Journal of Athletic Training 2023;58(1):79–83
doi: 10.4085/1062-6050-0042.22

www.natajournals.org

Comparing Sleep in Shared and Individual Rooms During Training Camps in Elite Youth Soccer Players: A Short Report

Júlio A. Costa, PhD*; Pedro Figueiredo, PhD*†‡; Michele Lastella, PhD§; Fábio Y. Nakamura, PhD||; José Guilherme, PhD, ATC*¶; João Brito, PhD*

*Portugal Football School, Portuguese Football Federation, FPF, Oeiras; †CIDEFES, Universidade Lusófona, Lisboa, Portugal; ‡Research Center in Sports Sciences, Health Sciences and Human Development (CIDESD), Vila Real, Portugal; §Appleton Institute for Behavioural Science, Central Queensland University, Adelaide, Australia; ||Research Center in Sports Sciences, Health Sciences and Human Development (CIDESD), University of Maia, Portugal; ¶Centre of Research, Education, Innovation and Intervention in Sport, Faculty of Sport, University of Porto, Portugal

Context: Athletes' sleep is the most important recovery strategy and has received growing attention. However, athletes may experience sleep disruptions due to numerous factors, such as training and competition workloads, travel, changes in sleep-wake schedules, and sleeping environments. They often spend nights in unfamiliar hotels, and sharing a bed, room, or both with another person might affect sleep duration and quality.

Objective: To analyze the effect of sleeping in shared (SRs) versus individual (IRs) rooms on objective and subjective sleep and on slow-wave-sleep–derived cardiac autonomic activity during an official training camp in elite youth soccer players. Training and match workloads were characterized.

Design: Observational case study.

Setting: Hotel accommodations.

Patients or Other Participants: Thirteen elite male youth soccer players.

Results: Players slept longer in IRs than in SRs (+1:28 [95% CI = 1:18, 1:42] hours:minutes; $P < .001$). Sleep efficiency was higher in IRs than in SRs (+12% [95% CI = 10%, 15%]; $P < .001$), whereas sleep latency was shorter in IRs than in SRs (–3 [95% CI = –15, –4] minutes; $P < .001$). Subjective sleep quality was lower in IRs than in SRs (–2 [–3 to –2] arbitrary units; $P < .001$). No differences were found for slow-wave-sleep–derived cardiac autonomic activity or for training or match workloads between training camps.

Conclusions: During soccer training camps, sleep may be affected by whether the athlete is in an SR versus an IR.

Key Words: sleep accelerometers, sleep environment, slow-wave sleep

Key Points

- In elite male youth soccer players, objective and subjective sleep may be affected by sleeping in shared versus individual rooms during training camps.
- Together, Actigraph variables and slow-wave-sleep–derived cardiac autonomic activity indices provide more complete information about an athlete's recovery state.

In recent years, growing interest in understanding how athletes sleep has boosted the number of scientific studies on the topic.[1,2] In fact, athletes and coaches have ranked sleep as the most important recovery strategy.[2] However, athletes may experience sleep disruptions due to numerous factors, including training and competition workloads, travel, wake length before sleep (ie, *sleep latency*, defined as the time in minutes attempting to fall asleep), regularity of sleep-wake schedules, sleeping environment, and light exposure.[2]

Elite athletes often spend nights in unfamiliar hotel environments before home and away matches[3] and during training camps.[4] For instance, Thornton et al[5] investigated the effects of a training camp on the sleep characteristics of professional rugby players compared with being at home. During the training camp, players' sleep duration and quality were considerably poorer. In addition and more recently, sharing the bed, room, or both with another person affected sleep duration and quality.[6] Yet no authors have studied the sleep characteristics of athletes, especially youth athletes, while in shared (SRs) versus individual (IRs) rooms.

It is also important to note that an increased interest in individualized approaches has given rise to a variety of athlete monitoring strategies, enabling coaches to better manage recovery and fatigue and prescribe training on an individual basis.[4] This is feasible in elite sports, and individualized analytic methods enable us to track changes in sleep and slow-wave-sleep (SWS)–derived cardiac autonomic activity indices in soccer players.

Currently, no researchers have specifically examined if sleeping in SRs versus IRs could also affect sleep during training camps. Therefore, we aimed to examine the effect of sleeping in SRs versus IRs on objective and subjective sleep and on SWS–derived cardiac autonomic activity during training camps in elite male youth soccer players.

METHODS

Participants

Thirteen elite male youth soccer players (age = 17.9 ± 0.4 years, height = 1.79 ± 0.11 m, body mass = 68.1 ± 5.3 kg) from the Portuguese U-19 National team agreed to participate in the study. The study design was carefully explained to the participants, and written informed consent was obtained from their parents or legal guardians. The study was approved by the Ethics Committee of the Portugal Football School (CE PFS 6/2021). To be included in the analysis, the same players had to have engaged in all training sessions and matches (≥60 minutes) during the 2 training camps: training camp with players sleeping in IRs versus training camp with players sleeping in SRs with separate beds.

Procedures

An observational case study design was adopted. Data were collected for 8 consecutive days during each training camp (IRs and SRs).

Throughout the study, the players were hosted in hotels (Oeiras [August] and Guimarães [September], Portugal) during the same summer period to avoid circadian rhythm effects. The training camps were separated by approximately 20 days. The players slept in IRs and in shared twin rooms with separate beds (allocated by the technical staff). The daily schedules were similar for both training camps (ie, wake up by 9:00, breakfast until 9:30, lunch at 13:00, dinner at 20:00, and return to rooms at 22:00). For players in IRs, all training sessions were held in a sports complex near the hotel (approximately 15 minutes by bus); for players in SRs, all training sessions were conducted in the hotel's sports complex. The friendly matches for both training camps were held in stadiums located in the same district (the farthest stadium from the hotel was approximately 15 to 20 minutes by bus); long journeys were avoided.

Data Analysis

Sleep was examined using 3-axial accelerometers (model wGT3X-BT; Actigraph LLC) worn on the nondominant wrist. Wrist-worn accelerometers have been used to monitor sleep in elite athletes and validated against polysomnography.[7] Data were analyzed using proprietary software (version 6.13.3; ActiLife LLC Pro). Wrist-worn accelerometers can estimate *total sleep time* (total amount of sleep obtained), sleep latency (time in minutes attempting to fall asleep), and *sleep efficiency* (percentage of time in bed that was spent asleep).[4] The sampling frequency was 50 Hz, and the epoch of activity counts was 60 seconds. Sleep duration, latency, and efficiency were determined every night throughout both training camps using the Sadeh algorithm, which was validated in young adults.[8] Players also reported individual sleep quality using a 7-point Likert scale[9] (1 = *very, very good* to 7 = *very, very bad*) each morning.

We used the SWS-derived cardiac autonomic activity method to analyze cardiac autonomic activity during night sleep.[10] This method records 10 minutes of normal *RR intervals* (ie, variations between consecutive heart beats [beat to beat]), considering the criteria proposed by Brandenberger et al,[10] using Kubios heart rate variability (HRV) software (version 3.0.0). Heart rate (HR) monitors (model Bodyguard2; Firstbeat Technologies Oy) were used during sleep. These devices have been validated against standard electrocardiogram equipment for detecting heartbeats.[11] To reduce any potential nonuniformity or skewness in HRV, we log transformed the data by determining the natural logarithm (ln) before conducting any statistical analyses.[12]

Training and match loads were quantified using the session rating of perceived exertion (s-RPE). Also, players used 10-Hz global positioning satellite pods (model Apex; STATSports Group) during training sessions.[13] External load variables were total training and match duration, total distance covered, and high-speed distance (>19.8 km/h).

Throughout the camps, the players reported individual ratings of perceived exertion (RPEs) using the Borg category ratio scale (CR10) approximately 30 minutes after each training session and match. We subsequently multiplied the CR10 score (perceived intensity) by individual exposure time (training and match duration), thereby providing an overall load quantification of the session or match.[14] Individual training and match exposures were recorded by the sports science staff.

No missing data were identified during data collection, and no concerns or compliance problems regarding the use of the monitoring devices were reported.

Statistical Analysis

Sample distribution was tested using the Shapiro-Wilk test for objective and subjective sleep, SWS–derived cardiac autonomic activity, and training and match workload variables during both training camps. Differences in these variables were examined using linear mixed-model analysis. The level of significance for statistical comparisons was set at .05. The days with training sessions and matches for each training camp were included as a fixed effect and player identity (participant ID) as the random effect. In addition, we analyzed the effects of training and match workload covariates on objective and subjective sleep and SWS–derived cardiac autonomic activity between training camps. The variance-covariance structures were selected according to the smallest Akaike information criterion. Bonferroni pairwise comparisons were used to test the mean differences between training camps for objective and subjective sleep, SWS–derived cardiac autonomic activity, and training and match workload variables.

The magnitudes of the differences (ie, between IRs and SRs) were assessed using the standardized differences based on Cohen *d* units by means of the effect size (ES) analysis, with corresponding 95% CIs.[15] The ESs were qualitatively interpreted using the following thresholds: <0.2 = *trivial*, 0.2 to 0.6 = *small*, 0.6 to 1.2 = *moderate*, 1.2 to 2.0 = *large*, 2.0 to 4.0 = *very large*, and >4.0 = *nearly perfect*.[16] When the 95% CI overlapped positive and negative values, the effect was deemed to be *unclear*.

Table. Elite Male Youth Soccer Players' Objective and Subjective Sleep, Slow-Wave-Sleep-Derived Cardiac Autonomic Activity, and Training and Match Workload Variables Between Training Camps By Sleeping Environment

Variable	Sleeping Environment: Individual Room (n = 13)	Sleeping Environment: Shared Room With Separate Beds SR (n = 13)	Mean Difference (95% CI)[a]	Effect Size (95% CI)	*P* Value
Total sleep time, h:min	7:35 (7:27, 7:43)[b]	6:07 (5:59, 6:15)	1:28 (1:18, 1:42)	1.42 (1.12, 1.68)	<.001
Sleep efficiency, %	88 (86, 89)[b]	75 (74, 77)	12 (10, 15)	1.38 (1.21,1.56)	<.001
Sleep latency, min	7 (6, 8)[b]	10 (8, 11)	−3 (−12, −1)	−0.75 (−1.06, −0.45)	<.001
Subjective sleep quality, AU	1.7 (1.6, 1.8)[b]	3.7 (3.4, 3.8)	−2 (−3, −2)	−0.61 (−1.75, −0.32)	<.001
Heart rate, bpm	44.3 (38.6, 45.1)	46.8 (44.1, 49.5)	−2.5 (−3.5, 0.5)	−0.11 (−0.23 to 0.12)	.17
lnRMSSD, ms	4.6 (4.4, 4.8)	4.1 (3.9, 4.2)	0.5 (−0.2, 0.7)	0.18 (−0.28, 0.25)	.11
Session rating of perceived exertion, AU	181.5 (161.4, 201.6)	215.1 (194.7, 235.4)	−33.6 (−53.1, 2.4)	−0.31 (−0.42, 0.16)	.10
Exposure time, min	58 (55, 61)	65 (63, 69)	−7 (−12, 3)	−0.03 (−0.28, 0.21)	.38
Total distance, m	3895 (3481, 4410)	4820 (4401, 5239)	−925 (−1527, 323)	−0.51 (−0.61, 0.15)	.19
High-speed (>19.8 km/h) distance, m	391 (309, 473)	577 (494, 660)	−186 (−277, 95)	−0.39 (−0.44, 0.11)	.20

Abbreviations: AU, arbitrary units; lnRMSSD, natural logarithm of square root of the mean of the sum of the squares of differences between adjacent beat-beat intervals.

[a] Values are group mean and 95% CI estimates.

[b] Different from the shared room (*P* < .05).

RESULTS

The descriptive and mean differences (95% CIs) estimated in objective and subjective sleep measures, SWS–derived cardiac autonomic activity, and training and match workload results comparing IRs and SRs are presented in the Table.

Descriptive individual data (n = 13) responsiveness for objective and subjective sleep indices are illustrated in the Figure.

Total sleep time was longer in IRs than in SRs (ES = 1.42 [1.12, 1.68], large; *P* < .001). Sleep efficiency was higher in IRs than in SRs (ES = 1.38 [1.21, 1.56], large; *P* < .001). Sleep latency was shorter in IRs than in SRs (ES = –0.75 [–1.06, –0.45], moderate; *P* < .001). Subjective sleep quality was lower in IRs than in SRs (ES = –0.61 [–1.75, –0.32], moderate; *P* < .001). In addition, after adjusting the models for training and match workloads, no effects on objective and subjective sleep and SWS–derived cardiac autonomic activity between IRs and SRs were found (unclear effects; *P* values > .05).

DISCUSSION

Our main findings were that objective and subjective sleep quality may be affected by sleeping in SRs versus IRs during training camps in elite male youth soccer players. Nonsignificant differences were found for SWS–derived cardiac autonomic activity and for training and match workloads between training camps. This is the first study to demonstrate the influence of changing the sleep environment (ie, sleeping in IRs versus SRs) during training camps on objective and subjective sleep and on SWS–derived cardiac autonomic activity in team-sport athletes. Overall, players slept more and had better sleep quality in IRs than in SRs.

Athletes' sleep can be affected by various factors, including travel, competition, and training or match workloads.[2] Further, Lastella et al[17] showed that increased daily competition load in cyclists reduced sleep duration without changing subjective or objective sleep quality. However, Figueiredo et al[4] observed that young soccer players' sleep duration was affected by training and match demands during a training camp. In the current study, we found that shifting from IRs to SRs affected sleep duration and quality despite the athletes being subjected to similar training and match workloads. In fact, we noted differences between IRs and SRs in sleep duration (+88 minutes) and sleep efficiency (+12%). Our findings reinforce the idea that strategies targeting sleep duration and quality (eg, athletes sleeping in IRs) can have additional benefits for sleep characteristics.

In addition, it is important to highlight that, even though no differences were present between IRs and SRs in SWS–derived cardiac autonomic activity, the higher results (ie, HRV) in IRs than in SRs may in part be explained by the lower results in workload metrics and higher results in objective and subjective sleep because training and sleep affected HRV.[4] More resilience to sustained elevated training and match loads without presenting signs of severe SWS–derived cardiac autonomic activity perturbation and a greater readiness to perform[4] may somewhat explain the absence of differences between IRs and SRs.

Nevertheless, future authors should identify the behavioral changes that are associated with changes in sleep characteristics. Training camps are often accompanied by altered daily schedules because of additional commitments outside of trainings and matches, which may affect sleep characteristics.[5] Nonetheless, this factor did not appear to have had a major influence on sleep indices because the daily schedule programs were similar for both training camps.

Reduced sleep in SRs versus in IRs may be driven by a conscious process of respecting teammates' space and limiting noise,[2] as our participants shared rooms with other players in the SR group. The degree and variation of consideration of fellow participants may also vary depending on the individual relationships and habits[2] of room-sharing participants; these possibilities should thus be considered in the interpretation of the findings. Moreover, posttraining or postmatch social activities[3] (eg, chatting) might have had more influence on sleep characteristics in SRs because players were sharing rooms for sleep. This topic deserves future investigation.

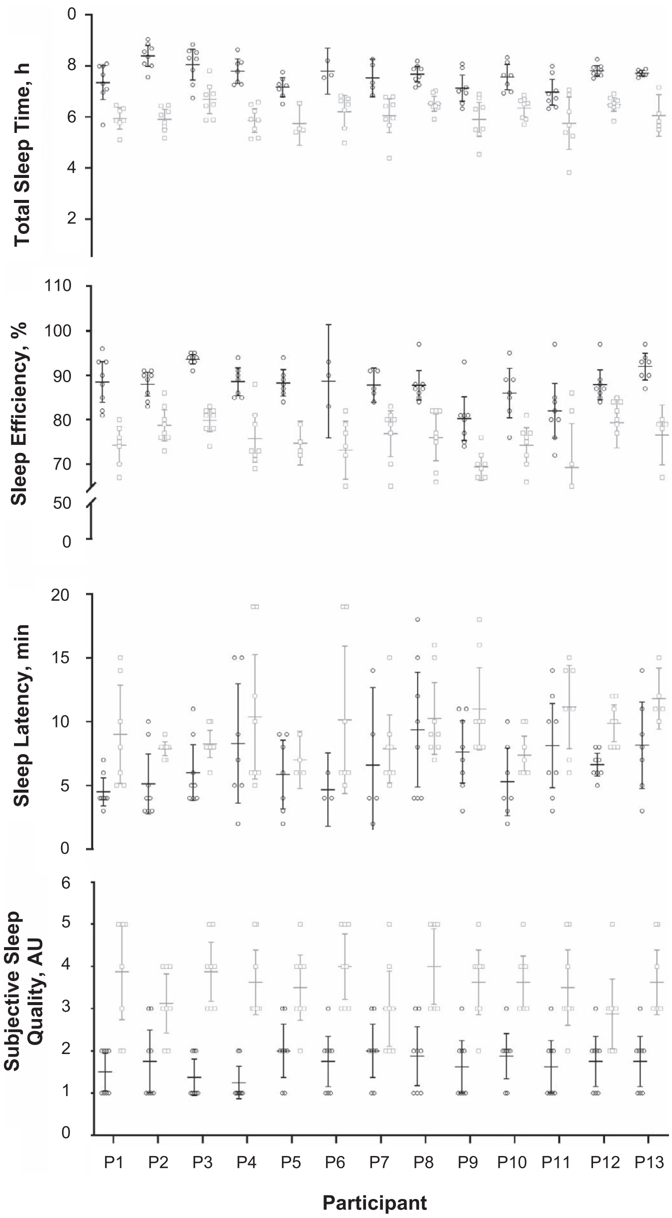

Figure. Descriptive individual data (n = 13) responsiveness for objective and subjective sleep indices. Horizontal black and gray lines show individual means (95% CIs) for each day of both training camps (training camp with players sleeping in individual rooms [IR] versus training camp with players sleeping in shared rooms with separate beds [SR]), respectively, of youth elite soccer players. The black dots represent IRs, and gray dots represent SRs. Abbreviation: AU, arbitrary units.

Most players displayed reduced objective and subjective sleep quality in SRs compared with IRs. Hence, it is important that individually tailored sleep interventions are implemented to enhance sleep. Theoretically, extending sleep duration and recovery during a period of high training stress may help to promote training adaptations and aid in reducing the risk of injury.[2] Despite the need for individualized approaches to promote optimal sleep, the individual nature of responses to changes in physical sleep environments requires further evaluation. Together, these items may have implications for the provision of sleep interventions and sleep hygiene recommendations.

Some limitations need to be acknowledged. For example, we did not control several factors known to affect sleep indices in applied settings (eg, room temperature and humidity, naps, and screen time immediately before bedtime). Moreover, the small size of the sample and the possible resulting bias should also be pointed out. Finally, this study was also limited by the fact that a true baseline was not evaluated for possible sleep and SWS–derived cardiac autonomic activity comparisons between training camps. However, a strength of the current study and a novelty in the investigation of sleep and cardiac autonomic activity in elite youth players was that wrist Actigraph units and HR monitors were used simultaneously to analyze sleep and cardiac autonomic activity in a real-world scenario. Moreover, the methods can be implemented in a team's daily routines at training or match facilities and at the players' homes or at hotels. In addition, individual differences in sleep characteristics in our study were evident, whereas individual sleep requirements may be attributed to an array of physiological and cultural differences.[5] Statistical approaches were needed to account for these differences, and as such, we used mixed linear modeling in the current study.

CONCLUSIONS

In this case study, we determined that in elite male youth soccer players, objective and subjective sleep may be affected by sleeping in SRs versus IRs during training camps. Thus, our findings reinforce that sleeping in IRs during training camps, may give youth athletes additional benefits in terms of sleep characteristics (ie, better sleep duration and quality) and consequently assist coaches and practitioners in better managing fatigue and manipulating training prescriptions on an individual basis.

ACKNOWLEDGMENTS

We thank the players for their time and participation during the study.

REFERENCES

1. Roberts SSH, Teo WP, Warmington SA. Effects of training and competition on the sleep of elite athletes: a systematic review and meta-analysis. *Br J Sports Med*. 2019;53(8):513–522. doi:10.1136/bjsports-2018-099322
2. Walsh NP, Halson SL, Sargent C, et al. Sleep and the athlete: narrative review and 2021 expert consensus recommendations. *Br J Sports Med*. 2021;55(7):356–368. doi:10.1136/bjsports-2020-102025
3. Costa JA, Brito J, Nakamura FY, Figueiredo P, Oliveira E, Rebelo A. Sleep patterns and nocturnal cardiac autonomic activity in female athletes are affected by the timing of exercise and match location. *Chronobiol Int*. 2018;36(3):360–373. doi:10.1080/07420528.2018.1545782
4. Figueiredo P, Costa J, Lastella M, Morais J, Brito J. Sleep indices and cardiac autonomic activity responses during an international tournament in a youth national soccer team. *Int J Environ Res Public Health*. 2021;18(4):2076. doi:10.3390/ijerph18042076
5. Thornton HR, Duthie GM, Pitchford NW, Delaney JA, Benton DT, Dascombe BJ. Effects of a 2-week high-intensity training camp on sleep activity of professional rugby league athletes. *Int J Sports Physiol Perform*. 2017;12(7):928–933. doi:10.1123/ijspp.2016-0414

6. Drews HJ, Wallot S, Brysch P, et al. Bed-sharing in couples is associated with increased and stabilized REM sleep and sleep-stage synchronization. *Front Psychiatry*. 2020;11:583. doi:10.3389/fpsyt.2020.00583
7. Sargent C, Lastella M, Halson SL, Roach GD. The validity of activity monitors for measuring sleep in elite athletes. *J Sci Med Sport*. 2016;19(10):848–853. doi:10.1016/j.jsams.2015.12.007
8. Sadeh A, Sharkey KM, Carskadon MA. Activity-based sleep-wake identification: an empirical test of methodological issues. *Sleep*. 1994;17(3):201–207. doi:10.1093/sleep/17.3.201
9. Sullivan GM, Artino AR Jr. Analyzing and interpreting data from Likert-type scales. *J Grad Med Educ*. 2013;5(4):541–542. doi:10.4300/JGME-5-4-18
10. Brandenberger G, Buchheit M, Ehrhart J, Simon C, Piquard F. Is slow wave sleep an appropriate recording condition for heart rate variability analysis? *Auton Neurosci*. 2005;121(1–2):81–86. doi:10.1016/j.autneu.2005.06.002
11. Parak J, Korhonen I. Accuracy of Firstbeat BodyGuard 2 beat-to-beat heart rate monitor. Firstbeat Technologies. Accessed May 8, 2017. https://www.firstbeat.com/app/uploads/2015/10/white_paper_bodyguard2_final.pdf
12. Mourot L, Bouhaddi M, Perrey S, et al. Decrease in heart rate variability with overtraining: assessment by the Poincare plot analysis. *Clin Physiol Funct Imaging*. 2004;24(1):10–18. doi:10.1046/j.1475-0961.2003.00523.x
13. Beato M, Devereux G, Stiff A. Validity and reliability of global positioning system units (STATSports Viper) for measuring distance and peak speed in sports. *J Strength Cond Res*. 2018;32(10):2831–2837. doi:10.1519/JSC.0000000000002778
14. Foster C, Florhaug JA, Franklin J, et al. A new approach to monitoring exercise training. *J Strength Cond Res*. 2001;15(1):109–115.
15. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Lawrence Erlbaum Associates; 1988.
16. Hopkins WG. Statistics in observational studies. In: Verhagen E, van Mechelen W, eds. *Methodology in Sports Injury Research*. OUP Oxford; 2009:69–81.
17. Lastella M, Roach GD, Halson SL, Sargent C. Sleep/wake behaviours of elite athletes from individual and team sports. *Eur J Sport Sci*. 2015;15(2):94–100. doi:10.1080/17461391.2014.932016

Address correspondence to Júlio A. Costa, PhD, ATC, Portugal Football School, Portuguese Football Federation, FPF, 1495-433 Cruz Quebrada, Oeiras, Portugal. Address email to julio.costa@fpf.pt.