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PHYSICAL CONDITIONING

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Internal and External Load in International Women's Beach Handball. Official and Unofficial Competition

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A Mexican man in pre-Hispanic Aztec costume eludes the ball during a traditional "Juego de Pelota" (in Spanish), called by the Maya "pok-ta-pok" and by the Aztecs "tlachtli". Xcaret eco-park, Mexico June 5, 2009
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Abstract

This study aimed to determine the kinematic, kinetic and heart rate demands of elite women's beach handball, differentiating between official and unofficial matches. Fourteen players (60.0 ± 4.1 kg; 168.5 ± 5.9 cm; 24.6 ± 4.0 years) from the Spanish Beach Handball Absolute National Team were monitored during eleven matches prior to the 2018 World Championship. The external load was gathered using the GPS device and the internal load was obtained using heart rate measured through a chest strap. The distance travelled by players per set in official matches (OMs) was greater (334.79 ± 135.41 m) than that of training matches (TMs) (324.97 ± 90.88 m) and friendly matches (FMs) (263.52 ± 133.92 m), with significant differences ($p < .001$) between OMs and FMs. The same applies to the S_{max} recorded in the OMs (14.00 ± 2.68 km/h^{-1}) compared to the FMs (13.47 ± 2.33 km h^{-1}). There were significant differences ($p < .05$) between OMs and FMs in both accelerations and decelerations in Zone 2 (2 to 3 m·s^{-2}) and it was the second set that reported the highest number of accelerations and decelerations. In the TMs, the second set showed a lower number of accelerations and decelerations as a higher level of fatigue was obtained. Therefore, OMs had a higher kinematic and kinetic demand than TMs and FMs. But it is in the TMs that the highest level of fatigue is recorded.

Keywords: beach sport, Global Positioning System, monitoring of matches, physical performance, team sport.

Introduction

Beach handball is a sport discipline that was introduced in the 1990s and has developed in recent decades (Dol et al., 2020; Morillo et al., 2021). One particular feature of this kind of sport is that it has a development format in which, over three days of competition, up to three matches can be played on the same day. In relation to the higher level competitions, the World and Continental Championships take place over five rounds, amounting to between six and nine matches in total at the end of the competition. As a result, and due to the high demands required in elite sport, it is vital to have a specific and individualised knowledge of the kinematic, kinetic and physiological demands required in the practice of beach handball.

When analysing beach handball —internal and external load—, the structure and duration of the matches must also be taken into account, consisting of two sets (halves) of 10 minutes each and a five-minute break, with an unlimited number of player substitutions (Morillo et al., 2021). Derived from the rules and the game itself (Lara et al., 2018), the demands required in the practice of elite women's beach handball have been studied in recent years and the findings demonstrate the demands of this discipline at a competitive level (Sánchez-Sáez et al., 2021); it has been shown that there are periods in which the intensity and duration of exertion varies intermittently, causing periods of high intensity activity interspersed with periods of low intensity and with players constantly switching roles.

Like in other women's team sports, for example hockey (McGuinness et al., 2019), football (Vescovi, 2012) or handball (Kniubaite et al., 2019), and more specifically beach sports, i.e. beach football (Larsen et al., 2021), in women's beach handball, the analysis of the kinematic, kinetic and physiological demands required has been essential to be able to design, with higher precision and with greater similarity to the real demands of competition in official matches, the training tasks, plan the competitions and the season (Lemos et al., 2020; Pueo et al., 2017; Sánchez-Sáez et al., 2021; Zapardiel & Asín-Izquierdo, 2020). These studies have been developed in different types of competitions: a) training: matches played between players of the same team (Pueo et al., 2017); b) friendly: unofficial matches outside competition (Zapardiel & Asín-Izquierdo, 2020); c) official: matches played during an official competition (Sánchez-Sáez et al., 2021). However, in this study, matches against other teams which have a friendly feel to them but counted towards their players' international caps were considered official matches.

Yet in these studies carried out on beach handball, no comparison between the different types of competition (training, friendly and official) has been proposed, with a resulting scarcity of information. However, in other sports, for example football (Campos-Vázquez et al., 2019), the differences between physical demands in training sessions compared to in friendly matches were analysed (Castellano & Casamichana, 2013), resulting in a higher demand during competition.

In order to obtain the most accurate information about the specific needs of team sports, some of the most commonly used methodologies and tools, etc. have been: a) external load: Global Positioning System (GPS) in outdoor sports (Aughey, 2011); this technology allows, in an effective and efficient way, the assessment of athletes' external load in different contexts, e.g. distances travelled, speed, jumps, impacts, collisions, tactical positioning aspects, etc., as the GPS device can be coupled with gyroscopes and accelerometers; b) internal load: heart rate (HR) monitoring (Vanrenterghem et al., 2017).

Therefore, the aim of this study was to establish and analyse the kinematic and kinetic demands and heart rate of women's international beach handball (Spanish Women's National Team) in official and unofficial competitions, using GPS and HR_{max}, with the aim of providing new data to coaches when planning the training load.

Methodology

Participants

Fourteen female players from the Spanish Absolute Beach Handball Team participated in the study (60.0 ± 4.1 kg body mass; height of 168.5 ± 5.9 cm; 24.6 ± 4.0 years of age; training experience: five years). The sample was selected on the basis of the following inclusion criteria: a) being a field player; b) having completed 100% of the matches; c) not having any physical limitations or musculoskeletal injuries that reduced their performance; d) having participated regularly in the national beach handball circuit (Arena Handball Tour®); this ensured consistent competition during the season. All players were notified of the research design, procedures, requirements, benefits and risks prior to data collection and agreed to participate voluntarily by signing the informed consent form. The technical and medical staff was also briefed in detail. The study complied with the guidelines of the Declaration of Helsinki.

Resources

The monitoring was carried out using a GPS device and the data obtained was collected using 10 Hz units (SPI HPU; GPSports Systems®, Canberra, Australia; mass: 67 g; size: 74 × 42 × 16 mm), in line with previous studies (Morencos et al., 2019) which indicated that this frequency unit appears to be more accurate than devices using frequencies of 1 Hz and 5 Hz (Macfarlane et al., 2016). The number of satellites in connection with each device was 10.5 ± 1.1 across all measurements, as recommended by Ashman et al. (2018). Together, all the devices used included a 100 Hz triaxial accelerometer.

Each athlete wore a bib underneath the competition shirt and each monitor was placed between the shoulder blades over the upper spine (T2-T4), where it was held stable by a padded neoprene waistcoat. Data from each device was then downloaded to a laptop using Team AMS software (v. R1.2; Canberra, Australia). HR was recorded via a coded chest strap worn by each player (Polar Electro, Kempele, Finland).

Procedure

The players were monitored across eleven matches in preparation for the 2018 World Championships in Kazan (Russia) — the team finished fourth at the World Championships. The classification of the matches was as follows: a) training matches: matches played between players of the same team; b) friendly matches: unofficial matches outside competition; c) official matches: official matches that counted as internationals for their players.

Recording of data was carried out on an individual basis, per player, irrespective of their usual position. It was not considered necessary to differentiate by specific position, as each player in the course of the same set (and for tactical reasons) frequently changed their position, as well as by the total number of participants in the sample. Similarly, due to the short duration of each set and the game play cycle of beach handball (Lara et al., 2018), where players are constantly coming on and off the court, the individual time variable was not considered, as in Pueo et al. (2017) and Sánchez-Sáez et al.'s (2021) studies.

The total playing time of the sets (10 mins each) was analysed without excluding the time-outs (1 min) during the sets; however, the rest time (5 mins) between sets was excluded. All matches took place in similar environmental conditions of 20-25 ºC, with no wind; after individual and collective warm-up of 10 minutes off the court; and 20 minutes on the court. A total of eleven matches were monitored: 3 training (TMs), 3 friendly (FMs) and 5 official (OMs).

The variables recorded for subsequent analysis were based on previous studies by Pueo et al. (2017), Sánchez-Sáez et al. (2021) and Zapardiel and Asín-Izquierdo (2020): total distance travelled (m) and relative distance (m/min^{-1}), maximum speed achieved (km/h^{-1}), distance travelled in the different zones (Z) of maximum speed (S_{max}) obtained by each player during all the matches recorded: Z1: < 10% S_{max}, Z2: 10-29% S_{max}, Z3: 30-49% S_{max}, Z4: 50-79% S_{max}, Z5: 80-95% S_{max} and Z6: > 95% S_{max}. The total number of accelerations and decelerations was also taken into account, with actions greater than 2 m/s^{-2} being analysed (Vázquez-Guerrero et al., 2019) Finally, HR_{max}, as physiological demand, was analysed, establishing the following zones: Zone 1: < 60% HR_{max}, Zone 2: 61-70% HR_{max}, Zone 3: 71-80% HR_{max}, Zone 4: 81-90 HR_{max}, Zone 5: 91-95% HR_{max} and Zone 6: >95% HR_{max}. This was collected by means of the Yo-Yo Intermittent Recovery Test Level 1 indirect stress test, designed to obtain aerobic capacity by determining the recovery of the athlete to accumulated intermittent efforts (Bangsbo et al., 2008).

Statistical Analysis

The descriptive statistical study was presented as averages and standard deviation. The distribution of the variables was examined using the Shapiro-Wilk test for normality and the homogeneity of variance was tested using Levene's test. The analysis of the differences between the different types of competition was examined through analysing averages (one-way ANOVA) and the level of significance accepted was $p < .05$, with *post hoc* analysis using Bonferroni. The free statistical package JASP (Version, 0.9.2; University of Amsterdam) and GPower for the calculation of statistical power were used for the data analysis.

Results

Kinematic Variables

Analysis of the data showed that the distance travelled by players per set in OMs was greater (334.79 ± 135.41 m) compared to TMs (324.97 ± 90.88 m) and FMs (263.52 ± 133.92 m). The differences were significant ($p < .001$). The *post hoc* analyses carried out using Bonferroni showed that greater distances were travelled in the OMs than in the FMs ($p < .001$) 95% CI [-264.87, -78.43] based on the differences in distance travelled in the first set ($p = .006$)

95% CI [-173.75, -24.52]. Similarly, greater distances were travelled in TMs compared to FMs ($p < .001$) 95% CI [-259.19, -61.19] based on differences in the first set ($p = .005$) 95% CI [-196.32, -30.35].

Only in the second set were differences found between OMs and TMs ($p = 0.15$) 95% CI [-114.14, -10.67]. It occurred similarly in the S_{max} recorded in OMs (14.00 ± 2.68 km/h^{-1}) versus FMs (13.47 ± 2.33 km/h^{-1}). This same analysis showed that the S_{max} achieved in OMs was higher than in FMs ($p < .001$) 95% CI [-2.93, -1.10], both in the first set ($p = .003$) 95% CI [-3.07, -0,52] and in the second set ($p = .009$) 95% CI [-3.23, -0.40]. Similarly a higher S_{max} was recorded in TMs versus FMs ($p < .001$) 95% CI [-2.69, -0.75] based on the first set ($p = .048$) 95% CI [-2.86, -0.04] (Table 1).

The relative distance variable as a function of playing time is defined as the distance travelled per minute. This variable determined that it was in the TMs (35.28 ± 8.17 m/min^{-1}) where greater distances were covered compared to the OMs (34.70 ± 11.34 m/min^{-1}) and FMs (34.55 ± 14.02 m/min^{-1}). The differences were not significant (Table 1).

Figure 1 shows the distance that was covered in the six zones (Z) of maximum speed. It was Z2 and Z4 where the greatest distance travelled per set was achieved. It was in the TMs that longer distances were covered at low speeds (Z2) and in the OMs at high speeds (Z4 and Z5).

The comparison between the different matches and sets played in the different speed zones showed that in TMs greater distances were made in the first set than in FMs Z2: $p = .42$; 95% CI [98.92 5.93], Z3: $p = .17$; 95% CI [31.84, 2.21], Z4: $p = .023$; IC 95% [94.64, 5.22], while between OMs and FMs the differences were in Z4: $p = .034$; 95% CI [85.44, 4.03] and Z5 $p = .024$; 95% CI [25.76, 1.33]. In the second set of the OMs, players performed a greater distance than in the TMs in Z4: $p = .43$; 95% CI [89.43, 2.09] and than in the FMs in Z5: $p = .015$; 95% CI [31.88, 2.36].

Table 1
Kinematic variables differentiating the types of competition.

	OMs	TMs	FMs	F	*p*	η^2_p	1-β	*f*
	A(SD)	A(SD)	A(SD)					
Comp. Match								
Distance	435.18 (223.22)	423.72 (210.43)	263.52 (133.92)	9.60	<.001	.059	.892	.279
Relative Distance (m/min)	33.33 (10.22)	34.84 (7.66)	34.55 (14.02)	.785	.457	.005	.658	.067
Maximum Speed (km·h^{-1})	15.49 (1.93)	15.20 (2.20)	13.47 (2.33)	13.59	<.001	.082	.769	.316
Set 1								
Distance	332.37 (130.51)	346.57 (90.21)	233.23 (137.27)	5.96	.003	.008	.576	.314
Relative Distance (m/min)	33.68 (10.78)	36.03 (7.96)	36.51 (15.68)	0.81	.044	.013	.660	.109
Maximum Speed (km·h^{-1})	14.96 (2.16)	14.61 (1.49)	13.16 (2.60)	5.64	.005	.084	.570	.298
Set 2								
Distance	369.89 (119.68)	307.48 (88.65)	304.71 (127.54)	4.957	.009	.076	.563	.280
Relative Distance (m/min)	34.83 (10.65)	34.67 (8.38)	32.48 (11.97)	0.32	.726	.005	.788	.070
Maximum Speed (km·h^{-1})	15.62 (1.69)	15.00 (2.49)	13.80 (2.00)	4.957	.009	.076	.554	.278

Note: Comp. Match: complete match; OMs: official matches; TMs: training matches; FMs: friendly matches.; A: average; SD: standard deviation.

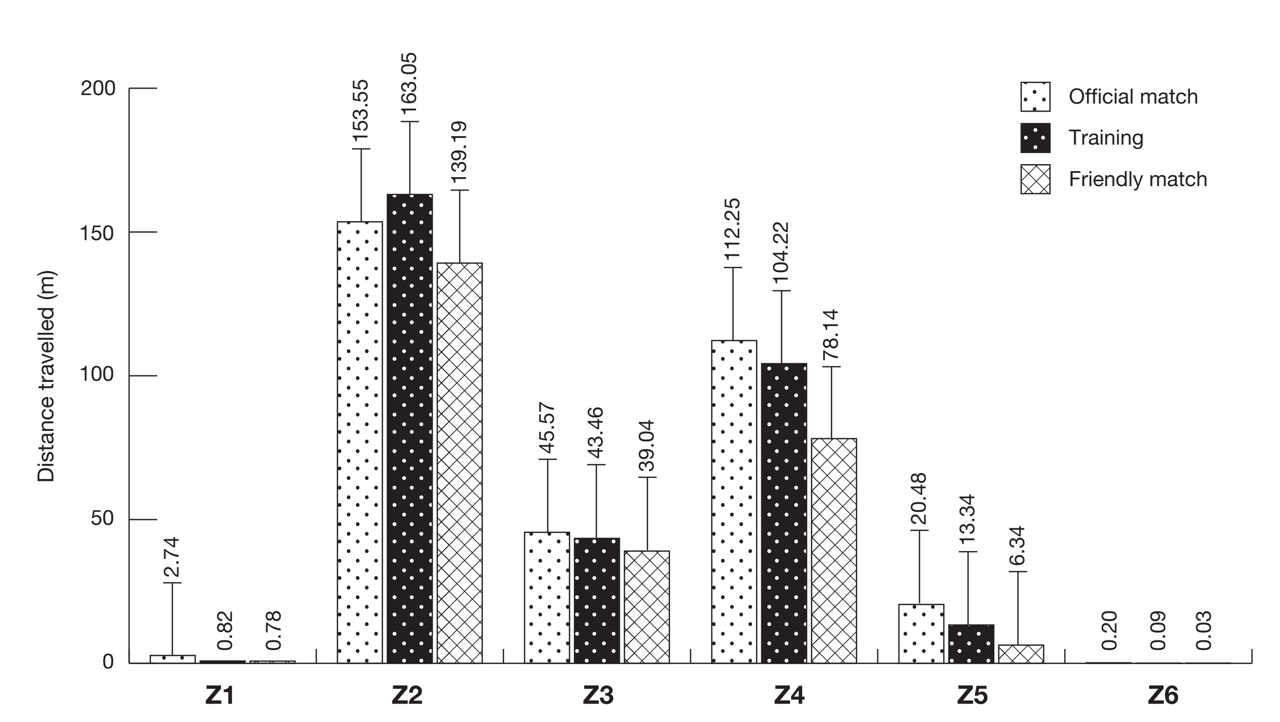

Figure 1
Distance travelled by maximum speed zones depending on the type of competition.

Kinetic Variables

With regard to the kinetic variables, there was a relationship from highest to lowest in OMs, TMs and FMs in terms of accelerations and decelerations. The *post hoc* analyses carried out using Bonferroni showed that a greater number of 2 to 3 m/s^{-2} accelerations were performed in the OMs than in the FMs ($p < .001$) 95% CI [-4.71, -1.02] both in the first set ($p < .001$) 95% CI [-8.13, -1.79] and in the second set ($p = .004$) 95% CI [-9.21, -1.43]. In the same way that occurred in the 2 a 3 m·s^{-2} decelerations, where they were higher in the OMs compared to the FMs ($p < .001$) 95% CI [-6.12, -1.37], appreciated in both the first set ($p = .35$) 95% CI [-6.33, -0.24] and the second set ($p = .026$) 95% CI [-7.95, -0.47]. Along the same lines, in the second set in the OPs there was a greater number of accelerations from 2 to 3 m-s^{-2} with respect to the TMs ($p < .001$) 95% CI [-7.41, -1.98] and decelerations of 2 a 3 m·s^{-2} ($p = .023$) 95% CI [-5.59, -0.36] and in decelerations of more than 3 m·s^{-2} ($p = .007$) 95% CI [-2.44, -0.32] (Table 2).

Table 2
Number of accelerations and decelerations according to the type of competition.

	OMs	TMs	FMs	F	*p*	η^2_p	1-β	*f*
	A(SD)	A(SD)	A(SD)					
Comp. Match								
Zone 1 Accel.	18.07 (8.337)	18.65 (8.23)	16.32 (9.54)	0.898	.409	.007	.655	.082
Zone 2 Accel.	10.01 (6.20)	7.14 (4.74)	4.82 (3.47)	15.24	<.001	.110	.926	.398
Zone 3 Accel.	0.90 (4.31)	0.31 (0.59)	0.23 (0.06)	1.11	.331	.009	.921	.167
Zone 1 Decel.	17.07 (7.83)	17.34 (7.07)	15.67 (9.00)	0.568	.567	.005	.711	.065
Zone 2 Decel.	8.60 (5.99)	7.18 (4.15)	4.85 (4.04)	7.41	<.001	.056	.736	.270
Zone 3 Decel.	2.84 (2.50)	2.02 (1.70)	1.55 (2.43)	5.97	.003	.046	.602	.224

Note: Accel.: acceleration (m·s^{-2}); Decel.: deceleration (m·s^{-2}); OMs: official matches, TMs: training matches; FMs: friendly matches. A: average, SD: standard deviation.

Table 2 (Continued)
Number of accelerations and decelerations according to the type of competition

	OMs	TMs	FMs	F	*p*	η^2_p	1-β	*f*
	A(SD)	A(SD)	A(SD)					
Set 1								
Zone 1 Accel.	16.84 (8.66)	21.08 (8.25)	13.89 (9.70)	4.70	.011	.071	.550	.268
Zone 2 Accel.	9.17 (5.84)	7.97 (4.39)	4.21 (3.45)	6.92	.001	.101	.699	.376
Zone 3 Accel.	0.49 (0.72)	0.29 (0.67)	0.21 (0.41)	1.84	.162	.029	.682	.190
Zone 1 Decel.	15.28 (7.62)	19.05 (5.82)	13.21 (8.03)	4.78	.010	.072	.581	.278
Zone 2 Decel.	7.97 (5.43)	7.97 (4.28)	4.68 (4.17)	3.51	.033	.054	.334	.254
Zone 3 Decel.	2.71 (2.56)	2.47 (1.79)	1.31 (2.18)	2.71	.070	.042	.297	.221
Set 2								
Zone 1 Accel.	19.38 (7.82)	16.45 (7.79)	19.40 (8.68)	1.85	.0161	.030	.593	.169
Zone 2 Accel.	10.92 (6.50)	6.22 (4.94)	5.6 (3.46)	10.96	<.001	.156	.843	.489
Zone 3 Accel.	1.35 (6.15)	0.30 (0.46)	0.26 (0.79)	0.804	.450	.013	.919	.213
Zone 1 Decel.	18.98 (7.64)	15.50 (7.23)	18.80 (9.45)	2.681	.073	.043	.552	.199
Zone 2 Decel.	9.27 (6.51)	6.30 (3.92)	5.06 (4.00)	5.741	.004	.087	.732	.350
Zone 3 Decel.	2.985 (2.446)	1.60 (1.56)	1.867 (2.77)	5.278	.006	.081	.546	.290

Note: Accel.: acceleration ($m{\cdot}s^{-2}$); Decel.: deceleration ($m{\cdot}s^{-2}$); OMs: official matches, TMs: training matches; FMs: friendly matches. A: average, SD: standard deviation.

In the TMs, the differences between the first and second sets were in favour of the first set, where a higher number of accelerations of 1-2 $m{\cdot}s^{-2}$ ($p = .015$) 95% CI [1.86, 0.91], decelerations of 2-3 $m{\cdot}s^{-2}$ ($p = .024$) 95% CI [1.54, 0.478] and of more than 3 $m{\cdot}s^{-2}$ ($p = .029$) 95% CI [0.39, 0.09]. In both the OMs and FMs this ratio was in favour of the second set.

Physiological Variable

Figure 2 shows the percentage of playing time that the players spent at different intensities of HR_{max}. In this sense, it was in the low intensity zones of the FMs (Zone 1) and TMs (Zone 2 and 3) where the highest percentages of playing time were obtained, while in the OMs a higher percentage of playing time was recorded in Zones 4, 5 and 6.

Significant differences were found in Zone 1 in favour of FMs compared to TMs: $p = .007$; 95% CI [0.05, 0.39] and to OMs: $p = .022$; 95% CI [0.02, 0.33], while in Zone 2 the differences were significant between TMs and OMs: $p < .001$; 95% CI [0.03, 0.11]. In Zone 3 TMs reported a higher percentage of time than FMs: $p = .005$; 95% CI [0.15, 0.02] and than OMs: $p < .001$; 95% CI [0.02, 0.11].

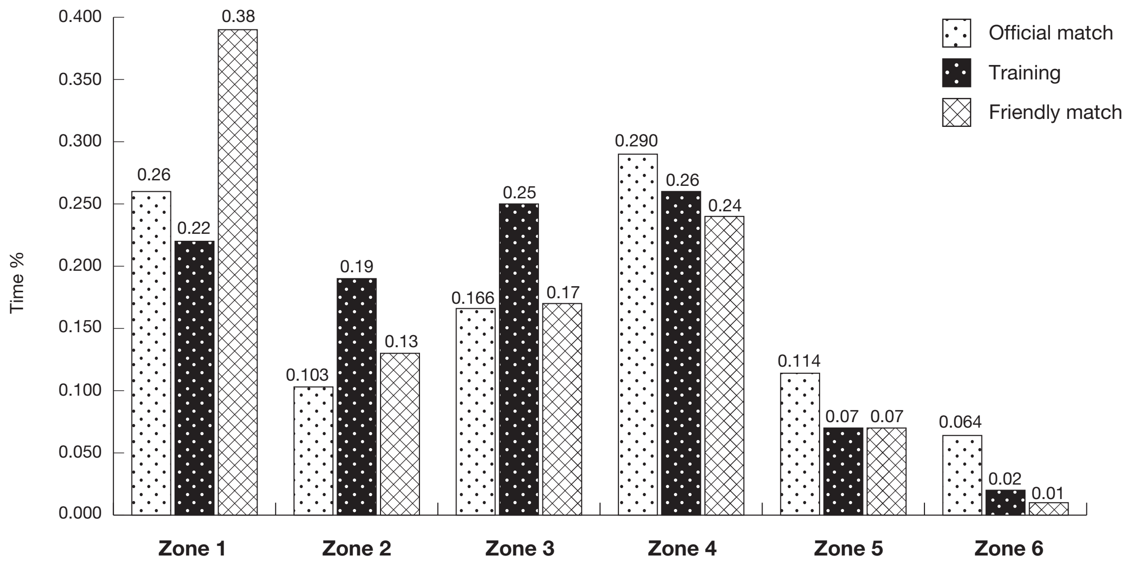

Figure 2
Percentage of time in the HRmax zones differentiating the type of competition.

Discussion

Different original findings were found that can help to understand the performance of the elite beach handball player in different conditioning activities such as TMs and FMs, with the aim of improving sporting performance during official competition.

The analysis of the data obtained in this research shows that the kinematic variables of distance travelled and maximum speed reached in OMs are greater than those observed in TMs and FMs, similarly to the findings found by Palucci et al. (2016) in indoor football. Likewise, the kinetic variables at high intensities (accelerations > 2 m·s^{-2} / decelerations > 2 m·s^{-2}) in OMs presented higher values compared to TMs and FMs, following Nobari et al.'s (2021) line of research, which compared accelerations and decelerations in professional football players in OMs and FMs.

At low intensities (Zone 1 to Zone 3 HR$_{max}$), TMs and FMs have a longer time at low heart rates —from < 60% HR$_{max}$ to 71-80% HR$_{max}$- than OMs. This aspect, despite not having been analysed in previous publications, is similar to studies that related FMs to training activities, where competition (friendlies) has a greater external and internal load than tactical and physical preparation sessions in professional football players (Campos-Vázquez et al., 2019).

The next variable studied was the evolution of kinematic and kinetic variables in the first and second sets in order to provide information on the players' ability to maintain their level of exertion throughout a match and to identify any significant decrease in performance during the second half.

In this study, it is observed that it was in the second set where the variables (distance: m/set and maximum speed: km-h^{-1}) were higher in the OMs and FMs, as occurs in OMs in Z5 in Sánchez-Sáez et al.'s (2020) study. These authors also reported that the maximum speed achieved in an official women's beach handball match was higher in the second set than in the first set, coinciding with the present study. On the other hand, in the TMs it was in the first set where the greatest distance travelled was reported, coinciding with the values presented by Pueo et al.'s (2017) study.

Similarly, accelerations (1 to > 3 m·s^{-2}) and decelerations (1 to > 3 m·s^{-2}) in the OMs and FMs were higher in the second set compared to the first. Pueo et al. (2017) provides evidence for the same relationship for accelerations (1-3 m·s^{-2}) in beach handball players in TMs. In contrast, in the present study, in the TMs the relationship was inverse; greater in the first set compared to the second, coinciding with other disciplines such as football (Nobari et al., 2021) or in U18 female basketball players (Reina et al., 2019). This may be because it is in this type of match that the player really reaches sufficient fatigue levels to be significant. Decelerations, especially above 3 m·s^{-2}, is a variable sensitive to fatigue levels.

The comparison between types of competition has remained unpublished until now, although it is true that the various studies carried out in women's beach handball have used different types of competition to analyse the kinematic, kinetic and physiological data. Contrasting the data from the present study with previously published research allows us to define what demands are placed on each of the competitions that a beach handball player performs in.

Research published by Pueo et al. (2017), Sánchez-Sáez et al. (2021) and Zapardiel and Asín-Izquierdo (2020) on Spanish beach handball players described the kinematic, kinetic and physiological demands in different types of competition. Whilst Pueo et al. (2017) analysed two TMs, Zapardiel and Asín-Izquierdo (2020) exclusively studied FMs. The only study that was conducted on OMs was Sánchez-Sáez et al.'s (2021) study, where six matches were monitored. The differences in these studies are consistent with the results found in the present study. The total distances travelled in FMs by Zapardiel and Asín-Izquierdo (2020) are less than the OMs studied by Sánchez-Sáez et al. (2021), as well as in the FMs (Zapardiel & Asín-Izquierdo, 2020), fewer accelerations were recorded than in the TMs reported by Pueo et al. (2017) study.

This comparison between studies is obviously biased, not only methodologically but because of the sample used. However, it provides support for the data found in this publication, where the comparison between OMs, TMs or FMs has proven to be valid and reliable.

The most studied physiological variable in beach handball has been the HR_{max} and the percentage of time that a player spends at certain intensity intervals, as explained in the methodological section. In that respect, the present study has been completely in line with the data presented about the OMs found by Sánchez-Sáez et al. (2021), where the distribution of time percentages is concentrated in Zone 4 (81-90% HR_{max}).

On the other hand, with regard to TMs, Pueo et al. (2017) reported a higher percentage of time in Zone 1. (< 60% HR_{max}). In relation to FMs, we can see in the present study that there was a higher percentage of accumulated playing time in the low intensity zone (Zone 1: < 60% HR_{max}). It should be noted that after Zone 1 it was Zone 4 that accumulated the highest HR_{max}.

Conclusions

The OMs have a higher kinematic and kinetic demand than TMs and FMs. It was at high intensities that this difference was found and it was at low intensities that TMs and FMs reported higher external load demands than OMs. Therefore, knowing the demands of unofficial matches (TMs and FMs) will allow coaches to design and plan the dynamic loads more efficiently by using them as a method of preparation for official competition. At the internal load level, OMs accumulate a higher percentage of time at high intensities compared to TMs, as do TMs over FMs.

It was in the second set where the distance covered, maximum speed, number of accelerations and decelerations reported higher data compared to the first set, with the exception of the TMs, where lower values were observed in the second set in the kinetic variables and it was in this type of competition where the player reached higher levels of fatigue.

Therefore, coaches and physical trainers could use the results of this study to modify training sessions and prepare players using different types of competition, according to the specific requirements of each match, season planning, competition typology, players' HR_{max} characteristics, etc.

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