PHYSICAL DEMANDS IN FEMALE INTERNATIONAL BEACH HANDBALL COMPETITION DEPENDING ON PLAYER'S POSITION DIFFERENTIATING GAME QUARTERS

DEMANDAS FÍSICAS DE LAS JUGADORAS DE BALONMANO EN COMPETICIÓN DEPENDIENDO DE SU POSICIÓN DE JUEGO Y DIFERENCIANDO EL TIEMPO DE JUEGO EN CUARTOS

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Abstract

Beach handball is a young team sport that is developing and spreading very rapidly in all continents. The aim of this study was to describe the physical demands during competition. The playing time was divided into five-minute periods in order to make comparisons between the variables under study; furthermore, these demands were analyzed in each playing position.

Fifteen players of the Spanish women's national team were equipped with a global positioning system (GPSport) during five official and three unofficial matches. The international beach handball players covered 280.60 ± 139.25 meters in the first set and 351.64 ± 129.57 meters in the second set, reporting significant differences between both sets (F = 6.14; p = .01). The greatest distance covered was in zone 2 (from 6 to 9 km-h-1) and zone 4 (from 9 to 12 km-h-1). According to the playing position, it is reported that the defense position is the one that travels the greatest distances per set 346.78 ± 133.00 meters and there are significant differences in the distance traveled, accelerations, decelerations and sprints between the wing, defense and fixed wing positions.

This study provides information to coaches and their technical staff to optimize the training load and individualize the physical demands of their handball players according to each playing position.

Keywords: Training load, match analysis, GPS, female sports team, sand sports.

Resumen

El balonmano playa es un deporte de equipo joven que se está desarrollando y extendiendo muy rápidamente en todos los continentes. El objetivo de este estudio fue describir las exigencias físicas durante la competición. El tiempo de juego se dividió en periodos de cinco minutos para realizar comparaciones entre las variables objeto de estudio; además, estas demandas se analizaron en cada posición de juego.

Quince jugadoras de la selección española femenina fueron equipadas con un sistema de posicionamiento global (GPSport) durante cinco partidos oficiales y tres no oficiales. Las jugadoras internacionales de balonmano playa recorrieron 280.60 ± 139.25 metros en el primer set y 351.64 ± 129.57 metros en el segundo set, reportando diferencias significativas entre ambos sets (F = 6.14; p = .01). La mayor distancia recorrida se encuentra en la zona 2 (de 6 a 9 km·h^{-1}) y en la zona 4 (de 9 a 12 km·h^{-1}). Según la posición de juego, se informa que la posición de defensa es la que recorre mayores distancias por set 346.78 ± 133.00 metros y existen diferencias significativas en la distancia recorrida, aceleraciones, desaceleraciones y esprints entre la posición de ala, defensa y ala fija.

Este estudio aporta información a los entrenadores y a su cuerpo técnico para optimizar la carga de entrenamiento e individualizar las exigencias físicas de sus jugadoras de balonmano en función de cada posición de juego.

Palabras clave: Carga de entrenamiento, análisis de partido, GPS, deporte femenino, deportes de arena.

Introduction

Beach handball is a team sport that requires high intensity efforts and has elevated technical-tactical demand (Navarro et al., 2018). Beach handball players must have a great physical capacity to cope with the demands of external load and have a high explosive capacity in their lower body (Sánchez-Sáez et al., 2021). In the same way as in handball, the specific positions determine these physical demands and defines the kinematic, kinetic and physiological profiles of the players (Font et al., 2021; Karcher & Buchheit, 2014). In beach handball we differentiate the attack players wing (Wi), the specialist player (Spe), fixed wing (FWi), pivot (Pi) and defense players (De) and goalkeeper (GK) (Morillo Baro et al., 2021). Fixed wing (FWi) is the only position how are active in both phase offensive and defensive.

Global Positioning Systems (GPS) technology (Aughey, 2011; Gray et al., 2010; Varley et al., 2012) and another inertial tracking devices (IMU, Inertial measurement unit) (Esser et al., 2009; Ricci et al., 2016) have been validated to provide an efficient quantification of the external load during competition and training, leading to a paradigm shift in the physical preparation of many sport discipline (Iannaccone et al., 2021), especially in team sports (Theodoropoulos et al., 2020; Varley et al., 2012), in football (Strauss et al., 2019), hockey (McGuinness et al., 2019; Morencos et al., 2019) and basketball (Reina et al., 2020) studies have assessed. Beach handball has also been studied (Gutiérrez-Vargas et al., 2019; Iannaccone et al., 2021; Lara-Cobos et al., 2023; Pueo, et al., 2017; Sánchez-Sáez et al., 2021; Zapardiel & Asín-Izquierdo, 2020). These studies indicate that the beach handball players perform high intensity efforts interspersed with phases of complete pauses or periods of waiting as described in the cycle of play (Lara-Cobos et al., 2018) during the 10 minutes duration of each set of play.

It has been observed that beach handball players in unofficial competitions cover an average of 600 meters (Gutiérrez-Vargas et al., 2019) to 1000 meters during a match (Pueo, et al., 2017) and more than 40% of the playing time is spent at high intensities. Only one study (Sánchez-Sáez et al., 2021) reports data in official matches with distances of 800 meters total per match. These distances covered are conditioned by the fact that in beach handball, due to its game cycle, the participants can develop defensive or offensive tasks performing unlimited rotations on one of the side-lines assigned to each team, this causes that the attack-defense transitions can be almost non-existent. Each action in beach handball has a duration of 11 to 15 second described in his study of polar coordinate analysis in men's and women's senior beach handball teams (Vázquez-Diaz et al., 2019).

All these demands conclude that this sport requires players to possess power, strength agility and coordination to perform a high frequency of actions, such as changes of direction, accelerations, and decelerations (Bago-Rascón, 2015; Lara-Cobos, 2021).

The aim of this study was to characterize the external and internal position-specific demands of international beach handball players by measuring the external load (distance, speed, acceleration, deceleration, and heart rate) during international competition to provide a benchmark to optimize the players preparation and the hypothesis formulated is that both playing position and the game quarter (Q1-Q2 and Q3-Q4) are aspects that condition the demands of the beach handball player.

Materials and Methods

Participants

Fifteen female players from the Spanish national beach handball team participated in the study (body weight 60.04 ± 0.1 kg; height 168.5 ± 5.9 cm; age 24.6 ± 4.0 years). All the players were notified of the research design and its requirements, benefits, and risks, and all provided informed consent. The data used in this study was obtained from the monitoring of field players competitions, excluding the position of goalkeeper.

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the local research ethics committee of the Hospitales Universitarios Virgen Macarena-Virgen del Rocio (reference: 1547-N-19). Informed consent Informed consent has been obtained from all individuals included in this study.

Procedure

The players were monitored during five official and three nonofficial preparation matches in June 2017 for the World Cup in Kazan (Russia), in total 89 complete records were obtained and seven that represented discontinuous data records were discarded. The average temperature of matches was 21.5 ± 2.5 ºC and the relative humidity was 60 ± 13%.

The game model used in the matches was a 1:2 pressing defence (one player close to six meters and two players pressing in a coordinated way). For the analysis by playing position the players were grouped in De (n = 23), Spe (n = 22), Wi (n = 21), FWi (n = 11) and Pi (n = 12). The total playing time of the sets was analysed without excluding the waiting time during the set and excluding pause between sets.

Kinematic monitoring was performed using a GPS device (GPS, SPI Elite, GPSport, Canberra: Australia) operating at a sampling rate of 10 Hz and incorporating an accelerometer at 100 Hz. The reliability and validity of this device was confirmed previously (Scott et al., 2016).

Each player wore a top under the competition clothes where the GPS device was placed on the upper back. The data form each unit were subsequently downloaded to a laptop computer using Team AMS software (v.R1.2; Canberra, Australia). The number of satellites 10.5 ± 1.1 during the matches, with four being the minimum required for three-dimensional navigation (Ashman et al., 2018) and a heart rate (HR) band was also used by each player (Polar Electro, Kempele, Finland).

The variables recorded for subsequent analysis were as follows: Total distance covered by set (m), relative distance (m·min^{-1}), peak speed achieved (km·h^{-1}), total number of accelerations and decelerations, different percentages of the maximum speed (obtained individually during all recorded matches): Z1: < 10% Vmax, Z2: 10-29% Vmax, Z3: 30-49% Vmax, Z4: 50-79% Vmax, Z5: 80-95% Vmax y Z6: > 95% Vmax (Sánchez-Sáez et al., 2021). The acceleration and deceleration were analysed in zones: Zone1: Low (1-2 m·s^{-2}), Zone 2: Moderate (2-3 m·s^{-2}), Zone 3: High (> 3 m·s^{-2}), following the studies published (Akenhead et al., 2013; Osgnach et al., 2010). Internal load was monitored by maximum Heart Rate of each player recorded was also included in the analysis. Data were evaluated using the software provided by the GPS manufacturer (Team AMS R1 2015, GPSports, Canberra, Australia).

Statistical Analysis

Descriptive statistics (*mean* ± *standard deviation*) of the dependent variables are reported. These measurements were crossed with the variables of type of competition and days of competition.

To contrast the effects of the intergroup and interaction factors, a mixed analysis of variance (ANOVA) followed by the Bonferroni post hoc adjustment test was performed. For all tests a significance level < .05 was considered. Prior to performing the inferential statistical analyses, the univariate normality test (Shapiro-Wilk) and homogeneity of variances (Levene Test) were performed. All statistical analyses were performed with JASP software version 0.14.1 (JASP Team 2020).

Results

International beach handball players covered 280.60 ± 139.25 meters in the first set and 351.64 ± 129.57 meters in the second set, reporting significant differences between both sets (F = 6,14; p = .01; 95% CI [-115.85, -12.88]).

Dividing the playing time into quarters it is observed that at the beginning of each set longer distances are covered compared to the final quarter sets, figure 1.

Figure 1
Total Distances Covered Differentiating Game Quarters

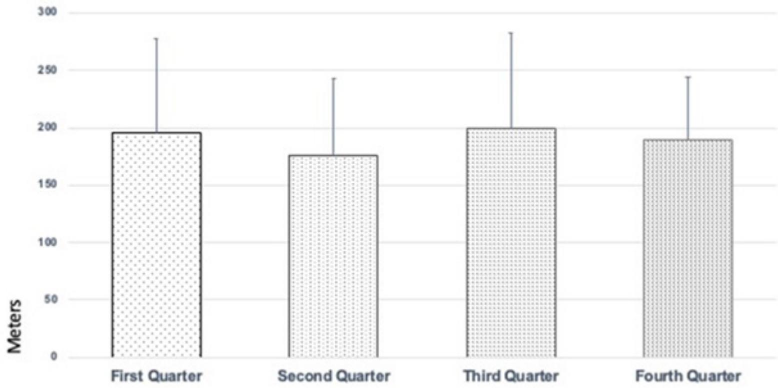


Figure 2 shows the distribution of the meters travelled in the six speed zones, differentiating the division into quarters of playing time. The greatest distance travelled is center in zone 2 (from 6 to 9 km·h-1) and zone 4 (from 9 to 12 km·h-1) with a differentiated data. In zone 2 the final quarter of each set reports greater distances compared to the start quarter of the set. This relationship is reversed in zone 4 where it is at the start of each set where greater distances are travelled compared to the final quarter of the set.

In table 1, the kinematic external load variables such as distance in relation to playing time (m·min^{-1}) are presented. In addition, kinetic external load variables (accelerations, decelerations, sprint) can be observed as well. Always reporting higher values at the beginning of the set (Q1 and Q3) than at the end of the set (Q2 and Q4) but being higher in the comparison between the first and second set. The ANOVA analyses identified significant differences in the accelerations from 1 to 2 m·s^{-2} (F = 6.33; p = .01; η^2 = .05; β-1 = .50) and the post hoc analysis showed that the second set (19.41 ± 8.28) reported higher accelerations than the first set (15.12 ± 9.05) p = .01; 95% CI [-4.29, -7.67] with a median effect size d_{Cohen} = - 0.49. Similarly, significant differences in decelerations from -1 to -2 m·s^{-2} (F = 11.18; p = .001; η^2 = .09; β-1 = .48) post hoc analysis showed that during the second set (19,06 ± 8.37) a higher number of decelerations were performed compared to the first set (13,89 ± 7.45) p = .001; 95% CI [-8.23, -2.10] with a median effect size d_{Cohen} = - 0.65.

Comparative analysis of the total number of accelerations of the first set and the second set reported significant differences (F = 7.41; p = .008; η^2 = .06; β-1 = .50) and in the post hoc analysis differences in favor of the second set were observed p = .008; 95% CI [-12.8, -2.01] with a median effect size d_{Cohen} = - 0.53.

Figure 2
Distances Covered in the six Speed Zones Differentiating Game Quarters

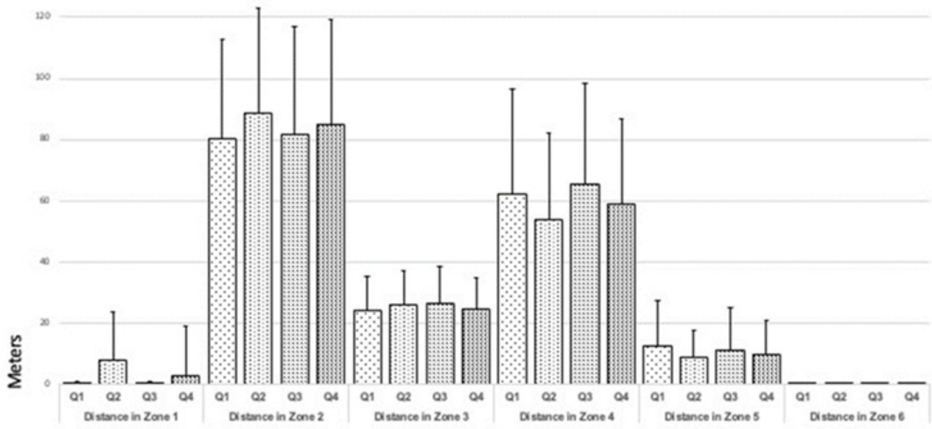


Table 1
Variable Differentiating Time Moment (set-quarters)

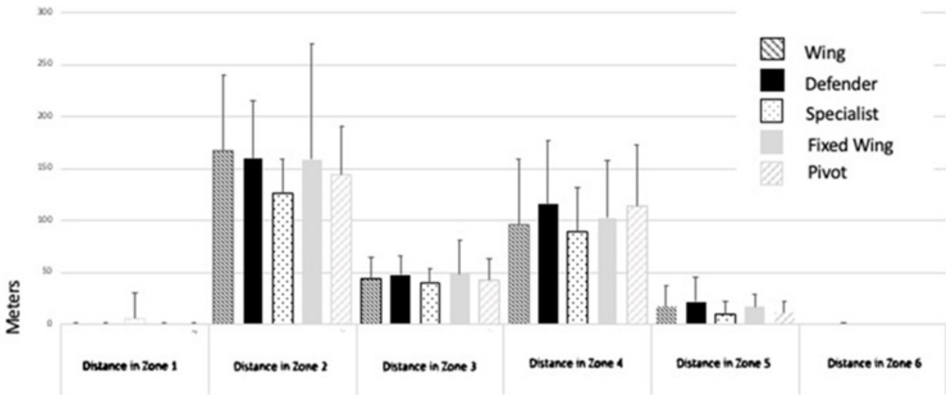
	Set 1	Set 2	Q1	Q2	Q3	Q4
Distance (meters)	280.60 ± 139.25	351.64 ± 129.57	180.38 ± 78.94	185.70 ± 67.94	185.54 ± 76.26	181.87 ± 52.56
Time (min)	8.00 ± 2.4	10.15 ± 1.05	5.19 ± 1.25	5.61 ± 1.01	5.27 ± 2.2	5.36 ± 2.3
DistRel ($m \cdot min^{-1}$)	35.40 ± 12.48	34.65 ± 11.07	34.74 ± 14.16	33.07 ± 10.99	35.19 ± 13.82	33.92 ± 10.44
Dist Rel Zone 1 ($m \cdot min^{-1}$)	0.31 ± 1.72	0.10 ± 0.07	0.09 ± 0.09	1.26 ± 4.77	0.11 ± 0.07	0.59 ± 3.00
Dist Rel Zone 2 ($m \cdot min^{-1}$)	16.95 ± 6.30	16.48 ± 5.40	15.47 ± 5.81	15.84 ± 5.75	15.49 ± 6.41	15.86 ± 5.04
Dist Rel Zone 3 ($m \cdot min^{-1}$)	4.85 ± 2.05	4.89 ± 1.70	4.66 ± 2.03	4.65 ± 2.03	5.01 ± 2.21	4.66 ± 2.03
Dist Rel Zone 4 ($m \cdot min^{-1}$)	10.88 ± 5.63	11.52 ± 5.03	12.03 ± 6.30	9.74 ± 4.95	12.46 ± 6.03	10.97 ± 5.28
Dist Rel Zone 5 ($m \cdot min^{-1}$)	1.78 ± 1.98	1.63 ± 1.82	2.47 ± 2.75	1.55 ± 1.55	2.11 ± 2.10	1.83 ± 2.08
Dist Rel Zone 6 ($m \cdot min^{-1}$)	0.01 ± 0.05	0.01 ± 0.04	0.02 ± 0.10	0.02 ± 0.10	0.03 ± 0.08	0.00 ± 0.03
Velocity Max ($km \cdot h^{-1}$)	14.36 ± 2.28	15.09 ± 1.96	14.78 ± 2.13	14.81 ± 1.98	15.00 ± 2.31	15.20 ± 1.76
Heart Rate Max (bpm)	177.68 ± 15.18	179.25 ± 14.61	176.73 ± 14.10	178.47 ± 13.53	178.80 ± 12.44	180.81 ± 11.73
Nº Sprints (n)	20.25 ± 10.36	20.37 ± 8.72	10.77 ± 5.54	9.61 ± 5.18	10.90 ± 5.65	9.71 ± 4.49
Nº Acc Total (n)	22.67 ± 13.56	30.08 ± 14.30	15.31 ± 8.58	13.30±6.40	15.95 ± 8.45	14.87 ± 6.60
Nº Decc Total (n)	22.67 ± 13.07	29.54 ± 13.82	15.04 ± 9.01	13.13±6.95	15.85 ± 8.30	14.79 ± 6.43
Nº Acc Zone 1 (n)	15.12 ± 9.05	19.41 ± 8.28	9.27 ± 5.93	8.97 ± 4.91	9.60 ± 5.21	9.43 ± 4.45
Nº Acc Zone 2 (n)	7.15 ± 5.60	9.29 ± 6.25	5.15 ± 3.64	4.68 ± 2.86	5.34 ± 3.90	4.91 ± 3.47
Nº Acc Zone 3 (n)	0.38 ± 0.64	1.56 ± 7.33	0.15 ± 0.44	0.35 ± 0.69	0.34 ± 0.59	0.23 ± 0.43
Nº Decc Zone1 (n)	13.89 ± 7.45	19.06 ± .37	7.94 ± 5.13	8.65 ± 4.51	9.11 ± 5.00	9.09 ± 3.74
Nº Decc Zone2 (n)	6.63 ± 5.07	7.87 ± 5.77	4.56 ± 3.85	3.88 ± 3.04	5.11 ± 3.64	3.91 ± 3.16
Nº Decc Zone3 (n)	2.14 ± 2.50	2.60 ± 2.52	1.65 ± 1.97	1.06 ± 1.23	1.46 ± 1.46	1.43 ± 1.50

Note. DistRel: Relative distance; Q1: first quarter; Q2: Second quarter; Q3: Third quarter Q4: Last quarter; Nº Acc: Accelerations number; Nº Dec: Deceleration number.

Figure 3 shows the distances (m) differentiating playing positions in the six speed zones. In total sum the defender travels the greatest distance compared to the other playing position and the specialist travels the least distance in all speed zones.

PHYSICAL DEMANDS IN FEMALE INTERNATIONAL BEACH HANDBALL COMPETITION DEPENDING ON PLAYER'S POSITION DIFFERENTIATING GAME QUARTERS

Figure 3
Distances Covered per Minute in the six Speed Zones Differentiating Playing Positions



Descriptive statistical study according to playing position reports that it is the defender position that covers the greatest distances per set 346.78 ± 133.00 (m). followed by the fixed wing position 328.63 ± 204.27 (m) and wing 323.64 ± 124.00 (m) and pivot 312.79 ± 122.39 (m). The one that covers the least distance is the specialist 269.03 ± 77.80 (m). This same relationship is observed in the total accelerations made by set where the defender position makes 32.53 ± 14.18 and 32.69 ± 13.93 decelerations. followed by the fixed wing with 27.50 ± 17.30 accelerations and 28.70 ±16.95 decelerations. pivot with 27.33 ± 17.30 accelerations and 29.17 ± 11.42 decelerations and the wing with 27.18 ± 16.51accelerations and 26.36 ± 13.00 decelerations, the specialist performs the least number of accelerations with 17.03 ± 7.46 and 15.41 ± 6.83 decelerations.

Table 2 shows the data for distance. speed. heart rate and number of accelerations in the three acceleration zones in each set of play and includes the distance. total accelerations and decelerations and Sprint performed in each quarter of play time. Inferential statistics show that there are differences between playing positions in the distance covered in each quarter (F = 8.88; p < .001; η^2 = .29; β-1 = .72) total number of accelerations performed in each quarter (F = 12.13; p > . 001; η^2 = .36; β-1 = .74), total number of decelerations per quarter (F = 16.93; p > .001; η^2 = .44; β-1 = .99) and number of sprints performed per quarter (F = 4.92; p = .001; η^2 = .16; β-1 = .98).

Table 2
Variables Differentiating Player Position

	Wing	Defender	Specialist	Pivot	Fixed Wing
SET					
Dist Zona 1 (m)	0.56 ± 0.43	6.48 ± 0.84	2.71 ± 0.22	0.46 ± 0.52	0.85 ± 0.73
Dist Zona 2 (m)	110.46 ± 30.36	83.41 ± 22.30	62.32 ± 24.42	76.14 ± 16.71	116.30 ± 43.01
Dist Zona 3 (m)	28.99 ± 11.74	27.40 ± 9.00	20.22 ± 10.62	24.15 ± 12.31	32.02 ± 7.64
Dist Zona 4 (m)	63.42 ± 33.73	71.06 ± 32.01	47.59 ± 25.55	55.25 ± 18.96	81.42 ± 32.66
Dist Zona 5 (m)	10.58 ± 11.21	16.38 ± 13.86	5.72 ± 7.26	6.30 ± 6.05	23.12 ± 11.74
Dist Zona 6 (m)	0.05 ± 0.22	0.19 ± 0.70	0.04 ± 0.28	0.00 ± 0.00	0.25 ± 0.50
Velocity Max (km/h)	14.21 ± 2.05	15.88 ± 1.93	14.75 ± 1.50	14.26 ± 1.63	15.77 ± 1.74
Heart Rate Max (bpm)	183.43 ± 7.922	182.05 ± 14.70	174.58 ± 10.45	167.00 ± 14.52	187.66 ± 6.65
Nº Sprints (n)	25.00 ± 9.32	27.28 ± 6.29	10.13 ± 4.59	23.57 ± 8.50	21.00 ± 6.78
Nº Acc Zone 1 (n)	17.73 ± 9.69	20.06 ± 8.71	12.21 ± 5.41	17.50 ± 7.49	19.80 ± 12.81
Nº Acc Zone 2 (n)	7.24 ± 5.57	12.00 ± 7.03	4.48 ± 2.92	9.25 ± 4.20	6.80 ± 4.47
Nº Acc Zone 3 (n)	2.55 ± 10.84	0.47 ± 0.72	0.32 ± 0.67	0.58 ± 0.79	0.90 ± 0.90
Nº Decc Zone 1 (n)	17.00 ± 8.38	19.81 ± 8.35	11.31 ± 5.37	18.00 ± 7.82	15.50 ± 9.53
Nº Decc Zone 2 (n)	7.55 ± 5.37	9.44 ± 6.22	3.24 ± 2.46	8.25 ± 3.65	9.50 ± 5.21
Nº Decc Zone 3 (n)	1.82 ± 1.71	3.44 ± 2.50	0.86 ± 1.22	2.92 ± 3.15	3.70 ± 3.65
Quarters					
Distance (m)	214.08 ± 75.43	204.93 ± 54.52	138.25 ± 55.50	162.32±38.43	253.97 ± 75.91
Nº Sprints (n)	11.81 ± 4.65	14.26 ± 3.04	5.13 ± 3.02	10.00±2.82	12.75 ± 5.62

Note. Dist.- Distance. Frec Card Max.- Heart Rate Max. Nº Sprints: Number sprints. Nº Ac.- Number accelerations. Nº Dec.- Number deaccelerations.

The post hoc analysis showed that the wing travelled more distance than the specialist ($p < .001$; 95% *CI* [40.49, 138.77]; $d_{Cohen} = 1.27$), performed a greater number of accelerations ($p < .001$; 95% *CI* [4.19, 13.90]; $d_{Cohen} = 1.39$) and decelerations ($p < .001$; 95% *CI* [5.82, 15.14]; $d_{Cohen} = 1.75$) and also performed a greater number of sprints ($p < .001$; 95% *CI* [3.80, 9.53]; $d_{Cohen} = 1.76$).

Similarly, the defender position reported differences with the specialist, travelling a greater distance ($p < .001$; 95% *CI* [24.37, 117.00]; $d_{Cohen} = 1.23$), performing a greater number of accelerations ($p < .001$; 95% *CI* [5.49, 14.64]; $d_{Cohen} = 1.85$) and decelerations ($p < .001$; 95% *CI* [6.36, 15.10]; $d_{Cohen} = 1.27$) and a greater number of sprints ($p < .001$; 95% *CI* [6.43. 11.82]; $d_{Cohen} = 3.01$).

The specialist position compared to the fixed wing reports differences in favor of the fixed wing in distance per quarter run ($p = .006$; 95% *CI* [- 24.25. 32. 80]; $d_{Cohen} = -1.83$), number of accelerations performed ($p = .005$; 95% *CI* [- 20.66, - 2.59]; $d_{Cohen} = 2.30$) and decelerations ($p < .001$; 95% *CI* [-23.44. -6.17]; $d_{Cohen} = - 3.25$), higher number of sprints ($p = .001$; 95% *CI* [-12.94, -2.28]; $d_{Cohen} = -2.26$).

The same relationship is observed between the specialist and pivot position in the number of decelerations in favor of the pivot ($p = .022$; 95% *CI* [-13.04. -0.68]; $d_{Cohen} = - 1.62$) and sprints ($p = .005$; 95% CI [-8.67, -1.05]; $d_{Cohen} = - 1.63$). Differences are also observed in the number of sprints in favor of the defender position compared to the pivot ($p = .023$; 95% *CI* [0.40, 8.13]; $d_{Cohen} = 1.42$).

Discussion

Knowledge of the external load variables of the international beach handball player is fundamental for the correct planning of training program and considering that there are gender differences (Gómez-Carmona et al., 2023) in these variables, it is important to study them by differentiating this aspect.

The study of the distance travelled as an external load variable has been the most widely used, specifically the distance travelled per minute ($m \cdot min^{-1}$) which allows a comparison between different sports disciplines such as beach football (Castellano & Casamichana, 2010) with 97.71 ± 5.1 $m \cdot min^{-1}$ or handball (Font et al., 2021) reporting 64.51 ± 0.4 $m \cdot min^{-1}$ for wings and 56.5 ± 6.6 $m \cdot min^{-1}$ for line players.

In the present study the distance per minute was 35.40 ± 12.48 $m \cdot min^{-1}$ in the first set and 34.65 ± 11.07 $m \cdot min^{-1}$ in the second set. The study by Gómez-Carmona et al. (2023) on Brazilian players during a tournament reported a relative distance of 28.31 ± 2.6 $m \cdot min^{-1}$. While it is true that the distance per set is like the study in Spanish players by Zapardiel and Asín-Izquierdo (2020) with 369.71 ± 58.4 m/set and (Gutiérrez-Vargas et al., 2019) with Costa Rican players with 332.2 ± 134.7 m/first set and 281.2 ± 87.7 m/second set. In all the studies presented, the first set reported greater distances than the second set. but not in the present study. where significant differences were observed between the two sets.

In the present study the difference in favor of the second set is observed at the beginning of the set (Q3) where the greatest total and relative distances are recorded. Just as it is at the beginning of each set (Q1 and Q3) that the distance travelled is greater compared to the final quarters of each set (Q2 and Q4). These data provide a different point of view where the aspects related to fatigue are related within sets and not intersets as previous studies have shown. Offering evidence that beach handball is an intermittent discipline.

Previous studies in other disciplines. basketball players. also found that it is in the third quarter where greater distances are travelled (García et al., 2020) this difference between quarters of games was argued through contextual variables (Romero et al., 2015). On the other hand. the study presented by Ortega-Becerra et al. (2020) in young handball players where the time in game was divided into 10-minute intervals, it was observed that in the intermediate intervals (10th and 20th minutes) the greatest distances were covered compared to the initial and final intervals studied.

The study of the same variable differentiating the five playing positions shows that it is the defender position that covers the greatest distances per set 346.78 ± 133.00 (m) and the specialist with 138.25 ± 55.50 (m) the least. The order of distance covered is defender, fixed wing, wing, pivot and specialist. The study presented by Zapardiel and Asín-Izquierdo (2020) confirms that the playing position with the greatest distance covered is the fixed wing and the specialist in this study covers a distance even greater than that of the defenders. This difference is due to tactical criteria where the specialist position can do more or less work depending on their role and position on the court.

Analyzing the distance travelled in the different speed zones; distances are travelled at different intensities. In the present study, the two zones where 80% of the distance covered is accumulated are zone 2 and zone 4. While in the low intensity zone 2 it is at the end of each set where the greatest distance is covered. in the higher intensity zone 4 it is at the beginning where the greatest distance is covered. This same distribution is observed in the study by Sánchez-Sáez et al. (2021).

The difference between the wing and defender position is based on the more distance covers by the wing in zone 2 and the defender covers more distance in zones 4 and 5. which means that the wing position covers more distance in the total. The difference between the pivot position and the specialist is 20% more distance covered in zones 2 to 6.

Distance is not only conditioned by the moment of play but also by the playing position played and the tactical decisions imposed during the match. For this reason. the distance variable presents inconsistencies in the evaluation of the load as it is affected by a greater number of conditioning factors.

The number of accelerations and decelerations as external load kinetic variables provides information about the profile of the player and the load she develops in competition, hence its importance (Delves et al., 2021). The total number of acceleration and decelerations found in this study are in the same line of research of Iannaccone et al. (2021) in Lithuanian U17 beach handball players and Pueo et al. (2017) in Spanish players. The same author reports higher low-intensity (1-2 $m{\cdot}s^{-2}$) and medium-intensity (2-3 $m{\cdot}s^{-2}$) accelerations in the second set compared to the first set. in line with the present study. even though that a greater number of accelerations are performed at the beginning of each set (Q1-Q3).

The high intensity actions (> 3 $m{\cdot}s^{-2}$) presented a different distribution, since it is at the end of the first set and at the beginning of the second set where a greater number of actions are performed, notwithstanding the total it is a very small percentage of actions at that intensity. Instead, the decelerations follow a distribution in which at the beginning of each set a greater number of decelerations are reported compared to the end of each set. While it is true that it is in the second set that more actions are still reported compared to the first set.

The study of accelerations and decelerations depending on the playing position developed also gives us information about the external load demands depending on where they are played. Acceleration at low intensity (1-2 $m{\cdot}s^{-2}$) shows that the fixed wing and defender positions perform a similar number of accelerations. with both positions performing a greater number of accelerations, coinciding with the study presented by Zapardiel and Asín-Izquierdo (2020). The defender position behaves in a similar way to the pivot in these same acceleration zones. On the other hand, at medium intensity (2-3 $m{\cdot}s^{-2}$) the position that reports the highest accelerations is the defender, followed by the pivot, while the wing and fixed wing positions report a similar number of accelerations. Finally, at high intensities (> 3 $m{\cdot}s^{-2}$) the only position that shows visible actions is the wing. In the same way that Font et al. (2021) in handball players can be defined by their high-intensity action pattern, beach handball also shows differentiated kinetic profiles depending on the specific position developed.

The decelerations report that the position that performs the greatest decelerations is the fixed wing, followed by the defender position and the pivot and wing report a similar number of actions. Although that at low intensities (1-2 $m{\cdot}s^{-2}$) the distribution from highest to lowest is in the defender, fixed wing, wing and pivot positions. The specialist position is always the one that reports the fewest deceleration actions. This aspect is not reflected in the same ratio since in the study by Zapardiel and Asín-Izquierdo (2020) the specialist is the third position with the highest number of accelerations and decelerations behind the fixed wing and the defender position. However. the difference between the decelerations between quarters of each set (Q1-Q2 and Q3-Q4) offer differences totally associated with fatigue like the accelerations. The second set presents a greater number of decelerations compared to the first set. following the same line of study of Reina et al. (2020) in U18 basketball players.

The third variable of study the number of sprints. in the present study the number of sprints in the first set was 20.25 ± 10.36 actions and in the second set 20.37 ± 8.72. Iannaccone et al. (2021) reports the number of HIE (High Intensity Events) with 12.8 ± 7.2 in U17 players. It also follows a distribution where the first part of the set is higher than the last quarter and it is also the beginning of the second set where a higher number of sprints (Q3) is reported. The second set shows a higher number of sprints compared to the first set. this result in matches the previous study of Ortega-Becerra (2020) which was conducted with male handball players.

In the analysis of the specific positions in this kinetic variable. it is reported that the defender position together with the wing position (10% lower) are the positions that perform the highest number of sprints, followed by the pivot and fixed wing positions (10% lower than the pivot position). In the same way as for the rest of the variables studied, the specialist position shows the lowest number of sprint actions.

The main object of this study concludes that zone 2 (from 6 to 9 $km{\cdot}h^{-1}$) and zone 4 (from 9 to 12 $km{\cdot}h^{-1}$) is where the greatest distance covered is accumulated and it is at speeds of 9 to 12 ($km{\cdot}h^{-1}$) where fatigue symptoms can be detected since less distance is covered at the end of each set.

The analysis of the kinetic variables dividing the playing time of each set reports that the beginning of each set is where the greatest number of accelerations, decelerations and sprints are performed.

Although player fatigue could have a negative effect on some game load variables in the last quarters of each set (Q2-Q4). contextual variables such as tactical principles and outcome could better explain the game load production in Q3 of the match. On the other hand, both high intensity accelerations and decelerations may be variables sensitive to fatigue processes during the competition and it is in them where their number decreases in the final quarters of a set.

The specialist position requires exclusive connotations to cope with the kinematic and kinetic demands required during competition. These conclusions confirm our initial hypothesis and should form the basis of the training processes aimed at improving the performance of the beach handball player, differentiating the specialist position in comparison with defender, fixed wing, wing and pivot position.

Although the present study provides significant information, some limitations must be acknowledged. Data were collected on a single women's beach handball team, therefore, the results may not generalize to players of different ages and genders. Future research should be conducted to investigate any potential differences resulting from the competitive level of the tournament and/or in relation to different seasonal periods. Furthermore, as the sample of the present study included only field players, future studies should also investigate the beach handball goalkeeper to provide specific training strategies useful for coaches.

Conclusions

These data provide coaches and physical trainers with valuable information for training design, as well as for competition planning, being able to plan specific exercises and tasks for elite women's beach handball.

It showed differences in the external and internal load demands of the specific positions of elite handball players. This makes us understand that not all beach handball players have the same conditional needs to compete. Therefore, the training of elite female beach handball players should focus on the development of individual physical capacities oriented to their position on the field, this could lead to a better performance of the athlete's energetic system.

Ethics Committee Statement

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the local research ethics committee of the Hospitales Universitarios Virgen Macarena-Virgen del Rocio (reference: 1547-N-19). Informed consent Informed consent has been obtained from all individuals included in this study.

Conflict of Interest Statement

No conflict of interests.

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Authors' Contribution

Conceptualization Daniel Lara. & Gabriel Daza.; Methodology Daniel Lara & Manuel Ortega.; Software Daniel Lara; Validation Daniel Lara & Juan Antonio Sánchez; Formal Analysis Daniel Lara & Manuel Ortega.; Investigation Daniel Lara; Resources Gabriel Daza.; Data Curation Juan Antonio Sánchez.; Writing – Original Draft Daniel Lara.; Writing – Review & Editing Gabriel Daza & Manuel Ortega.; Visualization Juan Antonio Sánchez.; Supervision Juan Antonio Sánchez; All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

Data available upon request from the corresponding author daniel.lara.cobos@gmail.com

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