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Poor sleep quality and quantity in water polo players and coaches: a worldwide survey

Supplementary Information

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Introduction

Water polo (WP) is a high-intensity intermittent water sport with incomplete recovery periods (Botonis, Toubekis, & Platanou, 2019). Recovery after exercise is a fundamental part of sport performance in team sports (Calleja-González et al., 2016; Calleja-González et al., 2018) and in particular in WP players (Barrenetxea-Garcia, Gil, Esain, & Torres-Unda, 2023; Barrenetxea-Garcia et al., 2024). In general, the most commonly used recovery strategies are nutritional, ergogenic supplementation, active recovery, hydrotherapy, stretching, compression garments, massage, psychological strategies, rest, and sleep (Calleja-González et al., 2016; Calleja-González et al., 2018). Among these mentioned strategies, sleep is essential for optimal health, performance, and recovery (Day, Nishino, & Tsukahara, 2024), being the most important factor in recovery (Cook & Charest, 2023).

In particular, the prevalence of insufficient sleep (< 7 h/night) has been shown to be high among elite athletic populations due to training and competition schedules (Halson et al., 2021; Walsh et al., 2021), which could cause daytime fatigue (Cook & Charest, 2023), decreased performance (Bonnar, Bartel, Kakoschke, & Lang, 2018), and daytime sleepiness (Blumenfeld, Winsell, Hicks, & Small, 2016). Indeed, training sessions and matches that take place in the evening (18:00 to 21:00 h) are associated with later sleep onset, less time in bed and less total sleep obtained (Nédélec, Dawson, & Dupont, 2019). This is because sport practice has the capacity to stimulate the neurotransmitters of the ascending arousal system (adrenaline and noradrenaline), causing the sleepy release of cortisol leading to a disruption of the sleep–wake cycle (Bonato et al., 2020), raising the heart rate during the first three hours of sleep (Costa, Brito, Nakamura, Oliveira, & Rebelo, 2018). In rugby players (Teece, Beaven, Argus, Gill, & Driller, 2023), soccer (Khalladi et al., 2019), endurance athletes (Wilson & Baker, 2021), and team sports (Fullagar et al., 2015), sleep patterns and/or the effects of sleep deprivation have already been described. In WP, in contrast, there is still very little literature on this topic (Botonis & Toubekis, 2023; Koutouvakis, Geladas, Mouratidis, Toubekis, & Botonis, 2024). Increased nocturnal sleep disturbances and salivary cortisol have been observed in international WP players in an Olympic preparation camp (Botonis & Toubekis, 2023).

For coaches, sleep problems and sleep deficiency the night before important matches have already been described (Lastella et al., 2017; Olusoga, Butt, Maynard, & Hays, 2010). Although research on athletes' sleep is becoming increasingly popular (Fullagar et al., 2015), there is very little literature on coaches' sleep to the best of our knowledge.

A risk factor that affects the sleep of both athletes and coaches is the frequent travel they undertake (Lastella et al., 2017; Singh, Bird, Charest, Huyghe, & Calleja-Gonzalez, 2021). Samuels (2012) noted that travel fatigue can be cumulative throughout the season and can affect performance (Singh et al., 2021). Consequently, assessing and monitoring the quality and quantity of sleep of athletes and coaches is important to optimize recovery, improve health, and performance (Day et al., 2024; Olusoga et al., 2010; Singh et al., 2021). Sleep quantity is defined as the difference between the time of sleep onset and the final awakening of the night, less the duration of any awakenings during the night (Carney et al., 2012). Sleep quality is generally represented in a field setting

by a combination of subjective quality ratings and calculated measures such as sleep efficiency (Wilson & Baker, 2021), defined as total sleep time expressed as a percentage of the sleep period (Halson et al., 2022). Sleep monitoring entails a comprehensive evaluation of various sleep aspects, including duration, quality, consistency, and contextual factors that may impact rest. Sleep can be measured both objectively (using polysomnography, activity trackers, smartphone apps, and wearable devices near the bed) and subjectively (through personal sleep diaries and questionnaires; Walsh et al., 2021). In team sports, effective strategies to assess sleep efficiency include actigraphy, the Pittsburgh Sleep Quality Index (PSQI), Likert scales, the Liverpool Jet-Lag Questionnaire, and the Recovery Stress Questionnaire for Athletes (Claudino et al., 2019). While the correlation between subjective and objective measures is moderate, subjective tools can offer unique and valuable insights (Claudino et al., 2019), suggesting that a combined approach might be beneficial.

To the best of the authors' knowledge, to date no study has analyzed differences in sleep patterns between WP players and coaches worldwide. We hypothesized that WP players and coaches have poor sleep quality and quantity as in other sports. Therefore, the present study aimed (i) to analyze the sleep patterns of WP players and coaches of both sexes, and (ii) to identify differences in sleep quality and quantity between WP players and coaches, male and female WP players, and elite and amateur WP players worldwide.

Materials and methods

Participants

A total of 231 WP players (male: $n = 112$; female: $n = 119$) and 76 coaches (male: $n = 70$; female: $n = 6$), representing all continents around the world and all levels of competition, completed a freely accessible online questionnaire, related to sleep quality and quantity. The sample size was adequate compared to previous similar studies (Suppiah, Swinbourne, Wee, Tay, & Gastin, 2021; Teece et al., 2023). The data obtained were treated with the utmost confidentiality and scientific rigor, their use being restricted by the guidelines for research projects following the required scientific method, complying with Organic Law 15/1999 on Personal Data Protection (LOPD). The study was approved by the Human Research Ethics Committee of the University of Basque Country (Ref. M10_2023_192) and was adjusted to the Code of Ethics of the World Medical Association (Declaration of Helsinki). All participants were adequately informed, participated voluntarily and anonymously.

Study design

For data collection, a freely accessible online questionnaire was developed with validated scales using Microsoft Forms (Microsoft, Redmond, WA, USA) with descriptive design (https://forms.office.com/r/BQCkk1NCv3). This survey aimed to evaluate the sleep quality and quantity of WP players and coaches. A pilot version of the survey was administered to two coaches and two players who had solid experience in the sport before distribution. Subsequently, the survey was sent by email, telephone, and social networks, in the same way as used by other authors (Barrenetxea-Garcia et al., 2024; Pernigoni et al., 2022). The survey was available online for 2 months (from 2 October to 2 December 2023) and was completed in a maximum of 6 min.

Data collection method

The survey was divided into two sections: sociodemographic data (8 questions) and sleep quality and disorders (10 questions). In section 1, sociodemographic data, information on age, gender, experience, competitive level of the team, and the participant's role in the team were recorded by means of closed questions (Barrenetxea-Garcia et al., 2024; Pernigoni et al., 2022). In section 2, the sleep quality and sleep disorders of the athlete or coach during 1 month were assessed by means of the PSQI questionnaire (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI is a tool consisting of 19 self-rated questions that provide a global rating of subjective sleep quality and subscale measures of sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, sleep medication consumption habits, and daytime dysfunction (Buysse et al., 1989). Global scores range from 0 to 21 with higher scores indicating poorer overall sleep quality and a global score of 5 or greater indicates a clinically significant sleep disorder who further screening is needed. The PSQI has been demonstrated to have good internal reliability, validity and is perhaps the most commonly used subjective sleep measure in the research literature (Buysse et al., 1989). In sport, it has been used in different sports and age categories (Driller et al., 2022; Suppiah et al., 2021; Teece et al., 2023).

Statistical analysis

Data were extracted from the online survey (Microsoft Forms®) into a spreadsheet (Microsoft Excel 2019®). Descriptive analyses were reported as mean and standard deviations (mean ± SD). Normality of the data was analyzed by Kolmogorov–Smirnov test (> 50). Differences between players and coaches and between men and women were analyzed using Student's t-test (parametric variables) or Mann–Whitney U-test (nonparametric variables). Effect size of the measurements was calculated using Cohen's d (Cohen, 1992). Threshold values to assess effect size were 0.1, 0.2, 0.5, and 0.8 for trivial, small, medium, and large effect sizes, respectively (Cohen, 1992). Absolute and relative frequencies were used for categorical variables, and qualitative terms were used to characterize observed frequencies as follows: all = 100% of participants; most = ≥ 75%; majority = 55–75%; about half = ~ 50%; about one-third = ~ 30%; minority = < 30% (Barrenetxea-Garcia et al., 2024; Pernigoni et al., 2022). Descriptive statistics were performed using PASW Statistics 25 (SPSS®, IBM, Armonk, NY, USA) and graphs were plotted using GraphPad Prism 9 Software (Insight Partners, New

York, NY, USA). The level of significance was established at $p < 0.05$.

Results

The majority of male ($n = 63$, 56.3%) and female ($n = 68$, 57.1%) players surveyed were under 21 years of age; had sport experience between 5 and 10 years ($n = 39$, 34.8% and $n = 60$, 50.5%; respectively); were from Europe ($n = 93$, 83% and $n = 109$, 91.6%; respectively); and were part of a First Division teams ($n = 51$, 45.5% and $n = 57$, 47.9%; respectively). In the case of the coaches, one third of the male ($n = 21$, 30%) and half of the female ($n = 3$, 50%) coaches were between 31 and 40 years of age; work experience between 11 and 15 years for approximately one third of the male coaches ($n = 18$, 25.7%) and between 5 and 10 years for most of the female coaches ($n = 4$, 66.7%); most were from Europe ($n = 57$, 81.4% and $n = 6$, 100%; respectively); and were part of a Territorial Division teams ($n = 26$, 37.1% and $n = 2$, 33.3%; respectively). **Table 1** details the sociodemographic characteristics of the WP players and coaches.

The frequencies of PSQI total values recorded for players and coaches are shown in **Fig. 1**. In all, 74% of the players ($n = 171$) and 63.2% of the coaches ($n = 48$) show a clinically significant sleep disorder. Specifically, 44.6% of the players deserve medical attention ($n = 103$), 28.6% deserve medical attention and medical treatment ($n = 66$), and 0.9% have serious sleep problems ($n = 2$). In coaches, 36.8% deserve medical attention ($n = 28$), 25% deserve medical attention and medical treatment ($n = 19$) and 1.3% have serious sleep problems ($n = 1$).

Players and coaches showed significant differences in PSQI values (**Table 2**). Players had higher sleep latency ($p < 0.01$), daytime dysfunction ($p < 0.001$), and shorter sleep duration ($p < 0.01$) than coaches. For instance, 11.3% of the players and 21% of the coaches slept less than 6 h; and 27.2% of the players and 23.6% of the coaches recorded fairly bad or bad perceived sleep quality. In addition, 4.3% of players and 2.6% of coaches took sleep medication three or more times per week; however, 13.9% of players had difficulty falling asleep three or more nights per week. Night-time awakenings three or more times per week were recorded by 13.9% of the players and 14.5% of the coaches; and habitual snoring affected 6.6% of the coaches. Furthermore, 26.5% of the players and 14.5% of the coaches reported difficulties in maintaining enthusiasm for their tasks, and 13.5% of the players experienced excessive daytime sleepiness (supplemental material).

Differences were also observed between male and female players (**Table 3**). Female players had higher sleep latency and daytime dysfunction ($p < 0.05$) than male players. There were no significant differences between male and female coaches. Likewise, elite (First Division teams) and amateur (Territorial Division teams) players showed significant differences (**Table 4**). Amateur male players had shorter sleep duration ($p < 0.01$) than elite player. In female players were no significant differences between elite and amateur players.

Discussion

This study aimed to analyze the sleep patterns of WP players and coaches in both sexes and to identify differences in sleep quality and quantity between WP players and coaches, male and female WP players, and elite and amateur WP players worldwide. The first main finding of this study was that 74% of the players and 63.2% of the coaches suffer from a clinically significant sleep disorder based on the PSQI. The descriptive statistic of our study suggested that in terms of duration players and coaches sleep slightly less than the recommendation of the US National Sleep Foundation (7–9 h for young adults and 7–8 h for other adults; Hirshkowitz et al., 2015). Especially for players who should sleep at least 8.3 h per night (Hirshkowitz et al., 2015), our findings are in line with previous research of Sargent, Lastella, Halson, and Roach (2021), which stated that majority of athletes analyzed in their study fail to meet this necessity on most nights, as well as with the study of Driller et al. (2022) which indicated a common habit for team sport players to display a poor perceived quantity and quality of sleep.

The second main finding of this study was that WP players and coaches presented significant differences regarding values of sleep latency, daytime dysfunction, and sleep duration. These

Abstract

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Poor sleep quality and quantity in water polo players and coaches: a worldwide survey

Abstract

Sleep is one of the most important aspects of recovery; however, insufficient sleep has been described in elite athletes. The objective of the present study was to investigate sleep quality and quantity in water polo (WP) players and coaches worldwide. In all, 231 WP players (male: $n = 112$; female: $n = 119$) and 76 coaches (male: $n = 70$; female: $n = 6$) representing all continents around the world and all levels of competition, completed a freely accessible online survey. This was divided into two sections: sociodemographic data (8 questions), and sleep quality and disorders (10 questions). Based on the Pittsburgh Sleep Quality Index (PSQI) results, 74% of the players and 63.2% of the coaches suffer from a clinically significant sleep disorder. Regarding players, 44.6% deserve medical attention, 28.6% deserve medical attention and medical treatment, and 0.9% have serious sleep problems. In coaches, 36.8% deserve medical attention, 25% deserve medical attention and medical treatment, and 1.3% have serious sleep problems. Players had higher sleep latency ($p < 0.01$), daytime dysfunction ($p < 0.001$), and shorter sleep duration ($p < 0.01$) than coaches; female players had higher sleep latency and daytime dysfunction ($p < 0.05$) than male players; and amateur male players had shorter sleep duration ($p < 0.01$) than elite players. These findings reveal deficiencies in sleep quality and quantity in WP worldwide; therefore, WP training staff should seek strategies to improve their sleep hygiene.

Keywords

Team sports · Performance · Rest · Training monitoring · Recovery

Table 1 Sociodemographic characteristics of water polo players ($n = 231$) and coaches ($n = 76$)

	Players				Coaches			
	Men ($n = 112$)		Women ($n = 119$)		Men ($n = 70$)		Women ($n = 6$)	
	n	%	*n*	%	*n*	%	*n*	%
Age (years)								
Less than 21	63	56.3	68	57.1	3	4.3	0	0
21–30 years of age	39	34.8	42	35.3	13	18.6	2	33.3
31–40 years of age	8	7.1	8	6.7	21	30	3	50
41–50 years of age	0	0	1	0.8	18	25.7	1	16.7
51–60 years of age	2	1.8	0	0	9	12.9	0	0
More than 60 years of age	0	0	0	0	6	8.6	0	0
Experience (years)								
Less than 5	21	18.8	9	7.6	13	18.6	1	16.7
Between 5 and 10	39	34.8	60	50.4	16	22.9	4	66.7
Between 11 and 15	36	32.1	35	29.4	18	25.7	0	0
Between 16 and 20	12	10.7	9	7.6	9	12.9	1	16.7
More than 20	4	3.6	6	5	14	20	0	0
Continent								
Europe	93	83	109	91.6	57	81.4	6	100
Africa	10	8.9	1	0.8	3	4.3	0	0
North America	4	3.6	3	2.5	4	5.7	0	0
South America	3	2.7	0	0	4	5.7	0	0
Asia	0	0	0	0	0	0	0	0
Oceania	2	1.8	6	5	2	2.9	0	0
Level								
First division club	51	45.5	57	47.9	18	25.7	2	33.3
Second division club	14	12.5	1	0.8	8	11.4	0	0
Third division club	3	2.7	1	0.8	0	0	0	0
Territorial division club	28	25	21	17.6	26	37.1	2	33.3
National senior team	4	3.6	17	14.3	1	1.4	0	0
National team of different categories except senior	0	0	3	2.5	2	2.9	1	16.7
Team of different categories except senior	12	10.7	19	16	15	21.4	1	16.7

Table 2 Pittsburgh Sleep Quality Index (PSQI) values (mean ± standard deviation) according to the different items between water polo players ($n = 231$) and coaches ($n = 76$)

Role									
	Players			Coaches			*p*	Cohen's d	ES magnitude
Subjective sleep quality	1.20	±	0.60	1.14	±	0.69	0.447	0.1	Trivial
Sleep latency	1.21	±	0.87	0.87	±	0.82	*0.003*	0.41	Small
Sleep duration	0.70	±	0.70	1.01	±	0.96	*0.009*	−0.38	Small
Habitual sleep efficiency	0.24	±	0.60	0.42	±	0.82	0.083	−0.25	Small
Sleep disturbances	1.15	±	0.49	1.17	±	0.50	0.765	−0.04	Trivial
Use of sleep medication	0.36	±	0.76	0.21	±	0.62	0.079	0.22	Small
Daytime dysfunction	1.37	±	0.83	0.97	±	0.73	*0.000*	0.51	Medium

ES Effect size

differences between players and coaches could be explained by their respective professional and recreational activities performed during daily routines and schedules. As indicated by Perazzetti, Dopsaj, Nedeljković, Mazić, and Tessitore (2023a) through an international survey that involved 40 WP head coaches, most of the WP players belonging to the first and second division of several European countries do not play WP as professional players, since they cannot live only on the club's salary. This fact clearly suggests that most of WP players are employed in other activities like academic studies or jobs that could influence their daily routine and obligations, as well as their sleep habits (Perazzetti et al., 2023a). On the contrary, in the same survey, 62.5% of head coaches stated that WP coaching was their main professional activity (Perazzetti et al., 2023a), assuming therefore the possibility of the coach to sleep more regularly than a WP player. The latter adhere to strict, meticulously organized training and matches schedules that are intended to maximize performance during the season's most significant contests. In WP, to do that, due to the problems of swimming facilities (Reverter-Masía, Jove-Deltell, Legaz-Arrese, & Munguía-Izquierdo, 2012), players often conduct demanding training that may extend into the late evening. Considering that in team sport players' sleep latency is influenced by their bedtime and regular sleep onset time (Halson et al., 2022) and exercising close to bedtime can elevate nocturnal body temperature and cardiac activities (Yamanaka et al., 2015), the WP players' routine makes it harder for them to wind down and fall asleep at the desired time than a coach (Costa et al., 2018). Furthermore, another explanation of our results could be that irregular training and competition schedules push WP players to overtrain or employ their bodies too hard without adequate rest, exposing them to overtraining problems (Varamenti et al., 2013). As indicated in other sport activities, this condition and higher volume of previous trainings is linked to less restful sleep, having a negative impact on athlete's sleep habits, especially for the sleep latency (Camp-

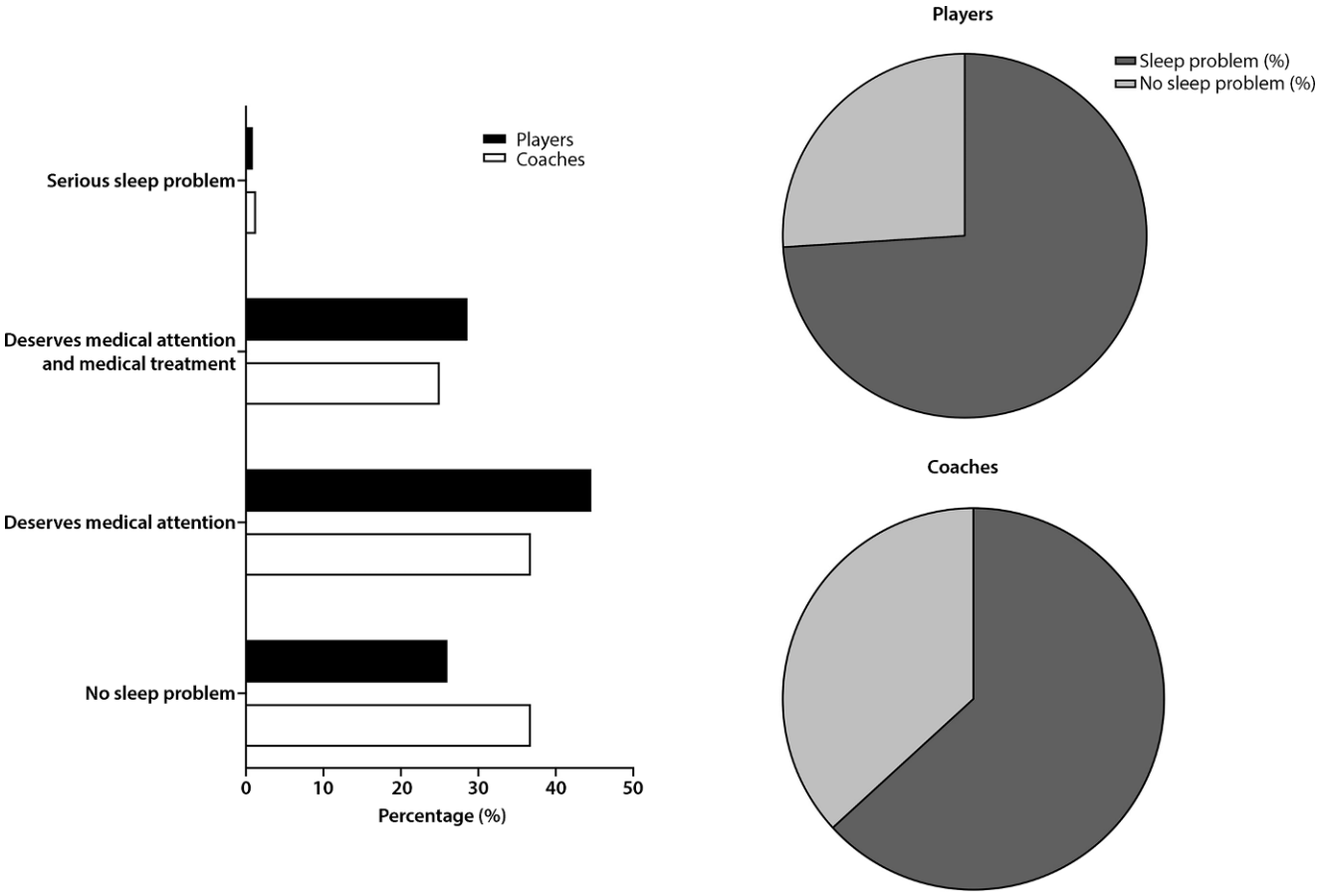

Fig. 1 ▲ Pittsburgh Sleep Quality Index (PSQI) percentages values (%) of players and coaches (less than 5, no sleep problem; between 5 and 7, deserves medical attention; between 8 and 14, deserves medical attention and medical treatment; and more than 14, serious sleep problem)

bell, Poudevigne, McFarlane, Dilworth, & Irving, 2021). This fact confirms the importance of monitoring recovery and sleep quality in WP players (Barrenetxea-Garcia et al., 2023; Barrenetxea-Garcia et al., 2024; Perazzetti, Dopsaj, Sansone, Mandorino, & Tessitore, 2023b). Educational sessions on sleep (quantity, quality, schedules and monitoring) have been highlighted as a valid tool to improve sleep in athletes (Walsh et al., 2021). Moreover, Penttilä et al. (2022) demonstrated that early intervention through sleep counseling may play an important role in prevention of sleep problems in athletes. Therefore, its integration into athletes' comprehensive training is advised (Penttilä et al., 2022; Walsh et al., 2021).

Regarding sleep duration, our study suggested that WP players sleep more than WP coaches. Although this aspect might appear as a contradiction with respect to our previous discussion on sleep latency, this finding is partially in line with previous studies that indicated adults may handle sleep deficits better than young (Wrzus, Wagner, & Riediger, 2014) because they have stronger emotion regulation and a lower sleep need (Hirshkowitz et al., 2015). Furthermore, as already revealed the sleep duration is influenced by the sleep offset (Halson et al., 2022) which has been demonstrated to be more altered in older adults than in young adults (Buysse, Monk, Carrier, & Begley, 2005). For coaches, this detail could be also explained by the fact that during competitions periods they must prepare match strategies or specific training sessions in a short period time for several consecutive weeks, increasing stress and reducing their sleep duration (Lastella et al., 2017).

In relation to daytime dysfunction, players indicated higher score with respect to coaches, supposing difficulties in staying awake, alert, and focused during the daytime hours. This result is consistent with earlier research in other team sports where the late bedtimes in professional players might indicate an evening chronotype, which is linked to sleep debt, or a delayed sleep phase syndrome (Khalladi et al., 2019). An additional potential explanation could be that WP players are often exposed to the risk of concussions that may be a critical factor to have a 'frequent headaches', 'difficulty sleeping', and 'irritability' during the day (Blumenfeld et al., 2016). At the same time improper nutrition can impact sleep and daytime dysfunction (Halson, 2014) and due the fact that team sport players commonly show questionable eating habits and low nutritional knowledge (Sánchez-Díaz, Yanci, Castillo, Scanlan, & Raya-González, 2020), this aspect could influence the level of well-being status and

Table 3 Pittsburgh Sleep Quality Index (PSQI) values (mean ± standard deviation) according to the different items between men and women water polo players and coaches

	Players									Coaches								
	Men			Women			*p*	Cohen's d	ES magnitude	Men			Women			*p*	Cohen's d	ES magnitude
Subjective sleep quality	1.18	±	0.62	1.24	±	0.59	0.477	−0.09	Trivial	1.11	±	0.67	1.30	±	0.84	0.189	−0.51	Medium
Sleep latency	1.10	±	0.82	1.32	±	0.90	*0.050*	−0.26	Small	0.86	±	0.84	1.00	±	0.63	0.686	−0.19	Trivial
Sleep duration	0.71	±	0.69	0.68	±	0.71	0.716	0.05	Trivial	1.04	±	0.94	0.67	±	1.21	0.360	0.35	Small
Habitual sleep efficiency	0.21	±	0.57	0.28	±	0.62	0.362	−0.12	Trivial	0.37	±	0.76	1.00	±	1.26	0.072	−0.6	Medium
Sleep disturbances	1.11	±	0.53	1.19	±	0.46	0.184	−0.18	Trivial	1.16	±	0.50	1.33	±	0.52	0.411	−0.35	Small
Use of sleep medication	0.32	±	0.70	0.40	±	0.81	0.412	−0.11	Trivial	0.21	±	0.63	0.17	±	0.41	0.858	0.09	Trivial
Daytime dysfunction	1.24	±	0.80	1.50	±	0.84	*0.019*	−0.31	Small	0.93	±	0.73	1.50	±	0.55	0.065	−0.89	Large

ES Effect size

Table 4 Pittsburgh Sleep Quality Index (PSQI) values (mean ± standard deviation) according to the different items between elite (First Division team) and amateur (Territorial Division team) water polo players

	Men									Women								
	Elite			Amateur			*p*	Cohen's d	ES magnitude	Elite			Amateur			*p*	Cohen's d	ES magnitude
Subjective sleep quality	1.15	±	0.58	1.19	±	0.73	0.740	−0.06	Trivial	1.27	±	0.58	1.17	±	0.58	0.497	0.18	Trivial
Sleep latency	1.01	±	0.78	0.94	±	0.88	0.640	0.08	Small	1.36	±	0.89	1.39	±	0.84	0.870	−0.04	Trivial
Sleep duration	0.62	±	0.69	1.07	±	0.89	*0.002*	−0.57	Medium	0.73	±	0.78	0.78	±	0.74	0.777	−0.07	Trivial
Habitual sleep efficiency	0.16	±	0.44	0.39	±	0.90	0.090	−0.32	Small	0.36	±	0.71	0.35	±	0.71	0.963	0.01	Trivial
Sleep disturbances	1.10	±	0.55	1.22	±	0.50	0.210	−0.23	Small	1.24	±	0.43	1.13	±	0.34	0.246	0.27	Small
Use of sleep medication	0.32	±	0.63	0.15	±	0.53	0.105	0.29	Small	0.42	±	0.88	0.26	±	0.54	0.408	0.22	Small
Daytime dysfunction	1.01	±	0.81	1.26	±	0.78	0.095	−0.31	Small	1.46	±	0.82	1.57	±	0.66	0.575	−0.14	Trivial

ES Effect size

vigilance of players during the day. However, there are very few randomized controlled trials on nutrition and sleep in athletes (Walsh et al., 2021). Future studies should analyze the impact of ergonutrion on WP performance and recovery.

The third main finding of this study was that female and male WP players showed significant differences in terms of sleep latency and daytime dysfunction. Different studies indicate that women tend to have slightly different circadian rhythms than men (Walton, Bumgarner, & Nelson, 2022), which could influence when they feel sleepy. Our results confirm previous findings by Silva et al. (2008) who using a polysomnographic analysis in an adult population indicated that women had significantly longer sleep latency than men. However, Kocevska et al. (2021) observed that women reported sleeping less time or slightly less efficiently than men subjectively, whereas with actigraphy they were estimated to sleep longer and more efficiently than men. In relation to daytime dysfunction, our results are in line with previous literature in young adults, as it has been shown that men associated higher exercise frequency with less daytime dysfunction than women, who instead associated higher exercise frequency with more anxiety and depressive mood (Glavin, Matthew, & Spaeth, 2022). This last point could speculate that also in WP female players might more frequently have this mood state during the busy period of the season, influencing their diurnal dysfunction more than male WP players. Therefore, it would be interesting to monitor the sleep of male and female WP players simultaneously employing different tools (objective and/or subjective) to contrast the results and during a greater temporalization in regular intervals due to the variability of male and female players themselves (Halson et al., 2021).

The last main finding of this study was that elite and amateur male WP players showed significant differences in sleep duration. Despite the fact that many elite and subelite WP players cannot solely rely on club salaries (Perazzetti et al., 2023a), our study revealed that they sleep more hours than amateur players. This finding underscores the disparity in professionalization between the two groups. Regarding the PSQI total scores, we found no differences between the two groups, in line with the findings of other authors (Jemal et al., 2022; Wilson & Baker, 2021). For instance, Wilson & Baker (2021) ob-

served that more experienced endurance athletes (international and national elite) implemented significant strategies to increase their sleep duration compared to amateur athletes (earlier sleep schedules, longer naps); however, poor sleep quality made it difficult to accumulate effective rest hours.

This study is not without limitations. On the one hand, the PSQI questionnaire was conducted without taking into consideration the organization of training (training loads, schedules, competitions, travels, etc.). In addition, the PSQI should be administered at different times of the season at regular intervals (2 months or more) due to variability within athletes (Walton et al., 2022). On the other hand, the recording of responses from some of the groups was limited. In future research, it would be interesting to monitor the quality and quantity of sleep and analyze its relationship with training load, recovery, and performance at different times of the season; to monitor circadian rhythms; to conduct randomized trials on sleep and performance; and to analyze the impact of naps on performance (Walsh et al., 2021; Walton et al., 2022). Indeed, it has been observed in elite WP players that long midday naps may interfere with nighttime sleep (Koutouvakis et al., 2024), although more research is needed. Likewise, researchers should collaborate and employ more consistent research methods and standardized methodological approaches to improve the quality of selected evidence (Cook & Charest, 2023; Walsh et al., 2021); technical staff should maintain close and collaborative communication between the different agents involved (Barrenetxea-García et al., 2024; Pernigoni et al., 2022); and athletes should be encouraged to follow sleep hygiene strategies that can facilitate adequate nighttime sleep and recovery the following day (Koutouvakis et al., 2024). In summary, more research is needed on this topic to develop practical protocols and recommendations. Nevertheless, this study contributes significantly to the growing scientific literature in WP, providing interesting information on the perceived sleep habits of players and coaches worldwide.

Conclusions

The present study shows that the majority of water polo (WP) players and coaches have a poor quality and quantity of sleep, which is in line with what has been shown in other sports. Also, players had higher sleep latency, daytime dysfunction, and shorter sleep duration than coaches; female players had higher sleep latency and daytime dysfunction than male players; and amateur male players had shorter sleep duration than elite player. We suggest that coaches and technical staff of WP teams should seek strategies to improve their sleep hygiene, as well as monitor recovery and rest within the weekly planning.

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Declarations

Conflict of interest. J. Barrenetxea-Garcia, A. Perazzetti, S. Nuell, E. Sáez de Villarreal, J. Mielgo-Ayuso and J. Calleja-González declare that they have no competing interests.

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