INFLUENCE OF CONTEXTUAL VARIABLES ON THE KINETIC DEMANDS OF ELITE WOMEN'S BEACH HANDBALL: AN INTERNATIONAL COMPETITION STUDY

INFLUENCIA DE LAS VARIABLES CONTEXTUALES EN LAS DEMANDAS CINÉTICAS DEL BALONMANO PLAYA FEMENINO DE ÉLITE: UN ESTUDIO EN COMPETICIÓN INTERNACIONAL

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Abstract

This study examined how contextual variables influences the kinetic demands of elite women's beach handball players during the 2024 World Championship. Ten Argentine national team players were monitored in eight official matches. External load was assessed using PlayerTek+ GPS units (Australia). Performance indicators included sprints (> 13 km·h^{-1}), accelerations and decelerations (2–3 m·s^{-2} and > 3 m·s^{-2}). Contextual variables were match outcome (2–0 vs. 2–1), opponent difficulty (low, medium, high), and tournament phase. Data were analysed via mixed ANOVA with Tukey *post hoc* tests (p < .05). On average, players recorded 8.97 sprints, 33.61 accelerations (2–3 m·s^{-2}), 22.48 decelerations (2–3 m·s^{-2}), 17.79 accelerations (> 3 m·s^{-2}), and 15.31 decelerations (> 3 m·s^{-2}) per match. Strong correlations were found between sprints, high-intensity accelerations, and decelerations (r = 0.55–0.81; p < .001), and a negative correlation between moderate accelerations and decelerations (r = –0.47; p < .001). Victories by 2–0 showed more moderate decelerations than 2–1 wins (p = .025). Matches against weaker opponents elicited more moderate decelerations than against stronger ones (p = .006). Contextual factors significantly influence kinetic demands in elite women's beach handball. Match outcome, opponent level, and competition development shape the balance between maximal and submaximal actions.

Keywords: Beach handball, women, contextual variables, external load, sprints.

Resumen

Se estudió cómo las variables contextuales influyen en las demandas cinéticas de las jugadoras de balonmano playa durante el Campeonato Mundial de 2024. Se monitorizó a diez jugadoras de la selección argentina en ocho partidos. La carga externa se evaluó utilizando GPS PlayerTek+ (Australia). Los indicadores incluyeron esprints, aceleraciones y desaceleraciones y como variables contextuales el resultado del partido, dificultad del oponente. Se analizaron mediante ANOVA con pruebas *post hoc* de Tukey (p < 0.05). Las jugadoras promediaron 8,97 esprints, 33.61 aceleraciones y 22.48 desaceleraciones (2-3 m·s^{-2}), 17.79 aceleraciones y 15.31 desaceleraciones (>3 m·s^{-2}) por partido. Se encontraron fuertes correlaciones entre los esprints, aceleraciones y desaceleraciones de alta intensidad (r = 0.55-0.81; p < 0.001), y una correlación negativa entre aceleraciones y desaceleraciones moderadas (r = –0.47; p < 0.001). Las victorias por 2-0 mostraron desaceleraciones más moderadas que las victorias por 2-1 (p = 0.025). Los partidos contra oponentes más débiles provocaron desaceleraciones más moderadas que los partidos contra oponentes más fuertes (p = 0.006). Las variables contextuales influyen significativamente en las exigencias cinéticas del balonmano playa. El resultado del partido, el nivel del oponente y el desarrollo de la competición determinan el equilibrio entre las acciones máximas y submáximas.

Palabras clave: Balonmano playa, mujer, variables contextuales, carga externa, esprints.

Introduction

Beach handball is a rapidly expanding sport, now recognised as a global discipline played across five continents. Its exponential growth over the last decade has led to the consolidation of international competitive structures, such as World Championships and inclusion in multi-sport events, including the Youth Olympic Games (Morillo-Baro, 2009; Morillo-Baro et al., 2021).

The first official Beach Handball World Championship was organised by the International Handball Federation (IHF) in 2004 in El Gouna, Egypt. Since then, regular editions have been held in both the men's and women's categories. The sport's inclusion in the Youth Olympic Games began in Buenos Aires 2018 and was repeated in Dakar 2026, consolidating its status as a relevant discipline within youth Olympism. This participation has been key to the internationalisation of the sport and its gradual de-seasonalisation.

In recent years, research has focused on describing the physical and kinetic demands of beach handball (Gómez-Carmona et al., 2020; Lara-Cobos, 2021; Sánchez-Sáez et al., 2021). These studies have used GPS and inertial measurement unit (IMU) devices such as PlayerTek+ and WIMU PRO, enabling the quantification of variables such as speed, accelerations, decelerations, and distance covered during official and unofficial competition. The application of these devices has been fundamental to confirming the intermittent, high-intensity nature of this sport and to establishing specific training protocols (Iannaccone, Conte, et al., 2021; Iannaccone et al., 2019; Iannaccone, Fusco, et al., 2021; Zapardiel et al., 2023).

Beach handball is characterised by a high-intensity intermittent structure, in which players alternate brief periods of explosive action (sprints, jumps, changes of direction) with passive or active recovery periods (Lara-Cobos et al., 2025). These are conditioned by the tactical system employed and by the number of attack–defence substitutions. The variability in activity patterns makes it essential to monitor individual physical load and adapt training sessions according to each player's position (Bon et al., 2015; Müller et al., 2022; Sánchez-Sáez et al., 2021).

Kinetic variables are an essential tool for performance analysis in competition. In particular, the number of accelerations (> 2 m·s^{-2}) and decelerations (< -2 m·s^{-2}) are considered key markers of external load, as they involve substantial neuromuscular demands, especially on sand, where the instability of the surface increases the physical cost of movement (Douchet et al., 2021). These variables have also been studied in women's football (Mara et al., 2017) and basketball (Reina et al., 2019), including position-specific analyses (Vigh-Larsen et al., 2018).

During multi-day tournaments, previous research has reported a progressive reduction in the number and magnitude of accelerations and decelerations, reflecting functional decline associated with accumulated fatigue (Harper et al., 2019). Likewise, the difference between accelerations and decelerations > 3 m·s^{-2} tends to increase as competition progresses, which has been proposed as an indirect indicator of neuromuscular fatigue (Nobari et al., 2021).

The relationship between these variables provides information not only about the player's acute physical status, but also about how to plan training loads, optimise recovery, and reduce injury risk. It is therefore important to consider the evolution of accelerations and decelerations in competitive contexts (Akenhead et al., 2013).

Player performance in beach handball does not depend solely on external load; it is also influenced by contextual variables that modulate both external and internal demands during competition. Factors such as match location, opponent quality, tournament phase, scoreline, and environmental conditions have been identified as significant determinants of physical performance in elite football, using video-tracking systems (Castellano et al., 2011).

In professional men's football, 27 matches in the top division were analysed using player-tracking video systems, showing that scoreline and match location significantly influenced distance covered at different intensities (Lago et al., 2009). In a similar line of work but using GPS in a study of university players across 15 matches, scoreline was identified as the contextual variable with the greatest capacity to modify external load variables (Viejo-Romero, 2015).

The characterisation of external load as a multi-component construct has shown that factors such as location, match outcome, and the duration of the competitive microcycle directly affect load variables such as accelerations and sprint frequency (Oliva-Lozano et al., 2020). These findings align with systematic reviews emphasising that contextual complexity

is difficult to address because its interactions generate performance patterns that cannot be explained by unidimensional models (Dalton-Barron et al., 2020; Fernández-Leo et al., 2020).

Although some beach handball studies have reported the number of accelerations and decelerations in competition, no study had previously examined how contextual variables act as critical determinants of sport performance, dynamically modulating players' load demands during competition. Their consideration is therefore essential both for performance analysis and for designing training and competition strategies aimed at optimising performance.

Materials and Methods

Participants

Ten players were selected from a squad of 20 players forming the beach handball section of the Argentine Handball Confederation. Table 1 presents the anthropometric characteristics and jumping ability of the participants. All players had experience in international competition and followed an annual training plan that began in January and ended with the World Championship in June.

Table 1

Characteristics of the Study Population

Variable	*Mean ± SD*
Age (years)	25 ± 4.16
Height (cm)	172.6 ± 8.49
International matches	34 ± 8.75
Abalakov	45.44 ± 5.12
CMJ	40.66 ± 3.95
Horizontal jump	190.0 ± 5.77

This investigation complied with all relevant national regulations and institutional policies, followed the principles of the Declaration of Helsinki, and was approved by the local research ethics committee of Virgen Macarena–Virgen del Rocío University Hospital (reference: 1547-N-19). Written informed consent was obtained from all participants.

Competition Sample

A total of eight of the nine matches from the 2024 Beach Handball World Championship were analysed. One recorded match was excluded due to connection problems. The competition took place at Long Wangtou Ocean Park, Pingtan Island, China, from 18 to 23 June, with a mean temperature of 28.3°C. Sixteen teams competed in a group stage followed by a knockout phase leading to the semi-finals and final. The Argentine team achieved its best historical result, finishing as runners-up.

Variables

Accelerations and decelerations were measured in two ranges: 2–3 $m \cdot s^{-2}$ and > 3 $m \cdot s^{-2}$. Sprints were defined as actions above 13 $km \cdot h^{-1}$ and were considered high-intensity external load variables.

The contextual variables studied were as follows: opponent difficulty was classified as level I (both sets won by more than 10 points), level II (both sets won by fewer than 10 points), and level III (matches decided by shoot-out and with a margin of fewer than five points)

Match outcome in beach handball is determined by sets won (2–0) or lost (0–2). If the sets are tied, the match is decided by a shoot-out, and the winner is assigned a 2–1 result.

Instruments

The PlayerTek+ system (Catapult Innovations, Melbourne, Australia), equipped with 10 Hz GPS and 100 Hz tri-axial accelerometry, was used to monitor the above variables. The device was positioned between the scapulae using a tight-fitting

vest. The data were collected and analysed to identify performance patterns throughout the tournament and according to playing position. The reliability and validity of this device have been confirmed in previous studies (Scott et al., 2016).

Procedure

Each player wore a vest under her playing kit with the GPS device positioned between the scapulae. Data from each device were downloaded after each match to a computer using the proprietary software (PlayerTek; Canberra, Australia). The mean number of satellites was 10.5 ± 1.1 during matches, with a minimum of four required for accurate triangulation (Ashman et al., 2018).

Statistical Analysis

Descriptive statistics were calculated for the dependent variables. These descriptive measures were then analysed inferentially in relation to competition type and competition day.

To examine the effects of inter-group factors and interactions, mixed analysis of variance (ANOVA) was performed, followed by Tukey's post hoc test. Statistical significance was set at $p < .05$. Before inferential analyses, univariate normality (Shapiro–Wilk) and homogeneity of variances (Levene's test) were assessed. All analyses were conducted using JASP version 0.14.1 (JASP Team, 2020).

Results

Data obtained from eight matches of the 2024 Women's Beach Handball World Championship showed a progressive reduction in high-intensity actions as the tournament progressed. Table 2 presents the mean external kinetic load of all players excluding goalkeepers.

Table 2

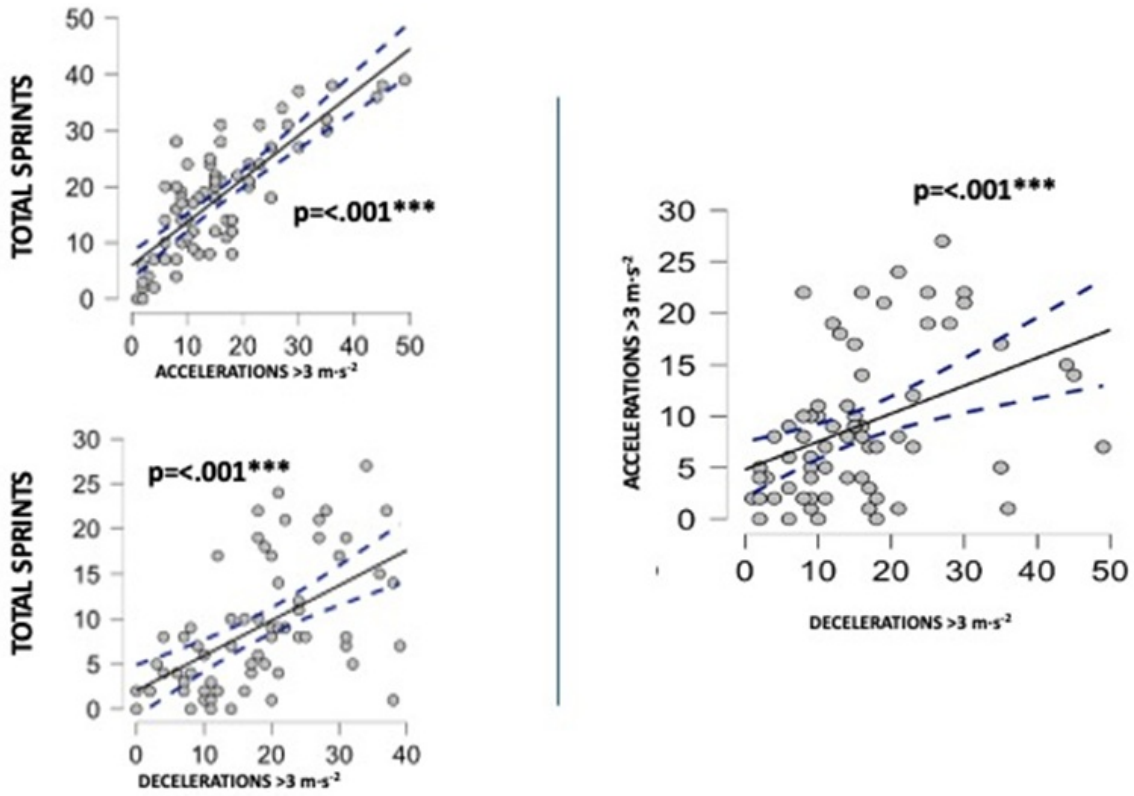
Kinetic Demands According to Contextual Variables: Comparison Between Competition Phases, Opponent Level, and Match Outcome

Variable	Number of actions per match
Sprints	8.972 ± 7.001
Accelerations 2-3 $m \cdot s^{-2}$	33.611 ± 11.527
Decelerations 2-3 $m \cdot s^{-2}$	22.486 ± 11.183
Accelerations > 3 $m \cdot s^{-2}$	17.792 ± 9.899
Decelerations > 3 $m \cdot s^{-2}$	15.319 ± 10.415
Variable	**Number of actions per minute**
Accelerations 2-3 $m \cdot s^{-2}$	0.499 ± 0.463
Decelerations 2-3 $m \cdot s^{-2}$	1.006 ± 0.515
Accelerations > 3 $m \cdot s^{-2}$	0.810 ± 0.481
Decelerations > 3 $m \cdot s^{-2}$	0.697 ± 0.513

Note Significant correlations were identified between total sprints, accelerations, and decelerations > 3 $m \cdot s^{-2}$ A negative correlation was also observed between accelerations and decelerations in the 2–3 $m \cdot s^{-2}$ range ($r = -0.469$; $p < .001$).

Figure 1

Study of the Correlation Between Total Sprints, Accelerations, and Decelerations >3m·s-2



The analysis of the variables per minute of play followed the same pattern, allowing observation of the difference between accelerations and decelerations >3 m·s^{-2} per minute (Figure 1).

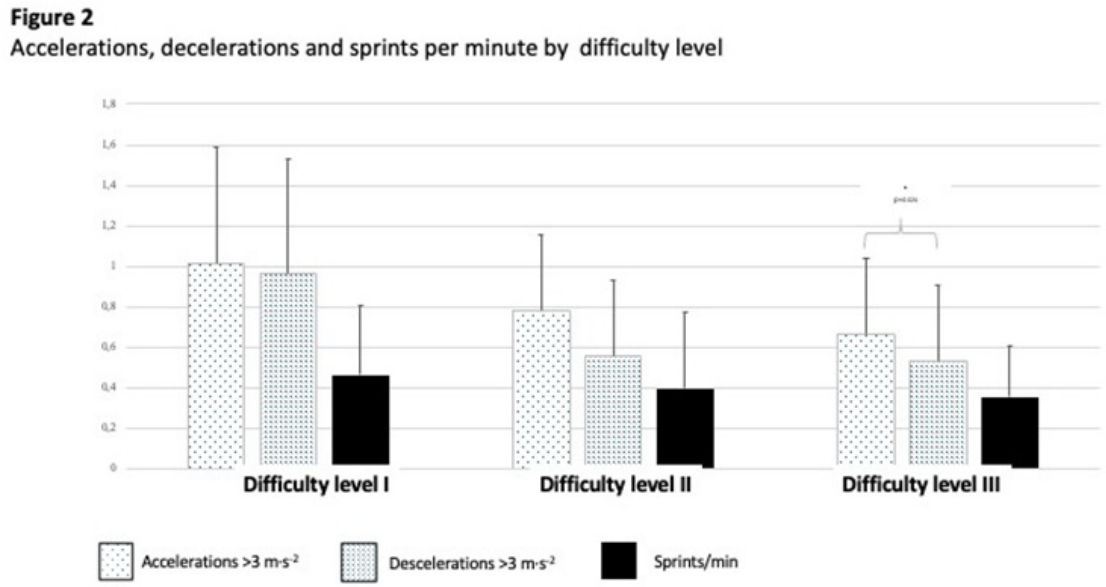
Match outcome was significantly associated with kinetic variables, $F(1,52) = 5.319$, $p = .024$, $\eta^2 = .093$. Tukey's post hoc analysis showed that matches won 2–0 involved a greater number of decelerations in the 2–3 m·s^{-2} range than matches won 2–1 ($p = .025$, $d = 0.625$). No significant differences were found for accelerations or decelerations > 3 m·s^{-2} ($p = .386$).

Opponent difficulty also significantly influenced the frequency of high-intensity actions, $F(1,43) = 8.379$, $p = .006$, $\eta^2 = .163$. Tukey's *post hoc* analysis showed that lower-difficulty matches (level I) involved a greater number of decelerations in the 2–3 m·s^{-2} range than higher-difficulty matches (level III) ($p = .006$, $d = 0.881$). No significant differences were found for accelerations < 3 m·s^{-2} ($p = .581$), decelerations > 3 m·s^{-2} ($p = .556$), accelerations 2–3 m·s^{-2} ($p = .579$), or the difference between accelerations and decelerations in these ranges.

Similarly, the difficulty level of the matches significantly influenced the frequency of high-intensity actions: $F(1,43) = 8.379$, $p = .006$, $n^2 = .163$ A Tukey post-hoc analysis showed that matches with lower difficulty (I) had a higher number of decelerations of 2-3 m·s^{-2} than matches with higher difficulty (III) ($p = .006$**, $d = .881$). No significant differences were found between accelerations < 3 m·s^{-2} ($p = .581$), decelerations > 3 m·s^{-2} ($p = .556$) nor in accelerations of 2–3 m·s^{-2} ($p = .579$), and that the difference between accelerations and decelerations was significantly greater in the higher-difficulty matches, as shown in (Figure 2).

Figure 2

Accelerations and Decelerations > 3 m/s² and Sprints per Minute, Reflecting the Difficulty Level of the Matches



It was observed that the most difficult matches (III) showed significant differences: $F(1,43) = 5.3442$, $p = .024$, $n^2 = .112$ A Tukey post-hoc analysis showed that in the most difficult matches (III), there was a greater difference between accelerations and decelerations of 2–3 m·s^{-2} than in the least difficult matches (I) ($p = .024$*, $d = -.710$). No significant differences were found in the difference between accelerations and decelerations > 3 m·s^{-2} ($p = .860$).

A comparison of the total number of actions on the first and second days of competition shows that the difference in high-intensity actions (sprints: 0.047 ± 0.089 and actions > 3 m·s^{-2}: 0.007 ± 0.082) favours the early days of competition and decreases as the competition progresses; conversely, for moderate-intensity actions (2–3 m· s^{-2}, the relationship is inverse, with more actions occurring in the last two days of competition (-0.240 ± 0.177).

Discussion

The main objective of this study was to analyse high-intensity demands, including sprints, accelerations, and decelerations, in elite beach handball players during official competition and to investigate their relationship with various contextual variables. The results obtained are consistent with those of studies on international beach handball players, such as Iannaccone, Conte, et al. (2021) on young players from Lithuania. However, studies such as those by Lara-Cobos (2021), Lara-Cobos et al. (2023), Lara-Cobos et al. (2025) and Pueo et al. (2017) report lower numbers of high-intensity actions in Spanish players.

Beyond the external load variables studied, the present study finds that contextual variables modulate these external load variables in specific and distinct ways.

Match Outcome

In this study, matches won 2-0 showed more decelerations of 2–3 m·s^{-2} than those won 2-1. In contrast, there were no differences in actions > 3 m·s^{-2}. This pattern suggests that when the score is in the team's favor, there is an increase in pace-control actions (submaximal decelerations) relative to maximum intensity peaks. Studies in soccer have shown that when the score is in the team's favor, high-speed actions decrease, whereas when the team is losing, these actions increase (Castellano et al., 2011; Lago et al., 2009). This same relationship between a contextual variable such as the score has been associated with total distance covered and high-intensity actions over an entire season (Oliva-Lozano et al., 2020). Concluding that the

load profile is modifiable at the submaximal level (decelerations of 2–3 $m \cdot s^{-2}$ rather than high-intensity decelerations > 3 $m \cdot s^{-2}$ when the victory is comfortable.

Opponent Difficulty or Opponent Level

The findings show more decelerations of 2–3 $m \cdot s^{-2}$ in lower-difficulty matches (I) than in higher-difficulty matches (III), as well as a greater difference between accelerations and decelerations of 2–3 $m \cdot s^{-2}$ in higher-difficulty matches. In soccer players, the opponent's level significantly alters the workload at different intensities (Castellano et al., 2011; Lago et al., 2009), although it is true that the effect of this variable also depends on the model and style of play employed against these opponents. The systematic review on rugby players (Dalton-Barron et al., 2020) acknowledges this complexity and multidimensionality of contextual variables. The results presented align with this line of research, where a strong opponent does not necessarily trigger maximal actions but does alter the balance between accelerating and decelerating in submaximal actions.

The existing literature offers a possible explanation for this effect, suggesting that players tend to conserve effort against more demanding opponents (Reardon et al., 2015; Scanlan et al., 2014) and where contextual variables such as the score and opponents' level influence the demands of external load in basketball (Fernández-Leo et al., 2020; Viejo Romero, 2015).

Competition Progression (Timing)

A comparison of the early days with the final days of competition reveals a decrease in high-intensity actions (sprints·min#[1] and accelerations/decelerations > 3 $m \cdot s^{-2}$) and, conversely, an increase in submaximal actions (accelerations and decelerations) at 2–3 $m \cdot s^{-2}$ Previous studies comparing the first and second halves in soccer (Castellano et al., 2011; Lago et al., 2009) similarly show a decrease in the number of actions when comparing the first and second halves in basketball (Fernández-Leo et al., 2020). Noteworthy is the study presented by Lara-Cobos et al. (2025), which divides playing time into quarters and concludes that at the start of each set, there is an accumulation of high-intensity actions across different matches.

Relationship Between External Load Variables

The correlations found in this study between sprints·min^{-1} and high-intensity actions (accelerations and decelerations of > 3 $m \cdot s^{-2}$) and the negative correlation between accelerations and decelerations of 2–3 $m \cdot s^{-2}$ lead us to conclude that a multivariate model is necessary to correctly interpret the external load results, as proposed in previous studies (Dalton-Barron et al., 2020).

These data provide relevant evidence regarding the kinetics of performance in this discipline, not only by relating them to playing position (Lara-Cobos et al., 2023; Lara-Cobos et al., 2025; Sánchez-Sáez et al., 2021) as in previous studies, but also as a possible accumulation of fatigue throughout the tournament, as concluded in the study of internal load variables in an official competition (Mediterranean Games) by Lara-Cobos et al. (2024). These findings have important implications for the design of specific training programs and the management of competitive load in high-level women's beach handball.

When considering the acceleration-deceleration metric, its analysis provides deeper insight into a player's functional state during competition. Several authors have noted that a higher number of decelerations relative to accelerations may reflect a conservative strategy or a state of accumulated fatigue (Douchet et al., 2021; Griffin et al., 2021). In the present study, this difference became more evident throughout the tournament, suggesting that it could serve as a valid marker of fatigue, especially when combined with contextual indicators.

It is important to consider the methodological relevance of using devices such as the PlayerTek+ (10 Hz GPS, 100 Hz triaxial accelerometry), which enables reliable, real-time data collection during official competition. This represents a significant advance over previous studies conducted in controlled or training settings, allowing for a more representative assessment of actual competitive performance (Cummins et al., 2013; Scott et al., 2016).

Finally, although this study focused on an elite team with a very specific profile (players on the Argentine national team), the results can be cautiously extrapolated to other similar contexts, particularly with regard to the distribution of training loads and their interaction with the contextual variables presented, as well as to fatigue indicators based on movement kinetics. However, future research should expand the sample and explore possible differences by sex, playing style, or

individual characteristics, as well as relate these variables to direct physiological indicators such as lactate, heart rate, or ratings of perceived exertion (RPE).

Conclusions

The findings of this study show that elite beach handball players were significantly influenced by the contextual variables analyzed. First, the match outcome emerged as a factor that modulated the external load. In matches won by a wider margin (2-0), a higher frequency of decelerations in the submaximal range was observed compared to victories by a 2-1 margin. This finding suggests that holding a lead on the scoreboard leads to the management of maximal efforts.

Second, the level of opposition had a distinct influence on physical demands, revealing that the degree of opposition does not necessarily translate into an increase in maximum-intensity actions, but rather into a redistribution of submaximal loads, closely linked to the tactical needs of collective reorganization.

Likewise, the temporal dynamics of the competition revealed a pattern of fatigue characterized by a decrease in the number of high-intensity actions accompanied by an increase in submaximal actions. This suggests a shift in the workload toward intermediate intensities as the competition progresses, interpreted as a sign of fatigue accumulation rather than a strategic adaptation by the players. That said, it would be interesting to determine in future studies whether these observed relationships hold true regardless of the participants' gender.

Finally, an analysis of the relationships among external load variables confirms the existence of information redundancy among some indicators. This supports the need to use multivariate models and variable reduction strategies to optimize the monitoring of external load and its practical application.

Ethics Committee Statement

The research involving human subjects has complied with all relevant national regulations and institutional policies, has followed the principles of the Declaration of Helsinki, and has been approved by the local research ethics committee of the Virgen Macarena-Virgen del Rocío (reference: 1547-N-19). Informed Consent has been obtained from all individuals included in this study.

Conflict of Interest

No conflict of interest.

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Authors' Contributions

Conceptualization Daniel Lara Cobos and Gustavo Andrés Sanz.; Methodology Daniel Lara Cobos.; Software Daniel Lara Cobos.; Validation Daniel Lara Cobos and Gustavo Andrés Sanz; Formal Analysis Daniel Lara Cobos; Investigation Daniel Lara Cobos.; Resources: Daniel Lara Cobos; Data Curation: Juan Ignacio Campora; Writing – Original Draft: Daniel Lara Cobos; Writing – Review & Editing: Juan Ignacio Campora and Gustavo Andrés Sanz; Visualization: Daniel Lara Cobos, Gustavo Andrés Sanz, and Juan Ignacio Campora; Supervision: Daniel Lara Cobos, Gustavo Andrés Sanz, and Juan Ignacio Campora; Project Administration: Juan Ignacio Campora; All authors have read and agree with the published version.

Data Availability Statement

Data available upon request from the corresponding author: Daniel Lara Cobos, dlaraco@uoc.edu

References

Akenhead, R., Hayes, P. R., Thompson, K. G., & French, D. (2013). Diminutions of acceleration and deceleration output during professional match play. *Journal of Science and Medicine in Sport, 16*(6), 556–561. https://doi.org/10.1016/j.jsams.2012.12.005

Ashman, B. W., Bauer, F. H., Parker, J. J. K., & Donaldson, J. E. (2018). GPS operations in high Earth orbit: Recent experiences and future opportunities. *Proceedings of the 15th International Conference on Space Operations*. https://doi.org/10.2514/6.2018-2568

Bon, M., Pori, P., & Sibila, M. (2015). Position-related differences in selected morphological body characteristics of top-level female handball players. *Collegium Antropologicum, 39*(3), 631–639. https://hrcak.srce.hr/en/clanak/245330

Castellano, J., Blanco-Villaseñor, A., & Álvarez, D. (2011). Contextual variables and time-motion analysis in soccer. *International Journal of Sports Medicine, 32*(6), 415–421. https://doi.org/10.1055/s-0031-1271771

Cummins, C., Orr, R., O'Connor, H., & West, C. (2013). Global positioning systems (GPS) and microtechnology sensors in team sports: A systematic review. *Sports Medicine, 43*(10), 1025–1042. https://doi.org/10.1007/s40279-013-0069-2

Dalton-Barron, N., Whitehead, S., Roe, G., Cummins, C., Beggs, C., & Jones, B. (2020). Time to embrace the complexity when analysing GPS data? A systematic review of contextual factors on match running in rugby league. *Journal of Sports Sciences, 38*(10), 1161–1180. https://doi.org/10.1080/02640414.2020.1745446

Douchet, T., Humbertclaude, A., Cometti, C., Paizis, C., & Babault, N. (2021). Quantifying accelerations and decelerations in elite women soccer players during regular in-season training as an index of training load. *Sports, 9*(8), Article 109. https://doi.org/10.3390/sports9080109

Fernández-Leo, A., Gómez-Carmona, C. D., García-Rubio, J., & Ibáñez, S. J. (2020). Influence of contextual variables on physical and technical performance in male amateur basketball: A case study. *International Journal of Environmental Research and Public Health, 17*(4), Article 1193. https://doi.org/10.3390/ijerph17041193

Gómez-Carmona, C. D., García-Santos, D., Mancha-Triguero, D., Antúnez, A., & Ibáñez, S. J. (2020). Analysis of sex-related differences in external load demands on beach handball. *Revista Brasileira de Cineantropometria e Desempenho Humano, 22*, e71448. https://doi.org/10.1590/1980-0037.2020v22e71448

Griffin, J., Newans, T., Horan, S., Keogh, J., Andreatta, M., & Minahan, C. (2021). Acceleration and high-speed running profiles of women's international and domestic football matches. *Frontiers in Sports and Active Living, 3*, Article 604605. https://doi.org/10.3389/fspor.2021.604605

Harper, D. J., Carling, C., & Kiely, J. (2019). High-intensity acceleration and deceleration demands in elite team sports competitive match play: A systematic review and meta-analysis of observational studies. *Sports Medicine, 49*(12), 1923–1947. https://doi.org/10.1007/s40279-019-01170-1

Iannaccone, A., Conte, D., & Kniubaite, A. (2019). *PlayerLoad of beach handball players during competitions*. EHF Scientific Conference Proceedings.

Iannaccone, A., Conte, D., Cortis, C., & Fusco, A. (2021). Usefulness of linear mixed-effects models to assess the relationship between objective and subjective internal load in team sports. *International Journal of Environmental Research and Public Health, 18*(2), Article 392. https://doi.org/10.3390/ijerph18020392

Iannaccone, A., Fusco, A., Skarbalius, A., Kniubaite, A., Cortis, C., & Conte, D. (2021). Relationship between external and internal load measures in youth beach handball. *International Journal of Sports Physiology and Performance,17* (2), 256-262. https://doi.org/10.1123/ijspp.2021-0225

JASP Team (2020). JASP (Version 0.14.1)[Computer software]. https://jasp-stats.org/

Lago, C., Casáis, L., Domínguez, E., Lago, J., & Rey, E. (2009). Influencia de las variables contextuales en el rendimiento físico en el fútbol de alto nivel. *Motricidad. European Journal of Human Movement, 23*, 107–121. https://www.eurjhm.com/index.php/eurjhm/article/view/232

Lara-Cobos, D. (2021). *Demandas cinemáticas, cinéticas y fisiológicas en el balonmano playa femenino* [Doctoral dissertation]. Universidad de Barcelona. https://hdl.handle.net/2445/180356

Lara-Cobos, D., Daza-Sobrino, G., Sánchez-Sáez, J. A., & Ortega-Becerra, M. (2025). Physical demands in female international beach handball competition depending on player's position differentiating game quarters. *Cultura, Ciencia y Deporte, 20*(64). https://doi.org/10.12800/ccd.v20i64.2282

Lara-Cobos, D., Ortega-Becerra, M., Daza, G., & Sánchez-Sáez, J. A. (2023). Internal and external load in international women's beach handball: Official and unofficial competition. *Apunts. Educación Física y Deportes, 151*, 79–87. https://doi.org/10.5672/apunts.2014-0983.es.(2023/1).151.08

Lara-Cobos, D., Sánchez-Sáez, J. A., & Puigarnau Coma, S. (2024). Perception of fatigue and well-being in international beach handball players in official competition. *E-Balonmano.com: Revista de Ciencias del Deporte, 20*(3), 263–270. https://doi.org/10.17398/1885-7019.20.263

Mara, J. K., Thompson, K. G., Pumpa, K. L., & Morgan, S. (2017). The acceleration and deceleration profiles of elite female soccer players during competitive matches. *Journal of Science and Medicine in Sport, 20*(9), 867–872. https://doi.org/10.1016/j.jsams.2017.02.009

Morillo Baro, J. P. (2009). *Balonmano playa*. Wanceulen.

Morillo Baro, J. P., Lara-Cobos, D., Sánchez-Sáez, J. A., & Sánchez Malia, J. M. (2021). *Balonmano playa: De la iniciación al rendimiento*. Real Federación Española de Balonmano.

Müller, C., Willberg, C., Reichert, L., & Zentgraf, K. (2022). External load analysis in beach handball using a local positioning system and inertial measurement units. *Sensors, 22*(8), Article 3011. https://doi.org/10.3390/s22083011

Nobari, H., Khalili, S. M., Oliveira, R., Castillo-Rodríguez, A., Pérez-Gómez, J., & Ardigò, L. P. (2021). Comparison of official and friendly matches through acceleration, deceleration and metabolic power measures: A full-season study in professional

soccer players. *International Journal of Environmental Research and Public Health, 18*(11), Article 5980. https://doi.org/10.3390/ijerph18115980

Oliva-Lozano, J. M., Rojas-Valverde, D., Gómez-Carmona, C. D., Fortes, V., & Pino-Ortega, J. (2020). Impact of contextual variables on the representative external load profile of Spanish professional soccer match-play: A full season study. *European Journal of Sport Science, 21*(4), 497–506. https://doi.org/10.1080/17461391.2020.1751305

Pueo, B., Jiménez-Olmedo, J. M., Penichet-Tomás, A., Ortega-Becerra, M., & Espina-Agulló, J. J. (2017). Analysis of time-motion and heart rate in elite male and female beach handball. *Journal of Sports Science and Medicine, 16*(4), 450–458. https://www.jssm.org/jssm-16-450.xml-Fulltext

Reardon, C., Tobin, D. P., & Delahunt, E. (2015). Application of individualized speed thresholds to interpret position-specific running demands in elite professional rugby union: A GPS study. *PLoS ONE, 10*(7), e0133410. https://doi.org/10.1371/journal.pone.0133410

Reina, M., García-Rubio, J., Pino-Ortega, J., & Ibáñez, S. J. (2019). The acceleration and deceleration profiles of U-18 women's basketball players during competitive matches. *Sports, 7*(7), Article 165. https://doi.org/10.3390/sports7070165

Sánchez-Sáez, J. A., Sánchez-Sánchez, J., Martínez-Rodríguez, A., Felipe, J. L., García-Unanue, J., & Lara-Cobos, D. (2021). Global positioning system analysis of physical demands in elite women's beach handball players in an official Spanish championship. *Sensors, 21*(3). https://doi.org/10.3390/s21030850

Scanlan, A. T., Wen, N., Tucker, P. S., & Dalbo, V. J. (2014). The relationships between internal and external training load models during basketball training. *Journal of Strength and Conditioning Research, 28*(9), 2397–2405. https://doi.org/10.1519/JSC.0000000000000458

Scott, M. T., Scott, T. J., & Kelly, V. G. (2016). The validity and reliability of global positioning systems in team sport: A brief review. *Journal of Strength and Conditioning Research, 30*(5), 1470–1490. https://doi.org/10.1519/JSC.0000000000001221

Viejo Romero, D. (2015). *Influencia de las variables contextuales sobre las variables físicas de futbolistas en competición evaluadas mediante tecnología GPS* [Doctoral dissertation]. Universidad Europea. http://hdl.handle.net/11268/4439

Vigh-Larsen, J. F., Dalgas, U., & Andersen, T. B. (2018). Position-specific acceleration and deceleration profiles in elite youth and senior soccer players. *Journal of Strength and Conditioning Research, 32*(4), 1114–1122. https://doi.org/10.1519/JSC.0000000000002368

Zapardiel, J. C., Paramio, E. M., Ferragut, C., Vila, H., & Asín-Izquierdo, I. (2023). Comparison of internal and external load metrics between won and lost game segments in elite beach handball. *Human Movement, 24*(3), 85–94. https://doi.org/10.5114/hm.2023.125926