Journal of Strength and Conditioning Research Publish Ahead of Print
DOI: 10.1519/JSC.0000000000002251

ORIGINAL RESEARCH

Title: Case study: sleep and injury in elite soccer. A mixed method approach

Brief running head: Sleep and injury in elite soccer

Laboratory where the research was conducted: Lille FC, Camphin-en-Pévèle, France

Authors: Mathieu Nédélec[1], Cédric Leduc[2], Brian Dawson[3], Gaël Guilhem[1], & Grégory Dupont[4]

[1] *French National Institute of Sport (INSEP), Research Department, Laboratory Sport, Expertise and Performance (EA 7370), Paris, France*

[2] *French Rugby Federation (FFR), Marcoussis, France*

[3] *University of Western Australia, Crawley, Australia*

[4] *Lille FC, Camphin-en-Pévèle, France*

Corresponding author:

Mathieu Nédélec

Institution: French National Institute of Sport (INSEP), Research Department, Laboratory Sport, Expertise and Performance (EA 7370) - 11 avenue du Tremblay - 75012 PARIS France

Telephone: +33670241129

E-mail address: matnedelec@orange.fr

No financial support was provided for this study.

ABSTRACT

The present case study allowed an examination of the link between sleep and injury occurrence in an elite male soccer player competing in French League 1 and Union of European Football Associations matches. During 4 months, a mixed method approach was used, combining actigraphic sleep assessment with qualitative interviews on a daily basis. Three injuries were reported over the study period. Sleep onset latency, both in the single night (117±43 min) and in the week (78±50 min) before injury occurrence, was longer than pre-season baseline values (18±13 min; effect size (ES): 3.1 and 1.6, respectively). Similarly, sleep efficiency in the single night (73±7%) and the week (75±7%) before injury occurrence, was lower than baseline (90±3%; ES: 3.2 and 2.8, respectively). In the present case-study, sleep onset latency and efficiency were altered on the night and in the week before injury occurrence. Individualized assessment of sleep during congested playing schedules may be useful to aid in preventing injury occurrence.

Keywords: Recovery; fatigue; football; Stress; interview

INTRODUCTION

In elite soccer, players are frequently exposed to various situations and conditions that can interfere with sleep, potentially leading to sleep restriction (25). Participation in a single match involves repetitive physically demanding activities (e.g. sprinting, accelerations and decelerations, changes of direction). Most of these tasks include braking actions which elicit active muscle lengthening leading to cytoskeletal disruptions (i.e. muscle damage) (11,26). Soccer players are consequently prone to pronounced muscle soreness immediately post-exercise (17). In the context of high training loads, it has been shown that muscle soreness may induce difficulties in remaining immobile during sleep and thus impaired sleep quantity and quality may result (16). Environmental conditions and behaviours related to evening soccer matches (e.g. bright light in the stadium, caffeine consumption) as well as engagement and arousal when competing at night are often not conducive to sleep. Several studies have revealed that following an evening match (kick off after 18:00), players fall asleep later, time in bed is significantly shorter and the resulting amount of sleep is significantly less than following day matches and/or training days (31,34). Alternating between domestic, continental and international matches may lead to additional exhausting travel stress and sleep restriction (6). When playing two evening matches per week across several months, a very late bedtime and early wake up time can lead to repetitive sleep curtailment, which may finally lead to chronic sleep debt. Sleep restriction may be detrimental to the outcome of the recovery process after a match, resulting in impaired muscle glycogen repletion and damage repair, alterations in cognitive function and greater mental fatigue (25). During congested playing schedules, the recovery time allowed between two successive matches (i.e. 3-4 days) may be insufficient to restore homeostasis (26). In addition, the accumulation of muscle damage associated with inadequate recovery may leave the muscles more prone to muscle injury (28). These processes can predispose an individual to greater risk of injury (4). Yet, to the best of our knowledge, little evidence is available regarding the role of sleep restriction on the risk of acute injury among elite soccer players.

Luke et al. (21) found that sleeping 6 or fewer hours the night before the injury was associated with fatigue-related injuries among a mix of youth athletes participating in basketball, football, soccer and running. Accordingly, Milewski et al. (24) found that hours of sleep per night were a significant independent risk factor for injury among adolescent athletes: athletes who slept on average less than 8 h per night were 1.7 times more likely to sustain an injury compared with athletes who slept more than 8 h. However, only questionnaires were used to assess sleep duration in these young athletes, rather than objective sleep measurements (21,24). Dennis et al. (3) have showed that sleep duration and efficiency were significantly greater in the week of injury occurrence than during the previous 2 weeks among elite Australian footballers. However, these differences were unrelated to injury and only match - and not training - injuries were included in this study (3). However, injury rate during training can reach up to ≈4 injuries per 1000 hours of exposure in soccer (4). Furthermore, the high inter-individual variability frequently observed in sleep variables within elite athletes underlies the importance of assessing sleep on a case-by-case basis (8,20,34). This is particularly true when assessment leads to the provision of interventions designed to improve the sleep of athletes. Using a case-study approach, the present investigation aimed to examine the link between sleep and injury occurrence in an elite soccer player across 4 months of a heavy playing schedule. Since qualitative methods are able to investigate reasons why players cannot achieve an adequate sleep quantity or quality for performance (27), this study combined both quantitative and qualitative methods to investigate not only how the player slept but also the psycho-socio-physiological factors influencing his sleep.

METHODS

Experimental Approach to the Problem

After pre-season familiarization, including baseline mean values for 5 nights and chronotype assessment, data were collected from 15th August 2014 to 7th December 2014. The six-week period leading up to the data collection involved a four-week pre-season training period (team training: 21 sessions; injury prevention: 7 sessions; strength and conditioning training: 20 sessions); and two weeks with one competitive match per week, i.e. UEFA (Union of European Football Associations) Champions League qualifications. The player performed in these two matches and was available for team selection at the start of the study. A typical in-season week is outlined in Table 1. During the study period, the team firstly participated in the UEFA Champions League qualifications; due to elimination, the team was then involved in the UEFA Europa League. Before both home and away matches, the player may have spent 1 or 2 night(s) before the match in an unfamiliar hotel environment. Evening soccer matches were played at a kick-off time between 19:00 and 21:05, with exposure to 250 floodlights and 2000-lux bright light during home matches (Grand Stade Pierre Mauroy). According to the number of matches per week, the typical week consisted of 5 to 6 training sessions. The training load for each training session was recorded using methods described by Foster et al. (5), whereby a total training load (arbitrary units) was calculated by multiplying the session-rating of perceived exertion (RPE) by the session time. An injury prevention program was regularly implemented two days before the match, which included proprioceptive exercises, Nordic hamstring lowers, good morning, calf eccentric exercises and abdominal core (plank and side plank). When playing one match per week, one session of upper- (lat pull down, push-ups, bench throw, biceps curl, dips) and lower- (leg press, squats, steps-ups, snatch, and clean-and-jerk) body strength training were additionally implemented in the training week. When playing two matches per week, the player was advised to immerse himself after the match in a cold bath at 10°C for 10 minutes. The player ate his pre-match meal 3 hours before the match. The meal comprised low-glycemic-index carbohydrate foods. Caffeine intake before and/or during the match was recorded as well as any hypnotic compound intake (i.e. short half-life non-benzodiazepine medications) before the night. At the end of the match, the player consumed high-glycemic-index carbohydrate foods and proteins (sport drinks, milkshakes, yogurt, soup, sandwiches). The main investigator met the player on a daily basis during the first month of the study and then on a weekly basis to ensure compliance with the protocol and completion of the sleep diary. He also discussed the rationale for the sleep recommendations. The player was recommended to sleep for at least 10 hours per night, based on a study by Mah et al. (22) who showed that obtaining as much nocturnal sleep as possible (with a minimum goal of 10 h in bed each night) contributes to improved athletic performance, reaction time, daytime sleepiness and mood. To encourage this, he was advised to create a low-light and cool (18–19 °C) sleep environment, avoid all electronic stimulants (i.e., television, mobile phone, computer) in the hour prior to sleep, have a regular bedtime/wake time, avoid sleeping too late in the morning on days off, and to only nap briefly (i.e., 5–30 min) and appropriately (close to the early afternoon and not during the morning or evening). Additionally, the entire team was regularly advised not to drink alcohol by means of posters in the dressing room and oral presentations to the players. All the recommendations were checked for compliance by the main investigator.

A mixed method approach was used, combining objective sleep assessment with qualitative interviews, to ascertain both sleep quantity/quality and the psycho-socio-physiological acute and chronic stressors (25). Qualitative interview techniques are particularly useful in the examination of the "why" questions at the heart of this research (35). In this respect, interview sessions with the player were carried out to obtain qualitative measures of the psycho-socio-physiological acute and chronic stressors experienced during the study period and their potential impact on sleep. Sleep and injury data were recorded each day throughout the study. Injury data corresponded to time loss injuries, which resulted when the player was unable to fully take part in future soccer training or matches owing to physical complaints (9). Illnesses, diseases, and mental complaints were not considered physical complaints but were taken into account during interviews. Information about injury circumstances (training or match), location and type were recorded (9). The same doctor diagnosed all injuries, and the player was considered injured until medical staff cleared him for participation in full training or matches. Injury severity was defined as the number of days that had elapsed from the date of injury to the date of the player's return to full participation in team training and availability for match selection (13).

The subject

The player is a 31-year-old male fullback (defender), currently competing in the French League 1, i.e. the top league in France. He turned professional at age 18 and was a regular starter for his club for 7 consecutive seasons before the start of the present study. He was internationally capped with the young French national teams. Baseline anthropometric characteristics were: height, 1.77 m; mass, 78.9 kg; body fat, 9.0% (Dual-energy X-ray absorptiometry, Hologic Discovery A, WA, USA). He was informed about the purpose of the study, and the main investigator answered any questions. The player did not outline any medically diagnosed sleeping disorder. Regular informal conversations with the player and support staff at the club (i.e., sports scientists and medical staff) contributed to full adherence to the protocol. The present study was approved by the Ethical Committee (Lille, France) prior to data collection (CCTIRS #10544). The subject was informed of the benefits and risks of the investigation prior to signing an institutionally approved informed consent document to participate in the study.

Procedures

In field-based studies that involve data collection over consecutive nights, activity monitors are typically preferred over polysomnography - the gold standard for monitoring sleep - because they are wearable, non-invasive and operate remotely without an attendant technician. In the present study, the player's sleep behaviour was monitored using self-report sleep diaries and a wrist activity monitor (Actisleep, TheActigraph, Pensacola, FL, USA), which is worn like a wristwatch on the non-dominant wrist during each sleep period and continuously records body movements. The data is sampled from the accelerometer at a frequency of 30 Hz, the device records 60-s epochs and stores 1800 data items per minute. The recorded data were processed automatically with Actilife5 software (Version 5.5.5, TheActigraph, Pensacola, FL, USA), which indicated whether the participant was awake or asleep for each recorded 60-s epoch. Essentially, all time was scored as wake unless: (1) the sleep dairy indicated that the participant was lying down attempting to sleep and (2) the activity counts from the monitor were sufficiently low to indicate that the participant was immobile (30). The actigraphy method has been shown to be reliable and valid to objectively measure sleep (1,33) with a medium sleep-wake threshold generating the smallest mean bias compared with polysomnography for total sleep time (8.5 min; 95% confidence limits (CL): 2.1-14.9; standard error of estimate (SEE): 26.1; r = 0.83), sleep efficiency (1.8%; 95% CL: 0.5-3.7; SEE: 4.6; r = 0.35) and wake after sleep onset (-4.1 min; 95% CL: -10.0 to 1.8; SEE: 20.5; r = 0.33) (10). A medium sleep–wake threshold (>= 50 activity counts is scored as wake) was accordingly applied to the data set. The sleep variables were measured as follows: Time In Bed (TIB) was defined as between lights off (bedtime) and sleep end; Sleep Onset Latency (SOL) was defined as the time between lights off and sleep onset; Total Sleep Time (TST) was defined as time spent asleep determined from sleep start to sleep end, minus any wake time; Sleep Efficiency (SE) was defined as the TST divided by the TIB (expressed as a percentage).

Each morning, the player was asked to rate his overall perceived sleep quality using a visual 10-point analogue scale, where 1 equals “excellent” and 10 equals “very poor”.

Interviews were conducted in order to enable the player to describe experiences in his own words. Each interview session started with the player’s recent performance. Then the conversation gradually narrowed down to topics related to his sleeping experience. Questions such as his nervousness and/or thoughts related to the match result provided the interviewer with insights into changes in his sleeping habits. Each interview session was conducted in a relaxed and comfortable atmosphere for the player. The issue of confidentiality was of critical concern; the player was given assurances that no negative impact from the research would affect his career progression.

Statistical Analyses

Simple descriptive statistics are reported as means ± standard deviations (SD). Comparisons between baseline and nights before injury occurrence / night after evening soccer match were assessed through the difference in change scores. Effect size data (ES) was calculated to determine the magnitude of the change score and was assessed using the following criteria: $<$ 0.2 = trivial, 0.2–0.6 = small, 0.6–1.2 = moderate, 1.2–2.0 = large, and $>$ 2.0 = very large.

RESULTS

Time loss due to injury

Throughout the study period, the player played 20.6 h in 15 matches, while the daily training load was 332±227 AU. A total of 3 injuries in matches (n=2) and training (n=1) were reported over the study period. The player successively suffered a groin tear (Day 12; moderate severity: 13 days), hamstring strain (Day 26; moderate severity: 10 days) and finally an ankle sprain injury (Day 115; major severity: 29 days). The player missed 3 competitive matches and was not available for a total of 23 days.

Sleep

The Athlete's Morningness–Eveningness Scale (29) revealed that the player's chronotype was mid range (18 to 23). Changes into player's sleep behaviour from baseline were examined over the considered period (Table 2). Sleep onset latency in the nights before injury occurrence was compared to the measured sleep onset latency during baseline (18±13 min) and was found to be systematically outside the intra-individual variability (mean ± 1SD), with a very large difference (ES = 3.1). Similarly, sleep efficiency in the nights before injury occurrence (66-79%) was found to be systematically outside the intra-individual variability reported during baseline (90±3%), with a very large difference (ES = 3.2). Sleep onset latency in the week before injury occurrence (78±50 min) was longer than the measured sleep onset latency during baseline (18±13 min), with a large difference (ES = 1.6). Similarly, sleep efficiency in the week before injury occurrence (75±7%) was outside the intra-individual variability reported during baseline (90±3%), with a very large difference (ES = 2.8).

Throughout the study period, the player played 12 evening matches (kick-off time between 19:00-21:05). Sleep onset latency in the night after an evening match (65±35 min) was longer than the measured sleep onset latency during baseline (18±13 min), with a large difference (ES = 1.8). Similarly, sleep efficiency in the night after an evening match (70±10%) was outside the intra-individual variability reported during baseline (90±3%), with a very large difference (ES = 2.7). Subjective sleep quality in the night after an evening match was rated lower than reported during baseline (7.1±2.0 versus 5.0±2.0, respectively).

DISCUSSION

The present case study allowed for an examination of the relationship between sleep and injury occurrence in an elite soccer player. Here, sleep onset latency and sleep efficiency were altered on both the night before the injury and in the week of injury occurrence. In addition to objective sleep assessment, qualitative interviews were performed to investigate not only how the player slept, but also the psycho-socio-physiological acute and chronic stressors affecting his sleep.

Leeder et al. (20) proposed that as good practice, reference data for “normal” athlete sleep behaviours measured in their own homes should be obtained, to allow for comparisons with heavy training and competing (home/away) schedules. The elite (Olympic) athletes investigated in their study normally spent 516±53 min in bed and slept 415±43 min with a high inter-individual variability in sleep measures. The player studied here matches these sleep characteristics of a “normal” athlete (20). Additionally, his sleep efficiency - a sensitive metric for estimating sleep quality - was 90±3% during baseline, whereas a measure below 85% is considered as indicative of disorder (12). As the player did not outline any medically diagnosed sleeping disorder before the study, the present case may be viewed as a “normal” sleeper into “normal” conditions, i.e. during a training week in familiar home environment.

However, as a regular starter for his club involved in domestic and UEFA continental matches, the player was frequently exposed to various situations and conditions that can interfere with sleep. Firstly, several studies have revealed that following an evening match (kick off after 18:00), sleep onset occurs significantly later, time in bed is significantly shorter and the amount of sleep obtained is significantly less than following a day match and/or training day (31,34). Our results agree with these previous reports, as sleep in the night after an evening soccer match (kick-off time between 19:00 and 21:05) is worse when compared to baseline, both objectively (i.e. sleep onset latency, sleep efficiency) and subjectively (sleep quality). The qualitative interviews were used to explain the reasons for difficulty in initiating and/or maintaining sleep in such circumstances. The main reasons reported by the player to explain his altered sleep after the 12 evening soccer matches studied were: "match-induced nervousness and/or thoughts on the match" (42% of matches) and "muscle damage and muscle/joint soreness" (25%). Interestingly, the player also explained that a very late bedtime (2:12) after a home evening match (kick-off time: 20:00) was also due to recovery strategies (i.e. cold bath and post-match meal) and social requirements (post-match interviews in VIP lounges). After an evening match, an elite soccer player may consequently experience insomnia-like symptoms, which is viewed as a disorder of hyperarousal, with the healthy transition from wake to sleep being substantially inhibited by two processes, cognitive arousal and attentional bias (12). Future studies are required to assess the effectiveness of "down time" strategies (e.g. stress management techniques) implemented between the end of an evening match and bedtime on sleep measures. In the present case study, mean wake up time after an evening match was 8:47±1:22, due to morning recovery sessions being planned at 10:00 (Table 1). The manager (60 years old) was an ex-professional player and held strong conservative ideas/traditions acquired through his own professional soccer career (27). Future studies are required to assess how coaches' sleep, by comparing it to the players, especially after an evening match. Such studies may assist in finding an optimal balance between scheduling morning training sessions and restricting sleep opportunity (32), despite preventing any "social jet lag" (18).

When playing two evening matches per week, a very late bedtime and early wake up time can lead to repetitive sleep curtailment, which may finally lead to sleep restriction. In conjunction with the accumulation of muscle damage, sleep restriction may be detrimental to the outcome of the recovery process after a match and may eventually predispose the individual to a greater risk of injury (4,25,28). Two potential arguments for delayed recovery in a sleep-deprived condition are that sleep restriction leads to a greater amount of exercise-induced damage and/or there is an impaired rate of repair after an exercise bout (2). Additionally, sleep restriction may result in an increased predisposition to injury due to decreased concentration, alertness and attention, reduced reaction time and response speed, and poor sports-specific skill execution (7,14,37). In the present case study, both sleep onset latency and sleep efficiency were altered both in the single night and the week before injury occurrence. These results are in contrast to those by Dennis et al. (3) who found that sleep duration and efficiency were significantly greater in the week of injury occurrence (437±61 min and 82±7%) than during the previous 2 weeks (414±64 min and 79±7%). Notably, differences in baseline efficiency values between studies (90±3 versus 79±7%) may explain this discrepancy. Throughout the study, the player spent 14 nights (12% of the total nights) before home and away matches in an unfamiliar hotel environment. Described by Suetsugi et al. (36) "the first night effect" may potentially contribute to the large impairments in sleep onset latency and/or sleep efficiency observed before injury occurrence. The player's nap frequency (i.e. the percentage of days on which a nap was taken) reached 20% when the player was available for training participation and team selection, which is twice more than for data reported in elite team sports (19). However, nap frequency decreased up to 9% during the injury-induced unavailability period. To explain this behaviour change, the player said: "I would like to nap more but medical care is mandatory at 16:00". During the return period from injury, a player is usually involved in the gym and/or treatment room and/or on the pitch at least twice per day. This procedure may consequently disrupt habitual sleeping patterns. Future studies are needed to ascertain the role of sleep (and especially napping) on injury recovery (e.g. rate of muscle repair).

Lastly, some methodological aspects of the present case study must be considered. The overall level of evidence for previous injury as a risk factor for both injuries of the same type and/or another location is high (23). In the present study, injuries of the same type and anatomical location were not included in the data analysis. However, we cannot exclude a potential bias arising from repeated measures on the same player. This contributes to the low level of evidence assigned to non-analytic studies such as case reports and case series (15). Future studies are required to investigate the link between sleep and injury occurrence in a whole team during a heavy playing schedule.

CONCLUSION

This case study was conducted as a real-world applied example for other players and practitioners seeking to deploy sleep hygiene strategies to reduce injury risk and maximize player availability. Sleep onset latency and sleep efficiency may be particularly useful sleep variables to track during congested playing schedules in order to prevent injury occurrence. Therefore, sport scientists should address each individual's post-match sleep to better appraise this fundamental physiological component in an attempt to enhance recovery and preparations for subsequent training and/or performance. Individualized assessment of sleep and sleep hygiene using actigraphy and sleep diaries/questionnaires, with consideration to physiological (e.g. caffeine intake), behavioural (e.g. screen use/viewing 1 h before bed), environmental (e.g. room temperature) and psychological (e.g. stressors) factors, is recommended. Based on this approach, individualised sleep interventions that focus on education, awareness and practical guidance can be provided to each athlete (34).

PRACTICAL APPLICATIONS

- Sleep onset latency and sleep efficiency may be particularly useful sleep variables to track during congested playing schedules in order to prevent injury occurrence
- Sleep in the night after an evening soccer match is deteriorated both objectively and subjectively
- Assessing sleep on a case-by-case basis is a promising strategy in an attempt to enhance recovery and preparations for subsequent training and competition

ACKNOWLEDGEMENTS

The authors have no conflicts of interest that are directly relevant to the content of this article. No financial support was provided for this study. Results of this study do not constitute endorsement of the product by the authors or the National Strength and Conditioning Association.

REFERENCES

1. Ancoli-Israel, S, Cole, R, Alessi, C, Chambers, M, Moorcroft, W, and Pollak, CP. The role of actigraphy in the study of sleep and circadian rhythms. Sleep 26(3): 342-392, 2003.

2. Dattilo, M, Antunes, HK, Medeiros, A, Mônico Neto, M, Souza, HS, Tufik, S, and de Mello, MT. Sleep and muscle recovery: endocrinological and molecular basis for a new and promising hypothesis. Med Hypotheses 77(2): 220-222, 2011.

3. Dennis, J, Dawson, B, Heasman, J, Rogalski, B, and Robey, E. Sleep patterns and injury occurrence in elite Australian footballers. J Sci Med Sport 19(2): 113-116, 2016.

4. Dupont, G, Nedelec, M, McCall, A, McCormack, D, Berthoin, S, and Wisløff, U. Effect of 2 soccer matches in a week on physical performance and injury rate. Am J Sports Med 38(9): 1752–1758, 2010.

5. Foster, C, Florhaug, JA, Franklin, J, Gottschall, L, Hrovatin, LA, Parker, S, Doleshal, P, and Dodge, C. A new approach to monitoring exercise training. J Strength Cond Res 15: 109-115, 2001.

6. Fowler, P, Duffield, R, and Vaile, J. Effects of simulated domestic and international air travel on sleep, performance, and recovery for team sports. Scand J Med Sci Sports 25(3): 441-451, 2015.

7. Fullagar, HH, Skorski, S, Duffield, R, Hammes, D, Coutts, AJ, and Meyer, T. Sleep and athletic performance: the effects of sleep loss on exercise performance, and physiological and cognitive responses to exercise. Sports Med 45(2): 161-186, 2015.

8. Fullagar, HH, and Bartlett, JD. Time to wake up: individualising the approach to sleep promotion interventions. Br J Sports Med 50(3): 143-144, 2016.

9. Fuller, CW, Ekstrand, J, Junge, A, Andersen, TE, Bahr, R, Dvorak, J, Hägglund, M, McCrory, P, and Meeuwisse, WH. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. Scand J Med Sci Sports 16(2): 83-92, 2006.

10. Fuller, KL, Juliff, L, Gore, CJ, Peiffer, JJ, and Halson, SL. Software thresholds alter the bias of actigraphy for monitoring sleep in team-sport athletes. J Sci Med Sport 20(8): 756-760, 2017.

11. Guilhem, G, Doguet, V, Hauraix, H, Lacourpaille, L, Jubeau, M, Nordez, A, and Dorel, S. Muscle force loss and soreness subsequent to maximal eccentric contractions depend on the amount of fascicle strain *in vivo*. Acta Physiol 217(2): 152-163, 2016.

12. Gupta, L, Morgan, K, and Gilchrist, S (2016). Does elite sport degrade sleep quality? A systematic review. Sports Med 47(7): 1317-1333, 2017.

13. Hägglund, M, Waldén, M, and Ekstrand, J. Exposure and injury risk in Swedish elite football: a comparison between seasons 1982 and 2001. Scand J Med Sci Sports 13(6): 364-370, 2003.

14. Halson, SL. Sleep in elite athletes and nutritional interventions to enhance sleep. Sports Med 44(Suppl 1): S13-23, 2014.

15. Harbour, R, and Miller, J. A new system for grading recommendations in evidence based guidelines. BMJ 323(7308): 334-336, 2001.

16. Hausswirth, C, Louis, J, Aubry, A, Bonnet, G, Duffield, R, and LE Meur, Y. Evidence of disturbed sleep and increased illness in overreached endurance athletes. Med Sci Sports Exerc 46(5): 1036-1045, 2014.

17. Ispirlidis, I, Fatouros, IG, Jamurtas, AZ, Nikolaidis, MG, Michailidis, I, Douroudos, I, Margonis, K, Chatzinikolaou, A, Kalistratos, E, Katrabasas, I, Alexiou, V, and Taxildaris, K. Time-course of changes in inflammatory and performance responses following a soccer game. Clin J Sport Med 18(5): 423-431, 2008.

18. Kabrita, CS, Hajjar-Muça, TA, and Duffy, JF. Predictors of poor sleep quality among Lebanese university students: association between evening typology, lifestyle behaviors, and sleep habits. Nat Sci Sleep 6: 11-18, 2014.

19. Lastella, M, Roach, GD, Halson, SL, and Sargent, C. Sleep/wake behaviours of elite athletes from individual and team sports. Eur J Sport Sci 15(2): 94-100, 2015.

20. Leeder, J, Glaister, M, Pizzoferro, K, Dawson, J, and Pedlar, C. Sleep duration and quality in elite athletes measured using wristwatch actigraphy. J Sports Sci 30(6): 541-545, 2012.

21. Luke, A, Lazaro, RM, Bergeron, MF, Keyser, L, Benjamin, H, Brenner, J, d'Hemecourt, P, Grady, M, Philpott, J, and Smith, A. Sports-related injuries in youth athletes: is overscheduling a risk factor? Clin J Sport Med 21(4): 307–314, 2011.

22. Mah, CD, Mah, KE, Kezirian, EJ, and Dement, WC. The effects of sleep extension on the athletic performance of collegiate basketball players. Sleep 34(7): 943-950, 2011.

23. McCall, A, Carling, C, Davison, M, Nedelec, M, Le Gall, F, Berthoin, S, and Dupont, G. Injury risk factors, screening tests and preventative strategies: a systematic review of the evidence that underpins the perceptions and practices of 44 football (soccer) teams from various premier leagues. Br J Sports Med 49(9): 583-589, 2015.

24. Milewski, MD, Skaggs, DL, Bishop, GA, Pace, JL, Ibrahim, DA, Wren, TA, and Barzdukas, A. Chronic lack of sleep is associated with increased sports injuries in adolescent athletes. J Pediatr Orthop 34(2): 129–133, 2014.

25. Nédélec, M, Halson, S, Abaidia, AE, Ahmaidi, S, and Dupont, G. Stress, sleep and recovery in elite soccer: a critical review of the literature. Sports Med 45(10): 1387-1400, 2015.

26. Nédélec, M, McCall, A, Carling, C, Legall, F, Berthoin, S, and Dupont, G. Recovery in soccer: part I—post-match fatigue and time course of recovery. Sports Med 42(12): 997–1015, 2012.

27. Ono, M, Kennedy, E, Reeves, S, and Cronin, L. Nutrition and culture in professional football. A mixed method approach. Appetite 58(1): 98-104, 2012.

28. Opar, DA, Williams, MD, and Shield, AJ. Hamstring strain injuries: factors that lead to injury and re-injury. Sports Med 42(3): 209-226, 2012.

29. Postolache, TT, Hung, TM, Rosenthal, RN, Soriano, JJ, Montes, F, and Stiller, JW. Sports chronobiology consultation: from the lab to the arena. Clin Sports Med 24(2): 415-456, xiv, 2005.

30. Roach, GD, Schmidt, WF, Aughey, RJ, Bourdon, PC, Soria, R, Claros, JC, Garvican-Lewis, LA, Buchheit, M, Simpson, BM, Hammond, K, Kley, M, Wachsmuth, N, Gore, CJ, and Sargent, C. The sleep of elite athletes at sea level and high altitude: a comparison of sea-level natives and high-altitude natives (ISA3600). Br J Sports Med 47(Suppl. 1): i114-120, 2013.

31. Sargent, C, and Roach, GD. Sleep duration is reduced in elite athletes following night-time competition. Chronobiol Int 33(6): 667-670, 2016.

32. Sargent, C, Halson, S, and Roach, GD. Sleep or swim? Early-morning training severely restricts the amount of sleep obtained by elite swimmers. Eur J Sport Sci 14 (Suppl. 1): S310-315, 2014.

33. Sargent, C, Lastella, M, Halson, SL, and Roach, GD. The validity of activity monitors for measuring sleep in elite athletes. J Sci Med Sport 19(10): 848-853, 2016.

34. Shearer, DA, Jones, RM, Kilduff, LP, and Cook, CJ. Effects of competition on the sleep patterns of elite rugby union players. Eur J Sport Sci 15(8): 681-686, 2015.

35. Stroh, M. Qualitative interviewing. In: Research Training for Social Scientists. D. Burton, ed. London: Sage, 2000. pp. 196-214.

36. Suetsugi, M, Mizuki, Y, Yamamoto, K, Uchida, S, and Watanabe, Y. The effect of placebo administration on the first-night effect in healthy young volunteers. Prog Neuropsychopharmacol Biol Psychiatry 31(4): 839-847, 2007.

37. Walters, PH. Sleep, the athlete, and performance. Strength Cond J 24:17-24, 2002.

Table 1. A typical in-season week for the player supported in this case study

Day	Morning	Afternoon
Monday	10:00: recovery (bike 25 min; ice bath; massage)	Off
Tuesday	10:00: injury prevention (20 min); team training (moderate intensity; 45 min)	Off
Wednesday	10:00: team training (moderate intensity; 70 min)	Off
Thursday	Off	21:05: UEFA Europa League match
Friday	10:00: recovery (bike 25 min; ice bath; massage)	Off
Saturday	10:00: team training (low intensity; 45 min)	Off
Sunday	Off	14:00: French League 1 match

UEFA: Union of European Football Associations

Team training = attacking and defensive patterns, match plans and general skills; Injury prevention = proprioceptive exercises, Nordic hamstring lowers, good morning, calf eccentric exercises and abdominal core (plank and side plank)

Table 2. Sleep variables during baseline, the week/night before injury occurrence and after an evening soccer match (mean±SD).

	Baseline	Week before injury occurrence	Night before injury occurrence (n=3)			Night after evening soccer match
Time in bed (min)	449±53	479±83	619	481	519	429±77
Sleep onset latency (min)	18±13	78±50	118	159	73	65±35
Total sleep time (min)	406±52	357±65	459	316	408	302±77
Sleep Efficiency (%)	90±3	75±7	74	66	79	70±10
Subjective sleep quality (AU)	5.0±2.0	5.3±1.4	4	6	4	7.1±2.0

AU = arbitrary unit