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Sleep Quality and Training Intensity in Soccer Players: Exploring Weekly Variations and Relationships

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Abstract: The aim of this study was twofold: it (i) analyzed the weekly variations of sleep quality and training intensity of youth soccer players and (ii) analyzed the relationships between sleep quality and training intensity. This study followed an observational design. Twenty men youth players (age: 18.81 ± 0.41 years) were monitored daily over two weeks for sleep quality and training intensity. Sleep quality was measured daily using the 15-item consensus sleep diary. The training intensity was measured daily using the CR-10 Borg's scale as a measure of rate of perceived exertion (RPE); a heart rate (HR) sensor was used to measure minimum, average and peak; a global positioning system (GPS) was used for measuring the total distance covered and distances covered at different speed thresholds. Repeated measures ANOVA was used to analyze the weekly variations of sleep quality and training intensity. The Pearson correlation test was executed to analyze the relationships between sleep quality and training intensity. Repeated measures ANOVA revealed significant within-week variations in sleep duration (hours) ($p = 0.043$), quality of sleep ($p = 0.035$), RPE ($p = 0.007$), session-RPE ($p = 0.011$), HRminimum ($p = 0.027$), HRpeak ($p = 0.005$), total distance ($p < 0.001$), pace ($p < 0.002$), distance covered at 3.00–6.99 km/h ($p < 0.001$), distance covered at 7.00–10.99 km/h ($p < 0.001$), distance covered at 11.00–14.99 km/h ($p < 0.001$), distance covered at 15.00–18.99 km/h ($p < 0.001$) and distance covered at >19.00 km/h ($p < 0.001$). Significant small correlations were found between sleep duration before training and session-RPE (r = 0.252), total distance (r = 0.205), distance covered at 3.00–6.99 km/h (r = 0.209) and distance covered at 7.00–10.99 km/h (r = 0.265). Significant small correlations were found between session-RPE and sleep duration after (r = 0.233), total distance and quality of sleep after (r = 0.198), distance at 3.00–6.99 km/h and quality of sleep after training (r = 0.220), distance covered at >19.00 km/h and quality of sleep after training (r = 0.286), session duration and rested feeling after training (r = 0.227), total distance and rested feeling after training (r = 0.202), distance covered at 11.00–14.99 km/h and rested feeling after training (r = 0.222) and distance covered at >19.00 km/h and rested feeling after training (r = 0.214). In conclusion, sleep duration was longer in the training sessions during the middle of the week; the training intensity was also greater (485.8 ± 56.8 A.U.). Moreover, sleep outcomes after training were slightly correlated with both physiological and locomotor demands.

Keywords: sleep; exercise; youth sports; football

1. Introduction

The importance of sleep as a recovery strategy is well-known and recognized by coaches and athletes [1]. Considering previous findings, sleep duration and sleep quality play a determinant role in the optimization of sports performance [2], recovery process [3], and maintenance of the quality of life and health in athletes [4]. Thus, ensuring proper patterns of sleep can positively impact performance, while sleep disturbance can ultimately be harmful not only for performance but also for the health of players [5]. As an example, a prospective cohort study conducted in 23 soccer players revealed that 44% of the total variance in the number of injuries can be explained by sleep efficiency, while 47% of injury severity was explained by sleep efficiency [6]. In the particular case of soccer players, different situations and conditions may influence the quality and duration of sleep (e.g., timing of competition, travel, sleep routines, changes in training environment) [7–9]. As an example, players often report the worst sleep quality on competition days due to a number of reasons, e.g., arousal and subjective alertness [10]. Moreover, heavy training demands can also disturb sleep quality, especially in young players [11]. Additionally, players are often exposed to travel that may negatively impact sleep routines [12]. Naturally, other factors related to sleep hygiene, such as exposure to light [13], or the ingestion of caffeine [14], or alcohol [15], can also play an important role in how and how much players sleep.

Besides the above-mentioned conditions that may influence sleep quality, training intensity and exercise itself can function as potential modulators of sleep efficiency. For example, late-night training can disrupt sleep, according to reports on female soccer players [16]. In addition, there is some evidence that the exposure of players to long periods of training intensities and volume results in a disturbance in sleep duration in athletes [17]. However, such evidence is not consistent with other studies [18]. Interestingly, a study conducted over 14 days in youth soccer players revealed that greater distances covered at high-speed running correlated with small increases in total sleep time [19]. In the same way, a study conducted in rugby players revealed that an intensification of training regarding accelerations/decelerations correlated with better sleep efficiency [20]. Thus, there is still a need for more research that considers identifying differences between volume and intensity and the respective impact on sleep efficiency. Possibly, a dose-dependent relationship can be considered, although further research is required.

Some attempts that aimed to analyze the effect of schedule on sleep efficiency, while crossing with daily training intensity experienced, have also been reported. As an example, a study conducted with youth soccer players revealed that, on the day after the match, players suffered a significant loss in sleep duration [19]. These differences between days of the week can be naturally influenced by the context of training sessions and competition, and possible within-week variations can occur. Although there are reports about daily variations of sleep efficiency [19], other studies have not confirmed these variations regarding the training intensity to which youth soccer players are exposed daily [21,22].

This relationship between training intensity and sleep efficiency cannot be faced only in one direction (i.e., sleeping being affected by training). In fact, some research has been conducted about the impact of sleep on training intensity [5,23]. As an example, a study conducted on small-sided soccer games revealed that sleep quality largely impacted training intensity reported by players [23]. Moreover, in sports, it has been reported that sleep deprivation may increase the perception of effort, with adverse impacts for sub-maximal performance [24,25].

Despite the above-mentioned studies, there is still a need for more research to help understand the direction of relationships between sleep quality and duration and training intensity to which players are exposed. In particular, understanding how the training intensity of one day may impact sleep after training or, on the other hand, how sleep may impact the training intensity of the following day is critical to helping the academic community enrich the evidence regarding this topic. Taking this into consideration, the aim of this study was two-fold: it (i) analyzed the within-week variations of sleep and training intensity in youth soccer players and (ii) analyzed the relationships between sleep and training intensity of the following day and the training intensity and the following sleep.

2. Materials and Methods

2.1. Experimental Approach to the Problem

We followed an observational study design. The players were monitored for their daily sleep quality and duration and training intensity over a period of 2 weeks (Table 1).

Table 1. Timeline of the study.

	10 January 2022	11 January 2022	12 January 2022	13 January 2022	14 January 2022	15 January 2022	16 January 2022	17 January 2022	18 January 2022	19 January 2022	20 January 2022	21 January 2022	22 January 2022	23 January 2022
	Monday (MD-6)	Tuesday (MD-5)	Wednesday (MD-4)	Thursday (MD-3)	Friday (MD-2)	Saturday (MD-1)	Sunday (MD)	Monday (MD-6)	Tuesday (MD-5)	Wednesday (MD-4)	Thursday (MD-3)	Friday (MD-2)	Saturday (MD-1)	Sunday (MD)
Sleep register	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Training session	No	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No	No
Match	No	No	No	No	No	No	Yes	No	No	No	No	No	No	Yes

MD: match day; MD-6: six days before match day); MD-5: five days before match day; MD-4: four days before match day; MD-3: three days before match day; MD-2: two days before match day; MD-1: one day before match day.

This period started 20 weeks after the beginning of the season (corresponding to the middle of the season). Four training sessions occurred each week and one official match occurred over the weekend. The training sessions started at 06:00 p.m. The match days (MD) occurred at 07:00 p.m. on Sundays. The training sessions occurred on Tuesdays (MD-5), Wednesdays (MD-4), Thursdays (MD-3), and Fridays (MD-2). No training sessions occurred on Mondays (MD-6) and Saturdays (MD-1). Over the period of data collection, the average temperature during training sessions and matches was $16 \pm 7°$ and the relative humidity was 57%. On each day, the consensus sleep diary [26] was answered by players. In addition to sleep measurements extracted from the diary, all field-based training and match intensities were quantified using the CR-10 Borg's scale [27], an heart rate monitor and a Polar Team Pro GPS unit. A repeated measures test was conducted to analyze the weekly variation of sleep quality and training intensity measures. A correlational analysis was conducted to analyze the relationships between sleep quality and training intensity. The sleep quality was correlated with the training demands of the same day (sleep*training after sleep) and the opposite (training*sleep after training). An overview of typical schedule activities is presented in Table 2.

Table 2. Overview of the schedule activities (e.g., training, competition, recovery) during the observed training period.

Week		MD-6	MD-5	MD-4	MD-3	MD-2	MD-1	MD
1	Data collected (N)	N/A	20	20	20	20	N/A	11
	Start and end time of training/match	N/A	10:00 a.m.	10:00 a.m.	10:00 a.m.	10:00 a.m.	N/A	11:00 a.m.
	Schedule activity	N/A	Training	Training	Training	Training	N/A	Match
	Description	Day Off	15 + 10 min warm-up + total warm-up drill 15 min quick + agility track work 10 min 30 m/30 m goaltender 6vs6 game (control pass) 15 min stop ball work 10 min cooling and flexibility	15 min collect warm-up drill 20 min oppression—levels—balance (technical + tactical) 10 min downs and raising run 5 min cool	15 + 10 min warm-up + total warm-up drill 35 min aerobic endurance track (total) 20 min crosses + penalties 15 min cool + flexibility	15 min total heat drill 20 min oppression—levels—balance (technical + tactical) 10 min starts and raising run 5 min cool	Day Off	Match day warm-up (Mobility, Acceleration skills, possession games) + 90 min of match play
2	Data collected (N)	N/A	20	20	20	20	N/A	11
	Start and end time of training/match	N/A	10:00 a.m.	10:00 a.m.	10:00 a.m.	10:00 a.m.	N/A	11:00 a.m.
	Schedule activity	N/A	Training	Training	Training	Training	N/A	Match
	Description	Day Off	Total warm-up Collect 25 min aerobic track 10 min cool + flexibility	15 + 10 min warm-up + total warm-up drill 30 min wing variations 1. Variation 2. Variation 3. Variation Overlay + exit + slip + reverse run 20 min small sided games (30 m 30 m) 10 min cool + flexibility	5 + 10 min warm-up + total warm-up drills 25 min tactical Gaming back Defense works Pressure + stage + balance 20 m Small sided games (20 m 20 m) (1vs1/2vs2/3vs3/4vs4/5vs5) 10 min cool + flexibility	5 min pressure—stage—balance 10 min ahead oppression 20 min back game installation 10 min fixed ball 5 min cool + flexibility	Day Off	Match day warm-up (Mobility, Accelerations skills, possession games) + 90 min of match play

MD: match day; MD-6: six days before match day); MD-5: five days before match day; MD-4: four days before match day; MD-3: three days before match day; MD-2: two days before match day; MD-1: one day before match day; N/A: not applicable.

2.2. Participants

Twenty youth male soccer players (age: 18.81 ± 0.41 years old; 63 ± 2.4 body mass) voluntarily participated in the current study. Players were from the same team, selected by convenience sampling. The team participated in the elite academy league. Players were enrolled in 5 training sessions a week plus an additional match. The eligibility criteria for including participants were: (i) being present in the entire training sessions observed over the two weeks (100% participation); (ii) not reporting any case of alcohol, caffeine, and drugs consumption over the period of observation; (iii) not missing reports to sleep diary and training intensity measures over the period of data collection. The control of alcohol, caffeine and drugs were made subjectively, by asking players individually. Of the 20 players, 8 were defenders, 7 were midfielders and 5 were attackers. Prior to any measures, participants and legal tutors/parents were informed about study design and protocol and, based on that, freely signed an informed consent. The study followed the ethical guidelines for study in humans as suggested in Declaration of Helsinki.

2.3. Measuring Sleep Duration and Quality

The consensus sleep diary [26] was used as the instrument to measure sleep duration and quality. This sleep diary was originally developed by an expert panel of 25 attendees of the Pittsburgh Assessment Conference, following a revision provided by a subset of experts and focus groups. A study of validation demonstrated good psychometric properties of the consensus sleep diary [28].

The participants of the current study were familiarized with the consensus sleep diary [26] in the week prior to the start of the data collection. The familiarization was made with all players in a single room, providing examples of how to fill out surveys using the Google form, which was specially designed to the measure the effect being investigated.

During the 2-week observation period, each participant was asked to fill out the consensus sleep diary [26] during the first two hours after waking up. The answers were provided online, using Google forms specially designed based on the questions that are present in the consensus sleep diary [26]. The athletes answered to the full version of the consensus sleep diary, aiming to ensure respect for the entire logic of the instrument. However, taking into account the main aims of the study (i.e., to test the relationships between time and quality of sleep and training intensity), and considering that the sleep diary covered items related to peripherical disturbances of sleep (which is not related to our aim of research), we only used four items for further data treatment. These items were selected based on the proximity to the main topics of the study. The selection of these four items was discussed between the research team and was also shared with two experts in the research of sleep quality and sports who confirmed the inclusion of those items as adequate.

From the 15-items questionnaire, we used questions 4 (“how long did it take you to fall asleep?”), 8 (“in total, how long did you sleep”), 9 (“how would you rate the quality of your sleep?”) and 10 (“how rested or refreshed did you feel when you woke-up for the day?”) for further data treatment. In the case of questions 9 and 10, respectively, we converted the answers to an ordinal scale (1-very poor; 2-fair; 3-good; and 4-very good) (1-not at all rested; 2-slightly rested; 3-somewhat rested; 4-well-rested; 5-very well-rested). Thus, with ultimate measures extracted, we collected the items: sleep duration (min); time to fall asleep (min); quality of sleep (A.U.); and rested feeling (A.U.).

2.4. Measuring Training Intensity

Heart rate and locomotor demands were objectively measured using heart rate monitors and global positioning systems (GPS), both integrated in the same device (Polar Team Pro GPS). The same unit (aiming to reduce inter-unit bias) was placed in the chest of players 30 min prior to each training session or match and was removed immediately after the training session. The starting and ending session duration or match was remotely controlled using the Polar Team Pro software.

2.4.1. External Intensity

The Polar Team Pro GPS (Polar Electro, Kempele, Finland) sampling at 10 Hz was used to monitor locomotor demands of players during training sessions and matches. This device was confirmed in a previous study to be accurate and reliable regarding measures such as total distance, low speed running, high speed running and very high speed running [29]. In each session, the following measures were collected: (i) total distance (overall distance covered in meters); (ii) pace (average distance covered per minute); (iii) maximal speed (peak speed registered in the session); (iv) distance covered at zone 1 (Z1; 3.00–6.99 km/h); (v) distance covered at zone 2 (Z2; 7.00–10.99 km/h); (vi) distance covered at zone 3 (Z3; 11.00–14.99 km/h); (vii) distance covered at zone 4 (Z4; 15.00–18.99 km/h); and (viii) distance covered at zone 5 (Z5; >19.00 km/h). The distance (meters) measured per each speed threshold were obtained in each training session and match for further data treatment.

2.4.2. Internal Intensity

The heart rate monitor included in the Polar Team Pro was used to monitor the heart rate of players. The heart rate monitor worked in a 1 Hz sampling, collecting data beat-by-beat. Maximum heart rates of all athletes were determined during the 30–15 Intermittent Fitness Test in the previous weeks. Maximum heart rates established in previous weeks were used for this study.

The CR-10 Borg's scale [27] was also used to monitor the rate of perceived exertion (RPE) of the players. Between 20 and 30 min at the end of training sessions and matches, players scored the scale individually using specially designed Google forms. Prior to the starting of the 2-week period of observation, players were familiarized with the scale. The scale varied from 0 to 10, in which the verbal anchors were associated to the question "how intense was the training session?": 0—nothing to all; 0.5—extremely weak; 1—very weak; 2—weak; 3—moderate; 4—somewhat strong; 5—strong; 7—very strong; and 10—extremely strong. Players were allowed to answer in the full number or decimal (0.5). The score was used as a measure of intensity: RPE (measured in arbitrary units; A.U.). Additionally, the duration of the entire training session and/or match (min) was multiplied by the RPE to obtain the session-RPE (also measured in A.U.).

2.5. Statistical Procedures

Descriptive statistics are presented in the form of mean and standard deviation. Normality and homogeneity of the different outcomes were tested using the Shapiro–wilk test and Levene's test, respectively. The different outcomes presented a normal ($p > 0.05$) and homogeneous ($p > 0.05$) distribution. The intra-week variations of sleep outcomes and training demands were explored using the repeated measures ANOVA. The Bonferroni test was used for pairwise comparisons. Partial eta squared was calculated to determine the effect size of repeated-measures ANOVA. The relationships between sleep outcomes and training demands were explored using the Pearson-product moment correlation test. The magnitude of correlations (provided by the Pearson r coefficient) was classified [30] as trivial (0.00 to 0.09), small (0.10 to 0.29), moderate (0.30 to 0.49), large (0.50 to 0.69), very large (0.70 to 0.89), and nearly perfect (>0.90). All the statistical procedures were executed in the SPSS software (version 28.0, IBM, Chicago, Ill., USA) for a $p < 0.05$.

3. Results

Descriptive statistics of intra-week variations of sleep and training demand outcomes can be found in Table 3. Repeated measures ANOVA revealed significant within-week variations in sleep duration ($p = 0.043$; $\eta_p^2 = 0.148$), quality of sleep ($p = 0.035$; $\eta_p^2 = 0.139$), RPE ($p = 0.007$; $\eta_p^2 = 0.306$), session-RPE ($p = 0.011$; $\eta_p^2 = 0.309$), HRmin ($p = 0.027$; $\eta_p^2 = 0.187$), HRpeak ($p = 0.005$; $\eta_p^2 = 0.369$), total distance ($p < 0.001$; $\eta_p^2 = 0.542$), pace ($p < 0.002$; $\eta_p^2 = 0.410$), distance covered at Z1 ($p < 0.001$; $\eta_p^2 = 0.511$), distance covered at Z2 ($p < 0.001$;

η_p^2 = 0.490), distance covered at Z3 (p < 0.001; η_p^2 = 0.606), distance covered at Z4 (p < 0.001; η_p^2 = 0.552) and distance covered at Z5 (p < 0.001; η_p^2 = 0.537). However, no significant intra-week differences in the time to fall asleep (p = 0.267; η_p^2 = 0.382), rested feeling (p = 0.093; η_p^2 = 0.109), session duration (p = 0.050; η_p^2 = 0.247), HR average (p = 0.088; η_p^2 = 0.189), nor peak speed (p = 0.137; η_p^2 = 0.143) were found.

Table 3. Descriptive statistics (mean ± standard deviation) of sleep and training demands over the week.

	MD	MD-1	MD-2	MD-3	MD-4	MD-5	MD-6
Time to fall asleep (min)	15.6 ± 4.9	15.6 ± 5.2	18.6 ± 7.8	15.6 ± 3.6	15.1 ± 5.3	15.4 ± 5.0	17.3 ± 7.2
Sleep duration (hours)	8.3 ± 0.9	8.3 ± 1.0	8.8 ± 1.2 [d,e]	8.3 ± 0.8	8.2 ± 1.0 [b]	7.8 ± 0.8 [b]	8.5 ± 1.3
Quality of sleep (A.U.)	3.1 ± 0.5	3.4 ± 0.6	3.1 ± 0.5	3.2 ± 0.4	3.2 ± 0.4	3.0 ± 0.5	3.4 ± 0.6
Rested feeling (A.U.)	3.8 ± 0.4	4.0 ± 0.7	3.8 ± 0.4	3.7 ± 0.4	3.6 ± 0.4	3.6 ± 0.6	4.0 ± 0.7
RPE (A.U.)	5.4 ± 1.6 [b]	Day off	6.7 ± 0.6 [a]	6.8 ± 0.8	6.8 ± 0.8 [e]	6.2 ± 0.6 [d]	Day off
Session duration (min)	72.0 ± 22.8	Day off	69.5 ± 0.0	72.0 ± 0.0	66.0 ± 0.0	58.5 ± 0.0	Day off
Session-RPE (A.U.)	483.0 ± 146.8	Day off	457.0 ± 42.7 [e]	485.8 ± 56.8 [e]	455.5 ± 52.2 [e]	361.8 ± 36.7 [b,c,d]	Day off
minimumHR (bpm)	68.1 ± 31.1 [d]	Day off	77.9 ± 25.4	73.5 ± 19.0 [d]	95.1 ± 16.3 [a,c]	83.6 ± 18.1	Day off
HRaverage (bpm)	126.3 ± 45.8	Day off	152.1 ± 7.5	153.2 ± 9.0	144.9 ± 5.2	140.0 ± 17.7	Day off
HRpeak (bpm)	152.9 ± 54.2 [c]	Day off	203.6 ± 18.4	205.3 ± 10.3 [a]	194.8 ± 7.9	189.1 ± 21.7	Day off
Total distance (m)	7179.0 ± 2442.1 [d,e]	Day off	4907.1 ± 1012.7 [d]	5769.3 ± 754.0 [d,e]	3543.7 ± 764.0 [a,b,c]	3861.3 ± 1049.2 [a,c]	Day off
Pace (m/min)	52.4 ± 10.5 [c]	Day off	68.7 ± 12.9	78.4 ± 12.3 [a,d]	51.1 ± 14.9 [c]	68.2 ± 20.6	Day off
Peak speed (km/h)	22.2 ± 7.4	Day off	25.3 ± 2.3	25.7 ± 2.2	25.0 ± 1.6	22.4 ± 4.0	Day off
Distance at Z1 (m)	2385.9 ± 892.4 [d,e]	Day off	1894.5 ± 327.2 [d,e]	2165.9 ± 306.4 [d,e]	1189.0 ± 177.5 [a,b,c]	1471.8 ± 336.7 [a,b,c]	Day off
Distance at Z2 (m)	1623.8 ± 522.9 [d]	Day off	1173.6 ± 191.0 [c,d]	1634.3 ± 401.6 [b,d,e]	823.3 ± 116.5 [a,b,c]	1049.6 ± 392.7 [c]	Day off
Distance at Z3 (m)	1614.2 ± 546.3 [b,c,d,e]	Day off	868.1 ± 311.9 [a]	794.6 ± 158.3 [a]	687.4 ± 225.2 [a]	599.4 ± 296.4 [a]	Day off
Distance at Z4 (m)	822.9 ± 302.3 [b,c,d,e]	Day off	414.0 ± 217.2 [a]	456.1 ± 96.3 [a,e]	520.1 ± 100.2 [a,e]	252.3 ± 146.4 [a,c,d]	Day off
Distance at Z5 (m)	470.6 ± 201.0 [b,d,e]	Day off	182.8 ± 164.6 [a]	288.9 ± 103.5 [d,e]	156.7 ± 47.4 [a,c]	101.0 ± 76.0 [a,c]	Day off

MD: match day; MD-6: six days before match day); MD-5: five days before match day; MD-4: four days before match day; MD-3: three days before match day; MD-2: two days before match day; MD-1: one day before match day; RPE: rate of perceived exertion using the CR-10 Borg's scale; Session-RPE: multiplication of session duration by the score of RPE; HR: heart rate; bpm: beats per minute; A.U.: arbitrary units; m: meters; min: minutes; km/h: kilometers per hour; Z1: distance covered at 3.00–6.99 km/h; Z2: distance covered at 7.00–10.99 km/h; Z3: distance covered at 11.00–14.99 km/h; Z4: distance covered at 15.00–18.99 km/h; Z5: distance covered at >19.00 km/h; significant differences at MD [a]; MD-2 [b]; MD-3 [c]; MD-4 [d]; MD-5 [e]; at p < 0.05.

Pairwise comparisons revealed that, on MD-2, the sleep duration was significantly longer than on MD-4 (+0.5 h; p = 0.013) and MD-5 (+1 h; p < 0.01). MD-2 was significantly more intense regarding RPE than MD (+1.3 A.U.; p = 0.035), while MD-4 was more intense in RPE than MD-5 (+0.6 A.U.; p = 0.031). The MD-5 had significantly lower session-RPE than MD-2 (−95.2 A.U.; p < 0.001), MD-3 (−124.0 A.U.; p < 0.001) and MD-4 (−93.7 A.U.; p < 0.001). The MD-4 had significantly greater minimum HR than MD (+27 bpm; p = 0.049) and MD-3 (+21.6 bpm; p = 0.030). The HRpeak was significantly higher in MD-3 than in MD (+52.4 bpm; p = 0.049).

Significantly less total distance was covered on MD-4 in comparison to MD (−3635.3 m; p = 0.001), MD-2 (−1363.3 m; p = 0.043), and MD-3 (−2225.3 m; p < 0.001). Moreover, significantly less total distance was covered on MD-5 in comparison to MD (−3317.7 m; p = 0.006) and MD-3 (−1908.0 m; p < 0.001). The pace (meters covered per minute) was significantly higher in MD-3 than in MD (+26 m/min; p = 0.025) and MD-4 (+27.3 m/min; p < 0.001).

Distance covered at Z1 was significantly lower in MD-4 than in MD (−1196.9 m; p = 0.002), MD-2 (−705.5 m; p < 0.001) and MD-3 (−976.9 m; p < 0.001). Similarly, distance covered at Z1 was significantly lower in MD-5 than in MD (−914.1 m; p = 0.045), MD-2 (−422.7 m; p = 0.040) and MD-3 (−694.1 m; p < 0.001). The distance covered at Z2 was significantly lower in MD-4 than in MD (−800.5 m; p = 0.002), MD-2 (−350.3 m; p < 0.001) and MD-3 (−811.0 m; $p < 0.001$). Moreover, the distance covered at Z2 was significantly greater in MD-3 than in MD-2 (+460.7 m; $p = 0.014$) and MD-5 (+584.7 m; $p = 0.040$).

Distance covered at Z3 was significantly greater in MD than in MD-2 (+868.1 m; $p = 0.008$), MD-3 (+794.6 m; $p = 0.001$) and MD-4 (+687.4 m; $p < 0.001$) and MD-5 (+599.4 m; $p < 0.001$). Regarding the distance at Z4, significantly more meters were covered in MD than in MD-2 (+408.9 m; $p = 0.019$), MD-3 (+366.8 m; $p = 0.007$), MD-4 (+302.8 m; $p < 0.030$) and MD-5 (+570.6 m; $p < 0.001$). Additionally, significantly less distance covered at Z4 was found in MD-5 in comparison to MD-3 (−203.8 m; $p = 0.014$) and MD-4 (−267.8 m; $p = 0.001$). The distance covered at Z5 was significantly greater in MD than in MD-2 (+287.8 m; $p = 0.020$), MD-4 (+313.9 m; $p < 0.001$) and MD-5 (+369.6 m; $p < 0.001$). Finally, in MD-3, significantly greater distance covered at Z5 was found in comparison to MD-4 (−132.2 m; $p = 0.005$) and MD-5 (−187.9 m; $p < 0.001$).

Table 4 presents the correlation coefficients of sleep and training after sleep. This means that only MD, MD-2, MD-3, MD-4 and MD-5 were correlated, since no training occurred at MD-1 nor MD-6. Significant small positive correlations were found between sleep duration before training and session-RPE (r = 0.252, 95% confidence interval, CI (0.058;0.427); $p = 0.012$), total distance (r = 0.205, 95% CI (0.009;0.386); $p = 0.041$), distance covered at Z1 (r = 0.209, 95% CI (0.014;0.390); $p = 0.037$) and distance covered at Z2 (r = 0.265, 95% CI (0.072;0.439); $p = 0.008$).

Table 4. Correlation coefficient (r) between sleep and training demands of the day after (sleep * training after sleep).

	RPE	Session Duration	SESSION-RPE	MinimumHR	HRaverage	HRpeak	Total Distance	Pace	Peak Speed	Distance at Z1	Distance at Z2	Distance at Z3	Distance at Z4	Distance at Z5
Time to fall asleep	0.145	0.150	0.191	0.160	0.171	0.092	0.148	0.134	0.077	0.145	0.182	0.130	0.062	0.038
Sleep duration	0.194	0.152	0.252 *	−0.160	0.043	0.072	0.205 *	0.098	0.134	0.209 *	0.265 *	0.169	0.139	0.179
Quality of sleep	0.138	0.143	0.164	0.074	0.106	0.095	0.149	0.080	0.155	0.108	0.144	0.118	0.151	0.187
Rested feeling	−0.043	0.055	0.039	−0.155	−0.021	0.000	0.087	−0.042	−0.007	0.113	0.147	0.092	−0.026	0.004

RPE: rate of perceived exertion using the CR-10 Borg's scale; Session-RPE: multiplication of session duration by the score of RPE; HR: heart rate; bpm: beats per minute; Z1: distance covered at 3.00–6.99 km/h; Z2: distance covered at 7.00–10.99 km/h; Z3: distance covered at 11.00–14.99 km/h; Z4: distance covered at 15.00–18.99 km/h; Z5: distance covered at >19.00 km/h.

Table 5 presents the correlation coefficients of training demands with the sleep outcomes after matches. Significant small correlations were found between session-RPE and sleep duration after matches (r = 0.233, 95% CI (0.039;0.411); $p = 0.020$), total distance and quality of sleep after training (r = 0.198, 95% CI (0.001;0.379); $p = 0.049$), distance at Z1 and quality of sleep after training (r = 0.220, 95% CI (0.025;0.400); $p = 0.028$), distance covered at Z5 and quality of sleep after training (r = 0.286, 95% CI (0.095;0.456); $p = 0.004$), session duration and rested feeling after training (r = 0.227, 95% CI (0.032;0.405); $p = 0.023$), total distance and rested feeling after training (r = 0.202, 95% CI (0.006;0.383); $p = 0.044$), distance covered at Z3 and rested feeling after training (r = 0.222, 95% CI (0.026;0.401); $p = 0.027$) and distance covered at Z5 and rested feeling after training (r = 0.214, 95%CI (0.018;0.394); $p = 0.032$).

Table 5. Correlation coefficient (r) between training demands and sleep outcomes of the night after training (training * sleep after training).

	Time to Fall Asleep	Sleep Duration	Quality of Sleep	Rested Feeling
RPE	0.155	0.213	0.101	0.041
Session duration	0.057	0.112	0.166	0.227 *

Table 5. *Cont.*

	Time to Fall Asleep	Sleep Duration	Quality of Sleep	Rested Feeling
Session-RPE	0.132	0.233 *	0.208 *	0.176
Minimum HR	0.134	−0.059	0.018	−0.121
HR average	0.096	0.016	0.031	0.040
HR peak	0.010	0.021	0.022	0.012
Total distance	0.060	0.089	0.198 *	0.202 *
Pace	0.045	−0.007	0.022	−0.005
Peak speed	0.018	0.050	0.095	0.113
Distance at Z1	−0.022	0.056	0.220 *	0.177
Distance at Z2	0.130	0.120	0.165	0.186
Distance at Z3	0.097	0.073	0.161	0.222 *
Distance at Z4	0.104	0.064	0.160	0.154
Distance at Z5	0.011	0.082	0.286 *	0.214 *

RPE: rate of perceived exertion using the CR-10 Borg's scale; Session-RPE: multiplication of session duration by the score of RPE; HR: heart rate; bpm: beats per minute; Z1: distance covered at 3.00–6.99 km/h; Z2: distance covered at 7.00–10.99 km/h; Z3: distance covered at 11.00–14.99 km/h; Z4: distance covered at 15.00–18.99 km/h; Z5: distance covered at >19.00 km/h.

4. Discussion

The aims of the present research were: (i) to analyze the within-week variations of sleep and training intensity in youth soccer players and (ii) to analyze the relationships between sleep and training intensity a day after training and the training intensity and sleep after training.

Considering the sleep variables, the main results showed that MD-2 was the day with the highest number of hours of sleep (almost 9 h), followed by MD-6 (8.5 h), while all others were similar, at approximately 8 h. Sleep quality, sleep duration and rested feeling were constant through the weeks, independently of the intensity applied in training or derived from the MD. Since the number of sleep hours is related to the night before, the sleep hours results were in line with the higher intensity applied on the day before. This means that higher intensity sessions tended to increase the number of sleep hours. On one hand, the day before MD-6 was the MD. On the other hand, the day before MD-2 was MD-3. While MD was the day with the highest external and internal intensities, MD-3 was the training day with the highest intensity values. These findings were reinforced by the correlations found between session-RPE and sleep duration after training. It is relevant to notice that the duration of the session was constant for training and match sessions, which means that this variable did not influence the results.

However, the present findings were not in line with other studies of young soccer players that found a reduction of sleep duration on MD. Indeed, the data from that study seemed to support that, with higher intensity, lower sleep duration occurred [19]. Nonetheless, both studies only analyzed two weeks, which suggests a need for more related studies. This can be related not only to different instruments used (which may influence the results) but also to the time at which the training and the exercise is performed. In our case, the exercise occurred in the morning, which provides more than 8 h of interval regarding the bedtime [25].

In fact, the results of the present study were also not supported by another study, which found evening high-intensity training had no impact on subsequent sleep quality and quantity in young soccer players [21]. This was also shown in professional soccer players, where sleep quality was not affected by higher intensity sessions (MD included) [31].

Furthermore, and considering the two previous paragraphs, our study found correlations between total distance and quality of sleep after training, distance at 3.00–6.99 km/h and quality of sleep after training, distance covered at >19.00 km/h and quality of sleep after training, session duration and rested feeling after training, total distance and rested feeling after training, distance covered at 11.00–14.99 km/h and rested feeling after training and distance covered at >19.00 km/h and rested feeling after training. It seems that longer walking/running distances contributed to better sleep quality and rested feeling. In fact, the acute impact of exercise may provide beneficial impacts on sleep quantity when the exercise takes place 4–8 h before bedtime, which was the case in our study [25]. Few studies have been conducted to analyze such associations. In this sense, a study also found correlations between external training intensity and the following sleep night [32]. A study with a different approach also found correlations between session-RPE and sleep quality [33]. In the same line, training monotony of session-RPE was correlated with accumulated sleep quality over the season [34]. We speculated that those authors would also find associations between sleep quality and external measures if those were accessed.

Despite the present results, further analysis should include contextual variables. For instance, a match win showed to provide better sleep quality when compared with a draw or a loss [35]. In addition, away matches, especially those that required longer travel distance, showed sleep/wake behaviors impairment [12]. Thus, future studies with a similar design as the present should be made considering match result and location to amplify knowledge in the field.

Regarding internal intensity, our study showed that RPE was higher between MD-4 and MD-2, while lower values were found in MD. This was not entirely revealed in a similar study [36]. In under-17 soccer players, the middle days of the week also presented higher RPE values; however, MD displayed the highest value [36]. Indeed, the different measures of HR also presented higher values in training and were the lowest in MD, which led us to speculate that both RPE and HR expressed by beats per minute are useful for training, but they did not seem to properly address match intensity.

Meanwhile, in the present study, s-RPE showed higher values in MD, followed by MD-3, which is in line with a study conducted in under-16 soccer players [37] but in opposition to the previous study conducted in under-17 soccer players [36]. While different results from the MD data values could be attributed to the different participations in the matches from the athletes from each study, it seems to be in line with the finding that middle days of the week present higher RPE and s-RPE values [38].

Finally, when addressing walking/running distance variables, MD displayed the highest values, with the exception of distance at Z2, where MD-3 presented the highest values (similar to the MD). Overall, MD-5 displayed the lowest values. Our results are in line with a recent systematic review on training intensity values for young soccer players that also found higher training intensity values in middle days of the week [38]. Regarding MD-5 findings, we only found one study that addressed external intensity, but it did not confirm the tendency of the present results [39]. On the other hand, the study of Martins et al. that only analysed RPE and session-RPE also showed lower values on MD-5 (internal intensity) [36]. The non-conclusive findings on this topic need more investigation. In fact, the recent systematic review from 2021 on training intensity values for young soccer players only found eight studies [38].

The present study has some limitations, namely, the small sample size that came from only one team and a short-term analysis of two weeks. Therefore, future studies should avoid previous limitations and use: larger sample sizes; if possible, more teams for analysis; long-term analysis (e.g., pre-season, half-season, in-season or the full-season). In addition, other contextual variables such as match location and match results could influence the findings and should be considered for future studies. Moreover, diet habits (which type of food and at which time they are eaten) were not monitored, which may influence some sleep patterns. Similar designs should be replicated not only for young soccer players, but also for professional elite male and female players. Finally, it is important to mention that our sleep diary is different from other research, which should be considered as a limitation for future comparisons. Additionally, subjective instruments may be complemented by objective ones, as electroencephalogram, polysomnography or accelerometry.

Despite the limitations, the specific context of the players analysed and the fact that all correlations were small (0.10–0.29) [30], this study should be considered by coaches and their staff to acknowledge the importance of intensity and sleep variables as daily tasks and not only as sporadic duty.

5. Conclusions

Sleep duration was longer in the training sessions during the middle of the week. Moreover, sleep outcomes after training were slightly correlated with both physiological and locomotor demands. The data from this short-term study seem to support that higher external and internal intensity sessions (training or matches) can contribute to better nights of sleep in terms of time, quality and rested feeling. Moreover, higher sleep duration seemed to contribute to higher session-RPE and higher values of total distance and walking low speed running distances.

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References

1. Venter, R.E. Perceptions of team athletes on the importance of recovery modalities. *Eur. J. Sport Sci.* **2014**, *14*, S69–S76. [CrossRef] [PubMed]
2. Malhotra, R.K. Sleep, Recovery, and Performance in Sports. *Neurol. Clin.* **2017**, *35*, 547–557. [CrossRef] [PubMed]
3. Fullagar, H.H.K.; Duffield, R.; Skorski, S.; Coutts, A.J.; Julian, R.; Meyer, T. Sleep and Recovery in Team Sport: Current Sleep-Related Issues Facing Professional Team-Sport Athletes. *Int. J. Sports Physiol. Perform.* **2015**, *10*, 950–957. [CrossRef] [PubMed]
4. Biggins, M.; Purtill, H.; Fowler, P.; Bender, A.; Sullivan, K.O.; Samuels, C.; Cahalan, R. Sleep, health, and well-being in elite athletes from different sports, before, during, and after international competition. *Phys. Sportsmed.* **2021**, *49*, 429–437. [CrossRef]
5. Clemente, F.M.; Afonso, J.; Costa, J.; Oliveira, R.; Pino-Ortega, J.; Rico-González, M. Relationships between Sleep, Athletic and Match Performance, Training Load, and Injuries: A Systematic Review of Soccer Players. *Healthcare* **2021**, *9*, 808. [CrossRef] [PubMed]
6. Silva, A.; Narciso, F.V.; Soalheiro, I.; Viegas, F.; Freitas, L.S.N.; Lima, A.; Leite, B.A.; Aleixo, H.C.; Duffield, R.; de Mello, M.T. Poor Sleep Quality's Association With Soccer Injuries: Preliminary Data. *Int. J. Sports Physiol. Perform.* **2020**, *15*, 671–676. [CrossRef]
7. Fullagar, H.H.K.; Skorski, S.; Duffield, R.; Julian, R.; Bartlett, J.; Meyer, T. Impaired sleep and recovery after night matches in elite football players. *J. Sports Sci.* **2016**, *34*, 1333–1339. [CrossRef]
8. Kölling, S.; Steinacker, J.M.; Endler, S.; Ferrauti, A.; Meyer, T.; Kellmann, M. The longer the better: Sleep–wake patterns during preparation of the World Rowing Junior Championships. *Chronobiol. Int.* **2016**, *33*, 73–84. [CrossRef]
9. Pitchford, N.W.; Robertson, S.J.; Sargent, C.; Cordy, J.; Bishop, D.J.; Bartlett, J.D. Sleep Quality but Not Quantity Altered With a Change in Training Environment in Elite Australian Rules Football Players. *Int. J. Sports Physiol. Perform.* **2017**, *12*, 75–80. [CrossRef]
10. Silva, A.C.; Amaral, A.S.; Guerreiro, R.; Silva, A.; DeMello, M.T.; DaSilva, S.G.; Rechenchosky, L.; Rinaldi, W. Elite soccer athlete's sleep: A literature review. *Apunt. Sport. Med.* **2022**, *57*, 100373. [CrossRef]

11. Vlahoyiannis, A.; Aphamis, G.; Bogdanis, G.C.; Sakkas, G.K.; Andreou, E.; Giannaki, C.D. Deconstructing athletes' sleep: A systematic review of the influence of age, sex, athletic expertise, sport type, and season on sleep characteristics. *J. Sport Health Sci.* **2021**, *10*, 387–402. [CrossRef] [PubMed]
12. Lastella, M.; Roach, G.D.; Sargent, C. Travel fatigue and sleep/wake behaviors of professional soccer players during international competition. *Sleep Health* **2019**, *5*, 141–147. [CrossRef] [PubMed]
13. Cajochen, C. Alerting effects of light. *Sleep Med. Rev.* **2007**, *11*, 453–464. [CrossRef] [PubMed]
14. Drake, C.; Roehrs, T.; Shambroom, J.; Roth, T. Caffeine Effects on Sleep Taken 0, 3, or 6 Hours before Going to Bed. *J. Clin. Sleep Med.* **2013**, *9*, 1195–1200. [CrossRef]
15. Murphy, A.P.; Snape, A.E.; Minett, G.M.; Skein, M.; Duffield, R. The Effect of Post-Match Alcohol Ingestion on Recovery From Competitive Rugby League Matches. *J. Strength Cond. Res.* **2013**, *27*, 1304–1312. [CrossRef]
16. Costa, J.A.; Brito, J.; Nakamura, F.Y.; Oliveira, E.M.; Costa, O.P.; Rebelo, A.N. Does Night Training Load Affect Sleep Patterns and Nocturnal Cardiac Autonomic Activity in High-Level Female Soccer Players? *Int. J. Sports Physiol. Perform.* **2019**, *14*, 779–787. [CrossRef]
17. Hausswirth, C.; Louis, J.; Aubry, A.; Bonnet, G.; Duffield, R.; Le Meur, Y. Evidence of Disturbed Sleep and Increased Illness in Overreached Endurance Athletes. *Med. Sci. Sport. Exerc.* **2014**, *46*, 1036–1045. [CrossRef]
18. Sekiguchi, Y.; Curtis, R.M.; Huggins, R.A.; Benjamin, C.L.; Walker, A.J.; Arent, S.M.; Adams, W.M.; Anderson, T.; Casa, D.J. The Relationships between Perceived Wellness, Sleep, and Acute: Chronic Training Load in National Collegiate Athletics Association Division I Male Soccer Players. *J. Strength Cond. Res.* **2021**, *35*, 1326–1330. [CrossRef]
19. Whitworth-Turner, C.M.; Di Michele, R.; Muir, I.; Gregson, W.; Drust, B. Training load and schedule are important determinants of sleep behaviours in youth-soccer players. *Eur. J. Sport Sci.* **2019**, *19*, 576–584. [CrossRef]
20. Thornton, H.R.; Delaney, J.A.; Duthie, G.M.; Dascombe, B.J. Effects of Preseason Training on the Sleep Characteristics of Professional Rugby League Players. *Int. J. Sports Physiol. Perform.* **2018**, *13*, 176–182. [CrossRef]
21. Robey, E.; Dawson, B.; Halson, S.; Gregson, W.; Goodman, C.; Eastwood, P. Sleep quantity and quality in elite youth soccer players: A pilot study. *Eur. J. Sport Sci.* **2014**, *14*, 410–417. [CrossRef] [PubMed]
22. Clemente, F.M.; Mendes, B.; Nikolaidis, P.T.; Calvete, F.; Carriço, S.; Owen, A.L. Internal training load and its longitudinal relationship with seasonal player wellness in elite professional soccer. *Physiol. Behav.* **2017**, *179*, 262–267. [CrossRef] [PubMed]
23. Clemente, F.M. Associations between wellness and internal and external load variables in two intermittent small-sided soccer games. *Physiol. Behav.* **2018**, *197*, 9–14. [CrossRef]
24. Marcora, S.M.; Staiano, W.; Manning, V. Mental fatigue impairs physical performance in humans. *J. Appl. Physiol.* **2009**, *106*, 857–864. [CrossRef] [PubMed]
25. Chennaoui, M.; Arnal, P.J.; Sauvet, F.; Léger, D. Sleep and exercise: A reciprocal issue? *Sleep Med. Rev.* **2015**, *20*, 59–72. [CrossRef]
26. Carney, C.E.; Buysse, D.J.; Ancoli-Israel, S.; Edinger, J.D.; Krystal, A.D.; Lichstein, K.L.; Morin, C.M. The Consensus Sleep Diary: Standardizing Prospective Sleep Self-Monitoring. *Sleep* **2012**, *35*, 287–302. [CrossRef]
27. Borg, G. *Perceived Exertion and Pain Scales*; Human Kinetics: Champaign, IL, USA, 1998; ISBN 0880116234.
28. Dietch, J.R.; Sethi, K.; Slavish, D.C.; Taylor, D.J. Validity of two retrospective questionnaire versions of the Consensus Sleep Diary: The whole week and split week Self-Assessment of Sleep Surveys. *Sleep Med.* **2019**, *63*, 127–136. [CrossRef]
29. Akyildiz, Z.; Yildiz, M.; Clemente, F.M. The reliability and accuracy of Polar Team Pro GPS units. *Proc. Inst. Mech. Eng. Part P J. Sport. Eng. Technol.* **2020**, 1754337120976660. [CrossRef]
30. Batterham, A.M.; Hopkins, W.G. Making Meaningful Inferences about Magnitudes. *Int. J. Sports Physiol. Perform.* **2006**, *1*, 50–57. [CrossRef]
31. Oliveira, R.; Brito, J.P.; Martins, A.; Mendes, B.; Marinho, D.A.; Ferraz, R.; Marques, M.C. In-season internal and external training load quantification of an elite European soccer team. *PLoS ONE* **2019**, *14*, e0209393. [CrossRef]
32. Lalor, B.J.; Halson, S.L.; Tran, J.; Kemp, J.G.; Cormack, S.J. A Complex Relationship: Sleep, External Training Load, and Well-Being in Elite Australian Footballers. *Int. J. Sport. Physiol. Perform.* **2020**, *15*, 777–787. [CrossRef] [PubMed]
33. Fessi, M.S.; Nouira, S.; Dellal, A.; Owen, A.; Elloumi, M.; Moalla, W. Changes of the psychophysical state and feeling of wellness of professional soccer players during pre-season and in-season periods. *Res. Sport. Med.* **2016**, *24*, 375–386. [CrossRef] [PubMed]
34. Nobari, H.; Alves, A.R.; Haghighi, H.; Clemente, F.M.; Carlos-Vivas, J.; Pérez-Gómez, J.; Ardigò, L.P. Association between training load and well-being measures in young soccer players during a season. *Int. J. Environ. Res. Public Health* **2021**, *18*, 4451. [CrossRef] [PubMed]
35. Fessi, M.S.; Moalla, W. Postmatch Perceived Exertion, Feeling, and Wellness in Professional Soccer Players. *Int. J. Sports Physiol. Perform.* **2018**, *13*, 631–637. [CrossRef] [PubMed]
36. Martins, A.D.; Oliveira, R.; Brito, J.P.; Loureiro, N.; Querido, S.M.; Nobari, H. Intra-season variations in workload parameters in europe's elite young soccer players: A comparative pilot study between starters and non-starters. *Healthcare* **2021**, *9*, 977. [CrossRef] [PubMed]
37. Nobari, H.; Vahabidelshad, R.; Pérez-Gómez, J.; Ardigò, L.P. Variations of Training Workload in Micro- and Meso-Cycles Based on Position in Elite Young Soccer Players: A Competition Season Study. *Front. Physiol.* **2021**, *12*, 529. [CrossRef]

38. Oliveira, R.; Brito, J.P.; Moreno-Villanueva, A.; Nalha, M.; Rico-González, M.; Clemente, F.M. Reference values for external and internal training intensity monitoring in young male soccer players: A systematic review. *Healthcare* **2021**, *9*, 1567. [CrossRef]
39. Hannon, M.P.; Coleman, N.M.; Parker, L.J.F.; McKeown, J.; Unnithan, V.B.; Close, G.L.; Drust, B.; Morton, J.P. Seasonal training and match load and micro-cycle periodization in male Premier League academy soccer players. *J. Sports Sci.* **2021**, *39*, 1838–1849. [CrossRef]