McKenzie, D.C., Prior, J.C., Taunton, J.E. (1995). Effects of menstrual cycle phase on athletic performance. *Medicine and Science in Sports and Exercise, 27*(3), 437–44. PMID: 7752873

León, C. (2000). Influencia del sexo en la práctica deportiva. Biología de la mujer deportista. *Arbor CLXV, 165*(650), 249-263. https://doi.org/10.3989/arbor.2000.i650.968

Logerstedt, D.S.; Snyder-Mackler, L.; Ritter, R.C.; Axe, M.J., y Godges, J.J. (2010). Knee stability and movement coordination impairments: knee ligament sprains. *Journal of Orthopaedic and Sports Physical Therapy, 40*(4), A1-A37.https://doi.org/10.2519/jospt.2010.0303

Martínez-Lagunas, V., Niessen, M., & Hartmann, U. (2014). Women's football: Player characteristics and demands of the game. *Journal of Sport and Health Science, 3*(4), 258-272. https://doi.org/10.1016/j.jshs.2014.10.001

Matsuda, T., Furuhata, T., Ogata, H., Kamemoto, K., Yamada, M., & Sakamaki-Sunaga, M. (2020). Effects of the Menstrual Cycle on Serum Carnitine and Endurance Performance of Women. *International Journal of Sports Medicine* (ahead of print). https://doi.org/10.1055/a-1088-5555

Middleton, L.E., & Wenger, H.A. (2006). Effects of menstrual phase on performance and recovery in intense intermittent activity. *European Journal of Applied Physiology, 96*(1), 53-58. https://doi.org/10.1007/s00421-005-0073-9

Oriol, P.A. (2006). La importancia de corrección de los estados psicológicos en el kickboxing femenino. *Educación Física Estudiantil, 6,* 43-51.

Oyón, P., Franco, L., Rubio, F.J., & Valero, A. (2016). Fútbol femenino categorías inferiores. Características antropométricas y fisiológicas. Evolución a lo largo de una temporada. *Archivos de Medicina del Deporte, 33*(1), 24-28. ID: ibc-152179

Pallavi, L. C., Souza, U. J. D., & Shivaprakash, G. (2017). Assessment of musculoskeletal strength and levels of fatigue during different phases of menstrual cycle in young adults. *Journal of Clinical and Diagnostic Research, 11*(2), CC11-CC13. https://doi.org/10.7860/JCDR/2017/24316.9408

Paris, H.C., & Jakeman, P.M. (1987). The effects of menstruation upon repeated maximal print performance. *Journal of Sports Sciences, 1*, 78.

Rabbani, A., Clemente, F. M., Kargarfard, M., & Chamari, K. (2019). Match Fatigue Time-Course Assessment Over Four Days: Usefulness of the Hooper Index and Heart Rate Variability in Professional Soccer Players. *Frontiers in*

physiology, 19(*10),* 109. https://doi.org/10.3389/fphys.2019.00109.

Ramírez-Balas, A. (2014). *Efectos de las fases del ciclo menstrual sobre la condición física, parámetros fisiológicos y psicológicos en mujeres jóvenes moderadamente entrenadas*. Tesis Doctoral. Universidad de Extremadura, Extremadura.

Reina-Gómez, A. y Hernández-Mendo, A. (2012). Revisión de indicadores de rendimiento en fútbol. *Revista Iberoamericana de Ciencias de la Actividad Física y el Deporte, 1*(1), 1-14. http://dx.doi.org/10.24310/riccafd.2012.v1i1.1990

Romero-Moraleda, B., Del Coso, J., Gutiérrez-Hellín, J., Ruíz-Moreno, C., Grgic, J., & Lara, B. (2019). The Influence of the Menstrual Cycle on Muscle Strength and Power Performance. *Journal of Human Kinetics, 68*(1), 123-133. https://doi.org/10.2478/hukin-2019-0061

Romero-Parra, N., Barba-Moreno, L., Rael, B., Alfaro-Magallanes, V. M., Cupeiro, R., Díaz, Á. E., Calderón, F. J., & Peinado, A. B. (2020). Influence of the Menstrual Cycle on Blood Markers of Muscle Damage and Inflammation Following Eccentric Exercise. *International journal of environmental research and public health, 17*(5), 1618. https://doi.org/10.3390/ijerph17051618

Seoane-Prado, A. (2013). Influence of menstrual cycle in synchronized swimming flexibility. *AGON, International Journal of Sport Sciences, 3*(2), 53-59. ISSN: 2254-2132

Somboonwong, J., Chutimakul, L., & Sanguanrungsirikul, S. (2015). Core temperature changes and sprint performance of elite female soccer players after a 15-minute warm-up in a hot-humid environment. *Journal of Strength and Conditioning Research, 29*(1), 262-269. https://doi/org/10.1097/JSC.0000000000000235.

Strauss, A., Sparks, M., & Pienaar, C. (2019). The Use of GPS Analysis to Quantify the Internal and External Match Demands of Semi-Elite Level Female Soccer Players during a Tournament. *Journal of sports science & medicine, 18*(1), 73–81. PMID: 30787654

Troule, S. & Casamichana, D. (2016). Application of functional test to the detection of asymmetries in soccer players. *Journal of Sport and Health Research. 8*(1), 53-64. ISSN: 1989-6239

Tsampoukos, A., Peckham, E. A., James, R., & Nevill, M. E. (2010). Effect of menstrual cycle phase on sprinting performance. *European Journal of Applied Physiology, 109*(4), 659-667. https://doi.org/10.1007/s00421-010-1384-z

Upton, D.E., & Ross, J.W. (2011). Assisted and Resisted Sprint Training: Effects on 13.7 M Speed, Speed with Direction Change, and Peak Power in Division I Female Soccer Athletes. *Journal of Strength and Conditioning Research*, 25, 83-84. https://doi.org/10.1097/01.JSC.0000395712.68999.f1

Villa-del Bosque, M. (2016). Influencia del ciclo menstrual en la capacidad anaeróbica en el fútbol femenino. *Papeles Salmantinos de Educación, 20*, 49-67. Recuperado de: file:///Users/conmar/Downloads/Papeles-Salmantinos-de-Educaci%C3%B3n-2016-n.%C2%BA-20-P%C3%A1ginas-49-67-Influencia-el-ciclo-menstrual-en-la-capacidad-anaer%C3%B3bica-en-el-futbol-femenino%20(2).pdf

Wiecek, M., Szymura, J., Maciejczyk, M., Cempla, J., & Szygula, Z. (2016). Effect of sex and menstrual cycle in women on starting speed, anaerobic endurance and muscle power. *Acta Physiologica Hungarica, 103*(1), 127-132. https://doi.org/10.1556/036.103.2016.1.13

Yap, C.W. (2000). Development of speed, agility, and quickness for the female soccer athlete. *Strength and Conditioning Journal, 22*, 1-9. https://doi.org/0.1519/1533-4295

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Analysis of the neuromuscular responses during two different high-intensity interval training sessions in athletes of cyclic and acyclic sports

Análisis de las respuestas neuromusculares durante dos diferentes sesiones de entrenamiento intervalado de alta intensidad en atletas de deportes cíclicos y acíclicos

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Abstract

The purpose of the present study was to investigate the acute effects of two high-intensity interval training (HIIT) sessions on countermovement jump performance. Twenty-two male regional-level athletes (cyclic, n = 11; acyclic, n = 11) completed two HIIT sessions consisted of multiple running bouts on a treadmill. A different work-interval duration was applied in each session. To determine the effect of fatigue on jumping performance, countermovement jump tests were executed pre-effort and at the end of all series. The results showed a decrease in jump performance at the end of the third series respect to the pre-effort condition (p < .001). In addition., the acyclic athletes jumped higher than the cyclic ones (p < .001), revealing a different jumping strategy based on a higher velocity component, and a more efficient elastic energy utilization (p < .01). The neuromuscular mechanisms affected by fatigue, were also different between groups. In conclusion, during HIIT sessions the neuromuscular status is principally conditioned by the total volume rather than by the work-interval duration, affecting specific performance variables depending on the sport discipline. The present findings may be useful when conducting HIIT concurrently with other training contents in athletes of both cyclic and acyclic sports.

Keywords: Countermovement jump, explosive strength, intermittent exercise, vertical ground reaction force..

Resumen

El propósito del presente estudio ha sido investigar los efectos agudos de dos sesiones de entrenamiento intervalado de alta intensidad (HIIT) sobre el rendimiento en el salto contramovimiento. Veintidós atletas hombres, de nivel regional (cíclicos, n = 11; acíclicos, n = 11) completaron dos sesiones de HIIT, que consistían en series repetidas de carrera sobre un tapiz rodante. Se aplicaron intervalos de trabajo de diferente duración en cada sesión. Para determinar el efecto de la fatiga sobre el rendimiento en el salto, se ejecutaron pruebas de salto contramovimiento antes del esfuerzo y al final de todas las series. Los resultados mostraron una disminución en el rendimiento del salto al final de las tercera serie respecto a la condición pre-esfuerzo (p < .001). Asimismo, los atletas acíclicos saltaron más alto que los cíclicos, (p < .001), revelando una estrategia de salto diferente, basada en un mayor componente de velocidad y una utilización más eficiente de la energía elástica (p < .01). Los mecanismos neuromusculares afectados por la fatiga también fueron diferentes entre los grupos. En conclusión, durante sesiones de HIIT, el estatus neuromuscular está principalmente condicionado por el volumen total, más que por la duración del intervalo de trabajo, afectando variables específicas dependiendo de la disciplina deportiva. Los presentes hallazgos pueden ser de utilidad cuando se prescribe HIIT de manera concurrente a otros contenidos de entrenamiento tanto en atletas de deportes cíclicos como acíclicos.

Palabras clave: Salto contramovimiento, fuerza explosiva, ejercicio intermitente, fuerza de reacción vertical..

Introduction

Physical conditioning programs should consider the various requirements of a given sport in order to maximize the efficacy of the training process. An appropriate selection of the methodology may help to concurrently enhance a specific performance parameter (i.e. endurance) without diminishing another (i.e. power) (Wilson et al., 2012). In this regard, high-intensity interval training (HIIT) has been demonstrated to be effective in activating central and peripheral components of VO_2 (Zafeiridis et al., 2015) as well as minimizing metabolic and cardiorespiratory responses at the same intensity compared with continuous prescriptions (Billat et al., 2000; Tschakert et al., 2015). This method consists of executing bouts of exercise at an elevated intensity intercalated with recovery periods of rest or low-intensity activity (Buchheit & Laursen, 2013; Tschakert & Hofmann, 2013). In addition, this kind of protocols can be used to elicit precise metabolic responses by modulating load components such as the intensity (Wakefield & Glaister, 2009), work-interval duration (Price & Moss, 2007; Warr-di Piero et al., 2018) and/or work-to-rest ratio (Rozenek et al., 2007).

Similarly, it is important to analyze neuromuscular responses associated with fatigue. For this purpose, jump tests are practical and non-invasive assessments used for monitoring athletic performance (Cormie et al., 2010; Harry et al., 2018), and comparing the effects of training programmes (Griffiths et al., 2019; Vasquez-Bonilla et al., 2021). Specifically, countermovement jump (CMJ) has proven to be sensitive in detecting fatigue or supercompensation effects (Benítez-Jiménez et al., 2020; Claudino et al., 2017) and it also presents a high level of reliability of measures during assessments performed on a force platform (Hori et al., 2009; Warr et al., 2020).

Previous studies have analyzed acute neuromuscular fatigue focusing on several parameters of jump performance (Bedo et al., 2020; Benjaminse et al., 2008; Cormack et al., 2008; Gathercole et al., 2015; Watkins et al., 2017). One study found that a stiff landing strategy was used following an incremental protocol until exhaustion (Benjaminse et al., 2008), marked by less knee valgus and knee flexion at initial contact of a single-leg-stop jump task. An altered movement strategy in CMJ was also reported after two consecutive intermittent protocols until exhaustion, suggesting that a full CMJ-variables battery is a more prudent approach to detect neuromuscular fatigue (Gathercole et al., 2015). Cormack et al. (2008) examined the acute responses in single and repeated CMJ after an elite Australian Rules Football match and found a decrease in the reactive strength index in the post-match condition.

These findings indicate that neuromuscular status can be affected by efforts performed until exhaustion. However, the effects that high-intensity interval training protocols could have on neuromuscular status remains unclear. Furthermore, to the best of our knowledge, no studies have analyzed the neuromuscular responses between interval protocols with different configurations (i.e. equal total load but different work-interval durations). Therefore, the aim of the present study was to analyze the acute effects of a short and a long HIIT session on CMJ performance in athletes of cyclic and acyclic sports. It was hypothesized that i) an increase of the relative volume would result in a diminution of the jump performance, ii) a HIIT session with long work-interval durations would evoke neuromuscular fatigue earlier than a session with short intervals, and iii) the jumping profile, and the neuromuscular responses to HIIT displayed by cyclic athletes would be different than those displayed by acyclic athletes.

Materials and Methods

Experimental Overview

Each participant completed a total of four testing sessions separated at least by 72 hours. All the tests were executed in the sports science laboratory, with environmental conditions of 21.8 ± 0.6°C, 39 ± 10% humidity and 1012 ± 10 hPa. The participants were required to attend the laboratory in their usual training clothes and wearing running shoes. A complete recovery condition was requested before starting all the sessions, which consisted of no previous physical activity during the 48 hours before testing, a minimum of 7 hours of sleep the night before, a carbohydrate-rich diet, avoidance of any food, tobacco, caffeine or supplement intake for at least 3 hours prior to testing, and drinking water regularly during the testing day. In the first session, a maximal incremental running test was completed to determine maximal oxygen uptake (VO_2max) and maximal aerobic speed (MAS). In the second session, a time to exhaustion test was executed. Based on these data, two HIIT protocols were designed and performed in sessions 3 and 4. Both experimental protocols were equal in terms of relative intensity, volume and density but differed in the work-interval duration. In consequence, short and long HIIT protocols were defined. To assess the effect of the type of protocol on neuromuscular fatigue, CMJ tests were conducted in each experimental session.

Participants

Twenty-two male regional-level athletes participated in the study. Based on the previous study by Warr-diPiero et al. (2018), an a priori power analysis (G*Power3) with $\alpha < 0.05$ and $1–\beta = 80$ indicated that a sample size of at least 18 was required to explore neuromuscular responses associated with HIIT in athletes of cyclic and acyclic sports. The participants were all experienced athletes with a minimum of 3 years of regular participation in competitions, and a training frequency of 4.5 ± 1.1 sessions per week. According to the characteristics of their sport, participants were classified into the cyclic group (middle- and long-endurance runners, n = 11, 20.3 ± 3.2 years, 176.2 ± 7.0 cm, 64.7 ± 6.7 kg, 8.7 ± 3.1 % fat mass) or the acyclic group (team sports players: handball, n = 4; football, n = 4; field hockey, n = 3, 20.8 ± 3.2 years, 181.2 ± 8.3 cm, 72.0 ± 7.0 kg, 10.1 ± 3.0 % fat mass). This classification applied only for data analysis, so all the participants completed the same intervention protocol. A complete written and verbal description of the research protocol was given to the volunteers. Afterwards, the participants signed an informed consent form prior to any further intervention. The study was approved by the University's Ethics Committee (ETICA-ULE-022-2021).

Procedures

All running tests were conducted on a motorized treadmill (H/P Cosmos Quasar, Cosmos Sports & Medical, Nussdorf-Traunstein, Germany) graded at a 1% inclination. The participants were equipped with a portable gas analyzer (Oxycon Mobile, CareFusion, Hoechberg, Germany) to measure gas exchange breath-by-breath during the

incremental test. Heart rate (HR) was recorded throughout all sessions at a sampling frequency of 1 Hz using a Polar RS800CX heart rate monitor (Polar Electro Oy, Kempele, Finland). Capillary blood samples were taken from the participants' earlobes before and one minute after completion of the incremental test to determine blood lactate concentrations using a Pro-Lactate 2 analyzer (Arkray Inc., Kyoto, Japan). All CMJ tests were performed on a force plate (Kistler 9281EA, Kistler Instrument AG, Winterthur, Switzerland) connected to computer software (Bioware 5.3). The vertical ground reaction force (VGRF) was recorded at a sampling frequency of 1000 Hz over a period of 10 s for each trial. Then, the data were downloaded and saved for subsequent analysis. The participants had to complete a total of 3 valid trials of CMJs separated by 30 s of recovery for every jump testing condition. The average of each set of three trials was considered as the value for a given condition (pre-effort and inter-series) in order to increase sensitivity in detecting of fatigue effects (Claudino et al., 2017). Participants started all sessions by performing a standardized warm-up (Warr et al., 2020). CMJ familiarization sets were implemented in sessions 1 and 2, in order to assure correct execution, and avoid learning effects during the experimental HIIT sessions.

Performance Assessments

The Maximal Incremental Running Test started at an initial speed of 10.0 $km \cdot h^{-1}$ and increased by 0.5 $km \cdot h^{-1}$ each minute until exhaustion. Oxygen uptake was considered maximal if at least 3 of the recommended criteria were met (Wakefield & Glaister, 2009; Zafeiridis et al., 2015). The speed of the stage in which VO_{2max} have been achieved was recorded as MAS. The Time to Exhaustion Test (T_{LIM}) consisted of running at MAS until volitional exhaustion (Dupont et al., 2002). T_{LIM} was registered in seconds.

HIIT protocols

The results obtained in the performance assessments allowed us to design the two experimental HIIT protocols, which were performed in a random and counterbalanced manner in sessions 3 and 4 to avoid order effects. The intensity of both protocols was equal to MAS and the work-to-rest ratio was 1:1. The total volume of each protocol was related to T_{LIM}, so that each HIIT protocol constituted a total volume equal to three times the volume reached in the T_{LIM} test. The work-interval duration determined the type of protocol and was also related to the T_{LIM} test. In this way, the work-interval duration of the short HIIT protocol was 5% of T_{LIM} ($T_{LIM\text{-}5}$) and the work-interval duration of the long HIIT protocol was 33% of T_{LIM} ($T_{LIM\text{-}33}$). Therefore, a total of 60 and 9 repetitions had to be completed in the short and long protocols, respectively. In addition, to analyze whether the increase of volume could trigger an inflection point due to fatigue accumulation, the protocols were conducted in 3 equal series (3 x 20 repetitions for the short protocol and 3 x 3 repetitions for the long one) between which CMJ performance was assessed, immediately after de cessation of the efforts. The duration of the inter-series measurements was fixed at 5 minutes for all subjects. A flow chart of the design is presented in Figure 1.

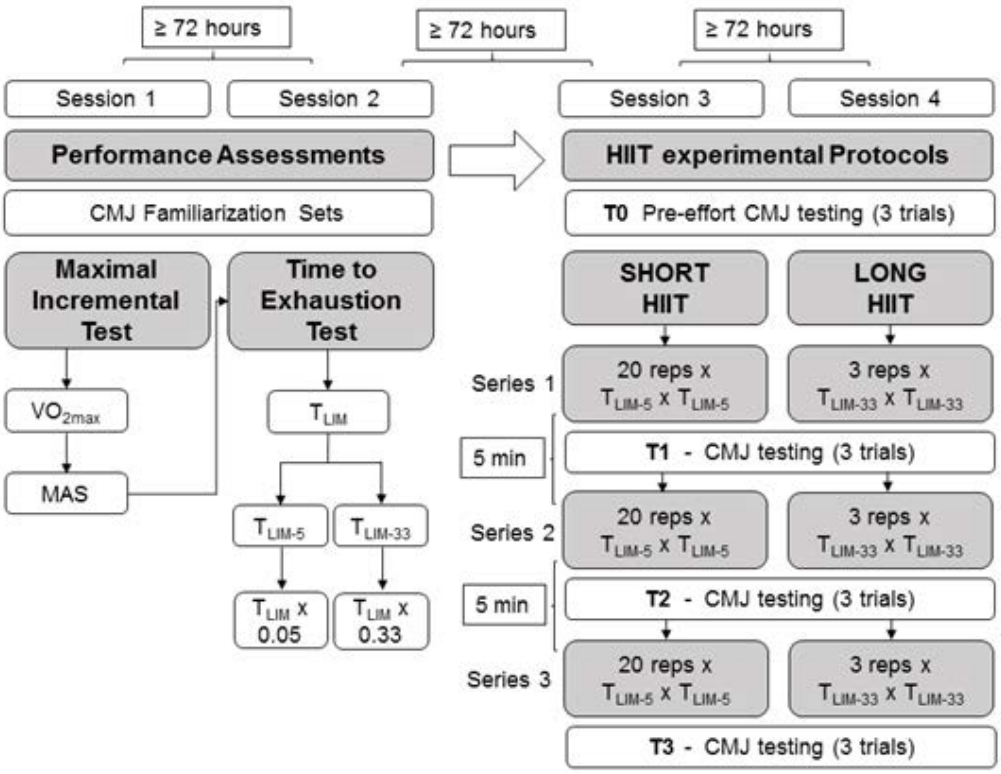

Figure 1. Schematic overview of the four sessions
HIIT = high-intensity interval training, MAS = maximal aerobic speed, T_{LIM} = time to exhaustion, reps = repetitions, CMJ = countermovement jump; T0 = pre-effort condition; T1 = post-series 1 condition; T2 = post-series 2 condition; T3 = post-series 3 condition.

Data Processing

The VGRF data from all the trials were included in the analysis. Basic calculations were conducted to obtain instantaneous values of velocity, displacement and power for each trial (Harry et al., 2018; Kirby et al., 2011; Warr et al., 2020).

Key points and determination of phases

Several points of interest were marked for the further determination of the different phases and sub-phases of the jump (Figure 2). The body weight (BW) was determined as the mean force of a two-second standing still stance before the jump initiation. The force value at jump initiation (F_{START}) was determined as BW minus 5 times the standard deviation of the two-second stance. The minimum force (F_{MIN}) was the lowest force value registered before reaching BW. The force value at minimum velocity was F_{BRAKE}. The countermovement amplitude (D_{MAX}) determined the initiation of propulsive sub-phase, and the force value at this point was F_{PROP}.

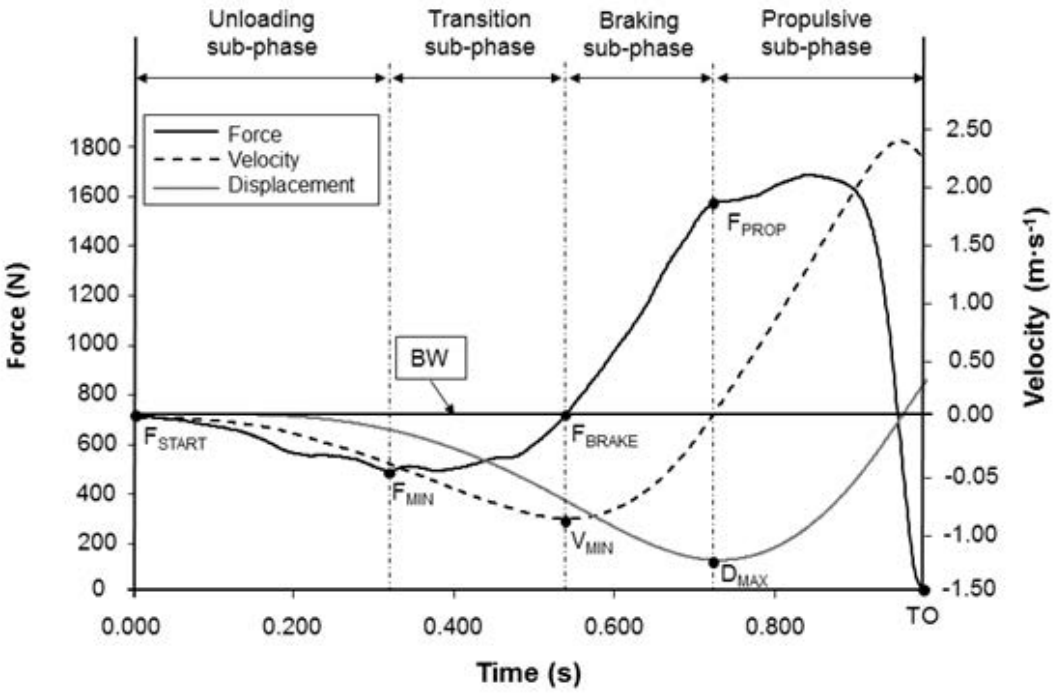

Figure 2. Key points and CMJ sub-phases of an example trial of one subject
BW = body weight, F_{START} = force at jump initiation, F_{MIN} = minimum force, FB_{RAKE} = force at minimum velocity, F_{PROP} = force at the beginning of the propulsive sub-phase, V_{MIN} = minimum velocity, D_{MAX} = countermovement amplitude, TO = take-off.
Note: The displacement scale has been omitted.

Calculation of Performance Variables

Time-, force-, power- and velocity-related variables, as well as net impulse and rates of force development, were calculated for the different sub-phases of the jump. A description of the variables is summarized in Table 1.

Table 1. CMJ performance variables

Variables (Abbreviation)	Description
Flight time (FT)	Time from take-off to landing. Both points were determined by the same force value threshold (mean force of a 30-ms period during the flight minus 5 times the SD of the same period).
Jump height (JH)	½ g $(FT/2)^2$, where g = 9.81 m/s^2 (Moir, 2008).
Contact time ($T_{CONTACT}$)	Time from jump initiation to take-off.
Unloading time (T_{UNLOAD})	Duration of the unloading sub-phase.
Transition time ($T_{TRANSITION}$)	Duration of the transition sub-phase.
Braking time (T_{BRAKE})	Duration of the braking sub-phase.
Propulsive time (T_{PROP})	Duration of the propulsive sub-phase.
Peak force (PF)	Highest force value achieved.
Mean unloading force (MF_{UNLOAD})	Average force during the unloading sub-phase.
Mean transition force ($MF_{TRANSITION}$)	Average force during the transition sub-phase.
Mean braking force (MF_{BRAKE})	Average force during the braking sub-phase.
Mean propulsive force (MF_{PROP})	Average force during the propulsive sub-phase.
Minimum power (P_{MIN})	Lowest power value generated during the jump.
Peak power (PP)	Highest power value achieved during the jump.
Mean transition power ($MP_{TRANSITION}$)	Average power of the transition sub-phase.
Mean braking power (MP_{BRAKE})	Average power of the braking sub-phase.
Mean propulsive power (MP_{PROP})	Average power of the propulsive sub-phase.
Minimum velocity (V_{MIN})	Lowest jump velocity (peak negative velocity).
Peak velocity (PV)	Highest velocity value achieved.
Velocity at peak power (V_{PP})	Velocity at the point where PP was registered.
Mean transition velocity ($V_{TRANSITION}$)	Average velocity of the transition sub-phase.
Mean braking velocity (V_{BRAKE})	Average velocity of the braking sub-phase.
Braking net impulse (NI_{BRAKE})	Net impulse calculated for the braking sub-phase.
Propulsive net impulse (NI_{PROP})	Net impulse calculated for the propulsive sub-phase.
Unloading RFD (RFD_{UNLOAD})	$(F_{MIN} - F_{START}) / T_{UNLOAD}$.
Transition RFD ($RFD_{TRANSITION}$)	$(F_{BRAKE} - F_{MIN}) / T_{TRANSITION}$.
Braking RFD (RFD_{BRAKE})	$(F_{PROP} - F_{BRAKE}) / T_{BRAKE}$.

SD = standard deviation, RFD = rate of force development, F_{MIN} = minimum force, F_{START} = force at jump initiation, F_{BRAKE} = force at the beginning of the braking sub-phase, F_{PROP} = force at the beginning of the propulsive sub-phase.

SD = standard deviation, RFD = rate of force development, F_{MIN} = minimum force, F_{START} = force at jump initiation, F_{BRAKE} = force at the beginning of the braking sub-phase, F_{PROP} = force at the beginning of the propulsive sub-phase.

Statistical Analysis

Statistical Package for Social Sciences (version 24.0, SPSS, Inc., Chicago, IL, USA) was used to analyze all the data. The Kolmogorov-Smirnoff test was used to confirm the normal distribution of the data. A single-factor ANOVA test was used to detect differences in the descriptive data between the cyclic and acyclic groups. A separate general linear repeated measures ANOVA model was used to determine effects on the performance variables, with "protocol" (short, long) and "time points" (T0, T1, T2, T3) as within-subject factors, and "discipline" (cyclic, acyclic) as the inter-subject factor. Assumptions of the test statistics were verified with the Mauchly test of sphericity. If significant effects were observed, a Bonferroni post-hoc test was undertaken. Partial

eta-squared (η_p^2) and observed power were used to interpret the magnitude of the main effects. The relative reliability of all the variables was assessed with the intraclass correlation coefficient (ICC) from a two-way mixed-effects model with a mean of . measurements and absolute agreement definition. Statistical significance was set at an α level of 0.05.

Results

All the variables exhibited a normal distribution and displayed high reliability values, expressed in ICCs ranging from 0.85 to 0.99.

The one-factor ANOVA indicated that there were significant differences in the anthropometric data and performance assessments between sport disciplines. The acyclic group showed a significantly greater mass than the cyclic one (F = 6.34, p = .020); consequently, further force, power and impulse comparisons between groups were conducted in relative terms. In the performance assessments, no significant differences between groups were observed in either absolute VO_{2max} (F = 0.06, p = .941) or relative VO_{2max} (F = 3.21, p = .090). However, an effect of the sport discipline was detected on MAS (F = 39.17, p < .001), with the cyclic athletes reaching a significantly higher speed (17.7 ± 1.3 $km \cdot h^{-1}$) than the acyclic ones (14.3 ± 1.2 $km \cdot h^{-1}$). In addition, a non-significant difference between disciplines (F = 2.50, p = .130) was observed in the time-to-exhaustion test (cyclic group: 408 ± 91 s; acyclic group: 355 ± 62 s).

A total of 528 CMJ trials were included in the analysis. There were no significant effects of the type of protocol on any of the CMJ performance variables.

CMJ gross performance outcomes

An effect of the sport discipline was observed on FT and JH (F = 5.76, p = .026, η_p^2 = 0.22, power = 0.63 and F = 6.64, p = .018, η_p^2 = 0.25, power = 0.69, respectively). The acyclic athletes developed a significantly longer flight time and, therefore, a higher jump than the cyclic ones. A main effect of time was also observed on these measures (Table 2). Post-hoc testing revealed that in the short protocol the acyclic group showed a significantly lower JH (p = .041) and a significantly shorter flight time (p = .047) in T3 than in the pre-effort condition.

Table 2. Gross performance outcomes Values are expressed as mean ± SD

Protocol	Time	FT (ms)		JH (cm)		$T_{CONTACT}$ (ms)	
		Cyclic	Acyclic	Cyclic	Acyclic	Cyclic	Acyclic
Short	T0	494 ± 41	**534 ± 29**	30 ± 5	**35 ± 4**	944 ± 204	896 ± 132
	T1	488 ± 38	**524 ± 29**	29 ± 5	**34 ± 4**	909 ± 162	871 ± 121
	T2	487 ± 43	**524 ± 33**	29 ± 5	**34 ± 4**	939 ± 133	859 ± 107
	T3	488 ± 42	**522 ± 30** §	29 ± 5	**33 ± 4** §	916 ± 163	877 ± 127
Long	T0	498 ± 40	530 ± 46	31 ± 5	35 ± 6	968 ± 187	882 ± 115
	T1	493 ± 30	522 ± 41	30 ± 4	**34 ± 7**	931 ± 165	854 ± 107
	T2	488 ± 29	**526 ± 42**	29 ± 3	**34 ± 6**	947 ± 122	871 ± 92
	T3	483 ± 29	**526 ± 44**	29 ± 3	**34 ± 7**	944 ± 143	876 ± 88
		p	η_p^2	p	η_p^2	P	η_p^2
Protocol		.940	0.00	.437	0.03	.338	0.05
Time		<.001	0.30	.024	0.15	.060	0.14
Discipline		.026	0.22	.018	0.25	.297	0.06
Protocol x Time		.747	0.02	.610	0.03	.534	0.04
Protocol x Discipline		.772	0.00	.594	0.01	.164	0.09
Time x Discipline		.631	0.03	.677	0.03	.923	0.01

§ Significantly different from T0 (p < .05). Values in bold express significant differences between groups for the given time point (p < .05). FT = flight time; JH = jump height; $T_{CONTACT}$ = contact time; T0 = pre-effort condition; T1 = post-series 1 condition; T2 = post-series 2 condition; T3 = post-series 3 condition.

Time- and Force -related variables

A significant effect of sport discipline was observed only in the variables associated to the braking sub-phase (Table 3). Moreover, an interaction between protocol and discipline (F = 5.16, p = .034, η_p^2 = 0.21, power = 0.58) was also observed in T_{BRAKE}.

Table 3. Time- and force -related variables. Values are expressed as mean ± SD

Protocol	Time	T_{BRAKE} (ms)		MF_{BRAKE} ($N \cdot kg^{-1}$)	
		Cyclic	Acyclic	Cyclic	Acyclic
Short	T0	240 ± 56	208 ± 51	14.1 ± 1.8	**16.3 ± 1.4**
	T1	227 ± 51	201 ± 28	14.3 ± 1.5	**16.1 ± 0.9**
	T2	251 ± 59	205 ± 34	14.1 ± 1.6	**16.0 ± 1.1**
	T3	236 ± 53	208 ± 30	14.2 ± 2.0	15.9 ± 1.0
Long	T0	265 ± 111	200 ± 33	14.0 ± 2.0	16.5 ± 2.0
	T1	255 ± 75	**199 ± 23**	13.8 ± 1.9	16.2 ± 1.5
	T2	252 ± 56	**203 ± 14**	13.7 ± 1.5	**15.9 ± 1.2**
	T3	259 ± 65	**208 ± 19**	13.7 ± 1.7	15.7 ± 1.1
		p	η_p^2	*p*	η_p^2
Protocol		.091	0.14	.117	0.11
Time		.325	0.06	.163	0.09
Discipline		.043	0.19	.036	0.20
Protocol x Time		.921	0.01	.626	0.03
Protocol x Discipline		.034	0.21	.680	0.01
Time x Discipline		.764	0.02	.444	0.04

Values in bold express significant differences between disciplines for the given time point ($p < .05$). MF_{BRAKE} = braking mean force; T0, pre-effort condition; T1 = post-series 1 condition; T2 = post-series 2 condition; T3 = post-series 3 condition.

Power-related variables

An effect of sport discipline was observed on P_{MIN}, $MP_{TRANSITION}$, MP_{BRAKE} and MP_{PROP} (Table 4). The acyclic group displayed higher positive and lower negative values than the cyclic group in all of these variables. An effect of time was also observed on MP_{PROP}, with the post-hoc test revealing that for the cyclic group MP_{PROP} was significantly lower in T3 than in T0 ($p = .035$) and T1 ($p = .039$) during the long protocol.

Velocity-related variables

A similar pattern was exhibited in the variables linked to the velocity component, where the outcomes of the acyclic players were more elevated (higher positive and lower negative) than those of the cyclic athletes (Table 5). An effect of time was observed on V_{PP} ($F = 9.64$, $p < .001$, $\eta_p^2 = 0.33$, power = 1.00). Post-hoc testing indicated that in the short protocol of the acyclic group V_{PP} was significantly higher during the pre-effort condition than during series 2 ($p = .029$) and series 3 ($p = .029$), as well as significantly higher in series 1 than in series 3 ($p = .049$).

Net impulse

An effect of the sport discipline was observed on both NI_{BRAKE} ($F = 8.78$, $p = .008$, $\eta_p^2 = 0.31$, power = 0.81) and NI_{PROP} ($F = 13.20$, $p = .002$, $\eta_p^2 = 0.34$, power = 0.86), with the acyclic group generating a greater net impulse during both sub-phases. In addition, there was a significant effect of time on NI_{PROP} ($F = 19.07$, $p < .001$, $\eta_p^2 = 0.49$, power = 1.00). Post-hoc testing revealed that in the long protocol of the cyclic group, NI_{PROP} was significantly lower during series 3 than in the pre-effort condition (. = .003) (Table 6).

Rates of force development

RFD_{UNLOAD}, $RFD_{TRANSITION}$ and RFD_{BRAKE} showed significant differences between the cyclic and acyclic groups ($F = 5.13$, $p = .035$, $\eta_p^2 = 0.20$, power = 0.58), ($F = 10.94$, $p = .004$, $\eta_p^2 = 0.35$, power = 0.88) and ($F = 10.02$, $p = .005$, $\eta_p^2 = 0.33$, power = 0.85), respectively. Post-hoc tests indicated that the acyclic group displayed higher rates than the cyclic group in all of these measures (Table 6).

Table 4. Power-related variables. Values are expressed as mean ± SD

Protocol	Time	Minimum Power ($W \cdot kg^{-1}$)		$MP_{TRANSITION}$ ($W \cdot kg^{-1}$)		MP_{BRAKE} ($W \cdot kg^{-1}$)		MP_{PROP} ($W \cdot kg^{-1}$)	
		Cyclic	Acyclic	Cyclic	Acyclic	Cyclic	Acyclic	Cyclic	Acyclic
Short	T0	-11.0 ± 4.9	**-16.5 ± 3.3**	-5.3 ± 1.2	**-6.2 ± 0.7**	-8.4 ± 4.0	**-12.5 ± 2.3**	23.4 ± 1.8	**26.3 ± 3.2**
	T1	-11.2 ± 4.7	**-15.8 ± 2.6**	-5.3 ± 1.2	-6.1 ± 0.7	-8.5 ± 3.7	**-12.1 ± 1.8**	23.2 ± 2.0	**26.1 ± 2.7**
	T2	-11.0 ± 4.1	**-15.8 ± 3.5**	-5.2 ± 1.1	-6.0 ± 0.6	-8.3 ± 3.2	**-12.0 ± 2.4**	23.1 ± 1.9	**25.9 ± 2.9**
	T3	-11.3 ± 4.9	**-15.9 ± 3.4**	-5.2 ± 1.3	-5.9 ± 0.6	-8.5 ± 3.6	**-11.8 ± 2.1**	23.8 ± 2.1	25.5 ± 2.8
Long	T0	-11.5 ± 3.9	**-17.2 ± 5.2**	-5.3 ± 1.2	-6.0 ± 0.6	-8.3 ± 3.4	**-12.9 ± 3.5**	24.0 ± 3.1	26.5 ± 3.9
	T1	-11.8 ± 4.6	**-16.0 ± 3.9**	-5.3 ± 1.4	-5.8 ± 0.5	-7.8 ± 3.1	**-12.0 ± 2.8**	23.9 ± 2.8	25.6 ± 2.8
	T2	-10.6 ± 3.5	**-15.6 ± 3.6**	-5.2 ± 0.7	**-6.1 ± 0.5**	-8.1 ± 2.7	**-11.9 ± 2.6**	23.9 ± 2.3	24.9 ± 5.1
	T3	-11.3 ± 3.7	**-15.3 ± 3.6**	-5.1 ± 0.9	**-5.9 ± 0.4**	-8.0 ± 3.0	**-11.7 ± 2.7**	22.3 ± 1.8 §†	**25.8 ± 3.3**
		p	η_p^2	p	η_p^2	p	η_p^2	p	η_p^2
Protocol		.845	0.00	.752	0.01	.625	0.01	.640	0.01
Time		.236	0.07	.226	0.07	.138	0.09	.040	0.13
Discipline		.006	0.33	.042	0.19	.003	0.36	.027	0.22
Protocol x Time		.219	0.07	.598	0.03	.473	0.04	.166	0.08
Protocol x Discipline		.937	0.00	.717	0.01	.537	0.02	.885	0.00
Time x Discipline		.330	0.06	.849	0.02	.398	0.05	.932	0.01

§ Significantly different from T0 ($p < .05$), † significantly different from T1 ($p < .05$), Values in bold express significant differences between disciplines for the given time point ($p < .05$), $MP_{TRANSITION}$ = transition mean power; MP_{BRAKE} = braking mean power; MP_{PROP} = propulsive mean power; T0 = pre-effort condition; T1 = post-series 1 condition; T2 = post-series 2 condition; T3 = post-series 3 condition.

Table 5. Velocity-related variables. Values are expressed as mean ± SD

Protocol	Time	Minimum Velocity ($m \cdot s^{-1}$)		Peak Velocity ($m \cdot s^{-1}$)		V_{PP} ($m \cdot s^{-1}$)		$V_{TRANSITION}$ ($m \cdot s^{-1}$)		V_{BRAKE} ($m \cdot s^{-1}$)	
		Cyclic	Acyclic	Cyclic	Acyclic	Cyclic	Acyclic	Cyclic	Acyclic	Cyclic	Acyclic
Short	T0	-0.95 ± 0.34	**-1.28 ± 0.18**	2.51 ± 0.16	**2.74 ± 0.15**	2.26 ± 0.20	**2.50 ± 0.13**	-0.77 ± 0.28	**-1.03 ± 0.17**	-0.63 ± 0.24	**-0.85 ± 0.11**
	T1	-0.97 ± 0.32	**-1.25 ± 0.16**	2.52 ± 0.15	**2.71 ± 0.16**	2.24 ± 0.17	**2.46 ± 0.15**	-0.78 ± 0.29	**-1.03 ± 0.12**	-0.63 ± 0.23	**-0.82 ± 0.09**
	T2	-0.97 ± 0.30	**-1.25 ± 0.20**	2.53 ± 0.16	**2.68 ± 0.16**	2.26 ± 0.17	**2.42 ± 0.15** §	-0.78 ± 0.25	**-1.03 ± 0.17**	-0.64 ± 0.20	**-0.82 ± 0.12**
	T3	-0.94 ± 0.33	**-1.25 ± 0.19**	2.53 ± 0.18	2.66 ± 0.17	2.25 ± 0.20	**2.41 ± 0.15** §†	-0.77 ± 0.28	**-1.02 ± 0.17**	-0.62 ± 0.21	**-0.81 ± 0.10**
Long	T0	-0.93 ± 0.31	**-1.30 ± 0.26**	2.55 ± 0.17	2.73 ± 0.21	2.30 ± 0.20	**2.49 ± 0.20**	-0.76 ± 0.24	**-1.09 ± 0.21**	-0.62 ± 0.21	**-0.85 ± 0.15**
	T1	-0.93 ± 0.28	**-1.24 ± 0.22**	2.55 ± 0.12	**2.71 ± 0.19**	2.26 ± 0.17	**2.45 ± 0.18**	-0.74 ± 0.25	**-1.01 ± 0.18**	-0.60 ± 0.20	**-0.81 ± 0.14**
	T2	-0.95 ± 0.24	**-1.23 ± 0.22**	2.53 ± 0.12	**2.71 ± 0.21**	2.26 ± 0.17	**2.45 ± 0.19**	-0.75 ± 0.19	**-1.02 ± 0.19**	-0.61 ± 0.16	**-0.81 ± 0.14**
	T3	-0.91 ± 0.29	**-1.25 ± 0.24**	2.49 ± 0.12	**2.78 ± 0.33**	2.22 ± 0.20	**2.44 ± 0.20**	-0.75 ± 0.21	**-1.00 ± 0.18**	-0.62 ± 0.18	-0.77 ± 0.20
		p	η_p^2	p	η_p^2	p	η_p^2	p	η_p^2	p	η_p^2
Protocol		.584	0.02	.169	0.09	.471	0.03	.749	0.00	.512	0.02
Time		.430	0.05	.423	0.05	< .001	0.33	.551	0.03	.220	0.07
Discipline		.008	0.31	.009	0.30	.008	0.30	.005	0.33	.008	0.30
Protocol x Time		.753	0.02	.712	0.01	.569	0.03	.156	0.08	.558	0.03
Protocol x Discipline		.823	0.00	.654	0.01	.926	0.00	.599	0.01	.995	0.00
Time x Discipline		.455	0.05	.604	0.03	.710	0.02	.627	0.03	.275	0.06

§ Significantly different from T0 ($p < .05$), † significantly different from T1 ($p < .05$), Values in bold express significant differences between disciplines for the given time point ($p < .05$).
V_{PP} = velocity at peak power; $V_{TRANSITION}$ = transition mean velocity; V_{BRAKE} = braking mean velocity; T0 = pre-effort condition; T1 = post-series 1 condition; T2 = post-series 2 condition; T3 = post-series 3 condition.

Table 6. Net impulse and Ratios of force development. Values are expressed as mean ± SD

Protocol	Time	NI_{BRAKE} (N·s·kg^{-1})		NI_{PROP} (N·s·kg^{-1})		RFD_{UNLOAD} (N·s^{-1})		$RFD_{TRANSITION}$ (N·s^{-1})		RFD_{BRAKE} (N·s^{-1})	
		Cyclic	Acyclic	Cyclic	Acyclic	Cyclic	Acyclic	Cyclic	Acyclic	Cyclic	Acyclic
Short	T0	0.96 ± 0.34	**1.28 ± 0.18**	2.38 ± 0.20	**2.66 ± 0.17**	-1591 ± 1052	-2465 ± 907	1954 ± 947	**3266 ± 982**	2739 ± 1550	**4300 ± 1334**
	T1	0.97 ± 0.32	**1.25 ± 0.16**	2.38 ± 0.17	**2.62 ± 0.16**	-1710 ± 1024	-2632 ± 1274	1970 ± 1065	**3544 ± 1230**	2816 ± 1487	**4182 ± 1109**
	T2	0.97 ± 0.30	**1.25 ± 0.20**	2.38 ± 0.20	**2.60 ± 0.17**	-1659 ± 1057	**-2612 ± 1031**	1783 ± 909	**3656 ± 1521**	2204 ± 1020	**4176 ± 1147**
	T3	0.94 ± 0.34	**1.27 ± 0.22**	2.38 ± 0.20	**2.56 ± 0.22**	-1521 ± 897	**-2659 ± 1104**	2017 ± 1146	**3450 ± 1301**	2752 ± 1661	3798 ± 1122
Long	T0	0.93 ± 0.30	**1.30 ± 0.26**	2.42 ± 0.20	**2.67 ± 0.22**	-1486 ± 987	**-2469 ± 997**	1854 ± 1081	**3662 ± 1709**	2679 ± 2025	**4449 ± 1704**
	T1	0.90 ± 0.30	**1.24 ± 0.22**	2.40 ± 0.15	**2.62 ± 0.20**	-1620 ± 961	**-2672 ± 1032**	1899 ± 1057	**3631 ± 1657**	2470 ± 1737	**4239 ± 1252**
	T2	0.92 ± 0.24	**1.25 ± 0.23**	2.38 ± 0.15	**2.63 ± 0.23**	-1531 ± 742	**-2602 ± 1058**	1860 ± 835	**3454 ± 1392**	2129 ± 1027	**4147 ± 815**
	T3	0.93 ± 0.27	**1.24 ± 0.22**	2.34 ± 0.14 §	**2.62 ± 0.23**	-1622 ± 1059	-2693 ± 1171	1776 ± 857	**3368 ± 1306**	2112 ± 1275	**3982 ± 695**

	p	η_p^2	p	η_p^2	p	η_p^2	p	η_p^2	p	η_p^2
Protocol	.527	0.02	.295	0.06	.720	0.01	.857	0.01	.305	0.05
Time	.151	0.08	< .001	0.33	.143	0.09	.726	0.02	.063	0.33
Discipline	.008	0.30	.005	0.34	.035	0.20	.004	0.35	.005	0.33
Protocol x Time	.732	0.02	.396	0.05	.924	0.01	.242	0.07	.300	0.02
Protocol x Discipline	.851	0.01	.791	0.00	.740	0.01	.508	0.01	.226	0.07
Time x Discipline	.675	0.03	.885	0.01	.790	0.02	.812	0.02	.486	0.04

§ Significantly different from T0 (p < .05), Values in bold express significant differences between disciplines for the given time point (p < .05), NI_{BRAKE} = braking net impulse; NI_{PROP} = propulsive net impulse; RFD_{UNLOAD} = unloading rate of force development; $RFD_{TRANSITION}$ = transition rate of force development; RFD_{BRAKE} = braking rate of force development; T0 = pre-effort condition; T1 = post-series 1 condition; T2 = post-series 2 condition; T3 = post-series 3 condition.

Discussion

The purpose of the present study was to determine the effects of short and long HIIT protocols on neuromuscular status assessed through CMJ tests was to analyze the acute effects of a short and a long HIIT session on CMJ performance. As the participants were athletes from different sport modalities, a secondary aim of this study was to compare both the CMJ characteristics and the neuromuscular responses to HIIT between endurance running athletes and team sport players. To our knowledge, this is the first study to analyze the effects of fatigue on jump performance between two HIIT sessions of equal relative load with different work-interval durations. The main findings of this study were a decrease in jump performance due to the total volume completed, irrespective of whether a short or long protocol was conducted, and the fact that specific performance parameters were affected depending on the jumping strategy associated with the sport profile.

Previous studies have addressed the effects of fatigue on neuromuscular function. However, most of them have implemented protocols performed until exhaustion (Bedo et al., 2020; Garrett et al., 2019; Gathercole et al., 2015; Watkins et al., 2017). The present design was based on the completion of regular HIIT prescriptions that are usually conducted in conditioning programs and, consequently, it was not performed until exhaustion. This issue should be considered when interpreting the results of the current study in order to contrast them adequately with those reported in the literature. For example, the 5.7% reduction in JH observed in the acyclic group at the end of the third series was notably smaller than the ≈15% found in an Australian Football Rules post-match measurement (Garrett et al., 2019) or after a knee extension fatiguing protocol (Rodacki et al., 2002), and smaller than the 10% reported after 3 consecutive maximal running test (Gathercole et al., 2015). These differences may be explained by the characteristics of the protocols and the total volume applied. In the aforementioned studies, the mean volume reported was 8600 m (Gathercole et al., 2015) and 12000 m (Garrett et al., 2019) while in the current study the mean volume was almost 5100 m. In addition, the completion of a fatigue protocol focused on specific muscle extenuation (Rodacki et al., 2002), leading to a higher reduction in jump outcomes compared with the present study, where the whole muscular system was involved.

On the other hand, the present findings coincide with those of Thorlund et al. (2008), who reported a 5.2% reduction in JH after series of handball-related movements simulating a handball match. This is consistent with the similarities in the configuration of both fatiguing protocols. The total volume of that study was 6500 m, pauses were implemented between repetitions and the total duration was 50 min, parameters that are comparable to the load components of the current study (5100 m, regular pauses and mean total duration of 53.1 min).

It has been argued that long HIIT protocols elicit higher lactate and perceptual responses than short-interval prescriptions (Price & Moss, 2007; Wakefield & Glaister, 2009; Warr et al., 2018). Therefore, we expected that a significant decrease in jump performance would also be observed in the long protocol than in the short one. Based on the present findings, that hypothesis was rejected, suggesting that CMJ performance during HIIT is not dependent on the metabolic and perceptual parameters.

This paper also explored the jumping strategy applied by groups of sport disciplines with a different performance profile. Previous research has reported a higher JH for outdoor team sports when compared with indoor team sports, suggesting that the profile of jumpers depended on the sporting background (Laffaye et al., 2014). In the current study, the criterion used to define both groups depended on the sport requirements. Based on this approach, we expected different profiles associated with each group, which were confirmed by the significantly higher speed at maximal oxygen uptake of the cyclic athletes and the significantly higher jumping gross outcomes of the acyclic players.

In addition, differences in CMJ sub-phase characteristics were also found between the cyclic and acyclic groups, revealing that specific jumping patterns were applied by each

group. The acyclic players executed jumps faster considering the higher values observed in all of the velocity-related variables. This is consistent with previous findings that demonstrated a slower jump contraction associated with groups of lower jump performance outcomes (Jordan et al., 2018; McMahon et al., 2017).

The acyclic group also showed higher values in 4 out of the 5 power-related variables, which is reasonable due to the compound determination of these variables with respect to the velocity component. There were no significant differences in peak power between the cyclic and acyclic groups. This contrasts with the findings of Mc Mahon et al. (2017), who reported a significantly higher peak concentric power in the group with greater jump height (men), attributed to the increased velocity during the concentric phase. An explanation for this discrepancy may lie in both the gender-based criterion used to determine the groups in that study and the smaller amplitude in the peak velocity values between groups observed in the current study.

Relative net impulse plays an important role in determining jumping performance (Kirby et al., 2011). Recent research has shown that a greater impulse during the jump phases was associated with better jumpers (Harry et al., 2018), which is consistent with our findings of significantly higher values in relative net impulse displayed by acyclic players. The rate of force development is another measure that has been shown to be a key determinant of vertical jump performance (Laffaye et al.; 2014, McLellan et al., 2011). However, there were studies that reported no correlation between RFD and vertical jump performance in male soccer players (Barker et al., 2018) and no significant differences between good and poor jumpers (Harry et al., 2018). In the current study, the acyclic group displayed significantly higher RFDs in the three sub-phases for which this measure was calculated, supporting the idea of a possible association between jump performance and RFD in better jumpers. In addition, the fact that differences were observed even in RFD_{UNLOAD} may indicate that a distinct jumping strategy could be applied from the early phases of the jump.

It has been shown that the duration of the CMJ sub-phases alone are weak predictors of jump performance in between-group comparisons (Laffaye et al., 2014; Sole et al., 2018) and insufficiently reliable measures in test-retest assessments (Warr et al., 2020). This is consistent with the present findings, which revealed a similar temporal structure exhibited by both groups in all the conditions, except for the duration of the braking sub-phase.

Interestingly, all variables of the braking sub-phase (T_{BRAKE}, MF_{BRAKE}, V_{BRAKE}, MP_{BRAKE}, NI_{BRAKE} and RFD_{BRAKE}) showed significant differences between athletes of cyclic and acyclic sports. This sub-phase reflects the deceleration of the center of mass and provides information on the stretch-shortening cycle (Sole et al., 2018). The explosive characteristics of team-sport movements require an efficient braking capacity prior to the propulsive action. Thus, it should not be surprising that, especially in this sub-phase, acyclic players exhibited higher performance measures than cyclic athletes, since they are familiar with these types of contractions.

Last but not least, the jumping performance was differentially affected by HIIT depending on the sport discipline. Our results suggest that during HIIT, fatigue could start affecting the principal component that the jumping strategy is based on. Acyclic players showed a fast pattern strategy and tended to reduce their velocity when fatigue was accumulated. In contrast, the low braking performance exhibited by the cyclic athletes may indicate that their jumping strategy was based on the propulsive sub-phase, where a decrease in the performance parameters is observed with the reduction of NI_{PROP} and MP_{PROP} on completion of the long protocol.

There are some aspects of the present study that must be noted as potential limitations. Firstly, as the analyses were based on the VGRF data, no specific information was obtained with regard to the muscular activation amplitude or segmental angular velocities. We have chosen force platform assessments because this is a practical and reliable device that can be easily introduced within the execution of a HIIT session. However, future research should include complementary methods such as electromyography or three-dimensional video modelling to determine the effects of HIIT on the neuromuscular function more precisely. The second aspect is that only male regional-level athletes participated in the study. Therefore, the present findings should be interpreted with caution, as it is unclear whether these results would be observed in other male populations (elite athletes, recreational sportsmen) or in females. The last aspect is that the present study focused exclusively on the work-interval duration. The effect that the variation of other components of HIIT could have on neuromuscular performance was beyond the scope of this study. Thus, further research is warranted to better understand the fatigue mechanisms affecting neuromuscular status during different prescriptions of intermittent exercise.

Conclusions

In summary, this study demonstrated that during one HIIT session, the neuromuscular status was principally affected by the total volume completed rather than by the type of protocol implemented. Specifically, decreases in CMJ performance did not occur until a relatively high volume of HIIT (i.e. three times the T_{LIM}) had been completed. In addition, different jumping strategies were applied depending on the profile of the sport discipline. Acyclic players jumped higher than cyclic athletes, this being expressed principally as higher values in the velocity component and the RFD with more efficient performance during the middle sub-phases of the jump (i.e. braking sub-phase). Finally, both groups manifested different responses to fatigue. The acyclic group showed a significant decrease in the jump height outcome, possibly elicited by a reduction of velocity at peak power. In the cyclic group, however, a significant decrease was observed in the net impulse and the mean power of the propulsive sub-phase, even though no reduction in jump height was detected.

Practical Applications

The present study has shown that HIIT executed at an intensity near the zone of maximal aerobic speed does not affect neuromuscular status until a volume equal to three times the T_{LIM} is reached. This could be useful for physical trainers and coaches, as it provides specific information about the neuromuscular responses that may be observed when conducting this type of protocols. In several training situations, coaches have to include different physical contents to be conducted within the same session. The current findings indicate that HIIT could be performed concurrently with other skills (i.e. strength training, power training) if a low volume is completed, irrespective of whether a long or short work-interval duration is selected. When the total volume exceeds

two times the T_{LIM}, then a decrease in jump performance should be expected. In this situation, following the HIIT session, the inclusion of exercises with a high demand in the velocity component are not suggested for acyclic athletes, and exercises with high requirements of propulsive actions (i.e. strength training) should not be implemented in cyclic athletes.

References

Barker L.A., Harry J.R., & Mercer J.A. (2018). Relationships between countermovement jump ground reaction forces and jump height, reactive strength index, and jump time. *Journal of Strength and Conditioning Research, 32*, 248-254. https://doi.org/10.1519/JSC.0000000000002160

Bedo B.L.S., Pereira D.R., Moraes R., Kalva-Filho C.A., Will-de-Lemos T., & Santiago P.R.P. (2020). The rapid recovery of vertical force propulsion production and postural sway after a specific fatigue protocol in female handball athletes. *Gait & Posture, 77*, 52-58. https://doi.org/10.1016/j.gaitpost.2020.01.017

Benítez-Jiménez, A.; Falces-Prieto, M.; García-Ramos, A. (2020). Jump performance after different friendly matches played on consecutive days. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 20* (77), 185-196 https://doi.org/10.15366/rimcafd2020.77.012

Benjaminse A., Habu A., Sell T.C., Abt J.P., Fu F.H., Myers J.B., & Lephart S.M. (2008). Fatigue alters lower extremity kinematics during a single-leg stop-jump task. *Knee Surgery, Sports Traumatology, Arthroscopy, 16*, 400-407. https://doi.org/10.1007/s00167-007-0432-7

Billat V.L., Slawinski J., Bocquet V., Demarle A., Lafitte L., Chassaing P., & Koralsztein J-P. (2000). Intermittent runs at the velocity associated with maximal oxygen uptake enables subjects to remain at maximal oxygen uptake for a longer time than intense but submaximal runs. *European Journal of Applied Physiology, 81*, 188-196. https://doi.org/10.1007/s004210050029

Buchheit M. & Laursen P. (2013). High-intensity training, solutions to the programming puzzle. Part II: anaerobic energy, neuromuscular load and practical applications. *Sports Medicine,* 43, 927-954. https://doi.org/10.1007/s40279-013-0066-5

Claudino J.G., Cronin J., Mezêncio B., McMaster D.T., McGuigan M., Tricoli V., Amadio A.C., & Serrão J.C. (2017). The countermovement jump to monitor neuromuscular status: A meta-analysis. *Journal of Science and Medicine in Sport, 20*, 397-402. https://doi.org/10.1016/j.jsams.2016.08.011

Cormack S.J., Newton R.U., McGuigan M.R., & Cormie P. (2008). Neuromuscular and endocrine responses of elite players during an Australian rules football season. *International Journal of Sports Physiology and Performance, 3*, 439-453. https://doi.org/10.1123/ijspp.3.4.439

Cormie P., McGuigan M.R., & Newton R.U. (2010). Changes in the eccentric phase contribute to improved stretch-shorten cycle performance after training. *Medicine & Science in Sports & Exercise, 42*, 1731-1744. https://doi.org/10.1249/mss.0b013e3181d392e8

Dupont G., Blondel N., Lensel G., & Berthoin S. (2002). Critical velocity and time spent at a high level of for short intermittent runs at supramaximal velocities. *Canadian Journal of Applied Physiology, 27*, 103-115. https://doi.org/10.1139/h02-008

Garrett J., Graham S.R., Eston R.G., Burgess D.J., Garrett L.J., Jakeman J., & Norton K. (2019). A Novel Method of Assessment for Monitoring Neuromuscular Fatigue in Australian Rules Football Players. *International Journal of Sports Physiology and Performance, 14*, 598-605. https://doi.org/10.1123/ijspp.2018-0253

Gathercole R., Sporer B., Stellingwerff T., & Sleivert G. (2015). Alternative Countermovement-jump analysis to quantify acute neuromuscular fatigue. *International Journal of Sports Physiology and Performance, 10*, 84-92. https://doi.org/10.1123/ijspp.2013-0413

Griffiths B., Grant J., Langdown L., Gentil P., Fisher J., & Steele J. (2019). The Effect of In-Season Traditional and Explosive Resistance Training Programs on Strength, Jump Height, and Speed in Recreational Soccer Players. *Research Quarterly for Exercise and Sport, 90*, 95-102. https://doi.org/10.1080/02701367.2018.1563276

Harry J.R., Paquette M.R., Schilling B.K., Barker L.A., James C.R., & Dufek J.S. (2018). Kinetic and electromyographic subphase characteristics with relation to countermovement vertical jump performance. *Journal of Applied Biomechanics, 34*, 291-297. https://doi.org/10.1123/jab.2017-0305

Hori N., Newton R.U., Kawamori N., McGuigan M.R., Kraemer W.J., & Nosaka K. (2009). Reliability of performance measurements derived from ground reaction force data during countermovement jump and the influence of sampling frequency. *Journal of Strength and Conditioning Research, 23*, 874-882. https://doi.org/10.1519/JSC.0b013e3181a00ca2

Jordan M.J., Aagaard P., & Herzog W. (2018). A comparison of lower limb stiffness and mechanical muscle function in ACL-reconstructed, elite, and adolescent alpine ski racers/ski cross athletes. *Journal of Sport and Health Science, 7*, 416-424. https://doi.org/10.1016/j.jshs.2018.09.006

Kirby T.J., McBride J.M., Haines T.L., & Dayne A.M. (2011). Relative net vertical impulse determines jumping performance. *Journal of Applied Biomechanics, 27*, 207-214. https://doi.org/10.1123/jab.27.3.207

Laffaye G., Wagner P.P., & Tombleson T.I. (2014). Countermovement jump height: Gender and sport-specific differences in the force-time variables. *Journal of Strength and Conditioning Research, 28*, 1096-1105. https://doi.org/10.1519/JSC.0b013e3182a1db03

McLellan C., Lovell D., & Gass G. (2011). The role of rate of force development on vertical jump performance. *Journal of Strength and Conditioning Research, 25*, 379-385. https://doi.org/10.1519/JSC.0b013e3181be305c

McMahon J.J., Rej S.J., & Comfort P. (2017). Sex differences in countermovement jump phase characteristics. *Sports, 5*, 8. https://doi.org/10.3390/sports5010008

Moir G.L. (2008). Three Different Methods of Calculating Vertical Jump Height from Force Platform Data in Men and Women. *Measurement in Physical Education and Exercise Science, 12*, 207-218. https://doi.org/10.1080/10913670802349766

Price M., & Moss P. (2007). The effects of work: rest duration on physiological and perceptual responses during intermittent exercise and performance. *Journal of Sports Sciences, 25*, 1613-1621. https://doi.org/10.1080/02640410701287248

Rodacki A.L.F., Fowler N.E., & Bennett S.J. (2002). Vertical jump coordination: fatigue effects. *Medicine & Science in Sports &*

Exercise, 34, 105-116. https://doi.org/10.1097/00005768-200201000-00017

Rozenek R., Funato K., Kubo J., Hoshikawa M., & Matsuo A. (2007). Physiological responses to interval training sessions at velocities associated with VO. max. *Journal of Strength and Conditioning Research, 21*, 188-192. https://doi.org/10.1519/R-19325.1

Sole C.J., Mizuguchi S., Sato K., Moir G.L., & Stone M.H. (2018). Phase characteristics of the countermovement jump force-time curve: A comparison of athletes by jumping ability. *Journal of Strength and Conditioning Research, 32*, 1155-1165. https://doi.org/10.1519/JSC.0000000000001945

Thorlund J., Michalsik L., Madsen K., & Aagaard P. (2008). Acute fatigue#induced changes in muscle mechanical properties and neuromuscular activity in elite handball players following a handball match. *Scandinavian Journal of Medicine & Science in Sports, 18*, 462-472. https://doi.org/10.1111/j.1600-0838.2007.00710.x

Tschakert G., & Hofmann P. (2013). High-intensity intermittent exercise: methodological and physiological aspects. *International Journal of Sports Physiology and Performance, 8*, 600-610. https://doi.org/10.1123/ijspp.8.6.600

Tschakert G., Kroepfl J., Mueller A., Moser O., Groeschl W., & Hofmann P. (2015). How to regulate the acute physiological response to "aerobic" high-intensity interval exercise. *Journal of Sports Science & Medicine, 14*, 29-36.

Vasquez-Bonilla, A.A., Brazo-Sayavera, J., Timon, R., & Olcina, G. (2021). Measurement of resting muscle oxygenation and the relationship with countermovement jumps and body composition in soccer players. *Cultura, Ciencia y Deporte, 16*(48), 215-223. http://dx.doi.org/10.12800/ccd.v16i48.1726

Wakefield B.R., & Glaister M. (2009). Influence of Work-Interval Intensity and Duration on Time Spent at a High Percentage VO2max During Intermittent Supramaximal Exercise. *Journal of Strength and Conditioning Research, 23*, 2548-2554. https://doi.org/10.1519/JSC.0b013e3181bc19b1

Warr-di Piero D., Valverde-Esteve T., Redondo-Castán J.C., Pablos-Abella C., & Sánchez-Alarcos Díaz-Pintado J.V. (2018). Effects of work-interval duration and sport specificity on blood lactate concentration, heart rate and perceptual responses during high intensity interval training. *PloS One, 13*, e0200690. https://doi.org/10.1371/journal.pone.0200690

Warr D.M., Pablos C., Sánchez-Alarcos J.V., Torres V., Izquierdo J.M., and Redondo J.C. (2020). Reliability of measurements during countermovement jump assessments: Analysis of performance across subphases. *Cogent Social Sciences, 6*, 1843835. https://doi.org/10.1080/23311886.2020.1843835

Watkins C.M., Barillas S.R., Wong M.A., Archer D.C., Dobbs I.J., Lockie R.G., Coburn J.W., Tran T.T., & Brown L.E. (2017). Determination of vertical jump as a measure of neuromuscular readiness and fatigue. *Journal of Strength and Conditioning Research, 31*, 3305-3310. https://doi.org/10.1519/JSC.0000000000002231

Wilson J.M., Marin P.J., Rhea M.R., Wilson S.M., Loenneke J.P., & Anderson J.C. (2012). Concurrent training: a meta-analysis examining interference of aerobic and resistance exercises. *Journal of Strength and Conditioning Research, 26*, 2293-2307. https://doi.org/10.1519/JSC.0b013e31823a3e2d

Zafeiridis A., Kounoupis A., Dipla K., Kyparos A., Nikolaidis M., Smilios I., & Vrabas I. (2015). Oxygen delivery and muscle deoxygenation during continuous, long-and short-interval exercise. *International Journal of Sports Medicine, 94*, 872-880. https://doi.org/10.1055/s-0035-1554634

CULTURA, CIENCIA Y DEPORTE

Tactical Performance of Talented Youth Soccer Players

Rendimiento táctico de jóvenes jugadores de fútbol con talento

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Abstract

The evaluation of talented soccer players has been based, traditionally, on physical capacities through technical-tactical tests. However, in the last years, soccer academies are focused their evaluations on technical-tactical and physical capacities, as well. Given that, the purpose of this work has been twofold: 1) to examine the evolution of the tactical performance of a group of talented players previously selected; 2) to compare the tactical performance between talented and non-talented players in previous literature. A total of 607 tactical sequences were evaluated. A total of 15 players were selected from an initial sample of 104 soccer players aged 14–23 years (17.03±2.01). The Nomination Scale for identifying Football Talent and the FUT-SAT instrument were used. The results indicated that the tactical principle *Width* and *Length* are the most used in the offensive phase, while *Defensive Unity* is the most frequent in the defensive phase. The effectiveness of the tactical principles decreases from U-16 to U-23. Finally, there is a greater percentage of efficacy in the use of tactical principles with talented players. In summary, that talented soccer players may have a better tactical acquisition in the offensive phase than the defensive. So, the precocity in tactical acquisition of these players must be considered when designing training sessions.

Keywords: sport initiation, gifted, education, decision-making, invasion game.

Resumen

La evaluación de los futbolistas talentosos se ha basado en pruebas técnicas aisladas. El lado táctico de cada jugador de fútbol ahora ha ganado más importancia. Por eso, el propósito de este trabajo ha sido doble. Primero, examinar la evolución del desempeño táctico de un grupo de jugadores talentosos previamente seleccionados. En segundo lugar, comparar el desempeño táctico entre jugadores talentosos y no talentosos. Se evaluaron un total de 607 secuencias tácticas. Estos jugadores fueron seleccionados de una muestra inicial de 104 jugadores de fútbol con edades comprendidas entre 14 y 23 años (17.03±2.01). Se utilizó la Escala de Nominación para la identificación del Talento del Fútbol y el instrumento FUT-SAT. Los resultados indicaron que el principio táctico *amplitud* y *longitud* son los más utilizados en la fase ofensiva, mientras que *unidad defensiva* es el más frecuente en la fase defensiva. La efectividad de los principios tácticos disminuye de U-16 a U-23. Existe un mayor porcentaje de eficacia en el uso de principios tácticos con jugadores talentosos. Se concluye que los futbolistas talentosos tienen una mejor adquisición táctica en la fase ofensiva que en la defensiva. Por tanto, la precocidad en la adquisición táctica de estos jugadores debe tenerse en cuenta a la hora de diseñar las sesiones de entrenamiento.

Palabras clave: iniciación deportiva, superdotados, educación, toma de decisiones, deporte de invasión.

Introduction

The evaluation of performance in talented players has been a matter of great interest in the last decade, increasingly in the topic in sports (Morley et al., 2017) and specifically in soccer (Pankhurst & Collins, 2013). Recent studies claim that the current selection processes must move the evaluation of talented soccer players towards new trends (Penney & McMahon, 2016) focusing on the tactical side of the player (Baker et al., 2017), replacing isolated tests (Serra-Olivares et al., 2016), which have no relevance when reaching the elite level (Nicolairé et al., 2013).

Regarding sporting initiation (from 8 to 14 years old), there are several instruments designed to evaluate the tactical performance of the young player (González-Víllora et al., 2015) such as the Game Performance Evaluation Tool, Performance Assessment in Team Sport and Game Performance Assessment Instrument. Thus, examples of how decision-making (DM) evolves has been studied in invasion games (Sanchez-Mora et al., 2011) such as volleyball (Araújo et al., 2015) and soccer (Praxedes et al., 2018), in which focus has even been given specifically to goalkeepers (Lamas et al., 2018). In short, it can be concluded that DM is the key characteristic that determines the trajectory of an athlete.

However, despite the enormous amount of money that soccer clubs are willing to invest in soccer players, experts do not count using these kinds of instruments from the youth age group onwards, or their reliability has been questioned (Ali, 2011; Forsman et al., 2016). On the one hand, performance indicators are being used to evaluate both soccer players and teams (Liu et al., 2015; Rein & Memmert, 2016; Sarmento et al., 2017). On the other hand, the insight of scouters is also considered a good way to make decisions when selecting young soccer players (Holt, 2002). Finally, classical tests are often used to evaluate technical, physiological or psychological aspects of soccer players (Murr et al., 2017; Phillips et al., 2010). Nevertheless, all these tests have limitations regarding their incapacity to measure DM (Santos et al., 2017), which can lead to biases regarding the relative age effect (Chittle et al., 2018; Gadžić et al., 2017; Gutierrez et al., 2010), maturation and physical condition (Towlson et al., 2017). It is necessary to take into account instruments such as TacticUp (Machado & Teoldo, 2019), an online evaluation platform that allows us to objectively determine soccer players' reading ability of the game and DM.

In this direction, the System of Tactical Assessment in Soccer (FUT-SAT) (Costa et al., 2011) can be a starting point for an improved evaluation of soccer players from 14 years old onwards, considering the importance of the tactical side of the player (Badari et al., 2021; Machado et al., 2019). In the last five years, some studies have used FUT-SAT with the purpose of understanding the DM in players of different ages. For example, Rechenchosky et al. (2017) analyzed the effectiveness of tactical principles in an U15 group, comparing them among the different game positions (defender, midfielder and striker). Correia et al. (2019) compared the quantity, quality and result of tactical actions in the U15 age group among professional and amateur soccer teams. Small-side games were used, and the results showed that professional players performed longer offensive tactical actions. Rodrigues et al. (2019) found in the U15 age group that soccer players with better tactical performance respond quicker to game demands. Bueno, Figueiredo and Costa (2013) compared the tactical performance between U11 and U17 players, finding that U17 players carried out more actions in nine of the ten principles that this tool evaluates. Figueiredo et al. (2013) analyzed tactical behavior, finding that U13 players exhibited better performance in four offensive tactical principles and four defensive tactical principles than U11 players. Brito et al. (2015) compared the performance of U14 and U15 players, finding that U15 players were able to protect the most dangerous areas of the field.

While there have been a number of studies looking at differences among lower age groups (González-Víllora et al., 2015; Praxedes et al., 2018), no study has been found the differences among talented and non-talented players in higher categories, which makes it difficult to conduct a suitable transition from youth soccer to senior soccer (Christensen & Sorensen, 2009; Roynesdal et al., 2018). Moreover, this process is based mainly on expert opinion instead of scientific evidence (Woods et al., 2016). Given that, the purpose of this work has been twofold: 1) to examine the evolution of the tactical performance of a group of talented players previously selected (U16, U18 and U23); 2) to compare the tactical performance between talented and non-talented players in previous literature.

Methods

Participants

A total of 607 tactical sequences were evaluated from 15 talented youth soccer players. These players were selected from an initial sample of 104 soccer players (M_{age} = 17.03, SD_{age} = 2.01; M_{weight} = 65.38 kg, SD_{weight} = 6.81 kg; M_{height} = 175 cm, SD_{height} = 6.55 cm) aged 14–23 years. They belonged to the soccer academy of a professional club. The U16 and U18 age group had the same amount of training: Four weekly sessions of 90 mins each; meanwhile, the U23 age group had five weekly sessions. Those players who were injured were not considered in this study. The table 1 shows the microcycle of the participants.

Table 1. Microcycle of the participants

Monday Session 1	Tuesday	Wednesday Session 2	Thursday Session 3	Friday Session 4	Saturday Session 5	Sunday
MD+1 Regenerative Complementary	No training session	MD-4 Strength session Game model session	MD-3 Preparatory match Eccentric session	MD-2 Compensatory session Offensive set pieces actions Defensive set pieces actions	MD-1 Match activation Game model session	Match day

Notes: MD = Match Day

As the sample was mostly composed of underage children, parents gave their consent for their children to participate in the study, while children also gave their verbal approval prior to data collection. The research project was fully approved by the Ethical Committee of the University of Castilla-La Mancha. The research has been developed under the recommendations of the Declaration of Helsinki.

Instruments

The Nomination Scale for Identifying Football Talent (NSIFT) helped to select those talented players through the evaluation of three dimensions: (1) cognitive aspects, relating to game intelligence and problem solving; (2) psychological aspects, relating to sport commitment and the ability to shoulder responsibilities; and (3) motivation, relating to the desire to improve as a player. It was recently designed and validated by Prieto-Ayuso et al. (2017).

Coaches, parents and teammates took part in the validation process. These three groups had a good correspondence with the final selection. Parents exhibited a moderate correlation with the selection (0.499), coaches showed a high correlation (0.711), and teammates showed a very high correlation (0.847). Finally, the scale had a reliability result of 0.88.

Once these players were selected, FUT-SAT (Costa et al., 2011) was used for tactical performance analysis. This instrument was designed to determine the tactical behavior of soccer players from 13–14 years old onwards. It is based on ten fundamental tactical principles in soccer, influenced by both spatial and temporal parameters of the game. We considered tactical principles (Penetration, Offensive coverage, Depth Mobility, Width and Length, and Offensive Unity), place of action (Offensive or Defensive side), and action outcomes (Keep or Lose the ball).

The test–retest method has been used to verify the reliability of the observations in FUT-SAT, maintaining an interval of three weeks between both tests to avoid problems of familiarity with the task (Robinson & O'Donoghue, 2007). Three evaluators that were based on the criteria of the "Observational criteria of FUT-SAT", which facilitates the analysis, evaluation and classification of the tactical actions carried out by the players who participated in the procedure.

Procedure

This was a descriptive design with two groups, carried out in two phases: (1) the selection process, in which the talented players were discriminated with the NSIFT; and (2) performance analysis, when the data collection was carried out through the recording of matches in the three groups. This took place in the last two months of the regular season. They were carried out over five days, one for each team analyzed. A random match of the regular season (11 vs 11) was recorded with a Sony HDR-AS100VR camera, located in the highest part of the stadium and recording the entire field, with the purpose to facilitate player analysis. A full match was recorded (90 minutes) but only the first ten minutes were analyzed, according to the indications of the authors (García-López et al., 2013).

Statistical Analysis

To conduct the statistical analysis, 10% of the sample were re-evaluated, a value equal to that indicated by previous studies (Tabchnick & Fidell, 2007). The values for intra-observer reliability indicated a minimum of 0.813 and maximum of 1000. The inter-observer reliability presented a minimum of 0.813 and maximum of 1000. SPSS v.22.0. software was used to process the data. For descriptive analysis, frequencies, means, standard deviations and percentages of success of the tactical actions were used. For the inferential analysis, the Kolmogorov–Smirnov test confirmed a normal distribution of variables, leading to the use of parametric tests. The Kappa de Cohen statistic was used to calculate the reliability. To check the tactical performance differences among the three groups, a one-way ANOVA with Bonferroni post-hoc test was applied, the purpose being to know the differences between each pair age group. Finally, a correlational analysis (Rho Pearson) was used to understand the relationship between the Tactical Performance Index (TPI) and the three groups analyzed. A difference was considered significant with a p-value of <0.05.

Results

On the one hand, the Table 2 presents the frequency and percentage of success for the tactical principles of talented soccer players in each sequence. The descriptive analysis demonstrates a high efficiency in tactical principles, with effectiveness between 50% and 100%. On the other hand, both frequency and effectiveness tend to decrease as the age group advances. Of all groups analyzed, the most common

behavior in the offensive phase was Width and Length, and in the defensive phase, this was Defensive Unity. In relation to the inferential analysis, only the tactical principle Defensive Unity (p = 0.003), as well as Total Defensive (p = 0.000), showed significant difference.

Table 2. Frequency of actions percentage of success % and significant differences p in tactical principles ANOVA in each sequence

	U-16	U-18	U-23	
	N (%)	N (%)	N (%)	*p*
Penetration	10 (100%)	2 (50%)	4 (100%)	.092
Offensive coverage	34 (100%)	20 (100%)	36 (96.82%)	.162
Depth mobility	1 (100%)	-	12 (100%)	-
Width and Length	131 (97.40%)	127 (93.22%)	123 (97.26%)	.450
Offensive Unity	123 (100%)	100 (100%)	31 (100%)	-
Delay	13 (100%)	18 94.44%)	1 (100%)	.600
Defensive Coverage	10 (100%)	22 (100%)	2 (50%)	-
Balance	22 (100%)	21 (100%)	5 (91.66)	.133
Concentration	38 (100%)	28 (100%)	5 (100%)	-
Defensive Unity	56 (100%)	156 (100%)	39 (97.60%)	.003*
Total Tactical Offensive	299 (98.55%)	249 (96.92%)	206 (97.60%)	.451
Total Tactical Defensive	139 (100%)	245 (99.30%)	52 (89.47%)	.000**
Total Sequences	230 (37.89%)	250 (41.18%)	127 (20.93%)	

Notes: Total offensive = ∑offensive tactical actions; total defensive = ∑defensive tactical total; *p<0.05; **p<0.001

Then, a post-hoc Bonferroni test was used. Table 3 shows that there was a significant difference in the Defensive Unity principle among the age group pairs of U16 and U23, and U18 and U23. Furthermore, the Total Defensive principle showed significant differences between all three groups.

Table 3. Mean differences between each pair of age groups (Bonferroni test).

	Pairs	*p*
Defensive unity	U-16 and U-23	.006*
	U-18 and U-23	.006*
Total defensive	U-16 and U-18	.000*
	U-18 and U-23	.000*
	U-16 and U-23	.000*

Notes: *p<0.05

Table 4 presents the relationship between the TPI of each of the tactical principles analyzed and the age group. It was observed that Penetration, Offensive Coverage, Width and Length, and Concentration, had a positive relationship with age group. In contrast with the previous results, Depth Mobility, Offensive Unity, Delay, Defensive Coverage, Balance and Offensive Unity all showed negative correlations with age group. These relationships were significant for Offensive Unity, Width and Length, Balance and Defensive Unity.

Table 4. Correlation analysis between tactical principles and age groups (Rho Pearson)

	r	*p*
Penetration	.359	.278
Offensive Coverage	.622	.017*
Depth Mobility	-.857	.344
Width and Length	.726	.002*
Offensive Unity	-.243	.384
Delay	-.090	.771
Defensive Coverage	-.498	.119
Balance	-.532	.041*
Concentration	.175	.533
Defensive Unity	-.609	.016*

Notes: r = correlation coefficient; (*) statistically significant correlation = *p<0.05; **p<0.001

Table 5 reflects the relationships that marked a significant association between the principles evaluated.

Table 5. Significant relationships between tactical principles (Pearson Rho).

	r	*p*
Width and Length – Penetration	.615	.044*
Width and Length – Offensive Coverage	.865	.000**
Delay – Depth Mobility	.1000	.000**
Width and Length – Balance	-.579	.024*
Delay - Concentration	.823	.001**

Notes: r = correlation coefficient; *p<0.05; **p<0.001

Discussion

The objectives of the study were to understand the tactical performance in a group of soccer players selected as talented (U16, U18 and U23) and to compare game performance between talented and non-talented players. The results showed that 15 players were nominated as talented. To our knowledge, no previous study whose objectives were to evaluate game performance in soccer players in these age groups has adopted a selection process as objective as is presented here. For example, Sánchez-Mora et al. (2011) divided the sample into teams of a similar level of skillfulness, without showing the protocol used. Hastie et al. (2011) used a participation requirement in which players had to have attended three tests of physical condition and six practice sessions. In the study of Araújo et al. (2015), the participants had no previous experience. Práxedes et al. (2018) divided the sample into average skill-level and low skill-level, according to the team level of each participant. However, despite the existence of studies aiming to understand the tactical performance of soccer players (Lamas et al., 2018; Liu et al., 2015), this study has chosen a sample based on a rigorous selection process using the NSIFT.

The results of talented soccer players indicated that the tactical principle Width and Length is mostly performed in the offensive phase, while Defensive Unity is the most frequent tactical principle adopted in the defensive phase. These results coincide with the results of Bueno et al. (2013), in which both principles were the most used by the players. In the offensive phase, the soccer players used to perform a greater number of actions without the ball in defense line of the ball, with the intention of creating a pass line. During the defense, more actions are also performed outside of the center of the game, with the purpose of protecting the goal or being well positioned to defend the rival's attack.

Previous studies, such as those conducted by Bueno et al. (2013) and Figueiredo et al. (2013) indicated significant differences in the comparison of tactical performance in the Defensive Unity principle. This difference among U11, U13 and U17 age groups was also found in this study among the U18 and U23 groups. This could indicate that while the players have assimilated those concepts related to offense from U16 level, this is not the same for the defensive side. There are differences in tactical performance as the age group progresses. In addition, the individual style of play can influence these results. The club in which the investigation was applied bases its game model on attacking, which

may explain why the players assimilated offensive tactical principles earlier than defensive ones.

The effectiveness of the tactical principles decreases slightly from U16 to U23. This result might be caused by the lack of an adequate talent development model in the literature reviewed (Sarmento et al., 2018). According to the pyramidal model (Bailey & Collins, 2013) the promotion into phases is based on age instead of performance. Moreover, the reliability of the instruments designed for the evaluation of the talented soccer players have not been proved (Nicolairé et al., 2013), even at elite level (Forsman et al., 2016). Bearing that in mind, the development of expertise might be influenced by both physical and maturation biases (Towlson et al., 2017), due to the well-known problem of relative age effect (Chittle et al., 2018) in the selection processes. New trends are emerging when it comes to evaluating talented soccer players (Sarmento et al., 2017). Unlike the classical test performed in isolated laboratory situations (Serra-Olivares et al., 2016), ecological processes are being considered (Sanchez-Mora et al., 2011; Araújo et al., 2017). The validation of the NSIFT (Prieto-Ayuso et al., 2017) has been a first step in the current evaluation of talented soccer players, including not only cognitive aspects related to game performance, but also both psychological and social aspects.

Regarding the second aim, it has been shown that there is a greater percentage of efficacy in the use of tactical principles through FUT-SAT, when comparing these results with a non-talented sample of players. For instance, Silva, Garganta, Santos and Teoldo (2014) found percentages of success in tactical principles of between 3% and 33%; the results of Bueno et al. (2013) were between 65% and 94%; and the results of Figueiredo et al. (2013) were between 25% and 99%. Nevertheless, the results presented with a sample previously selected as talented showed an effectiveness of between 50% and 100%, which is higher than previous studies.

Therefore, it is once again shown that talented players learn tactical principles earlier than their peers do. In addition, the higher effectiveness in older age groups shows the importance of deliberate practice (Ford et al., 2012) in the pathway to expertise. This has also been proved with the Tactical Performance Index. The results revealed a better TPI in older age groups in Penetration, Offensive Coverage, Width and Length, and Concentration compared with previous studies (Correia et al., 2019; Rechenchosky et al., 2017). However, Depth Mobility, Offensive Unity, Delay, Defensive Coverage, Balance and Defensive Unity exhibited lower values in older age groups. This could be explained by the fact that the soccer team in which the research was carried out focused its playing style on offense instead of defense, meaning soccer players will develop more skills in the attacking rather than the defensive side of the game. Special attention should be given to Balance and Defensive Unity, as they showed a negative relationship. These results should be taken into account by coaches, bearing in mind that the improvement of one tactical principle can positively affect another (e.g., Delay and Concentration).

The findings of this work can lead us to consider some practical applications not only for coaches but also for Physical Education teachers (Houlihan, 2000). Due to the fact that the high tactical performance shown by those players nominated as talented, it is necessary to put into practice a specific program for those players from a young age. This is common practice in other subjects (Hornstra et al., 2017; Wilkinson et al., 2015), but does not seem common in the soccer context. Thus, modified games (Kirk & Gorely, 2000), teaching games for understanding (Light & Tan, 2006) and futsal (Travassos et al., 2018; Yiannaki et al., 2018) could be good starting points in order to improve the tactical side of these soccer players. Moreover, the work has been carried out in males, but it is necessary to know the results for females as well, in order to improve physical activity and participation in sport (Gutierrez & Garcia-Lopez, 2015; Kirk, 2005; Young et al., 2015).

Finally, despite the strengths that this study presents, it is necessary to bring to light two limitations. First, the small number of participants who participated in the study. However, it is a common limitation in the studies with talented people, due to the number of talented people is only the 10% of a normal population. Secondly, we only studied male soccer players. Future studies must consider female samples in their objectives.

Conclusions

After carrying out the tactical evaluation of a group of talented soccer players, it was possible to come to the following conclusions. First, from a general point of view, talented soccer players show a better tactical acquisition in the offensive phase than the defensive phase. Secondly, talented players should be offered an individualized teaching program due to the fact they have exhibited greater tactical effectiveness in comparison with those non-detected for talent players in previous studies. Therefore, the precocity in tactical acquisition of these players must be considered by coaches in their training sessions.

References

Ali, A. (2011). Measuring soccer skill performance: a review. *Scandinavian journal of medicine & science in sports,* 21(2), 170-183. http://dx.doi.org/10.1111/j.1600-0838.2010.01256.x

Araújo, D., Hristovski, R., Seifert, L., Carvalho, J., & Davids, K. (2017). Ecological cognition: expert decision-making behaviour in sport. *International Review of Sport and Exercise Psychology*, 1-25. http://dx.doi.org/10.1080/1750984X.2017.1349826

Araújo, R., Mesquita, I., Hastie, P., & Pereira, C. (2016). Students' game performance improvements during a hybrid sport education–step-game-approach volleyball unit. *European Physical Education Review*, 22(2), 185-200. http://dx.doi.org/10.1177/1356336X15597927

Badari, T. P., Machado, G., Moniz, F., Fontes, A., & Teoldo, I. (2021). Comparison of soccer players' tactical behaviour in small-sided games according to match status. *Journal of Physical Education and Sport, 21*(1), 12-20. http://dx.doi.org/10.7752/jpes.2021.01002

Bailey, R. & Collins, D. (2013). The standard model of talent development and its discontents. *Kinesiology Review*, 2(4), 248-259. http://dx.doi.org/10.1123/krj.2.4.248

Brito, R., De Oliveira, V., Moreira, G., Julio, C., Da Costa, I. T., & Juan, P. (2015). Avaliaçao do comportamento tático no futebol: Princípios táticos fundamentais nas categorias Sub-14 e Sub-15 *Revista Brasileira de Ciência e Movimento,* 23(2), 59-65. http://dx.doi.org/10.18511/0103-1716/rbcm.v23n2p59-65

Bueno, H., Figueiredo, G., & Costa, I. T. (2013). Comparação do comportamento tático de jogadores de futebol entre

categorias sub-11 e sub-17. *Revista Mineira de Educação Física*, 715-721.

Baker, J., Schorer, J., & Wattie, N. (2017). Compromising talent: issues in identifying and selecting talent in sport. *Quest*, 1-16. http://dx.doi.org/10.1080/00336297.2017.1333438

Chittle, L., Horton, S., & Dixon, J. C. (2018). Relative age effects and academic timing in Canadian interuniversity football. *High Ability Studies*. 1-14. http://dx.doi.org/10.1080/13598139.2017.1423042

Costa, I., Garganta, J., Greco, P., Mesquita, I., & Maia, J. (2011). System of tactical assessment in Soccer (FUT-SAT): Development and preliminary validation. *Motricidade,* 7(1), 69-83. http://dx.doi.org/10.6063/motricidade.7(1).121

Correia, D., Teoldo, V., Casanova, F., Clemente, F. M., & Teoldo, I. (2019). Comparison between teams of different ranks in small-sided and conditioned games tournaments, *International Journal of Performance Analysis in Sport,* 19(4), 608-623, http://dx.doi.org/10.1080/24748668.2019.1643598

Christensen, M. K., & Sorensen, J. K. (2009). Sport or school? Dreams and dilemmas for talented young Danish football players. *European Physical Education Review*, 15(1), 115-133. http://dx.doi.org/10.1177/1356336X09105214

Figueiredo, G., Gonçalves, E., & Costa, I. T. (2013). Comparação entre o comportamento tático de jogadores de futebol das categorias sub-11 e sub-13. *Revista Mineira de Educacao Fisica (UFV),* 9, 701-707.

Ford, P. R., Carling, C., Garces, M., Marques, M., Miguel, C., Farrant, A., & Salmela, J. H. (2012). The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. *Journal of sports sciences,* 30(15), 1653-1663. http://dx.doi.org/10.1080/02640414.2012.701762

Forsman, H., Blomqvist, M., Davids, K., Liukkonen, J., & Konttinen, N. (2016). Identifying technical, physiological, tactical and psychological characteristics that contribute to career progression in soccer. *International journal of Sports Science & Coaching,* 11(4), 505-513. http://dx.doi.org/10.1177/1747954116655051

Gadžić, A., Milojević, A., Stanković, V., & Vučković, I. (2017). Relative age effects on motor performance of seventh-grade pupils. *European Physical Education Review,* 23(4), 534-542. http://dx.doi.org/10.1177/1356336X16671696

García-López, L. M., González-Víllora, S., Gutiérrez, D., & Serra, J. (2013). Development and validation of the Game Performance Evaluation Tool (GPET) in soccer. *Sport TK: Revista Euroamericana de Ciencias del Deporte,* 2(1), 89-99.

González-Víllora, S., García-López, L. M., & Contreras-Jordán, O. R. (2015). Decision Making and Technical Skills Evolution in Football. *International Journal of Medicine and Science of Physical Activity and Sport*, 59, 467-487. http://dx.doi.org/10.15366/rimcafd2015.59.005

González-Víllora, S., Serra-Olivares, J., Pastor-Vicedo, J. C., & Costa, I. T. (2015). Review of the tactical evaluation tools for youth players, assessing the tactics in team sports: football. *SpringerPlus,* 4(1), 663. http://dx.doi.org/10.1186/s40064-015-1462-0

Gutierrez, D., & Garcia-Lopez, L. M. (2012). Gender differences in game behaviour in invasion games. *Physical Education & Sport Pedagogy*, 17(3), 289-301. http://dx.doi.org/10.1080/17408989.2012.690379

Gutierrez, D., Pastor-Vicedo, J.C., Gonzalez-Villora, S. & Contreras-Jordan, C. (2010). The relative age effect in youth soccer players from Spain. *Journal of Sports Science and Medicine,* 9(2), 190-198.

Hastie, P.A., Calderón, A., Palao, J. & Ortega. E. (2011). Quantity and quality of practice: Interrelationships between task organization and student skill level in physical education. *Research Quarterly for Exercise and Sport,* 82(4), 784-787. http://dx.doi.org/10.1080/02701367.2011.10599815

Holt, N. L. (2002). A comparison of the soccer talent development systems in England and Canada. *European Physical Education Review*, 8(3), 270-285. http://dx.doi.org/10.1177/1356336X020083006

Hornstra, L., Van der Veen, I., & Peetsma, T. (2017). Effects of full-time and part-time high-ability programs on developments in students' achievement emotions. *High Ability Studies,* 28(2), 199-224. http://dx.doi.org/10.1080/13598139.2017.1332575

Houlihan, B. (2000). Sporting excellence, schools and sports development: The politics of crowded policy spaces. *European physical education review,* 6(2), 171-193. http://dx.doi.org/10.1177/1356336X000062005

Kirk, D. (2005). Physical education, youth sport and lifelong participation: the importance of early learning experiences. *European Physical Education Review,* 11(3), 239-255. http://dx.doi.org/10.1177/1356336X05056649

Kirk, D., & Gorely, T. (2000). Challenging thinking about the relationship between school physical education and sport performance. *European Physical Education Review,* 6(2), 119-134. http://dx.doi.org/10.1177/1356336X000062002

Lamas, L., Drezner, R., Otranto, G., & Barrera, J. (2018). Analytic method for evaluating players' decisions in team sports: Applications to the soccer goalkeeper. *PloS One,* 13(2), e0191431. http://dx.doi.org/10.1371/journal.pone.0191431

Light, R., & Tan, S. (2006). Culture, embodied experience and teachers' development of TGfU in Australia and Singapore. *European Physical Education Review,* 12(1), 99-117. http://dx.doi.org/10.1177/1356336X06060659

Liu, H., Gomez, M. Á., Lago-Peñas, C., & Sampaio, J. (2015). Match statistics related to winning in the group stage of 2014 Brazil FIFA World Cup. *Journal of Sports Sciences,* 33(12), 1205-1213. http://dx.doi.org/10.1080/02640414.2015.1022578

Machado, G., Bach, M., González, S., Clemente, F. M., & Teoldo, I. (2019). The effects of positional role on tactical behaviour in a four-a-side small-sided and conditioning soccer game. *Kinesiology, 51*(2.), 261-270. http://dx.doi.org/10.26582/k.51.2.15

Machado, G. & Teoldo, I, (2019). TacticUP: Validação de construto de um teste para avaliação do conhecimento tático declarativo de jogadores de futebol. *Anais 7ºSoccer Experience – Tática. Revista Brasileira de Futebol*, ISSN: 1983-7194

Morley, D., McKenna, J., Gilbert, S., French, J., Till, K., Quarmby, T., & Turner, G. (2017). Can't pay, can't play? Talent lead's perspectives on the financial constraints experienced by athletes on the England Talent Pathway. *High Ability Studies,* 1-14. http://dx.doi.org/10.1080/13598139.2017.1341389

Murr, D., Raabe, J., & Höner, O. (2018). The prognostic value of physiological and physical characteristics in youth soccer: A systematic review. *European journal of sport science,* 18(1), 62-74. http://dx.doi.org/10.1080/17461391.2017.1386719

Nicolairé, A. H., Cattuzzo, M. T., & De Mello, C. B. (2013). Questionable use of performance testing to predict success in soccer players: comment on Ljach, et al. (2012). *Perceptual and Motor Skills,* 116(1), 352-354. http://dx.doi.org/10.2466/30.10.25.PMS.116.1.352-354

Pankhurst, A., & Collins, D. (2013). Talent identification and development: The need for coherence between research, system, and process. *Quest,* 65(1), 83-97. http://dx.doi.org/10.1080/00336297.2012.727374

Penney, D., & McMahon, J. (2016). High-performance sport, learning and culture: new horizons for sport pedagogues?. *Physical Education and Sport Pedagogy,* 21(1), 81-88. http://dx.doi.org/10.1080/17408989.2015.1072511

Phillips, E., Davids, K., Renshaw, I., & Portus, M. (2010). Expert performance in sport and the dynamics of talent development. *Sports medicine*, 40(4), 271-283. http://dx.doi.org/10.2165/11319430-000000000-00000

Práxedes, A., Moreno, A., Gil-Arias, A., Claver, F., & Del Villar, F. (2018). The effect of small-sided games with different levels of opposition on the tactical behaviour of young footballers with different levels of sport expertise. *PloS One*, 13(1), e0190157. http://dx.doi.org/10.1371/journal.pone.0190157.

Prieto-Ayuso, A., Pastor-Vicedo, J. C., & Contreras-Jordán, O. (2017). Content validity and psychometric properties of the nomination scale for identifying football talent (NSIFT): Application to coaches, parents and players. *Sports,* 5(1), 2. http://dx.doi.org/10.3390/sports5010002

Rein, R., & Memmert, D. (2016). Big data and tactical analysis in elite soccer: future challenges and opportunities for sports science. *SpringerPlus*, 5(1), 1410. http://dx.doi.org/10.1186/s40064-016-3108-2

Rechenchosky, L., Borges, PH., Menegassi, VM., de Oliveira, JM., Guilherme, J., Teoldo, I., & Rinaldi, W. (2017). Comparison of tactical principles efficiency among soccer players from different game positions. *Human Movement,* 18(5) special/issue:31–38; doi: 10.1515/humo-2017-0040

Rodrigues, M., dos Santos, A., Greco, PJ., & Teoldo I. (2019). Association between inhibitory control and tactical performance of under-15 soccer players. *Journal of Sport Psychology,* 28 (1). 63–70.

Robinson, G., & O'Donoghue, P. (2007). A weighted kappa statistic for reliability testing in performance analysis of sport. *International Journal of Performance Analysis in Sport. 7*(1), 12-19. http://dx.doi.org/10.1080/24748668.2007.11868383

Røynesdal, Ø., Toering, T., & Gustafsson, H. (2018). Understanding players' transition from youth to senior professional football environments: A coach perspective. *International Journal of Sports Science & Coaching,* 13(1), 26-37. http://dx.doi.org/10.1177/1747954117746497

Sanchez-Mora, D., García, L. M., Del Valle, M., & Solera, I. (2011). Spanish primary school students' knowledge of invasion games. *Physical Education & Sport Pedagogy. 16*(3), 251-264. http://dx.doi.org/10.1080/17408989.2010.535195

Santos, S., Jiménez, S., Sampaio, J., & Leite, N. (2017). Effects of the Skills4Genius sports-based training program in creative behavior. *PloS One,* 12(2), e0172520. http://dx.doi.org/10.1371/journal.pone.0172520

Sarmento, H., Anguera, M. T., Pereira, A., & Araújo, D. (2018). Talent Identification and Development in Male Football: A Systematic Review. *Sports Medicine,* 1-25. http://dx.doi.org/10.1007/s40279-017-0851-7

Sarmento, H., Clemente, F. M., Araújo, D., Davids, K., McRobert, A., & Figueiredo, A. (2017). What Performance Analysts Need to Know About Research Trends in Association Football (2012–2016): A Systematic Review. *Sports medicine,* 1-38. http://dx.doi.org/10.1007/s40279-017-0836-6

Serra-Olivares, J., Clemente, F. M., & González-Víllora, S. (2016). Tactical expertise assessment in youth football using representative tasks. *SpringerPlus,* 5(1), 1301. http://dx.doi.org/10.1186/s40064-016-2955-1

Tabchnick, B., & Fidell, L. (2007). *Using multivariate statistics*. Boston: Allyin & Bacon.

Towlson, C., Cobley, S., Wayne Midgley, A., Garrett, A., Parkin, G., and Lovell, R. (2017). Relative Age, Maturation and Physical Biases on Position Allocation in Elite-Youth Soccer. *International Journal of Sports Medicine*, 38(3), 201-209. http://dx.doi.org/10.1055/s-0042-119029

Travassos, B., Araújo, D., & Davids, K. (2018). Is futsal a donor sport for football?: exploiting complementarity for early diversification in talent development. *Science and Medicine in Football,* 2(1), 66-70. http://dx.doi.org/10.1080/24733938.2017.1390322

Wilkinson, S., Penney, D., & Allin, L. (2016). Setting and within-class ability grouping: A survey of practices in physical education. *European Physical Education Review,* 22(3), 336-354. http://dx.doi.org/10.1177/1356336X15610784

Williams, A. M., & Reilly, T. (2000). Talent Identification and Development in Soccer. *Journal of Sport Sciences,* 18, 657-667. http://dx.doi.org/10.1080/02640410050120041

Woods, C. T., Joyce, C., & Robertson, S. (2016). What are talent scouts actually identifying? Investigating the physical and technical skill match activity profiles of drafted and non-drafted U18 Australian footballers. *Journal of science and medicine in sport,* 19(5), 419-423. http://dx.doi.org/10.1016/j.jsams.2015.04.013

Yiannaki, C., Carling, C., & Collins, D. (2018). Could futsal hold the key to developing the next generation of youth soccer players?. *Science and Medicine in Football,* 2(1), 71-74. http://dx.doi.org/10.1080/24733938.2017.1332422

Young, J. A., Symons, C. M., Pain, M. D., Harvey, J. T., Eime, R. M., Craike, M. J., & Payne, W. R. (2015). Role models of Australian female adolescents: A longitudinal study to inform programmes designed to increase physical activity and sport participation. *European Physical Education Review*, 21(4), 451-466. http://dx.doi.org/10.1177/1356336X15579574

CULTURA, CIENCIA Y DEPORTE

High-intensity functional training and quantification by Perceived Exertion Scale in physically active subjects

Entrenamiento funcional de alta intensidad y su cuantificación por Escala de Esfuerzo Percibido en sujetos físicamente activos

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Abstract

The purpose of the study was to determine the relationship between internal and external load in physically active subjects (11 men and 5 women) during a high-intensity functional training session, using different load markers: heart rate, perceived effort and the Edwards index. The maximum heart rate was assessed during a maximal incremental endurance test (Course Navette). Thereafter each participant performed a high-intensity functional training session (Workout of the Day - Pukie), while wearing a heart rate monitor, and the perceived effort was assessed with the 0-10 point scale at 0-min, 10-min, 20-min, and 30-min. Thereafter the Edwards index was calculated. The perceived effort was positively correlated with the heart rate and the Edwards index during the different time-points analyzed (Spearman r = 0,76-0,88; p<0,01). In conclusion, perceived effort can be used as a low-cost and logistically convenient method to assess the internal load experienced by physically active participants during a high-intensity functional training session.

Keywords: Physical conditioning, exercise, exercise test (Source: Mesh).

Resumen

El propósito del estudio fue determinar la relación entre la valoración del esfuerzo percibido en la sesión (EPES) y el Índice de Edwards (IE) para cuantificar la carga interna basado en la frecuencia cardíaca en el entrenamiento funcional de alta intensidad con sujetos físicamente activos. Estudio descriptivo de tipo correlacional con una muestra por conveniencia conformada por 11 hombres y 5 mujeres. Para valorar la frecuencia cardiaca máxima se utilizó el Test de Course-Navette, posteriormente se realizó el Workout of the Day (WOD) denominado "Pukie" donde cada participante contaba con un pulsómetro Polar H7, que recolectaba la escala de percepción subjetiva de la sesión (0-10), a partir de estos datos se calculó el IE. En el software PSPP (p-valor de 0,05) se llevó a cabo el análisis estadístico donde se manejó un coeficiente correlacional de Spearman para relacionar la EPES y el IE. La relación entre la escala recolectada en los diferentes fragmentos de tiempo post-ejercicio y el IE fue positiva, y el resultado obtenido fue muy significativo (r = 0,76-0,88; p < 0,01). Se puede concluir que la EPES es un método viable, económico y de fácil aplicación para cuantificar la carga interna en el entrenamiento funcional de alta intensidad con sujetos físicamente activos.

Palabras clave: Acondicionamiento físico, ejercicio, test de ejercicio (Fuente: Mesh).

Introduction

High intensity functional training or high intensity functional training (HIFT) is credited with employing high volumes and intensities of training (Teixeira, 2020), which is considered a novel way to perform exercises that test some of the body systems (muscular, nervous, respiratory, skeletal) and challenges people's abilities to complete the mechanical work (Crawford et al., 2018). Next, one of the HIFT training modalities that is currently listed by the training environment as the fastest growing in the world is CrossFit® (Claudino et al., 2018), likewise, this modality requires a high technical level of maximum effort and incomplete recovery between blocks and sessions (Camacho- Cardeñosa et al., 2020).

However, there is a need to control certain variables of the training load by specialized professionals, physical trainers and/or sport scientists (Balaguer & Caparrós, 2021), since there is a continuous challenge regarding the dosage of the training load, due to the possibility of obtaining an effective adaptation of the training, minimizing fatigue, inhibition of performance, overtraining and the occurrence of injuries (Halson, 2014; Jones et al., 2017). Because, within the training process an important factor is the quantification of the internal load (González-Fimbres et al., 2020), however, regarding HIFT there is still a lack of information on the monitoring and control of training methods (Alsamir-Tibana & De Sousa, 2018), therefore, it is necessary to expand scientific knowledge to improve preparation methods (Reche-Soto et al., 2020).

In the context of research one of the ideal topics is to compare, relate and analyze the influence of high intensity training with health and sports performance (Bustos-Viviescas et al., 2021a), from this previous research has contrasted the reliability and applicability of the subjective perception of effort scale in the session to assess the internal load in HIFT, however, this has been carried out mainly with subjects trained in this training modality (Tibana 2018c; Crawford et al., 2018; Tibana 2019a; Tibana 2019b; Falk et al., 2020),

This could be of concern for coaches of this modality, since there is no research to identify whether this method of effort quantification is valid for populations with no previous experience in HIFT.

Therefore, the purpose of the present study is to determine the relationship between the assessment of perceived exertion in the training session and the Edwards Index (1993) with the purpose of quantifying the internal load based on heart rate in high-intensity functional training with physically active subjects.

Method

Type of study

Descriptive correlational study. The type of sampling was by convenience. This study is a secondary result of the project called "Analysis of physical condition through weight training and fitness in physically active university students".

Participants

The sample was composed of 14 men and 6 women who met the following inclusion criteria: 1) Voluntary participation, 2) Being a student of the Bachelor's Degree in Physical Education, Recreation and Sports at the University of Pamplona (Villa del Rosario).

The following students were excluded from the study: 1) Presence of any type of cardiovascular and/or metabolic pathology that could affect performance in the tests, 2) Presence of any pathology or injury that could affect muscle strength and/or have a feeling of discomfort or pain during the evaluation, 3) Be trained in high intensity functional training (experience greater than 3 months).

Ethical considerations

This study was developed considering the parameters established for research with human beings in the Declaration of Helsinki of the World Medical Association (2013) and the ethical standards established for research in sport and exercise sciences (Harriss et al., 2017). On the other hand, Resolution No. 008430 of 1993, issued by Ministry of Health of the Republic of Colombia, article 11, was considered, classifying this study in the category of major risk, therefore, the participants signed an informed consent, which, contained the objective of the study, the description of the tests, risks, benefits and contributions at the level of training. Likewise, this study has the endorsement of the Ethics and Environmental Impact Committee of the University of Pamplona by means of Act No. 002 of March 4, 2019.

Procedure

The study was carried out over two days, with a 72-hour break in between to perform the assessments. On the first day, data on height, body mass and cardiorespiratory fitness assessment test were collected by means of the Course-Navette test (Léger & Lambert, 1982). The macro anthropometric data were collected on an empty stomach (6:00 am) and the cardiorespiratory fitness test was performed hours after breakfast (10:00-11:00 am). On the second day, the Workout of the Day WOD "Pukie" was performed to obtain the time to complete the training, which consists of performing 150 burpees in the shortest possible time. It counts as burpee, the exercise that combines the squat and the front support on the floor and the vertical jump (burpee). It should be noted that prior to the development of the tests, a familiarization with the technical execution of the burpee and the scale of subjective perception of effort was performed.

The heart rate was assessed in each period of the test with the Polar H7 heart rate monitor to obtain the maximum heart rate (HRmax), while the exercise intensity during the training session was recorded every 30 burpees, so that the heart rate collected presented 5 data during the training session in order to avoid interfering with the normal development.

In the Course-Navette Test (Léger & Lambert, 1982) the participant must move from one line to another, located 20 meters apart and making the change of direction according to the rhythm imposed by the sound signal, which is progressively increased by means of a recorder, and the test culminates when the examiner considers that the participant is not able to reach the line with the sound signal twice in a row or when he/she retires due to fatigue. The initial speed of the test is 8.5 km/h and will increase by 0,5 km/h every minute.

Load quantification

Edwards Method

For the quantification of the training load, the training zone summation method of Edwards (1993) was used:

The equation for the Edwards training load is:

Edwards CE = (duration in zone 1 × 1) + (duration in zone 2 × 2) + (duration in zone 3 ×3) + (duration in zone 4 × 4) + (duration in zone 5 × 5).

Where: zone 1 = 50 - 60% of maximum HR, zone 2 = 60 - 70 % of max HR. Zone 3 = 70 - 80 % max HR. Zone 4 = 80 - 90 % max HR. Zone 5 = 90 - 100 % max HR.

The duration in zone is expressed in minutes, therefore, considering the 5 records obtained during the session, it was decided to average the intensity zone according to the maximum heart rate and multiply it by the total duration in minutes of the Pukie WOD to obtain the Edwards Index.

Subjective perception of effort scale

To calculate the training load, the method suggested by Foster et al., (2001) was used, which consists of multiplying the total duration by the training intensity; consequently, the modified version of Borg's CR-10 scale of perceived exertion (Borg, 1982) was used to measure the intensity (Table 1).

Table 1. Subjective perception of effort scale from 0 to 10 points (Borg, 1982)

Points	Description
0	
1	Extremely weak
2	Weak
3	Moderate
4	
5	Strong
6	
7	Very Strong
8	
9	
10	Extremely strong

Source: Borg CR-10 Scale of Perceived Effort (Borg, 1982).

The evaluation of the subjective perception of the training session was obtained from the participants once the WOD was finished and at 10, 20 and 30 min after it. The question "How hard was your training?" was used, so that the training load was expressed as a single value in arbitrary units (AU), the total time in minutes to perform the WOD was multiplied and multiplied with the arbitrary units obtained to identify the scale of subjective perception of the effort in session.

For example, at the end of the training (0 min) the effort perception scale (EPE) was 9 and the duration of the WOD was 10 minutes, this would give a training load of 90 arbitrary units (AU).

It should be noted that a familiarization with the instrument was carried out prior to the training session.

Data analysis

The data were analyzed with the statistical package PSPP (Free License), and measures of central tendency and dispersion were calculated.

Subsequently, a Shapiro-Wilk normality test and a Spearman correlation coefficient were applied to establish the correlation between the subjective perception of effort in the session scale (EPES) and the Edwards Index obtained in the Pukie WOD.

A confidence level of 95% and a p-value of 0,05 were considered for the statistical analysis.

On the other hand, the magnitude ranges proposed by Cohen for correlation were considered: trivial ($r \leq 0,1$), small ($0,1 < r \leq 0,3$) moderate ($0,3 < r \leq 0,5$), large ($0,5 < r \leq 0,7$), very large ($0,7 < r \leq 0,9$) and almost perfect ($r \geq 0,9$) and perfect ($r = 1,0$) (Cohen, 1988).

Results

Table 2 shows that the age of the participants by sex was similar, although men had greater height and body mass than women, which translates into a higher body mass index (BMI).

Table 2. General characteristics

Participants	Age	Body Weigth (kg)	Size (m)	BMI (kg/m^2)
Men (n = 14)	22,96±1,91	71,61±10,01	1,75±0,05	23,25±2,79
Woman (n = 6)	23,50±1,76	59,05±12,87	1,55±0,03	24,69±6,04
Total (n = 20)	23,12±1,83	67,84±12,12	1,69±0,10	23,68±3,92

Table 3 shows the values obtained in the field test and the Pukie WOD. It can be evidenced that the subjective perception of effort in the session (EPES) scale was categorized as "Very strong" according to the Borg's CR-10 scale.

Likewise, the Edwards Index value and the EPES (0 min, 10 min, 20 min and 30 min) showed a non-symmetrical distribution of the data (p<0,05).

Table 3. Participants' internal load variables

	Mean ± DS
WOD Time (sec)	876,90±373,06
HRmax Test (bpm)	192,70±7,46
HR WOD Pukie total (bpm)	179,12±9,72
HR WOD Pukie total (%)	93,04±5,34
Edwards index	69,76±32,49
EPE (0 min)	9,00±1,34
EPE (10 min)	8,65±0,49
EPE (20 min)	8,40±0,50
EPE (30 min)	8,10±0,55
EPES (0 min)	132,34±61,80
EPES (10 min)	126,18±54,73
EPES (20 min)	123,09±55,33
EPES (30 min)	118,70±51,98

Next, Table 4 shows that there is a positive and highly significant relationship between the subjective perception of effort scale of the training session and the Edward index (p < 0,01), likewise, the magnitude of the correlation between the Edward index and the subjective perception of effort scale was classified as very high (r = 0,76 to 0,88).

Table 4. Relationship between variables

	Edward Index	
	Coef. Spearman	Sig. (Bilateral)
EPES 0 min post-exercise	0,76	0,00
EPES 10 min post-exercise	0,79	0,00
EPES 20 min post-exercise	0,88	0,00
EPES 30 min post-exercise	0,84	0,00

Discussion

The objective of this study was to determine the relationship between the assessment of perceived exertion in the training session and the Edwards Index for quantifying internal load based on heart rate in high-intensity functional training with physically active subjects.

Among the main findings of this research, a positive and highly significant relationship was evidenced between the Edwards Index for internal load and the subjective perception of effort scale in the training session (r = 0,76-0,88; p < 0,01).

A study developed by Crawford et al., (2018) with recreational athletes inexperienced in high-intensity functional training programs concluded that the subjective perception of exertion scale in the session significantly predicted the Edwards index in two training blocks separated by three weeks (r = 0,818-0,885, p < 0,001).

Recently Tibana et al., (2018c) validated the subjective perception of effort scale in subjects practicing high-intensity functional training finding a positive and highly significant association (r = > 0,8; p < 0,01).

On the other hand, this scale in high-intensity functional training has obtained some significant relationships with workload variables (training heart rate x session duration) (r = 0,426; p = 0,019) (Drake et al., 2017), lactate (r = 0,66; p = 0,005), number of completed repetitions (mechanical work) (r = 0,55; p = 0,026) (Tibana et al., 2019b).

Now, regarding the usefulness of this scale for the evaluation and prescription in high intensity functional training, the literature is still scarce, but several works stand out among which we find the assessment of the internal load during a period of 38 weeks with an elite female athlete in high intensity functional training (Tibana et al., 2019a), and the quantification of the load during 6 weeks of high intensity functional training on physical performance in participants with different training volumes and frequencies (Teixeira et al., 2020).

For example, one method of training load quantification is the training impulse (TRIMP), which suggests combining the elements of training intensity and duration into a single index concept (Foster et al., 2017), and a recent study prepared by Falk et al., (2020) in which they concluded that, EPES is more accurate than the training impulse quantification method (TRIMP) in representing the overall load in HIFT sessions.

In the same way, this scale enables self-regulation of internal load during these high- intensity functional training sessions (Tibana et al., 2019b).

Similarly, another study concluded that it is possible to obtain potential benefits in aerobic capacity, strength, cardiovascular performances and body composition with HIFT training controlled by heart rate variability even with fewer sessions performed at high intensity in physically active subjects (DeBlauw et al., 2021), consequently, accurate quantification of the HIFT training load is essential to determine and examine the relationship between training and physiological adaptations obtained with this type of high-intensity exercise.

Now, regarding the evaluation of the internal load in different WODs we evidenced that it was lower than that obtained in the WOD "Fight Gone Bad" (77,7±4,9) although higher than the WOD "Fran" (19,8±8,4), this can be explained by means of the subjective perception scale of the session and the own duration of each training (9,6±0,5 and 8,7±0,8; 17 minutes and 4 minutes respectively) (Tibana et al., 2018b).

Continuing the comparison of the internal load in WOD according to its modality, it was evidenced that according to the priority of the WOD (time, task/mark and single element) there are higher values in time priority training (14,7±0,7 EPE; p = 0,000) and task/mark priority (14,8±0,5 EPE; p = 0,000) compared to element or single element priority training (9,4±0,8 EPE) (Borg Scale 0-20) (Drake et al., 2017).

Although HIFT is not synonymous with HIIT (High Intensity Interval Training) both share a common factor that they are high intensity (Lu et al., 2021), for this reason, one aspect that may explain the differences between the results of this work and the others mentioned are the characteristics of the WOD from its structure (AMRAP, For Time, among others) or its components/movements (lifting, calisthenics/gymnastics and aerobic), since, an exercise session with the aforementioned movements induces a higher increase in the subjective perception scale of the session, compared to another exercise session (metabolic predominance in calisthenic exercises) (8,0±1,2 EPE) (p<0,02) (Tibana et al., 2018a).

Following, the analysis of the WOD "Pukie" was applied in this research where a single calisthenic element (Burpee) was performed, which is an exercise that improves endurance to fatigue (Maté-Muñoz et al., 2018) and cardiorespiratory capacity (Mangine et al., 2020). Likewise, this is a high-intensity exercise that is complicated to quantify and qualify, given the wide technical variation, sequence and morphological characteristics of the athletes (Bingley et al., 2019).

For such reason, it is advisable that in these trainings that include mainly calisthenic/gymnastic exercises, the external load be prescribed from the time of the stimulus and the recovery of the physical effort (Machado et al., 2018), in addition, it is advisable that the frequency of training and the exercises assigned during the training be prescribed with respect to the functional capacity of the participant (Machado et al., 2017).

Experience in high intensity functional training can also influence the subjective perception of effort, authors such as Gomes et al., (2020) compared the RPE of the AMRAP WOD "Cindy" between an experienced group and a non-experienced group, concluding that the cardiovascular responses were similar (93,1±0,6 %HRmax vs 93,0± 0,8 %HRmax) but with a slightly higher perception of effort in the non-experienced (7,5±0,3 RPE vs 8,1±0,3 RPE).

A recent research evaluated the internal load of three WOD For Time (Angie plus, Grace and Karen) performed continuously and uninterruptedly by subjects trained in HIFT, this work evidenced that the subjective perception ranged between in women an RPE of 7,17±0,71 AU in intermediate and 7,33±1,15 AU in advanced, while in men the RPE was 7,67±0,33 AU for intermediate and 7,67±0,47 AU in advanced, finding that when WODs of different modalities are combined, very hard efforts are obtained for subjects conditioned in HIFT (Bustos-Viviescas et al., 2021b).

Among the limitations of this work we can highlight the small sample of participants, likewise, we could not compare the internal load for the same WOD between various groups of experience (advanced vs recreational vs non-practitioners), because it would be interesting for decision making in terms of exercise prescription in high-intensity functional training. In addition, current evidence suggests that load quantification by means of the perceived exertion scale is valid in HIFT-

trained subjects, and further research is required for its applicability in non-experienced subjects.

Conclusions

The scale of subjective perception of effort in a training session is a valid method to quantify the internal load in high-intensity functional training sessions in physically active subjects who have no experience in these types of training, making it an economical and easily applicable tool to keep track of the periodization in this type of fitness training.

References

Alsamir-Tibana, R. & De Sousa, N. (2018). Are extreme conditioning programmes effective and safe? A narrative review of high-intensity functional training methods research paradigms and findings. BMJ Open Sport Exerc Med, 4 (1), 1–10. DOI: https://doi.org/10.1136/bmjsem-2018-000435

Asociación Médica Mundial (2013). *Declaración de Helsinki de la AMM-Principios éticos para las investigaciones médicas en seres humanos*. DOI: https://doi.org/10.17126/joralres.2013.009

Balaguer Cabeza, O., & Caparrós Pons, T. (2021). Cuantificación de carga externa e interna en fútbol masculino semiprofesional (External and Internal Load Quantification in a semi-professional male football team). *Cultura, Ciencia Y Deporte, 16* (48), 275-284. DOI: https://doi.org/10.12800/ccd.v16i48.1750

Bingley, S., Witchalls, J., McKune, A. & Humberstone, C. (2019). The Burpee Enigma. *Literature Review, 22* (2), S78, DOI: https://doi.org/10.1016/j.jsams.2019.08.079

Borg, G. (1982). *A category scale with ratio properties for intermodal and interindividual comparison*. In: Geissler H-G, Petzold P, eds. Psychophysical judgment and the process of perception. Berlin: VEB DeutscherVerlag der Wissenschaften, 25–34.

Bustos-Viviescas, B. J., Duran-Luna, L. A., Merchan Osorio, R. D., Ortega Parra, A. J., Acevedo-Mindiola, A. A., & Garcia Yerena, C. E. (2021a). Entrenamiento funcional de alta intensidad: asociación de la grasa corporal con el fitness cardiorrespiratorio. *Revista Cubana de Medicina Militar, 50* (2), e0210910. Recuperado de: http://www.revmedmilitar.sld.cu/index.php/mil/article/view/910/727

Bustos-Viviescas, B. J., Delgado-Molina, M. C., & Rolon, N. A. (2021b). Evaluación de la carga interna en una sesión de entrenamiento funcional de alta intensidad: estudio de casos múltiples. *Revista Cubana de Ortopedia y Traumatología, 35* (1). Recuperado de http://www.revortopedia.sld.cu/index.php/revortopedia/article/view/325/246

Camacho-Cardeñosa, A., Timón, R., Camacho-Cardeñosa, M., Guerrero-Flores, S., Olcina, G., & Marcos-Serrano, M. (2020). Six-months CrossFit training improves metabolic efficiency in young trained men (Seis meses de CrossFit mejora la eficiencia metabólica en jóvenes entrenados). *Cultura, Ciencia Y Deporte, 15* (45), 421-427. DOI: https://doi.org/10.12800/ccd.v15i45.1519

Claudino, J. G., Gabbett, T. J., Bourgeois, F., Souza, H. S., Miranda, R. C., Mezêncio, B., Soncin, R., Cardoso Filho, C. A., Bottaro, M., Hernandez, A. J., Amadio, A. C. & Serrão, J. C. (2018). CrossFit Overview: Systematic Review and Meta-analysis. *Sports Medicine - Open, 4* (1), 11. DOI: https://dx.doi.org/10.1186%2Fs40798-018-0124-5

Crawford, D. A., Drake, N. B., Carper, M. J., DeBlauw, J., & Heinrich, K. M. (2018). Validity, Reliability, and Application of the Session-RPE Method for Quantifying Training Loads during High Intensity Functional Training. *Sports (Basel, Switzerland), 6* (3), 84. DOI: https://doi.org/10.3390/sports6030084

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2.ª ed). Hillsdale, NJ: Lawrence Erlbaum Associates. Disponible en: http://www.utstat.toronto.edu/~brunner/oldclass/378f16/readings/CohenPower.pdf

DeBlauw, J. A., Drake, N. B., Kurtz, B. K., Crawford, D. A., Carper, M. J., Wakeman, A., Heinrich, K. M. (2021). High-Intensity Functional Training Guided by Individualized Heart Rate Variability Results in Similar Health and Fitness Improvements as Predetermined Training with Less Effort. *J. Funct. Morphol. Kinesiol.,* 6, 102. DOI: https://doi.org/10.3390/jfmk6040102

Drake, N., Smeed, J., Carper, M. & Crawford, D. (2017). Effects of ShortTerm CrossFit™ Training: A Magnitude-Based Approach. *JEPonline, 20* (2), 111-133. Recuperado de: https://www.asep.org/asep/asep/JEPonlineAPRIL2017_Drake_Crawford.pdf

Edwards, S. (1993). *The Heart Rate Monitor Book*. Sacramento, CA: Fleet Feet Press.

Falk Neto, J. H., Tibana, R. A., de Sousa, N., Prestes, J., Voltarelli, F. A. & Kennedy, M. D. (2020). Session Rating of Perceived Exertion Is a Superior Method to Monitor Internal Training Loads of Functional Fitness Training Sessions Performed at Different Intensities When Compared to Training Impulse. *Frontiers in physiology, 11*, 919. DOI: https://doi.org/10.3389/fphys.2020.00919

Foster, C., Florhaug, J., Franklin, J., Gottschall, L., Hrovatin, L., Parker, S., Doleshal, P. & Dodge, C. (2001). A new approach to monitoring exercise training. *J. Strength Cond. Res., 15* (1), 109-115. Recuperado de: https://pubmed.ncbi.nlm.nih.gov/11708692/

Foster, C., Rodriguez-Marroyo, J. A. & de Koning, J. J. (2017). Monitoring Training Loads: The Past, the Present, and the Future. *International journal of sports physiology and performance, 12* (Suppl 2), S22–S28. DOI: https://doi.org/10.1123/ijspp.2016-0388

Gomes, J. H., Mendes, R. R., Franca, C. S., Da Silva-Grigoletto, M. E., Pereira da Silva, D. R., Antoniolli, A. R., de Oliveira E Silva, A. M. & Quintans-Júnior, L. J. (2020). Acute leucocyte, muscle damage, and stress marker responses to high-intensity functional training. *PloS one, 15* (12), e0243276. DOI: https://doi.org/10.1371/journal.pone.0243276

González-Fimbres, R. A., Ramírez-Siqueiros, M. G., Vaca-Rubio, H., Moueth-Cabrera, M. T. & Hernández-Cruz, G. (2020). Relationship Between Post-Exercise hrv and Internal Training Load in Triathletes. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte, 20* (77), 87-102. DOI:10.15366/rimcafd2020.77.006

Halson, S. (2014). Monitoring Training Load to Understand Fatigue in Athletes. *Sport Med., 44* (2), s139–47. DOI: https://doi.org/10.1007/s40279-014-0253-z

Harriss, D., Macsween, A. & Atkinson, G. (2017). Standards for Ethics in Sport and Exercise Science Research: 2018 Update. *Int J Sports Med., 38* (14), 1126-1131. doi: https://doi.org/10.1055/s-0043-124001

Jones, C. M., Griffiths, P. C. & Mellalieu, S. D. (2017). Training Load and Fatigue Marker Associations with Injury and Illness: A Systematic Review of Longitudinal Studies. *Sports Med, 47* (5), 943-974. DOI: https://doi.org/10.1007/s40279-016-0619-5

Leger, L. A., & Lambert, J. (1982). A maximal multistage 20-m shuttle run test to predict VO2 max. *Eur J Appl Physiol Occup Physiol, 49* (1), 1-12. DOI: https://doi.org/10.1007/bf00428958

Lu, Y., Wiltshire, H. D., Baker, J. S., & Wang, Q. (2021). The Effects of Running Compared with Functional High-Intensity Interval Training on Body Composition and Aerobic Fitness in Female University Students. *International journal of environmental research and public health, 18* (21), 11312. DOI: https://doi.org/10.3390/ijerph182111312

Machado, A. F., Baker, J. S., Figueira Junior, A. J., & Bocalini, D. S. (2017). High-intensity interval training using whole-body exercises: training recommendations and methodological overview. *Clinical Physiology and Functional Imaging*. doi: 10.1111/cpf.12433

Machado, A. F., Miranda, M. L., Rica, R. L., Figueira Junior, A. & Bocalini, D. S. (2018). Bodyweight high-intensity interval training: a systematic review. *Revista Brasileira de Medicina do Esporte, 24* (3), 234-237. DOI: https://doi.org/10.1590/1517-869220182403176199

Mangine, G. T., Tankersley, J. E., McDougle, J. M., Velazquez, N., Roberts, M. D., Esmat, T. A., VanDusseldorp, T. A. & Feito, Y. (2020). Predictors of CrossFit Open Performance. *Sports, 8*, 102. DOI: https://doi.org/10.3390/sports8070102

Maté-Muñoz, J. L., Lougedo, J. H., Barba, M., Cañuelo-Márquez, A. M., Guodemar-Pérez, J., García-Fernández, P., Lozano-Estevan, M., Alonso-Melero, R., Sánchez-Calabuig, M. A., Ruíz-López, M., de Jesús, F. & Garnacho-Castaño, M. V. (2018). Cardiometabolic and Muscular Fatigue Responses to Different CrossFit® Workouts. *Journal of Sports Science & Medicine, 17* (4), 668-679. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6243628/pdf/jssm-17-668.pdf

Reche-Soto, P., Cardona, D., Díaz, A., Gómez-Carmona, C. & Pino-Ortega, J. (2020). ACELT and PLAYERLOAD: Two Variables to Quantify Neuromuscular Load. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte, 20 (77), 67-183. DOI:10.15366/rimcafd2020.77.011

Teixeira, R. V. (2020). *Carga interna de treinamento, desempenho e assimetria entre membros inferiores em praticantes de treinamento funcional de alta intensidade* (Tesis de maestría). Universidade Federal do Rio Grande do Norte: Brasil.

Teixeira, R. V., Batista, G. R., Mortatti, A. L., Dantas, P. & Cabral, B. (2020). Effects of Six Weeks of High-Intensity Functional Training on Physical Performance in Participants with Different Training Volumes and Frequencies. *International journal of environmental research and public health, 17* (17), 6058. DOI: https://doi.org/10.3390/ijerph17176058

Tibana, R., Almeida, L., de Sousa Neto, I. de Sousa, N., de Almeida, J., de Salles, B., Bentes, C., Prestes, J., Collier, S. & Voltarelli, F. (2018a). Extreme Conditioning Program Induced Acute Hypotensive Effects are Independent of the Exercise Session Intensity. *International Journal of Exercise Science, 10* (8), 1165-1173. DOI: https://doi.org/10.1590/1517-869220182402160028

Tibana, R., de Sousa, N., Prestes, J. & Voltarelli, F. (2018b). Lactate, Heart Rate and Rating of Perceived Exertion Responses to Shorter and Longer Duration CrossFit® Training Sessions. *Journal of Functional Morphology and Kinesiology, 3* (4), 60. DOI: https://doi.org/10.3390/jfmk3040060

Tibana, R. A., de Sousa, N., Cunha, G. V., Prestes, J., Fett, C., Gabbett, T. J. & Voltarelli, F. A. (2018c). Validity of Session Rating Perceived Exertion Method for Quantifying Internal Training Load during High-Intensity Functional Training. *Sports (Basel, Switzerland), 6* (3), 68. DOI: https://doi.org/10.3390/sports6030068

Tibana, R. A., Sousa, N. M. F., Prestes, J., Feito, Y., Ernesto, C. & Voltarelli, F. A. (2019a). Monitoring Training Load, Well-Being, Heart Rate Variability, and Competitive Performance of a Functional-Fitness Female Athlete: A Case Study. *Sports*, 7, 35. DOI: https://doi.org/10.3390/sports7020035

Tibana, R. A., Manuel Frade de Sousa, N., Prestes, J., da Cunha Nascimento, D., Ernesto, C., Falk Neto, J. H., Kennedy, M. D. & Azevedo Voltarelli, F. (2019b). Is Perceived Exertion a Useful Indicator of the Metabolic and Cardiovascular Responses to a Metabolic Conditioning Session of Functional Fitness?. *Sports, 7* (7), 161. DOI: http://dx.doi.org/10.3390/sports7070161

Entrenamiento funcional de alta intensidad y su cuantificación por Escala de Esfuerzo Percibido en sujetos físicamente activos

High-intensity functional training and quantification by Perceived Exertion Scale in physically active subjects

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Resumen

El propósito del estudio fue determinar la relación entre la valoración del esfuerzo percibido en la sesión (EPES) y el Índice de Edwards (IE) para cuantificar la carga interna basado en la frecuencia cardíaca en el entrenamiento funcional de alta intensidad con sujetos físicamente activos. Estudio descriptivo de tipo correlacional con una muestra por conveniencia conformada por 11 hombres y 5 mujeres. Para valorar la frecuencia cardiaca máxima se utilizó el Test de Course-Navette, posteriormente se realizó el Workout of the Day (WOD) denominado "Pukie" donde cada participante contaba con un pulsómetro Polar H7, que recolectaba la escala de percepción subjetiva de la sesión (0-10), a partir de estos datos se calculó el IE. En el software PSPP (p-valor de 0,05) se llevó a cabo el análisis estadístico donde se manejó un coeficiente correlacional de Spearman para relacionar la EPES y el IE. La relación entre la escala recolectada en los diferentes fragmentos de tiempo post-ejercicio y el IE fue positiva, y el resultado obtenido fue muy significativo (r = 0,76-0,88; p < 0,01). Se puede concluir que la EPES es un método viable, económico y de fácil aplicación para cuantificar la carga interna en el entrenamiento funcional de alta intensidad con sujetos físicamente activos.

Palabras clave: Acondicionamiento físico, ejercicio, test de ejercicio (Fuente: Mesh).

Abstract

The purpose of the study was to determine the relationship between internal and external load in physically active subjects (11 men and 5 women) during a high-intensity functional training session, using different load markers: heart rate, perceived effort and the Edwards index. The maximum heart rate was assessed during a maximal incremental endurance test (course Navette). Thereafter each participant performed a high-intensity functional training session (Workout of the Day - Pukie), while wearing a heart rate monitor, and the perceived effort was assessed with the 0-10 point scale at 0-min, 10-min, 20-min, and 30-min. Thereafter the Edwards index was calculated. The perceived effort was positively correlated with the heart rate and the Edwards index during the different time-points analyzed (Spearman r = 0,76-0,88; p<0,01). In conclusion, perceived effort can be used as a low-cost and logistically convenient method to assess the internal load experienced by physically active participants during a high-intensity functional training session.

Keywords: Physical conditioning, exercise, exercise test (Source: Mesh).

Introducción

Al entrenamiento funcional de alta intensidad o high intensity functional training (HIFT) se le atribuye el emplear altos volúmenes e intensidades de entrenamiento (Teixeira, 2020), el cual, es considerado una forma novedosa al realizar ejercicios que ponen a prueba algunos de los sistemas del cuerpo (muscular, nervioso, respiratorio, óseo) y desafía las habilidades de las personas para completar el trabajo mecánico (Crawford et al., 2018). Seguidamente una de las modalidades de entrenamiento HIFT que actualmente es catalogado por el medio del entrenamiento como el de mayor crecimiento en el mundo es el CrossFit® (Claudino et al., 2018), así mismo, dicha modalidad requiere un alto nivel técnico de máximo esfuerzo y una recuperación incompleta entre bloques y sesiones (Camacho-Cardeñosa et al., 2020).

Ahora bien, surge la necesidad de controlar determinadas variables de la carga de entrenamiento por parte de los profesionales especializados, preparadores físicos y/o científicos del deporte (Balaguer & Caparrós, 2021), puesto que, existe un desafío continuo por parte de los entrenadores, médicos y personal de salud con respecto a la dosificación de la carga de entrenamiento, debido a la posibilidad de lograr obtener en los practicantes una adaptación eficaz del entrenamiento, logrando minimizar la fatiga, la inhibición del desempeño, el sobreentrenamiento y la aparición de lesiones (Halson, 2014; Jones et al., 2017). Debido a que, dentro del proceso de entrenamiento un factor importante es la cuantificación de la carga interna (González-Fimbres et al., 2020), sin embargo, en cuanto al HIFT aun hace falta información sobre el monitoreo y control de los métodos de capacitación (Alsamir-Tibana & De Sousa, 2018), por lo que, es necesario ampliar el conocimiento científico para mejorar los métodos de preparación (Reche-Soto et al., 2020).

En el contexto de investigación uno de los temas ideales es comparar, relacionar y analizar la influencia del entrenamiento de alta intensidad con la salud y el rendimiento deportivo (Bustos-Viviescas et al., 2021a), a partir de esto las investigaciones previas han contrastado la fiabilidad y aplicabilidad de la escala de percepción subjetiva del esfuerzo en la sesión para valorar la carga interna en el HIFT, sin embargo, esto se ha llevado a cabo principalmente con sujetos capacitados en esta modalidad de entrenamiento (Tibana 2018c; Crawford et al., 2018; Tibana 2019a; Tibana 2019b; Falk et al., 2020), esto podría resultar preocupante para los entrenadores de esta modalidad, dado que no existen investigaciones que permitan identificar si este método de cuantificación del esfuerzo es válido para poblaciones sin experiencia previa en HIFT. Por lo anterior, la finalidad del presente estudio es determinar la relación entre la valoración del esfuerzo percibido en la sesión de entrenamiento y el Índice de Edwards (1993) con el propósito de cuantificar la carga interna basado en la frecuencia cardíaca en el entrenamiento funcional de alta intensidad con sujetos físicamente activos.

Método

Tipo de estudio

Estudio descriptivo de tipo correlacional. El tipo de muestreo fue por conveniencia. Este estudio es resultado secundario del proyecto denominado "Análisis de la condición física a través de la musculación y el fitness en universitarios físicamente activos".

Participantes

La muestra estuvo compuesta por 14 hombres y 6 mujeres quienes cumplieron con los siguientes criterios de inclusión: 1) Participación voluntaria, 2) Estar cursando la Licenciatura en Educación Física, Recreación y Deportes de la Universidad de Pamplona (Villa del Rosario).

Se excluyeron del estudio estudiantes con: 1) Presencia de algún tipo de patología cardiovascular y/o metabólica que pudiese afectar el desempeño en las pruebas, 2) Presencia de alguna patología o lesión que pudiera afectar la fuerza muscular y/o tener sensación de molestia o dolor durante la evaluación, 3) Estar capacitado en el entrenamiento funcional de alta intensidad (experiencia mayor a 3 meses).

Consideraciones éticas

Este estudio se desarrolló teniendo en cuenta los parámetros establecidos para las investigaciones con seres humanos en la Declaración de Helsinki de la Asociación Médica Mundial (2013) y los estándares éticos establecidos para investigaciones en ciencias del deporte y del ejercicio (Harriss et al., 2017). Por otra parte, se consideró la Resolución No. 008430 de 1993, emitida por Ministerio de Salud de la República de Colombia, artículo 11, clasificando este estudio en la categoría de riesgo mayor, por tanto, los participantes firmaron un consentimiento informado, el cual, contenía el objetivo del estudio, la descripción de las pruebas, riesgos, beneficios y aportes a nivel del entrenamiento. Así mismo, este estudio cuenta con el aval de comité de ética e impacto ambiental de la Universidad de Pamplona por medio del Acta Nº 002 del 04 de marzo del 2019.

Procedimiento

El estudio se llevó a cabo en dos días, con un descanso de 72 horas entre ellos para realizar las valoraciones. El primer día se realizó la recolección de los datos de talla, masa corporal y prueba de valoración de la aptitud cardiorrespiratoria por medio de la prueba de Course-Navette (Léger y Lambert, 1982). Los datos macro antropométricos fueron recolectados en ayunas (6:00 am) y la prueba de aptitud cardiorrespiratoria se realizó horas después al desayuno de los participantes (10:00-11:00 am). En el segundo día se efectuó the Workout of the Day WOD "Pukie" obteniendo el tiempo para completar el entrenamiento, el cual, consiste en realizar 150 burpees en el menor tiempo posible. Cuenta como burpee, el ejercicio que combina la sentadilla y el apoyo frontal en suelo y el salto vertical (burpee). Cabe resaltar que previo al desarrollo de las pruebas se realizó una familiarización con la ejecución técnica del burpee y la escala de percepción subjetiva del esfuerzo.

La frecuencia cardíaca fue valorada en cada periodo de la prueba con el pulsómetro Polar H7 para obtener la frecuencia cardíaca máxima (FCmáx), mientras que la intensidad del ejercicio durante la sesión de entrenamiento se registró cada 30 burpees, por lo que la frecuencia cardíaca recolectada presentaba 5 datos durante la sesión de entrenamiento con la finalidad de evitar interferir el normal desarrollo.

En el Test de Course-Navette (Léger y Lambert, 1982) el participante debe desplazarse de una línea a otra, situadas a 20 metros de distancia y haciendo el cambio de sentido acorde al ritmo impuesto por la señal sonora, la cual va incrementando progresivamente por medio de

una grabadora, y la prueba culminaría cuando a juicio del examinador el participante no sea capaz de llegar dos veces consecutivas a la línea con la señal sonora o cuando se retire por fatiga, la velocidad inicial de la prueba es 8,5 km/h e ira incrementando 0.5 km/h cada minuto.

Cuantificación de la carga

Método Edwards

Para la cuantificación de la carga de entrenamiento, se ha utilizado el método de sumatorio de zonas de entrenamiento de Edwards (1993):

La ecuación para la carga de entrenamiento Edwards es:

Edwards CE = (duración en zona 1 × 1) + (duración en zona 2 × 2) + (duración en zona 3 × 3) + (duración en zona 4 × 4) + (duración en zona 5 × 5).

Dónde: zona 1 = 50 – 60% de la FC máxima, zona 2 = 60 – 70 % de FC máx. Zona 3 = 70 – 80 % FC máx. Zona 4 = 80 – 90 % FC máx. Zona 5 = 90 – 100 % FC máx.

La duración en zona esta expresada en minutos, por ende, teniendo en cuenta los 5 registros obtenidos durante la sesión se optó por promediar la zona de intensidad acorde a la frecuencia cardiaca máxima y multiplicarlo por la duración total en minutos del WOD Pukie para obtener el Índice Edwards.

Escala de percepción subjetiva del esfuerzo

Para calcular la carga de entrenamiento se empleó el método sugerido por Foster et al. (2001), el cual, consiste en multiplicar la duración total por la intensidad de entrenamiento, en consecuencia, para medir la intensidad se empleó la versión modificada de la escala CR-10 de Borg del esfuerzo percibido (Borg, 1982) (Tabla 1).

Tabla 1. Escala de percepción subjetiva del esfuerzo de 0 a 10 puntos (Borg, 1982)

Puntaje	Descripción
0	
1	Extremadamente ligero
2	Ligero
3	Moderado
4	
5	Duro
6	
7	Muy Duro
8	
9	
10	Extremadamente Duro

Fuente: Escala CR-10 de Borg del esfuerzo percibido (Borg, 1982).

La evaluación de la percepción subjetiva de la sesión de entrenamiento se obtuvo de los participantes una vez acabó el WOD y a los 10, 20 y 30 min posteriores al mismo. Para ello se utilizó la pregunta "¿Qué tan difícil fue su entrenamiento?", de modo que la carga de entrenamiento se expresó como un valor único en unidades arbitrarias (UA), igualmente se multiplicó el tiempo total en minutos en realizar el WOD y se multiplicó con las unidades arbitrarias obtenidas para identificar la escala de percepción subjetiva del esfuerzo en sesión.

Por ejemplo, al finalizar el entrenamiento (0 min) la escala de percepción del esfuerzo (EPE) fue 9 y la duración del WOD fue 10 minutos, esto daría una carga de entrenamiento de 90 unidades arbitrarias (UA).

Cabe resaltar que, se realizó una familiarización con el instrumento previo al desarrollo de la sesión de entrenamiento.

Análisis de datos

Los datos fueron analizados con el paquete estadístico PSPP (Licencia Libre), se calcularon medidas de tendencia central y de dispersión.

Posteriormente, fue aplicado una prueba de normalidad de Shapiro-Wilk y un coeficiente correlacional de Spearman para establecer la correlación entre la escala de percepción subjetiva del esfuerzo en la sesión (EPES) y el Índice de Edwards obtenido en el WOD Pukie.

Se considero un nivel de confianza del 95% y un p-valor de 0,05 para el análisis estadístico.

Por otro lado, se tuvieron en cuenta los rangos de magnitud propuestos por Cohen para la correlación: triviales ($r \leq 0,1$), pequeño ($0,1 < r \leq 0,3$) moderado ($0,3 < r \leq 0,5$), grande ($0,5 < r \leq 0,7$), muy grande ($0,7 < r \leq 0,9$) y casi perfecto ($r \geq 0,9$) y perfecto ($r = 1,0$) (Cohen, 1988).

Resultados

En la Tabla 2 es posible evidenciar que la edad de los participantes por sexo fue similar, aunque los hombres presentaron mayor talla y masa corporal con respecto a las mujeres lo cual se traduce en un mayor índice de masa corporal (IMC).

Tabla 2. Características generales

Participantes	Edad	Masa corporal (kg)	Talla (m)	IMC (kg/m^2)
Hombres (n = 14)	22,96±1,91	71,61±10,01	1,75±0,05	23,25±2,79
Mujeres (n = 6)	23,50±1,76	59,05±12,87	1,55±0,03	24,69±6,04
Total (n = 20)	23,12±1,83	67,84±12,12	1,69±0,10	23,68±3,92

En la Tabla 3, se presentan los valores obtenidos en el test de campo y el WOD Pukie. Se puede evidenciar que la escala de percepción subjetiva del esfuerzo en la sesión (EPES) se categorizó en "Muy duro" según lo establecido en la escala CR-10 de Borg.

Igualmente, el valor del Índice de Edwards y las EPES (0 min, 10 min, 20 min y 30 min) presentaron distribución no simétrica de los datos ($p<0,05$).

Tabla 3. Variables de carga interna de los participantes

	Media ± SD
Tiempo WOD (seg)	876,90±373,06
FCmáx Test (ppm)	192,70±7,46
FC WOD Pukie total (ppm)	179,12±9,72
FC WOD Pukie total (%)	93,04±5,34
Índice de Edward	69,76±32,49
EPE (0 min)	9,00±1,34
EPE (10 min)	8,65±0,49
EPE (20 min)	8,40±0,50
EPE (30 min)	8,10±0,55
EPES (0 min)	132,34±61,80
EPES (10 min)	126,18±54,73
EPES (20 min)	123,09±55,33
EPES (30 min)	118,70±51,98

Seguidamente, en la Tabla 4 se puede contrastar que existe una relación positiva y muy significativa entre la escala de percepción subjetiva del esfuerzo de la sesión de entrenamiento y el Índice de Edward ($p < 0,01$), así mismo, la magnitud de la correlación entre el índice de Edward con la escala de percepción subjetiva del esfuerzo se clasifico en muy grande ($r = 0,76$ a $0,88$).

Tabla 4. Relación entre variables

	Índice Edward	
	Coef. Spearman	Sig. (Bilateral)
EPES 0 min post-ejercicio	0,76	0,00
EPES 10 min post-ejercicio	0,79	0,00
EPES 20 min post-ejercicio	0,88	0,00
EPES 30 min post-ejercicio	0,84	0,00

Discusión

El objetivo de este estudio fue determinar la relación entre la valoración del esfuerzo percibido en la sesión de entrenamiento y el Índice de Edwards para cuantificar la carga interna basado en la frecuencia cardiaca en el entrenamiento funcional de alta intensidad con sujetos físicamente activos.

Entre los principales hallazgos de esta investigación se evidenció una relación positiva y muy significativa entre el Índice de Edwards para la carga interna y la escala de percepción subjetiva del esfuerzo en la sesión de entrenamiento (r = 0,76-0,88; p < 0,01).

Un estudio desarrollado por Crawford et al., (2018) con deportistas recreativos sin experiencia en programas de entrenamiento funcional de alta intensidad concluyo que la escala de percepción subjetiva del esfuerzo en la sesión predijo significativamente el índice Edwards en dos bloques de entrenamiento separados por tres semanas (r = 0,818-0,885, p < 0,001).

Recientemente Tibana et al., (2018c) validaron la escala de percepción subjetiva del esfuerzo en sujetos practicantes de entrenamiento funcional de alta intensidad encontrando una asociación positiva y muy significativa (r = > 0,8; p < 0,01).

Por otro lado, esta escala en el entrenamiento funcional de alta intensidad ha obtenido algunas relaciones significativas con variables de la carga de trabajo (frecuencia cardíaca de entrenamiento x duración de la sesión) (r = 0,426; P = 0,019) (Drake et al., 2017), el lactato (r = 0,66; p = 0,005), numero de repeticiones completadas (trabajo mecánico) (r = 0,55; p = 0,026) (Tibana et al., 2019b).

Ahora bien, con respecto a la utilidad de esta escala para la evaluación y prescripción en el entrenamiento funcional de alta intensidad la literatura aun es escasa, pero se destacan varios trabajos entre los cuales encontramos la valoración de la carga interna durante un periodo de 38 semanas con una atleta femenina de élite en entrenamiento funcional de alta intensidad (Tibana et al., 2019a), y la cuantificación de la carga durante 6 semanas de entrenamiento funcional de alta intensidad sobre el rendimiento físico en participantes con diferentes volúmenes de entrenamiento y frecuencias (Teixeira et a., 2020).

Por ejemplo, un método de cuantificación de la carga de entrenamiento es el impulso de entrenamiento (TRIMP), el cual sugiere combinar los elementos de intensidad y duración del entrenamiento en un concepto de índice único (Foster et al., 2017), y un estudio reciente elaborado por Falk et al., (2020) en el cual concluyeron que, la EPES es más precisa que el método de cuantificación del impulso de entrenamiento (TRIMP) para representar la carga general en las sesiones HIFT.

De la misma forma, esta escala posibilita la autorregulación de la carga interna durante estas sesiones de entrenamiento funcional de alta intensidad (Tibana et al., 2019b).

Igualmente, otro estudio concluyo que es posible obtener beneficios potenciales en la capacidad aeróbica, la fuerza, las adopciones cardiovasculares y la composición corporal con un entrenamiento HIFT controlado por la variabilidad de la frecuencia cardiaca incluso con menos sesiones realizadas a alta intensidad en sujetos físicamente activos (DeBlauw et al., 2021), en consecuencia, la cuantificación de forma precisa de la carga de entrenamiento en HIFT es fundamental para determinar y examinar la relación entre el entrenamiento y las adaptaciones fisiológicas obtenidas con este tipo de ejercicio de alta intensidad.

Ahora bien, en cuanto a la evaluación de la carga interna en diferentes WOD evidenciamos que fue inferior al obtenido en el WOD "Fight Gone Bad" (77,7 ± 4,9) aunque superior al WOD "Fran" (19,8±8,4), esto se puede explicar por medio de la escala de percepción subjetiva de la sesión y la duración propia de cada entrenamiento (9,6±0,5 y 8,7±0,8; 17 minutos y 4 minutos respectivamente) (Tibana et al., 2018b).

Continuando la comparación de la carga interna en WOD según su modalidad, se evidencio que de acuerdo a la prioridad del WOD (tiempo, tarea/marca y elemento único) existen mayores valores en los entrenamientos de prioridad de tiempo (14,7 ± 0,7 EPE; p = 0,000) y prioridad de tarea/marca (14,8 ± 0,5 EPE; p = 0,000) en comparación al entrenamiento de prioridad de elemento o elemento único (9,4 ± 0,8 EPE) (Drake et al., 2017).

Si bien HIFT no es sinónimo de HIIT (Entrenamiento Interválico de Alta Intensidad) ambos comparten un factor en común que son de alta intensidad (Lu et al., 2021), por tal razón, un aspecto que pueda explicar las diferencias entre los resultados de este trabajo y los otros mencionados son las características propias del WOD desde su estructura (AMRAP, For Time, entre otras) o sus componentes/movimientos (levantamiento, calistenia/gimnasia y aeróbico), puesto que, una sesión de ejercicio con los movimientos anteriormente mencionados induce a un aumento mayor de la escala de percepción subjetiva de la sesión, en comparación con otra sesión de ejercicio (predominio metabólico en ejercicios calisténicos) (8,0 ± 1,2 EPE) (p < 0,02) (Tibana et al., 2018a).

Seguidamente, se aplicó en esta investigación el análisis del WOD "Pukie" donde se realizaba un solo elemento calisténico (Burpee), el cual, es un ejercicio que mejorar la resistencia a la fatiga (Maté-Muñoz et al., 2018) y la capacidad cardiorrespiratoria (Mangine et al., 2020). Igualmente, este es un ejercicio de alta intensidad que resulta complicado cuantificar y cualificar, dada la amplia variación técnica, secuencia y características morfológicas de los atletas (Bingley et al., 2019).

Por tal motivo, es recomendable que en estos entrenamos que incluyen principalmente ejercicios calisténicos/ gimnásticos, la carga externa sea prescrita a partir del tiempo del estímulo y la recuperación del esfuerzo físico (Machado et al., 2018), además, resulta recomendable que la frecuencia del entrenamiento y los ejercicios asignados durante el entrenamiento se prescriban con respecto a la capacidad funcional del participante (Machado et al., 2019).

La experiencia en el entrenamiento funcional de alta intensidad también puede incidir en la percepción subjetiva del esfuerzo, autores como Gomes et al., (2020) compararon la EPE del WOD AMRAP "Cindy" entre un grupo experimentado y un grupo no experimentando, concluyendo que las respuestas cardiovasculares fueron similares (93,1 ± 0,6 %FCmáx vs 93,0 ± 0,8 %FCmáx) pero con una percepción del esfuerzo ligeramente superior en los no experimentados (7,5 ± 0,3 EPE vs 8,1 ± 0,3 EPE).

Una investigación reciente evaluó la carga interna de tres WOD For Time (Angie plus, Grace y Karen) realizadas de forma continua e ininterrumpida por sujetos capacitados en HIFT, este trabajo evidencio que la percepción subjetiva oscilo entre en mujeres un RPE de 7,17 ± 0,71 UA en intermedia y 7,33 ± 1,15 UA en avanzadas, mientras que, en hombres el RPE fue de 7,67 ± 0,33 UA para intermedios y 7,67 ± 0,47 UA en avanzados, encontrando que cuando se combinan WOD de diferentes modalidades se obtienen esfuerzos muy duros para sujetos acondicionados en HIFT (Bustos-Viviescas et al., 2021b).

Entre las limitaciones de este trabajo se puede destacar la poca muestra de participantes, del mismo modo, no se pudo comparar la carga interna para el mismo WOD entre varios grupos de experiencia (avanzados vs recreativos vs no practicantes), debido a que resultaría interesante para la toma de decisiones en cuanto a la prescripción del ejercicio en el entrenamiento funcional de alta intensidad., igualmente la evidencia actual sugiere que la cuantificación de la carga por medio de la escala de percepción del esfuerzo es válida en sujetos capacitados en HIFT, y se requiere más investigaciones para su aplicabilidad en sujetos no experimentados.

Conclusiones

La escala de percepción subjetiva del esfuerzo en una sesión de entrenamiento es un método valido para cuantificar la carga interna en sesiones de entrenamiento funcional de alta intensidad en sujetos físicamente activos que no cuentan con experiencia en estos tipos de entrenamiento, por lo cual, es una herramienta económica y de fácil aplicabilidad para llevar un control de la periodización en esta modalidad de entrenamiento en fitness.

Referencias

Alsamir-Tibana, R. & De Sousa, N. (2018). Are extreme conditioning programmes effective and safe? A narrative review of high-intensity functional training methods research paradigms and findings. *BMJ Open Sport Exerc Med, 4* (1), 1–10. doi: 10.1136/bmjsem-2018-000435

Asociación Médica Mundial (2013). *Declaración de Helsinki de la AMM-Principios éticos para las investigaciones médicas en seres humanos*. doi:10.17126/joralres.2013.009

Balaguer Cabeza, O., & Caparrós Pons, T. (2021). Cuantificación de carga externa e interna en fútbol masculino semiprofesional (External and Internal Load Quantification in a semi-professional male football team). *Cultura, Ciencia Y Deporte, 16* (48), 275-284. doi:10.12800/ccd.v16i48.1750

Bingley, S., Witchalls, J., McKune, A. & Humberstone, C. (2019). The Burpee Enigma. *Literature Review, 22* (2), S78. doi:10.1016/j.jsams.2019.08.079

Borg, G. (1982). *A category scale with ratio properties for intermodal and interindividual comparison*. In: Geissler H-G, Petzold P, eds. Psychophysical judgment and the process of perception. Berlin: VEB DeutscherVerlag der Wissenschaften, 25–34.

Bustos-Viviescas, B. J., Duran-Luna, L. A., Merchan Osorio, R. D., Ortega Parra, A. J., Acevedo-Mindiola, A. A., & Garcia Yerena, C. E. (2021a). Entrenamiento funcional de alta intensidad: asociación de la grasa corporal con el fitness cardiorrespiratorio. *Revista Cubana de Medicina Militar, 50* (2), e0210910. Recuperado de: http://www.revmedmilitar.sld.cu/index.php/mil/article/view/910/727

Bustos-Viviescas, B. J., Delgado-Molina, M. C., & Rolon, N. A. (2021b). Evaluación de la carga interna en una sesión de entrenamiento funcional de alta intensidad: estudio de casos múltiples. *Revista Cubana de Ortopedia y Traumatología, 35* (1). Recuperado de http://www.revortopedia.sld.cu/index.php/revortopedia/article/view/325/246

Camacho-Cardeñosa, A., Timón, R., Camacho-Cardeñosa, M., Guerrero-Flores, S., Olcina, G., & Marcos-Serrano, M. (2020). Six-months CrossFit training improves metabolic efficiency in young trained men. *Cultura, Ciencia Y Deporte, 15* (45), 421-427. doi:10.12800/ccd.v15i45.1519

Claudino, J. G., Gabbett, T. J., Bourgeois, F., Souza, H. S., Miranda, R. C., Mezêncio, B., Soncin, R., Cardoso Filho, C. A., Bottaro, M., Hernandez, A. J., Amadio, A. C. & Serrão, J. C. (2018). CrossFit Overview: Systematic Review and Meta-analysis. *Sports Medicine - Open, 4* (1), 11. doi:10.1186%2Fs40798-018-0124-5

Crawford, D. A., Drake, N. B., Carper, M. J., DeBlauw, J., & Heinrich, K. M. (2018). Validity, Reliability, and Application of the Session-RPE Method for Quantifying Training Loads during High Intensity Functional Training. *Sports (Basel, Switzerland), 6*(3), 84. doi:10.3390/sports6030084

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2.ª ed). Hillsdale, NJ: Lawrence Erlbaum Associates. Disponible en: http://www.utstat.toronto.edu/~brunner/oldclass/378f16/readings/CohenPower.pdf

DeBlauw, J. A., Drake, N. B., Kurtz, B. K., Crawford, D. A., Carper, M. J., Wakeman, A., Heinrich, K. M. (2021). High-Intensity Functional Training Guided by Individualized Heart Rate Variability Results in Similar Health and Fitness Improvements as Predetermined Training with Less Effort. *J. Funct. Morphol. Kinesiol.,* 6, 102. doi:10.3390/jfmk6040102

Drake, N., Smeed, J., Carper, M. & Crawford, D. (2017). Effects of ShortTerm CrossFit™ Training: A Magnitude-Based Approach. *JEPonline, 20* (2), 111-133. Recuperado de: https://www.asep.org/asep/asep/JEPonlineAPRIL2017_Drake_Crawford.pdf

Edwards, S. (1993). *The Heart Rate Monitor Book*. Sacramento, CA: Fleet Feet Press.

Falk Neto, J. H., Tibana, R. A., de Sousa, N., Prestes, J., Voltarelli, F. A. & Kennedy, M. D. (2020). Session Rating of Perceived Exertion Is a Superior Method to Monitor Internal Training Loads of Functional Fitness Training Sessions Performed at Different Intensities When Compared to Training Impulse. *Frontiers in physiology, 11*, 919. doi:10.3389/fphys.2020.00919

Foster, C., Florhaug, J., Franklin, J., Gottschall, L., Hrovatin, L., Parker, S., Doleshal, P. & Dodge, C. (2001). A new approach to monitoring exercise training. *J. Strength Cond. Res., 15* (1), 109-115. Recuperado de: https://pubmed.ncbi.nlm.nih.gov/11708692/

Foster, C., Rodriguez-Marroyo, J. A. & de Koning, J. J. (2017). Monitoring Training Loads: The Past, the Present, and the Future. *International journal of sports physiology and performance, 12* (Suppl 2), S22–S28. doi:10.1123/ijspp.2016-0388

Gomes, J. H., Mendes, R. R., Franca, C. S., Da Silva-Grigoletto, M. E., Pereira da Silva, D. R., Antoniolli, A. R., de Oliveira E Silva, A. M. & Quintans-Júnior, L. J. (2020). Acute leucocyte, muscle damage, and stress marker responses to high-intensity functional training. *PloS one, 15* (12), e0243276. doi:10.1371/journal.pone.0243276

González-Fimbres, R. A., Ramírez-Siqueiros, M. G., Vaca-Rubio, H., Moueth-Cabrera, M. T. & Hernández-Cruz, G. (2020). Relationship Between Post-Exercise hrv and Internal Training Load in Triathletes. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte, 20* (77), 87-102. doi:10.15366/rimcafd2020.77.006

Halson, S. (2014). Monitoring Training Load to Understand Fatigue in Athletes. *Sport Med., 44* (2), s139–47. doi:10.1007/s40279-014-0253-z

Harriss, D., Macsween, A. & Atkinson, G. (2017). Standards for Ethics in Sport and Exercise Science Research: 2018 Update. *Int J Sports Med., 38* (14), 1126-1131. doi:10.1055/s-0043-124001

Jones, C. M., Griffiths, P. C. & Mellalieu, S. D. (2017). Training Load and Fatigue Marker Associations with Injury and Illness: A Systematic Review of Longitudinal Studies. *Sports Med, 47* (5), 943-974. doi:10.1007/s40279-016-0619-5

Leger, L. A., & Lambert, J. (1982). A maximal multistage 20-m shuttle run test to predict VO2 max. *Eur J Appl Physiol Occup Physiol, 49* (1), 1-12. doi:10.1007/bf00428958

Lu, Y., Wiltshire, H. D., Baker, J. S., & Wang, Q. (2021). The Effects of Running Compared with Functional High-Intensity Interval Training on Body Composition and Aerobic Fitness in Female University Students. *International journal of environmental research and public health, 18* (21), 11312. doi:10.3390/ijerph182111312

Machado, A. F., Miranda, M. L., Rica, R. L., Figueira Junior, A. & Bocalini, D. S. (2018). Bodyweight high-intensity interval training: a systematic review. *Revista Brasileira de Medicina do Esporte, 24* (3), 234-237. doi:10.1590/1517-869220182403176199

Machado, A. F., Baker, J. S., Figueira Junior, A. J., & Bocalini, D. S. (2019). High-intensity interval training using whole-body exercises: training recommendations and methodological overview. *Clinical Physiology and Functional Imaging, 39* (6), 378-383. doi:10.1111/cpf.12433

Mangine, G. T., Tankersley, J. E., McDougle, J. M., Velazquez, N., Roberts, M. D., Esmat, T. A., VanDusseldorp, T. A. & Feito, Y. (2020). Predictors of CrossFit Open Performance. *Sports, 8*, 102. doi:10.3390/sports8070102

Maté-Muñoz, J. L., Lougedo, J. H., Barba, M., Cañuelo-Márquez, A. M., Guodemar-Pérez, J., García-Fernández, P., Lozano-Estevan, M., Alonso-Melero, R., Sánchez-Calabuig, M. A., Ruíz-López, M., de Jesús, F. & Garnacho-Castaño, M. V. (2018). Cardiometabolic and Muscular Fatigue Responses to Different CrossFit® Workouts. *Journal of Sports Science & Medicine, 17* (4), 668-679. Recuperado de: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6243628/pdf/jssm-17-668.pdf

Reche-Soto, P., Cardona, D., Díaz, A., Gómez-Carmona, C. & Pino-Ortega, J. (2020). ACELT and PLAYERLOAD: Two Variables to Quantify Neuromuscular Load. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte, 20 (77), 67-183. doi:10.15366/rimcafd2020.77.011

Teixeira, R. V. (2020). *Carga interna de treinamento, desempenho e assimetria entre membros inferiores em praticantes de treinamento funcional de alta intensidade* (Tesis de maestría). Universidade Federal do Rio Grande do Norte: Brasil.

Teixeira, R. V., Batista, G. R., Mortatti, A. L., Dantas, P. & Cabral, B. (2020). Effects of Six Weeks of High-Intensity Functional Training on Physical Performance in Participants with Different Training Volumes and Frequencies. *International journal of environmental research and public health, 17* (17), 6058. doi:10.3390/ijerph17176058

Tibana, R., Almeida, L., de Sousa Neto, I. de Sousa, N., de Almeida, J., de Salles, B., Bentes, C., Prestes, J., Collier, S. & Voltarelli, F. (2018a). Extreme Conditioning Program Induced Acute Hypotensive Effects are Independent of the Exercise Session Intensity. *International Journal of Exercise Science, 10* (8), 1165-1173. doi:10.1590/1517-869220182402160028

Tibana, R., de Sousa, N., Prestes, J. & Voltarelli, F. (2018b). Lactate, Heart Rate and Rating of Perceived Exertion Responses to Shorter and Longer Duration CrossFit® Training Sessions. *Journal of Functional Morphology and Kinesiology, 3* (4), 60. doi:10.3390/jfmk3040060

Tibana, R. A., de Sousa, N., Cunha, G. V., Prestes, J., Fett, C., Gabbett, T. J. & Voltarelli, F. A. (2018c). Validity of Session Rating Perceived Exertion Method for Quantifying Internal Training Load during High-Intensity Functional Training. *Sports (Basel, Switzerland), 6* (3), 68. doi:10.3390/sports6030068

Tibana, R. A., Sousa, N. M. F., Prestes, J., Feito, Y., Ernesto, C. & Voltarelli, F. A. (2019a). Monitoring Training Load, Well-Being, Heart Rate Variability, and Competitive Performance of a Functional-Fitness Female Athlete: A Case Study. *Sports*, 7, 35. doi:10.3390/sports7020035

Tibana, R. A., Manuel Frade de Sousa, N., Prestes, J., da Cunha Nascimento, D., Ernesto, C., Falk Neto, J. H., Kennedy, M. D. & Azevedo Voltarelli, F. (2019b). Is Perceived Exertion a Useful Indicator of the Metabolic and Cardiovascular Responses to a Metabolic Conditioning Session of Functional Fitness?. *Sports, 7* (7), 161. doi:10.3390/sports7070161

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Resumen de Visibilidad, Calidad Editorial y Científica e Impacto de CCD (modificado a partir de la Tabla Resumen de la Memoria Anual de CCD)

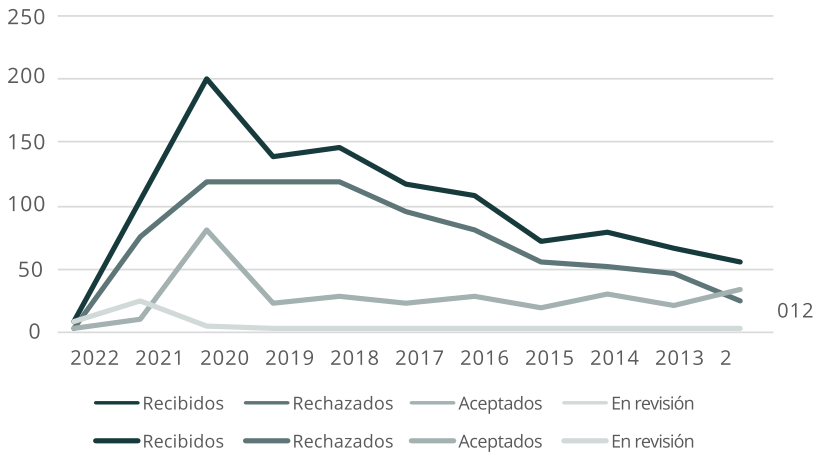
Visibilidad
ISI Web of Science, SCOPUS, EBSCO, MIAR, LATINDEX, REDIB, REDALYC, DIALNET, COMPLUDOC, RECOLECTA, ERIH PLUS, CEDUS, REDINET, SPORTDISCUS, PSICODOC, DOAJ, ISOC, IN-RECS, DULCINEA, SCIRUS, WORLDCAT, LILACS, GTBib, RESEARCH GATE, SAFETYLIT, REBIUN, Universal Impact Factor, Index Copernicus, e-Revistas, Cabell's Directory, SJIF, DLP, Fuente Académica Plus, ERA, BVS, PRESCOPUS RUSSIA, JournalTOCs, Viref, Genamics

Calidad
REDALYC: Superada
LATINDEX: (Total Criterios Cumplidos: 33/33)
CNEAI: (Total Criterios Cumplidos: 18/18)
ANECA: (Total Criterios Cumplidos: 22/22)
ANEP: Categoría A
CIRC (2020): Categoría B
Valoración de la difusión internacional (DICE): 14.25
DIALNET: gB
MIAR (2020): 9.7
ARCE 2014 (FECYT): Sello de calidad - Actualizado 2020
ERIH PLUS (European Reference Index for Humanities and Social Sciences): Indexada

Impacto
SCOPUS: 0.44 (SJR). Índice H (2019): 9. Segundo cuartil en Health (Social Science), Physical Therapy, Sports Therapy and Rehabilitation. Tercer cuartil en Sports Science.
Emerging Sources Citation Index (ESCI)
Índice H (2013-17): 11. Mediana H: 18. Posición 36/96
Scientific Journal Impact Factor SJIF 2020: under evaluation
Nivel CONICET (Res. 2249/14): Grupo 1

Redes sociales
Twitter: https://twitter.com/UCAM_CCD

Estadísticas



Recibidos
Rechazados
Aceptados
En revisión

Lista revisores CCD 51

Alberto Castillo Díaz
Lourdes Meroño García
Antonia Pelegrín Muñoz
Verónica Gómez Espejo
Verónica Alcaraz Muñoz
María T. Morales Belando
Roberto Ruiz Barquín
Noelia González Gálvez
Álvaro Díaz Aroca
Javier Raya
Itziar Alonso-Arbiol
Joaquín Madera Gil
Elena Conde
María Huertas González-Serrano
Rodrigo Vargas Vitoria
Ángel Camblor Navarro
Alberto Ruiz
Alberto Gómez Marmol
Jorge Arede
Daniel López Plaza Palomo
Luis Andreu Caravaca
Vicente Enrique Brito Vásquez
Francisco Javier Flores de Frutos
Ana María Benito Trigueros
Kostantino Spyrou

NORMAS DE PRESENTACIÓN DE ARTÍCULOS EN CULTURA, CIENCIA Y DEPORTE

La Revista *Cultura, Ciencia y Deporte* considerará para su publicación trabajos de investigación relacionados con las diferentes áreas temáticas y campos de trabajo en Educación Física y Deportes, que estén científicamente fundamentados. Dado el carácter especializado de la revista, no tienen en ella cabida los artículos de simple divulgación, ni los que se limitan a exponer opiniones en vez de conclusiones derivadas de una investigación contrastada. Los trabajos se enviarán telemáticamente a través de nuestra página web: http://ccd.ucam.edu, en la que el autor se deberá registrar como autor y proceder tal como indica la herramienta.

1. CONDICIONES

Todos los trabajos recibidos serán examinados por el Editor y por el Comité de Redacción de *Cultura, Ciencia y Deporte,* que decidirán si reúne las características indicadas en el párrafo anterior, para pasar al proceso de revisión por pares a doble ciego, por parte del Comité Asesor. Los artículos rechazados en esta primera valoración serán devueltos al autor indicándole los motivos por los cuales su trabajo no ha sido admitido. Así mismo, los autores de todos aquellos trabajos que, habiendo superado este primer filtro, no presenten los requisitos formales planteados en esta normativa, serán requeridos para subsanar las deficiencias detectadas lo más rápidamente posible. La aceptación del artículo para su publicación en *Cultura, Ciencia y Deporte,* exigirá el juicio positivo de los dos revisores, y en su caso, de un tercero. Durante este proceso, los derechos del artículo serán de la Revista *Cultura, Ciencia y Deporte*, a no ser que el autor/es soliciten que no se continúe con la revisión de su trabajo. La publicación de artículos no da derecho a remuneración alguna. Los derechos de edición son de la revista y es necesario su permiso para cualquier reproducción. El envío de un artículo a *Cultura, Ciencia y Deporte* implica la cesión de derechos a la revista, permitiendo que el artículo pueda ser publicado. En un plazo de cuatro meses se comunicará al autor la decisión de la revisión.

2. ENVÍO DE ARTÍCULOS

2.1 Normativa general

El artículo se enviará a través de la url: http://ccd.ucam.edu/index.php/revista/login. Todo el texto debe escribirse atendiendo a las directrices presentes en **el template de la revista** (https://docs.google.com/document/d/1YjojriyIgd0VUNS9Jk55gPbdf5oEcuN_/edit?usp=sharing&ouid=109045219128359206476&rtpof=true&sd=true), sin modificar en ningún caso la fuente del texto o el tamaño del mismo. Si su artículo es aceptado para publicación presentará la disposición del template final, por tanto, le rogamos lo revise cuidadosamente antes de proceder a su envío. La extensión máxima recomendada no deberá sobrepasar las 7500 palabras incluyendo Figuras, Tablas y Lista de Referencias.

Cada envío estará compuesto por **dos documentos**. El primero recibirá el nombre de "**artículo con autores**" e incluirá en el manuscrito el nombre de todos los autores que formen parte del trabajo, así como sus afiliaciones, autor de correspondencia, códigos de comités (por ejemplo, comité de ética), proyectos de investigación vinculados, agradecimientos y financiación. El segundo recibirá el nombre de "**artículo anónimo**" en el que se incluirá el título del trabajo, el resumen, las palabras clave, el texto del trabajo y las referencias, sin ningún tipo de indicación que permita a los revisores identificar a los autores del manuscrito.

- En la **primera página** del manuscrito deben ir los siguientes elementos del trabajo (por este orden, presentándose en el orden contrario si el texto del artículo está en inglés). Es importante que no se incluyan los nombres de los autores ni su filiación en el documento titulado "**artículo anónimo**", pero sí deberá hacerse en "**artículo con autores**".
  - **Título** del artículo en español y en inglés (en minúscula ambos, sin punto al final). Se recomiendan 10-12 palabras. Debe ser informativo del contenido y tener fuerza por sí mismo, pues es lo que aparecerá en los índices informativos y llamará la atención de los posibles lectores. Debe procurarse la concisión y evitar un excesivo verbalismo y longitud que no añada información.
  - **Resumen** del trabajo en español y en inglés.
    a. Debe reflejar el contenido y propósito del manuscrito.
    b. Si es la réplica del trabajo de otro autor debe mencionarse.
    c. c) La longitud del resumen no debe sobrepasar las **200 palabras**.
    d. d) En estas 200 palabras debe aparecer: el problema, si es posible en una frase; los participantes, especificando las principales variables concernientes a los mismos (número, edad, género, etc.); la metodología empleada (diseño, aparatos, procedimiento de recogida de datos, nombres completos de los test, etc.); resultados (incluyendo niveles estadísticos de significación); y conclusión e implicaciones o aplicaciones. El resumen **no ha de ser estructurado** (no se deben incluir los encabezados "problema", "participantes", etc.) y debe estar escrito en un único párrafo.
  - **Palabras claves** en español e inglés. Las 4 o 5 palabras que reflejen claramente cuál es el contenido específico del trabajo y no estén incluidas en el título (puede utilizar el Tesauro). En cursiva. Sólo la primera palabra se escribirá con mayúscula. Se separarán con comas y al final se incluirá un punto.
- La **segunda página** se iniciará el **texto completo** del artículo. El cuerpo de texto del trabajo deberá empezar en página independiente de la anterior de los resúmenes y con una indicación clara de los apartados o secciones de que consta, así como con una clara jerarquización de los posibles sub- apartados:
  - El primer nivel irá en negrita, sin tabular y minúscula.
  - El segundo irá sin negrita, sin tabular y minúscula.
  - El tercero irá en cursiva, sin tabulación y minúscula.
- Tras el texto completo se debe incluir un apartado de **Referencias**. Las citas y referencias tanto dentro del texto como en el apartado específico deben realizarse en normativa **APA 7ª ed**. A continuación, se presenta un resumen de la misma:

Durante el texto.

- Las citas de trabajos de tres o más autores solo incluyen el apellido del primer autor seguido por "et al.". Ejemplo: Fernández et al. (2019).
- Las citas literales se realizarán en el texto, poniendo tras la cita, entre paréntesis, el apellido del autor, coma, el año del trabajo citado, coma y la página donde se encuentra el texto: (Sánchez, 1995, 143).
- Si se desea hacer una referencia genérica en el texto, es decir, sin concretar página, a los libros o artículos de las referencias, se puede citar de la forma siguiente: paréntesis, apellido del autor, coma y año de edición: (Ferro, 2015). Las referencias citadas en el texto deben aparecer en la lista de referencias.
- Las citas incluidas en el mismo paréntesis deben seguir el orden alfabético.
- Siempre que la cita esté incluida en paréntesis se utilizará la "&". Cuando la cita no está incluida en paréntesis siempre se utilizará la "y". Las citas de dos autores van unidas por "y" o "&", y las citas de varios autores acaban en coma e "y" o "&". Ejemplo: Fernández y Ruiz (2008) o Moreno, Ferro, y Díaz (2007).
- Cuando el mismo autor haya publicado dos o más trabajos el mismo año, deben citarse sus trabajos añadiendo las letras minúsculas a, b, c... a la fecha. Ejemplo: Ferro (1994 a, 1994 b).

Al final del artículo-Lista de referencias.

- Los autores se ordenan por orden alfabético, con independencia del número de los mismos. Cuando son varios, el orden alfabético lo determina, en cada trabajo, el primer autor, después el segundo, luego el tercero y así sucesivamente.

- Es obligado utilizar el DOI (Digital Object Identifier) en las citas bibliográficas de los artículos y publicaciones electrónicas:
  Muñoz, V., Gargallo, P., Juesas, Á., Flández, J., Calatayud, J., & Colado, J. (2019). Influencia de los distintos tipos y parámetros del ejercicio físico sobre la calidad seminal: una revisión sistemática de la literatura. *Cultura, Ciencia y Deporte*, *14(40), 25-42*. http://dx.doi.org/10.12800/ccd.v14i40.1223

- Las citas de varios autores estarán separadas por coma e "&". Algunos ejemplos son los siguientes:
  Autor, A. A., Autor, B. B., & Autor, C. C. (2020). Título del artículo. *Título de la revista, xx*(x), xxx-xxx. http://dx.doi.org/xxxxxx
  Autor, A. A. (2020). *Título del trabajo.* Editorial.
  Autor, A. A., & Autor, B. B. (2020). Título del capítulo. En A. Editor, B. Editor, y C. Editor. (Eds.), *Título del libro* (pp. xxx-xxx). Editorial.
  Autor, A. A., Autor, B. B., & Autor, C. C. (en prensa). Título del artículo. *Título de la revista.*

- Además, para la correcta referenciación habrá que considerar:
  - Aunque haya dos autores, se pone coma antes de la "&".
  - Después de ":" (dos puntos) se empieza con mayúscula.
  - Sólo se escribe en mayúscula la primera letra de la primera palabra del título. Sin embargo, para los títulos de las revistas se pone en mayúscula la primera letra de cada palabra.

– Tras las Referencias, se ha de incluir un apartado de **Agradecimientos.** En el mismo se ha de hacer referencia a cualquier entidad financiadora del estudio de investigación.

2.2. Tipos de artículos que se pueden someter a evaluación en *Cultura, Ciencia y Deporte*

2.2.1. Investigaciones originales

Son artículos que dan cuenta de un estudio empírico original configurados en partes que reflejan los pasos seguidos en la investigación. El texto completo debe tener la siguiente estructura:

2.2.1.1. *Introducción.* Problema del que se parte, estado de la cuestión y enunciado del objetivo e hipótesis de la investigación.

Se debe introducir y fundamentar teóricamente el problema de estudio y describir la estrategia de investigación. En el último párrafo el objetivo del trabajo se debe establecer claramente. Cuando se quiera llamar la atención sobre alguna palabra se usarán las cursivas. El uso de subrayado, negrita y mayúsculas no está permitido. Se evitará también, en lo posible, el uso de abreviaturas. Tampoco se admite el uso de las barras, por ejemplo, y/o, alumnos/as. Habrá que buscar una redacción alternativa. En documento aparte, se presentan las directrices generales de estilo para los informes que utilicen el sistema internacional de unidades.

2.2.1.2. *Método.* Descripción de la metodología empleada en el proceso de la investigación. En esta sección debería detallarse suficientemente todos aquellos aspectos que permitan al lector comprender qué y cómo se ha desarrollado la investigación. La descripción puede ser abreviada cuando las técnicas suficientemente conocidas hayan sido empleadas en el estudio. Debe mostrarse información sobre los participantes describiendo sus características básicas y los controles utilizados para la distribución de los participantes en los posibles grupos. Deben describirse los métodos, aparatos, procedimientos y variables con suficiente detalle para permitir a otros investigadores reproducir los resultados. Si utilizan métodos establecidos por otros autores debe incluirse la referencia a los mismos. No olvidar describir los procedimientos estadísticos utilizados. Si se citan números menores de diez se escribirán en forma de texto, si los números son iguales o mayores de 10 se expresarán numéricamente.

Este apartado suele subdividirse en sub-apartados:

- *Participantes.* Debe describirse la muestra (número de personas, sexo, edad, y otras características pertinentes en cada caso) y el procedimiento de selección. Además, en aquellos estudios realizados con humanos o animales es obligatorio identificar el comité ético que aprobó el estudio. Cuando se describen experimentos que se han realizado con seres humanos, se debe indicar que además del comité ético institucional o regional, el estudio está de acuerdo con la Asociación Médica Mundial y la Declaración de Helsinki. No se deben utilizar nombres, iniciales o números que permitan identificar a los participantes.
- *Instrumentos.* Especificar sus características técnicas y/o cualitativas.
- *Procedimiento.* Resumir cada paso acometido en la investigación: instrucciones a los participantes, formación de grupos, manipulaciones experimentales específicas. Si el trabajo consta de más de un experimento, describa el método y resultados de cada uno de ellos por separado. Numerarlos, Estudio 1, Estudio 2, etc.

2.2.1.3. *Resultados.* Exposición de los resultados obtenidos. Los resultados del estudio deberían ser presentados de la forma más precisa posible. La discusión de los mismos será mínima en este apartado. Los resultados se podrán presentar en el texto, en Tablas o Figuras.

Cuando se expresen los datos estadísticos, las abreviaturas deben ir en cursiva, así como al utilizar el *p*-valor (que irá siempre en minúscula). Por ejemplo: *p, F, gl, SD, SEM, SRD, CCI, ICC*. Es necesario que antes y después del signo igual (=) se incluya un espacio. Se debe incluir un espacio también cuando entre el número y la unidad de medida (7 Kg y no 7Kg), pero no se incluirá dicho espacio entre el número y el signo de porcentaje (7% y no 7 %). Los decimales irán precedidos de puntos (9.1 y no 9,1).

No se incluirán los mismos datos que en el texto, en las tablas o en las figuras. Tanto las Figuras como en las Tablas no deben denominarse de ninguna otra manera. Las Figuras y Tablas serán introducidas donde corresponda en el texto, con su numeración correlativa, poniendo la leyenda de las Figuras en su parte inferior y la leyenda de las Tablas en su parte superior.

Las *Tablas* son un resumen organizado de palabras o cifras en líneas o renglones. Todas las tablas deben seguir el formato APA, incluyendo: a) su numeración en número arábigos, b) un título, c) líneas solo horizontales sobre el encabezado, debajo del mismo y al fin de la tabla, sin líneas verticales, y d) fondo de tabla blanco. Los decimales dentro de las tablas deben estar separados por **puntos** (.). Se debe incluir en el pie de la tabla todas aquellas abreviaturas o símbolos utilizados en la misma. El tamaño de la fuente en las tablas podrá variar en función de la cantidad de datos que incluya, pudiéndose reducir hasta 8 cpi máximo.

Tabla 1. Ejemplo 1 de tabla para incluir en los artículos enviados aCCD.

	P5	POT	STD	SDS	SDI	EQG	SDT	ENF	CA	EH	ES	Esuc	F	MT	ED
MT	9.1	21.	9.1	6.1	92.	63.6	9.0	33.3	3.0	30.	15.	12.	0.0	82.1	35.
ED	33.3	13.3	16.7	6.7	23.0	70.0	16.6	26.7	21.1	63.3	0.0	30	10.0	13.3	96.0

Leyenda: MT=Indicar el significado de las abreviaturas

Tabla 2. Ejemplo 2 de tabla para incluir en los artículos enviados a CCD.

Nombre 1	Ítem 1. Explicación de las características del ítem 1 Ítem 2. Explicación de las características del ítem 2 Ítem 3. Explicación de las características del ítem 3
Nombre 2	Ítem 1. Explicación de las características del ítem 1 Ítem 2. Explicación de las características del ítem 2 Ítem 3. Explicación de las características del ítem 3

Las *Figuras* son exposiciones de datos en forma no lineal mediante recursos icónicos de cualquier género. En caso de incluirse fotografías deben ser seleccionadas cuidadosamente, procurando que tengan una calidad de al menos 300 píxeles/pulgada y 8 cm de ancho. Si se reproducen fotografías no se debe poder identificar a los sujetos. En todo caso los autores deben haber obtenido el consentido informado para la realización de dichas imágenes, autorizando su publicación, reproducción y divulgación en *Cultura, Ciencia y Deporte*. Las Figuras deben ser incluidas dentro del texto, incluyendo: a) su numeración en número arábigos, b) un título.

2.2.1.4. *Discusión.* En este apartado se procederá a la interpretación de los resultados y sus implicaciones. Este apartado debe relacionar los resultados del estudio con las referencias y discutir la significación de lo conseguido en los resultados. No debe incluirse una revisión general del problema. Se centrará en los resultados más importantes del estudio y se evitará repetir los resultados mostrados en el apartado anterior. Evitar la polémica, la trivialidad y las comparaciones teóricas superficiales. La especulación es adecuada si aparece como tal, se relaciona estrechamente con la teoría y datos empíricos, y está expresada concisamente. Identificar las implicaciones teóricas y prácticas del estudio. Sugerir mejoras en la investigación o nuevas investigaciones, pero brevemente.

2.2.1.5. *Conclusiones.* Recapitulación de los hallazgos más importantes del trabajo para el futuro de la investigación. Sólo deben relacionarse conclusiones que se apoyen en los resultados y discusión del estudio. Debe comentarse la significación del trabajo, sus limitaciones y ventajas, aplicación de los resultados y trabajo posterior que debería ser desarrollado.

2.2.2. Artículos de revisión

Los artículos de revisión histórica contemplarán los apartados y el formato de las *investigaciones originales*. Las revisiones sobre el estado o nivel de desarrollo científico de una temática concreta deberán ser sistemáticas.

2.2.3. Ensayos

Esta sección de *Cultura, Ciencia y Deporte* admitirá ensayos, correctamente estructurados y suficientemente justificados, fundamentados, argumentamos y con coherencia lógica, sobre temas relacionados con el deporte, que tengan un profundo trasfondo filosófico o antropológico que propicie el avance en la compresión del deporte como fenómeno genuinamente humano. Pretende ser una sección dinámica, actual, que marque la línea editorial y la filosofía del deporte que subyace a la revista. No precisa seguir el esquema de las investigaciones originales, pero sí el mismo formato.

2.3 Información relevante de la revista

La revista Cultura, Ciencia y Deporte se adhiere al "***Code of Conduct and the Best Practices Guidelines for Journals Editors del Committee on Publication Ethics – COPE***" y a las recomendaciones del "***International Committee of Medical Journal Editors - ICJME***". Existe compromiso por parte de la revista para la detección de plagio y otros tipos de fraude en la redacción y presentación de artículos a ***Cultura, Ciencia y Deporte***.

La política editorial de la revista promueve el uso de lenguaje inclusivo en los artículos científicos. Por favor, tenga en cuenta esta directriz y revise su documento antes de remitirlo a la revista.

3 TRATAMIENTO DE DATOS PERSONALES

En virtud de lo establecido en el artículo 17 del Real Decreto 994/1999, por el que se aprueba el Reglamento de Medidas de Seguridad de los Ficheros Automatizados que contengan Datos de Carácter Personal, así como en la Ley Orgánica 15/1999 de Protección de Datos de Carácter Personal, y la Ley Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales, la Dirección de *Cultura, Ciencia y Deporte* garantiza el adecuado tratamiento de los datos de carácter personal.

4 INFORMACIÓN RELATIVA A LA CORRECCIÓN DE PRUEBAS / GALERADAS UNA VEZ ACEPTADO EL ARTÍCULO

En caso de aceptación, el autor designado como responsable de correspondencia recibirá un informe de estilo (con aspectos de formato a modificar, en caso de que sea necesario) junto con un documento donde se solicitarán los nombres y apellidos de todos los autores junto a su afiliación (para el encabezado del artículo), la aportación de cada uno de los autores, las redes sociales de los autores y los agradecimientos. Dichos documentos se devolverán completos en un plazo máximo de tres días. Posteriormente, recibirá en su email una prueba de imprenta del artículo en formato PDF. La prueba se revisará y se marcarán los posibles errores con la opción notas de Adobe Acrobat, devolviendo las pruebas corregidas a la redacción de la revista en un plazo máximo de 48 horas. De no recibir estas pruebas en el plazo fijado, el Comité Editorial de la revista podrá decir publicar el artículo en su estado original, no pudiendo hacerse cambios tras su publicación y no haciéndose responsable la revista de cualquier error u omisión que pudiera publicarse; o retrasar su publicación a un número posterior. En esta fase de edición del manuscrito, las correcciones introducidas deben ser mínimas (erratas). El equipo editorial se reserva el derecho de admitir o no las correcciones efectuadas por el autor en la prueba de impresión.

5 INFORMACIÓN SOBRE LA APORTACIÓN DE TODOS LOS FIRMANTES DEL ARTÍCULO

Los autores deberán informar sobre el criterio escogido para decidir el orden de firma y sobre la contribución específica realizada por cada uno de ellos en el trabajo publicado. Esta información se pedirá en la hoja final donde se solicita a los autores sus datos, afiliaciones, aportaciones de los autores, redes sociales y agradecimientos. En la lista de autores firmantes deben figurar únicamente aquellas personas que han contribuido intelectualmente al desarrollo del trabajo. En general, para figurar como autor se deben cumplir los siguientes requisitos: a) haber participado en la concepción y realización del trabajo que ha dado como resultado el artículo en cuestión; b) haber participado en la redacción del texto y en las posibles revisiones del mismo; c) haber aprobado la versión que finalmente va a ser publicada. El equipo editorial de *Cultura, Ciencia y Deporte* rehúsa cualquier responsabilidad sobre posibles conflictos derivados de la autoría de los trabajos que se publican en la revista.

El autor firmante como autor de correspondencia será el encargado de actuar como mediador entre la revista y los demás autores y debe mantener informados a todos los coautores e involucrarlos en las decisiones importantes sobre la publicación. Posteriormente a la aceptación del artículo no se admitirán cambios en el mismo (salvo erratas), por lo que se recomienda contar con el visto bueno de todos los coautores antes de remitir las revisiones a la revista.

6 REGISTRO DE LA FUENTE DE FINANCIACIÓN DE LOS ARTÍCULOS PUBLICADOS

Los autores deberán declarar si el trabajo ha tenido algún tipo de financiación para realizar la investigación que se pretende publicar, así como los proyectos de investigación o contratos financiados de la que es resultado. Esta información se deberá incluir en los metadatos de la revista a la hora de cargar el artículo en la plataforma. Además, se volverá a pedir esta información en la hoja final donde se solicita a los autores sus datos, filiaciones, aportaciones, redes sociales y agradecimientos.

7 ABONO EN CONCEPTO DE FINANCIACIÓN PARCIAL DE LA PUBLICACIÓN

Las normas de este apartado entran en vigor para los envíos y revisiones realizadas a partir del 29 de octubre de 2019.

De acuerdo con la filosofía de *Open Access* de la revista y con el fin de sufragar parte de los gastos de la publicación en aras de mejorar la calidad de la misma, la visibilidad y la repercusión de

la publicación, CCD fija una tarifa de publicación de 120 € (IVA incluido). Este pago deberá hacerse efectivo tras la comunicación de la aceptación del artículo. Para ello tras la aceptación del artículo se debe enviar a gjimenez@ucam.edu el resguardo de la transferencia realizada al nº de cuenta ES02 0081 5089 3800 0109 4420 (CODIGO BIC-SWIFT: BSABESBB), cuyo titular es la "FUNDACIÓN UNIVERSITARIA SAN ANTONIO", indicando en el concepto "Revista CCD + nº del artículo".

Por otra parte, los revisores de artículos CCD tendrán derecho a una publicación sin coste por cada tres artículos que hayan revisado en el tiempo y la forma solicitada por los editores. A tal fin, deben indicar los artículos revisados si quieren beneficiarse de la exención de pago cuando se les solicite el mismo. Los editores están exentos de pago.

8 ACTUALIZACIÓN IMPORTANTE EN LA NORMATIVA DE ENVÍO QUE ENTRARÁ EN VIGOR PARA TODOS LOS ARTÍCULOS ENVIADOS A PARTIR DEL 1 DE ENERO DEL 2021.

Todos los autores que realicen un envío a partir de dicha fecha (en un idioma diferente al inglés), y cuyo artículo finalmente sea aceptado, también deberán remitir la versión definitiva en inglés. En la versión en inglés deberá aparecer el nombre completo del traductor y su email. La intención de este cambio es aumentar la difusión de los artículos publicados en nuestra revista.

9 PROPUESTA DE PUBLICACIÓN DE MONOGRÁFICOS EN *CULTURA, CIENCIA Y DEPORTE.*

Las personas interesadas en proponer la publicación de un monográfico en la *Revista Cultura, Ciencia y Deporte,* deben enviar una descripción de 500-600 palabras (incluidas referencias) a la dirección email de la revista (ccd@ucam.edu). En dicho email, el coordinador o coordinadores del mismo (máximo 3 personas) deben realizar una aproximación a la temática y contenido del monográfico propuesto, así como sus CV.

Una vez aceptada la propuesta de monográfico, se establecerá un período de llamada de artículos *"Call for papers"* y una fecha límite de envíos "*Deadline*" cuya duración será determinada por el coordinador del mismo. El equipo editorial de la *Revista Cultura, Ciencia y Deporte* propondrá la fecha prevista de publicación del monográfico en función de su disponibilidad.

Las funciones del coordinador del monográfico serán, redactar el editorial del mismo, y aportar un listado de posibles revisores que serán seleccionados por el equipo editorial para llevar a cabo las revisiones por pares de los artículos del monográfico. Para que el monográfico sea publicado serán necesarios un mínimo de 10 artículos aceptados. El coordinador del monográfico tendrá la posibilidad de invitar autores para que colaboren con sus manuscritos. La decisión final de aceptación para que un artículo forme parte del monográfico será del equipo editorial, no del coordinador del monográfico.

Todos los manuscritos aceptados para publicación, incluido el editorial, contarán con DOI.

10 PUBLICACIÓN DE ARTÍCULOS EN UN MONOGRÁFICO

Los manuscritos deben presentarse a través de la web *Cultura, Ciencia y Deporte* (https://ccd.ucam.edu), registrándose e iniciando sesión. Durante el proceso de envío, se seleccionará la pestaña con el nombre del monográfico donde se pretende publicar. Se invita a presentar artículos de investigación y de revisión. Los trabajos aceptados se publicarán en la página web de la *Revista Cultura, Ciencia y Deporte*, y contarán con su correspondiente DOI.

Los manuscritos que se presenten no deben haber sido publicados anteriormente, ni estar en consideración para su publicación en otro lugar. Todos los manuscritos se someten a un riguroso proceso de revisión por pares a ciegas. Los manuscritos deben redactarse de acuerdo a las directrices generales de la revista: https://ccd.ucam.edu/index.php/revista/about/submissions#authorGuidelines y siguiendo las directrices del template de la revista (https://docs.google.com/document/d/1Y-jojriyIgd0VUNS9Jk55gPbdf5oEcuN_/edit?usp=sharing&ouid=109045219128359206476&rtpof=true&sd=true). El coste de procesamiento de artículos para los autores en números especiales (monográficos) de acceso abierto es de 250 euros por artículo (IVA incluido). El coordinador del monográfico no debe abonar ninguna tasa por la edición del editorial y tendrá un artículo gratuito en dicho monográfico. Los artículos presentados deben tener el formato correcto de acuerdo a las normas de publicación de la revista, de lo contrario no serán aceptados. Los envíos pueden realizarse en idioma español o inglés, siendo necesario en caso de que se hayan enviado en español su traducción al inglés por parte de los autores una vez que el artículo haya sido aceptado.

CHECKLIST FORMATO PARA ARTÍCULOS EN *CCD*

- *Texto*: adaptado al template disponible en la página web y en las normas de publicación de la revista.
- *Alineación del texto:* a izquierda y derecha (justificada).
- *Extensión:* no debe sobrepasar las 7500 palabras incluyendo Figuras, Tablas, y Referencias.
- *Primera página:* debe contener los siguientes elementos del trabajo: título del artículo en español y en inglés en minúscula, un resumen del trabajo en español y en inglés, más las palabras claves en español y en inglés. Por este orden, o el contrario si el artículo está escrito en inglés.
- *Segunda página*: se iniciará con el texto completo del artículo. El cuerpo de texto del trabajo deberá empezar en página independiente de la anterior de los resúmenes.
- Indicación clara de los apartados o secciones de que consta, así como con una clara jerarquización de los posibles sub-apartados (primer nivel irá en negrita y sin tabular, segundo irá en cursiva y sin tabular, tercero irá en cursiva y con una tabulación). Todos ellos en minúscula.
- *Título*: Se recomiendan 10-12 palabras.
- *Resumen:* La longitud no debe sobrepasar las 200 palabras.
- *Palabras clave*: 4 ó 5 palabras que reflejen claramente cuál es el contenido específico del trabajo.
- No repetidas del título.
- *Figuras y Tablas*: introducidas donde corresponda en el texto, con su numeración correlativa.
- *Figuras y Tablas*: leyenda de las Figuras en su parte inferior y la leyenda de las Tablas en su parte superior.
- *Figuras y Tablas*: Mantener las tablas simples sin líneas verticales.
- *Figuras y Tablas*: El tamaño de la fuente en las tablas podrá variar en función de la cantidad de datos que incluya, pudiéndose reducir hasta 8 cpi máximo.
- *Citas y referencias:* Deben seguir formato APA 7th edición.
- *Agradecimientos:* se colocan al final del artículo, tras las referencias.
- *Envío*: se incluyen dos manuscritos, uno con el nombre de "**artículo con autores**" y el otro "**artículo anónimo**".

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CULTURA, CIENCIA Y DEPORTE MANUSCRIPTS SUBMISSION GUIDELINESS

Cultura, Ciencia y Deporte will consider research studies related to the different areas of Physical Activity and Sport Sciences, which are scientifically based. Given the specialized nature of the journal, popular articles will not be accepted, nor will those limited to exposing opinions without conclusions based on academic investigation. Papers should be sent electronically through our website: http://ccd.ucam.edu,where the author must register as an author and proceed as indicated by the tool.

1. CONDITIONS

All manuscripts received will be examined by the Editorial Board of *Cultura, Ciencia y Deporte*. If the manuscript adequately fulfills the conditions defined by the Editorial Board, it will be sent on for the anonymous peer review process by at least two external reviewers, who are members of the Advisory Committee. The manuscripts rejected in this first evaluation will be returned to the author with an explanation of the motives for which the paper was not admitted. Likewise, the authors of those manuscripts that having passed this first filtering process may be subsequently required to alter any corrections needed in their manuscript as quickly as possible. Acceptance of the article for publication in Cultura, Ciencia y Deporte, will require the positive judgment of the two reviewers, and where appropriate, of a third review. Throughout this process, the manuscript will continue to be in possession of the journal, though the author may request that his/her paper be returned if so desired. The publication of articles does not entitle any remuneration. Editing rights belong to the journal and permission is required for any reproduction. The acceptance of an article for publication in the *Cultura, Ciencia y* Deporte implies the author's transfer of copyright to the editor, to allow the paper to be reproduced or published in part or the entire article. Within four months the outcomes from any paper submitted will be communicated to the author.

2 SUBMISSION

2.1 General guideliness

Manuscripts must be submitted via http://ccd.ucam.edu/index.php/revista/login. All text should be written according to the guidelines in the journal template (https://docs.google.com/document/d/1YjojriyIgd0VUNS9Jk55gPbdf5oEcuN_/edit?usp=sharing&ouid=109045219128359206476&rtpof=true&sd=true), without modifying the font or size of the text. If your article is accepted for publication, it will present the layout of the final template, therefore, please review it carefully before submitting it. The maximum recommended length should not exceed 7500 words including Figures, Tables and Reference List.

Each submission will consist of **two documents**. The first will be called "**article with authors**" and will include in the manuscript the name of all authors who are part of the work, as well as their affiliations, author of correspondence, committee codes (e.g., ethics committee), linked research projects, acknowledgements and funding. The second will be called "**anonymous article**" in which the title of the paper, abstract, keywords, text of the paper and references will be included, without any indication that would allow the reviewers to identify the authors of the manuscript.

- On the **first page** of the article, the following elements should be presented (in this order, or the opposite order if the text of the article is in English). It is important not to include the names of the authors or their affiliation in the document entitled "anonymous article", but this should be done in "article with authors".
  - **Title** in Spanish and English (both in lowercase, without full stop). 10 – 12 words are recommended. Since it will be shown on the index information, the title should be informative itself and call the attention of potential readers. The title must be concise and avoid being over long.
  - **Abstract** of the work in Spanish and English.
    a. Should reflect the content and purpose of the manuscript.
    b. If the paper is reproducing another author´s work, it should be acknowledged.
    c. The length of the abstract should not exceed **200 words**.
    d. The abstract should include: the problem, if possible in one sentence; participants, identifying the main variables (number, age, gender, etc.); methodology (design, equipment, procedure data collection, full names of tests, etc.); results (including levels of statistical significance); conclusions and implications or applications. The summary should not be unstructured and **should be written in a single paragraph**.
  - **Key words** in Spanish and English**.** 4 or 5 words that reflect the specific content of the work (in italics and not included in the title). Only the first word is written with a capital letter. Words should be separated with commas, and a full stop at the end of a sentence. plus the key words in Spanish and English, in this order, or the opposite if the item is in English. A full stop should not be included at the end of the title.
- On the **second page** of the article, will start the **full text** of the article. Full text of the article should begin on separate page to the abstracts with a clear indication of the paragraphs or sections and with a clear hierarchy of possible sub-paragraphs: .
  - The first level should be in bold, without tabs and lowercase.
  - The second should be without bold, tabs and lowercase.
  - The third should be in italics, without tabs and lowercase.
- After the full text, a **References** section must be included. Citations and references in the text and in the specific section must be made in **APA 7th ed** regulations. Below is a summary of it:

References through the text.

- References of three or more authors only the first author should appear followed by "et al." For example: Fernandez et al. (2019).
- The literal references will be made in the text, after being reference in parentheses, the author's last name, coma, the year of the cited work, coma and page where the text: (Sanchez, 1995, 143).
- If you want to make a generic reference in the text, i.e. without specifying the page of the book or article, it should be cited as follows: the author's name, comma and year of publication in parentheses: (Ferro, 2015).
- References cited in the text should appear in the reference list.
- The references included in the same parentheses should be in alphabetical order.
- Whenever the reference is included in parentheses: the "&" will be used. When the reference is not included in parentheses, "and" should always will be used. The references of two authors are linked by "and" or "&", and references from various authors end up in a coma plus "and" or "&". For example: Fernandez and Ruiz (2008) or Moreno, Ferro, and Diaz (2007).
- When citing two authors with the same name, the initials of the relevant names must precede them.
- When the same author published two or more pieces of work in the same year, their work should add in the lowercase letters a, b, c. For example: Ferro (1994a, 1994b).

At the end of the manuscript – References list

- Authors are listed in alphabetical order, independently of the number. When various authors are listed, the alphabetical order should be determined in each work by the first author, then the second, then the third successively.
- The DOI (Digital Object Identifier) must be used in the bibliographic citations of articles and electronic publications:

  Muñoz, V., Gargallo, P., Juesas, Á., Flández, J., Calatayud, J., & Colado, J. (2019). Influence of the different types and parameters of the physical exercise on seminal quality: a systematic review of the literature. *Cultura, Ciencia y Deporte*, *14(40), 25-42*. http://dx.doi.org/10.12800/ccd.v14i40.1223

- References of various authors will be separated by a comma and "&". Some examples as follows:
  Author, A. A.; Author, B. B., & Author, C. C. (2020). Title. *Journal, xx*(x), xxx-xxx. http://dx.doi.org/xxxxxx
  Author, A. A. (2020). *Title*. Publisher.
  Author, A. A., & Author, B. B. (2020). Title. In A. Editor, B. Editor, & C. Editor. (Eds.),
  Book title (pp. xxx-xxx). Publisher.
  Author, A. A.; Author, B. B., & Author, C. C. (in press). Title. *Journal*
- In addition, for correct referencing:
  - If there are two authors, add a comma before "&".
  - After a ":" (colon) a capital letter should be used.
  - Just type the uppercase for the first letter of the first word of the title for a Book reference. However, titles of journal references are capitalized, using the first letter of each word.

– After the References, a section of **Acknowledgments.** It must be placed in the space set out for this purpose. If is necessary, you can refer to the financing entity of the research study.

2.2 Type of papers that can be submitted for evaluation in CCD

2.2.1 *Original research*
These are articles that account for an empirical study set in original parts that reflect the steps taken in the investigation. The full text must have the following structure:

2.2.1.1. *Introduction.* State the problem of the investigation and the aim and hypothesis of the work. The research problem should be substantiated theoretically, describing the experimental approach to the problem. In the last paragraph, the aim of the work should be established clearly.

Use **italics** to show relevant information. Underline, bold or capital letters are not allowed. The use of abbreviations should be as minimum as possible. See the International System of Units for general style guidelines International System of Units.

2.2.1.1. *Method*. Description of the methodology used in the research process. This section should be detailed enough to allow the reader to understand all aspects regarding what and how the research has been developed. Well known techniques used within the study should be abbreviated. Information about the participants must be displayed to describe their basic characteristics and criteria used for the distribution of participants in any group. The experiment must be reproducible by others and methods, devices, procedures and variables must be detailed. Methods used by other authors should include a reference. All statistical procedures must be described. Numbers lower than ten should be in the form of text, if the numbers are equal to or greater than 10, they should be expressed numerically.

The method is usually divided into subsections:

- • *Participants.* The sample´s characteristics (number, sex, age and other relevant characteristics in each case) and selection process. Studies involving humans or animals must cite the ethical committee that approved the study. When describing experiments that have been performed with human beings, it should be noted that in addition to the institutional or regional ethical committee, the study agrees with the World Medical Association and the Helsinki Declaration. No names, initials or numbers should be used to identify the participants.
- • *Instruments.* Specify technical characteristics.
- • *Procedure.* Summarize each step carried out in the research: instructions to the participants, groups, and specific experimental manipulations. If the study involves more than one experiment, describe the method and results of each of them separately. Numbered, Study 1, Study 2,etc.

2.2.1.3. *Results.* The results must be presented as accurately as possible. The discussion should be minimal and reserved for the Discussion section. The results may be presented as text, tables or figures. To report statistical data, abbreviations should be in italics, as well as when using the *p*-value (which should always be in lowercase). For example: *p, F, gl, SD, SEM, SRD, ICC, ICC*. It is necessary to include a space before and after the equal sign (=). A space must be included also between the number and the unit of measure (not 7Kg but 7 Kg), conversely the space between the number and the percentage sign should not be included (7% and 7% do not). Decimals will be preceded by points (9.1 and not 9,1).

Do not include the same information in the text as used in the tables or figures. The Figures and Tables will be introduced where appropriate in the text, with their correlative numbering, putting the legend of the Figures at the bottom and the legend of the Tables at the top.

Tables are an organized summary of words or figures in lines or lines. All tables must follow the APA format, including: a) their numbering in Arabic numerals, b) a title, c) only horizontal lines above the heading, below it and at the end of the table, without vertical lines, and d) background of white table. Decimals within tables must be separated by dock (.). All abbreviations or symbols used in it should be included at the bottom of the table. The font size in the tables may vary depending on the amount of data that is included, and can be illustrated up to 8 cpi as a maximum.

Table 1. Example Table 1 to include articles sent to *CCD*.

	P5	POT	STD	SDS	SDI	EQG	SDT	ENF	CA	EH	ES	Esuc	F	MT	ED
MT	9.1	21.	9.1	6.1	92.	63.6	9.0	33.3	3.0	30.	15.	12.	0.0	82.1	35.
ED	33.3	13.3	16.7	6.7	23.0	70.0	16.6	26.7	21.1	63.3	0.0	30	10.0	13.3	96.0

Note: P5=Write the meaning of abbreviations.

Table 2. Example Table 2 to include articles sent to *CCD*.

Name 1	Item 1. Explanation of the characteristics of the item 1 Item 2. Explanation of the characteristics of the item 2 Item 3. Explanation of the characteristics of the item 3
Name 2	Item 1. Explanation of the characteristics of the item 1 Item 2. Explanation of the characteristics of the item 2 Item 3. Explanation of the characteristics of the item 3

The Figures are exposures of data in a non-linear way by means of iconic resources of any genre. If photographs are included, they must be carefully selected, ensuring that they have a quality of at least 300 pixels / inch and 8 cm wide. If photographs are reproduced, subjects should not be identified. In any case, the authors must have obtained the informed consent for the realization of these images, authorizing their publication, reproduction and dissemination in CCD. Figures should be included in the text, including: a) their numbering in Arabic numerals, b) a title.

2.2.1.4. *Discussion.* The discussion is an interpretation of the results and their implications. This section should relate the results of the study to theory, and or, previous research with references and discuss the significance of what has been achieved. A general review of the problem must not be included. The discussion will be focused on the most important results of the study and avoid repeating the results shown in the previous paragraph. Avoid controversy, triviality and comparisons theoretical surface. Speculation is appropriate if it appears as such and is closely related to the theory and empirical data. Identify theoretical and practical implications of the study. Suggest improvements in the investigation or further investigation, but briefly.

2.2.1.5. *Conclusions.* Summarize the most important findings of the work for future research. Only conclusions supported by the results of the study and discussion must be presented.

The significance of the work, its limitations and advantages, the application of results and future lines of investigation should be presented.

2.2.2. *Review articles.* Historical review articles should use the following the same sections and style from original research. Reviews on the status of an issue should be systematic.

2.2.2. *Essays.* This section of *Cultura, Ciencia y Deporte* will admit essays, properly structured and sufficiently justified, grounded, we argue and with logical coherence, on issues related to sport, that have a deep philosophical or anthropological background that promotes the advance in the compression of sport as a phenomenon genuinely human. It aims to be a dynamic, current section that marks the editorial line and the philosophy of the sport that underlies the journal. You do not need to follow the original research scheme, but the same format.

2.3 Relevant information from the journal

The journal *Cultura, Ciencia y Deporte* adheres to the "Code of Conduct and the Best Practices Guidelines for Journals Editors of the Committee on Publication Ethics - COPE" and the recommendations of the "International Committee of Medical Journal Editors - ICJME". There is a commitment by the journal to detect plagiarism and other types of fraud in the writing and submission of articles to *Cultura, Ciencia y Deporte.*

The journal's editorial policy promotes the use of inclusive language in scientific articles. Please take note of this guideline and review your document before submitting it to the journal.

3 TREATMENT OF PERSONAL DATA

In virtue of what was established in article 17 of the Royal Decree 994/1999, in which the Regulation for Security Measures Pertaining to Automated Files That Contain Personal Data was approved, as well as the Constitutional Law 15/1999 for Personal Data Protection, and Law Organic Law 3/2018, of 5 December, on the Protection of Personal Data and guarantee of digital rights, the editorial committee of *Cultura, Ciencia y Deporte* guarantees adequate treatment of personal data.

4 INFORMATION REGARDING PROOFS AFTER ACCEPTANCE OF THE ARTICLE

In case of acceptance, the author appointed as correspondent will receive a style report (with formatting aspects to be modified, if necessary) together with a document requesting the names and surnames of all authors together with their affiliation (for the head of the article), the contribution of each of the authors, the authors' social networks and acknowledgements. These documents will be returned complete within a maximum of three days. You will then receive a proof of the article in PDF format by email. The proof will be reviewed and any errors marked with the Adobe Acrobat notes option, and the corrected proofs will be returned to the journal's editorial staff within a maximum of 48 hours. If these proofs are not received by the deadline, the journal's Editorial Committee may decide to publish the article in its original state, with no changes made after publication and the journal will not be responsible for any errors or omissions that may be published; or delay publication to a later issue. At this stage of editing the manuscript, corrections made should be kept to a minimum. The editorial team reserves the right to admit or not the corrections made by the author in the proof print.

5 INFORMATION ON THE CONTRIBUTION OF ALL SIGNATORIES TO THE ARTICLE

Authors must inform about the criteria chosen to decide the order of signature and about the specific contribution made by each one of them in the published work. This information will be requested on the final sheet where the authors are asked for their details, affiliations, contributions from the authors, social networks and acknowledgements. Only those persons who have contributed intellectually to the development of the work should appear on the list of signatory authors. In general, in order to appear as an author, the following requirements must be met: a) to have participated in the conception and execution of the work that has resulted in the article in question; b) to have participated in the drafting of the text and possible revisions of the same; c) to have approved the version that is finally going to be published. The editorial team of *Cultura, Ciencia y Deporte* refuses any responsibility for possible conflicts derived from the authorship of the works published in the journal. The author who signs as a correspondent will be responsible for acting as a mediator between the journal and the other authors and must keep all co-authors informed and involved in important decisions about the publication. After the article has been accepted, no changes will be made to it, and it is therefore recommended that all co-authors give their approval before revisions are sent to the journal.

6 SOURCE OF FUNDING FOR PUBLISHED PAPERS

Authors must declare whether the work has had any funding to carry out the research to be published, as well as the research projects or contracts funded as a result. This information must be included in the journal's metadata when the article is uploaded to the platform. In addition, this information will be requested again in the final page where authors are asked for their data, affiliations, contributions, social networks and acknowledgements.

7 PAYMENT IN CONCEPT OF PARTIAL FINANCING OF PUBLICATION

The rules in this section are effective for submissions and revisions send from 29 October, 2019. In accordance with the Open Access philosophy of the journal and in order to cover part of the expenses of the publication in to improve its quality, visibility and impact of the publication, CCD sets a publication fee of €120 (VAT included). This payment must be done after the notification of acceptance of the article.

To do this, after acceptance of the article, the receipt of the transfer made to "FUNDACIÓN UNIVERSITARIA SAN ANTONIO" in the account number ES02 0081 5089 3800 0109 4420 (BIC-SWIFT CODE: BSABESBB) must be sent to gjimenez@ucam.edu, indicating in the concept of the transfer "CCD journal + article number".

Furthermore, reviewers of CCD articles will be entitled to a free publication for every three articles they have reviewed in time and in the form requested by the editors. To this end, they must indicate the reviewed articles if they want to benefit from the exemption of payment when requested. Editors are exempt from payment.

8 IMPORTANT UPDATE IN THE SENDING REGULATIONS AS OF JANUARY 1, 2021.

All authors who submit an article after this date (in a language other than English), and whose article is finally accepted, must also submit the final version in English. The full name of the translator and his/her e-mail address must appear on the English version. The intention of this change is to increase the circulation of articles published in our journal.

9 PROPOSAL FOR THE PUBLICATION OF MONOGRAPHS ON CULTURA, CIENCIA Y DEPORTE

Those interested in proposing the publication of a monograph in the journal Cultura, Ciencia y Deporte should send a 500-600 word description (including references) to the journal's email address (ccd@ucam.edu). In this email, the coordinator or coordinators (maximum 3 people) must provide an approximation of the subject matter and content of the proposed monograph, as well as their CVs.

Once the monograph proposal has been accepted, a "Call for papers" period and a "Deadline" for submissions will be established, the duration of which will be determined by the coordinator of the monograph. The editorial team of the Journal Cultura, Ciencia y Deporte will propose a date for the publication of the monograph according to its availability.

The functions of the coordinator of the monograph will be to write the editorial of the monograph, and to provide a list of possible reviewers who will be selected by the editorial team to carry out the peer reviews of the articles in the monograph. A minimum of 10 accepted articles will be required for the monograph to be published. The coordinator of the monograph will have the possibility to invite authors to collaborate with their manuscripts. The final decision as to whether an article is accepted for inclusion in the monograph will be made by the editorial team, not by the monograph coordinator. All manuscripts accepted for publication, including the editorial, will have a DOI.

10 PUBLICATION OF ARTICLES IN A MONOGRAPH

Manuscripts must be submitted through the Cultura, Ciencia y Deporte website (https://ccd.ucam.edu), by registering and logging in. During the submission process, select the tab with the name of the monograph where you intend to publish. Research and review articles are invited. Accepted papers will be published on the website of the Journal Cultura, Ciencia y Deporte, and will have their corresponding DOI.

Manuscripts submitted must not have been previously published, nor be under consideration for publication elsewhere. All manuscripts undergo a rigorous blind peer review process. Manuscripts should be written according to the general guidelines of the journal: https://ccd.ucam.edu/index.php/revista/about/submissions#authorGuidelines and following the guidelines of the journal's template (https://docs.google.com/document/d/1Yjojr i y I g d 0 V U N S 9 J k 5 5 g P b d f 5 o E c u N _ / e d i t ? u s p = s h a r - ing&ouid=109045219128359206476&rtpof=true&sd=true). The article processing fee for authors in open access special issues (monographs) is 250 euros per article (including VAT). The coordinator of the monograph is not required to pay any editorial editing fee and will have a free article in the monograph. Articles submitted must be in the correct format according to the journal's publication guidelines, otherwise they will not be accepted. Submissions can be made in Spanish or English, and if the article is submitted in Spanish, it must be translated into English by the authors once the article has been accepted.

CHECKLIST FORMAT FOR ARTICLES IN CCD

- Text: adapted to the template available on the website and in the journal's publication guidelines.
- Text alignment: left and right (justified).
- Length: should not exceed 7500 words including figures, tables, and references.
- First page: should contain the following items of the work: title in Spanish and English in lowercase, a summary of the work in Spanish and English, plus the key words in Spanish and English. By this order, or the opposite if the article is written in English.
- Second page: start with the text. The main document should be in a new page (after abstract).
- Clear indication of paragraphs or sections that comprise, and with a clear hierarchy of
- possible sub-sections (first level will be without tabulating in bold type, second will be in italic without tabulating, and the third will be in italics and with tabulation). All in lowercase letter.
- Title: Recommended 10 to 12 words.
- Abstract: The length of the abstracts should not exceed 200 words.
- Keywords: 4 or 5 words that clearly reflect what the specific content of the work. Do not repeat the title. Only the first word is written with capital. Words separated with commas, and point at the end.
- Figures and Tables: In the text, with consecutive numbering.
- Figures and Tables: Figures caption in the bottom and Tables caption at the top.
- Figures and Tables: Maintain simple tables without vertical lines.
- Figures and Tables: The font size in the tables may vary depending on the amount of data that includes, and can be cut up to 8 cpi.
- References: They must follow the APA 7th edition format.
- Acknowledgements: They must be placed in the application in the space defined for this purpose.
- Submission: two manuscripts are included, one with the name "**article with authors**" and the other "**anonymous article**".

Murcia, 5th October 2021

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MANUAL DE AYUDA PARA LOS REVISORES EN EL PROCESO DE REVISIÓN DE ARTÍCULOS EN CCD*

Estimado revisor, su labor es inestimable. Le estamos extraordinariamente agradecidos. Sin su aportación rigurosa , la calidad de los trabajos que se publican en CCD, no sería tal. Es por ello por lo que estamos completamente abiertos a tantas recomendaciones y aportaciones que sirvan para mejorar el ya de por sí complejo proceso de revisión. En esta nueva etapa de CCD tenemos una premisa: agilidad, eficiencia y rigor de los procesos de revisión. Por ello le pedimos que, por favor, plantee valoraciones sólidas y las argumente de forma constructiva con un objetivo principal: mejorar la calidad del artículo (siempre que sea posible). Además, le recomendamos que tenga en cuenta las premisas para los revisores que marca la *Declaración de Ética y Negligencia de la Publicación* que puede ver en el pie de página.

A continuación se presenta un manual, en el que los revisores de la revista CCD podrán seguir paso a paso todas y cada una de las tareas que deben acometer para realizar un proceso de revisión riguroso y que se ajuste a las características de la plataforma de revisión (OJS) y de la filosofía de la revista. Cualquier duda que le surja, por favor, no dude en contactar con los editores de la revista (rvaquero@ucam.edu y labenza@ucam.edu). Todas y cada una de las fases se describen a continuación:

1. El revisor recibe el e-mail de CCD con la solicitud de revisión de un artículo. Debe decidir si acepta (o no) la petición del editor de sección. Para ello, debe clicar sobre el título del artículo dentro de "Envíos activos".
2. Una vez hecho esto, aparecerá una pantalla como la siguien- te, en la que el revisor debe seleccionar si hará (o no) la revisión. Si se acepta (o no), aparecerá una ventana automática con una plantilla de correo al editor de sección para comunicarle su decisión. Independientemente de su decisión, el revisor debe enviar este correo electrónico. Una vez la revisión es aceptada el revisor debe cumplir las indicaciones que aparecen en la pantalla siguiente.
3. A continuación debe primero abrir y descargar el fichero del manuscrito; y segundo, abrir y descargar la hoja de evaluación de CCD que puede encontrar en el apartado "Normas de revisor" (parte inferior en el epígrafe 1). La revisión y todos los comentarios que el revisor realice deberán plasmarse en esta hoja de evaluación (nunca en el texto completo a modo de comentarios o utilizando el control de cambios). Con ambos documentos descargados se procederá a la revisión propiamente dicha. Es muy importante que el revisor conozca las normas de publicación de CCD, para proceder de forma exhaustiva. Si bien los editores en fases previas del proceso de revisión han dado visto/bueno al formato del artículo, es importante que se conozcan las normas a nivel general para poder evaluar el artículo con mayor rigurosidad.
4. Una vez completada la revisión y rellenada la hoja de evaluación puede escribir algunos comentarios de revisión para el autor y/o para el editor. El comité editorial de CCD recomienda no introducir comentarios específicos en estos apartados. De utilizarse (pues no es obligatorio) se recomienda que hagan una valoración global del artículo, en la que se utilice un lenguaje formal.
5. A continuación debe subir el fichero con la hoja de evaluación del manuscrito actualizada. En este apartado únicamente se debe subir un archivo con la correspondiente evaluación del artículo. No se olvide de clicar en "Subir" o de lo contrario, a pesar de haber sido seleccionado, no se subirá el archivo, y el editor de sección no podrá acceder a él.
6. Por último, se debe tomar una decisión sobre el manuscrito revisado y enviarla al editor. Para ello debe pulsar el botón de enviar el correo, ya que de no ser así el correo no será enviado. Las diferentes opciones de decisión que la plataforma ofrece son las que puede ver en la pantalla. En el caso de considerar que "se necesitan revisiones" o "reenviar para revisión" llegado el momento, el editor se volverá a poner en contacto con usted y le solicitará empezar con la segunda (o siguientes rondas de revisión), que deberá aceptar y volver a empezar el proceso tal y como se explica en el presente manual. Caso de aceptar o rechazar el manuscrito, el trabajo del revisor habrá terminado cuando informe al editor de sección de esta decisión, tal como se ha indicado anteriormente (correo al editor mediante la plataforma).

En la segunda y siguientes rondas de revisión, el revisor se encontrará con dos archivos: uno con el texto completo del manuscrito, en el que el autor ha modificado con otro color distinto al negro en función de las aportaciones sugeridas; y otro fichero adicional con la planilla de evaluación, en la que el autor ha res- pondido punto por punto en un color distinto al negro, a todas las aportaciones que usted le hizo. Por favor, compruebe que todo está correctamente modificado. Caso de no producirse, responda en la misma hoja de evaluación con tantos comentarios considere, para que el autor pueda "afinar más" y realizar las modificaciones de forma satisfactoria y rigurosa. Este proceso se repetirá tantas veces como los editores de sección consideren oportuno.

Una vez completada la segunda (o siguientes rondas de revisión) del manuscrito, se volverá a tomar una decisión sobre el mismo, y se procederá de la misma manera que en la primera ronda. Una vez se da por finalizada la revisión doble-ciego del manuscrito, desaparecerá de su perfil de revisor, en el que encontrará 0 activos.

Antonio Sánchez Pato
Editor-jefe
(apato@ucam.edu)

*** Se puede acceder a una versión ampliada de este manual en la siguiente url: http://ccd.ucam.edu/index.php/revista/pages/view/revisores**

RESPONSABILIDADES DE LOS REVISORES

1) Los revisores deben mantener toda la información relativa a los documentos confidenciales y tratarlos como información privilegiada.
2) Las revisiones deben realizarse objetivamente, sin crítica personal del autor.
3) Los revisores deben expresar sus puntos de vista con claridad, con argumentos de apoyo.
4) Los revisores deben identificar el trabajo publicado relevante que no haya sido citado por los autores.
5) Los revisores también deben llamar la atención del Editor-jefe acerca de cualquier similitud sustancial o superposición entre el manuscrito en cuestión y cualquier otro documento publicado de los que tengan conocimiento.
6) Los revisores no deben revisar los manuscritos en los que tienen conflictos de interés que resulte de la competencia, colaboración u otras relaciones o conexiones con alguno de los autores, empresas o instituciones en relación a los manuscritos.

INFO FOR REVIEWERS IN THE REVIEW PROCESS FOR ARTICLES IN CCD*

Dear reviewer, your work is essential. We are remarkably grateful. Without your rigorous contribution, the qua-lity of the papers published in CCD would not be the same. That is why we are completely open to recommendations and contributions that can open the already complex process of revision. In this new stage of CDD we have a premise: agility, efficiency and the exactitude of the revision process. Thus, we please ask you solid ratings, and argue constructively with one main objective: to improve the quality of the article. In addition, we recommend you to consider the premises that denotes the Statement of Ethics and Publication Malpractice that can be ob-served in the footer.

Below a manual is presented, where the CCD journal reviewers are going to be able to follow step by step the process in order to perform a rigorous review process that fits the characteristics of the review platform (OJS) and the philosophy of the journal. Any questions that may raise, please do not hesitate to contact the publishers of the journal (rvaquero@ucam.edu y labenza@ucam.edu). Each and every one of the steps are described here:

1. The reviewer receives the e-mail of CCD with the request for revision of an article. You must decide whether to accept (or not) the request of the "Section Editor". For this, you must click on the title of the article under "Active Submissions".
2. Once this is done, a screen like the following one is going to appear in which the reviewer must select whether will (or not) review the article. If accepted (or not) an automatic window ap-pears with a template email to the Section Editor to communi-cate its decision. Regardless its decision, the reviewer must send this email. Once the revision is accepted, the reviewer should fo-llow the directions that appear on the screen below.
3. The next step is to open and download the file of the ma-nuscript; and second, open and download the evaluation sheet that can be found under the "Reviewer Guidelines" (in the sec-tion 1). The review and any comments that the reviewer makes, should be written in the evaluation sheet (not in the full text as a comment). It is very important that the reviewers knows the CCD publishing standards in order to proceed exhaustively. When the editors accept the format of the article, it is crucial that the re-viewers know the general rules, to assess more rigorously the article.
4. After completing the revision and filled the evaluation sheet, you can write some review comments to the author and/or publisher. The CCD editorial committee recommends not to introduce specific comments on these sections. If it needs to be used (not required) make an overall assessment of the article, using a formal language.
5. The next step consists of uploading the manuscript evalua-tion sheet updated. Here, you only need to upload a file with the corresponding evaluation of the article. Make sure you first click on "select file" and then on "upload".
6. Eventually, a decision on the manuscript must be taken and send it to the Editor. Thus, it is needed to press the button to send the email because if not it will not be sent. The different op-tions that can be chosen appear in the screen below. In the case of considering "revisions required" or "resubmit for review", the editor will get in touch with you and ask you to start with the second round (or further rounds), having to accept and start the same process that has been explained. If the manuscript is accepted or declined, the reviewer´s job will be over, informing the Section Editor by email.

In the second and subsequent rounds of review, the reviewer will find two files: one with the full text of the manuscript in which the author has modified with another colour different to black depending on the contributions suggested, and another additional file with the evaluation form, where the author has responded point by point in a different colour to black all contri-butions that the reviewer made. Please, check that everything is correctly modified. If not, answer the same evaluation sheet with the considered comments, so that the author can "refine" and make the changes in a satisfactory and rigorous way. This process will be repeated as many times as the Section Editors consider appropriate.

Once the second (or subsequent rounds of revision) of the ma-nuscript is completed, a new decision will be made, and proceed in the same way as in the first round. Once ends the double-blind review of the manuscript, it will disappear from your reviewer profile, where you will find none "Active Submissions".

Antonio Sánchez Pato
Editor-jefe
(apato@ucam.edu)

*** Se puede acceder a una versión ampliada de este manual en la siguiente url: http://ccd.ucam.edu/index.php/revista/pages/view/revisores**

RESPONSIBILITIES OF THE REVIEWERS

1) Reviewers should keep all information relating to confidential documents and treat them as privileged.
2) The revisions must be made objectively, without personal criticism of the author.
3) Reviewers should express their views clearly with supporting arguments.
4) Reviewers should identify relevant published work that has not been mentioned by the authors.
5) Reviewers also should draw the attention of Editor-in-chief about any substantial similarity or overlap between the manuscript in question and any other document of which they are aware.
6) Reviewers should not review manuscripts in which they have conflicts of interest resulting from competitive, collaborative, or other relationships or connections with any of the authors, companies, or institutions connected to the manuscripts.

BOLETÍN DE SUSCRIPCIÓN
SERVICIO DE PUBLICACIONES CIENTÍFICAS

CULTURA, CIENCIA Y DEPORTE
REVISTA DE LA FACULTAD DE DEPORTE

SUSCRIPCIÓN ANUAL
(Incluye 4 números en papel: marzo, junio, septiembre y diciembre)

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