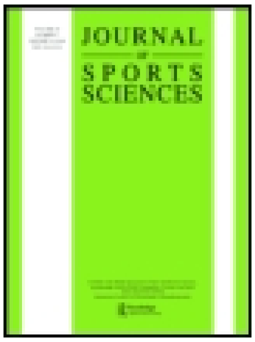

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Impaired sleep and recovery after night matches in elite football players

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ABSTRACT

Despite the perceived importance of sleep for elite footballers, descriptions of the duration and quality of sleep, especially following match play, are limited. Moreover, recovery responses following sleep loss remain unclear. Accordingly, the present study examined the subjective sleep and recovery responses of elite footballers across training days (TD) and both day and night matches (DM and NM). Sixteen top division European players from three clubs completed a subjective online questionnaire twice a day for 21 days during the season. Subjective recall of sleep variables (duration, onset latency, time of wake/sleep, wake episode duration), a range of perceptual variables related to recovery, mood, performance and internal training loads and non-exercise stressors were collected. Players reported significantly reduced sleep durations for NM compared to DM (−157 min) and TD (−181 min). In addition, sleep restfulness (SR; arbitrary scale 1 = very restful, 5 = not at all restful) and perceived recovery (PR; acute recovery and stress scale 0 = not recovered at all, 6 = fully recovered) were significantly poorer following NM than both TD (SR: +2.0, PR: −2.6), and DM (SR: +1.5; PR: −1.5). These results suggest that reduced sleep quantity and quality and reduced PR are mainly evident following NM in elite players.

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KEYWORDS
Soccer; circadian rhythms; night; travel; regeneration; performance

Introduction

Self-reported sleep loss is suggested as a common occurrence prior to competition in elite athlete populations (Erlacher, Ehrlenspiel, Adegbesan, & Galal El-Din, 2011; Juliff, Halson, & Peiffer, 2015), which can result in a reduction in ensuing athletic performance outcomes (Edwards & Waterhouse, 2009; Jarraya, Jarraya, Chtourou, & Souissi, 2013; Reyner & Horne, 2013). However, despite these suggestions, there is limited evidence to highlight that team-sport athletes, particularly elite footballers, experience sleep issues as part of their normative behaviour (Erlacher et al., 2011; Juliff et al., 2015). In addition, sleep behaviour following competitive match play remains unclear (Fowler, Duffield, & Vaile, 2014). This is concerning, given the proposed relationship between sleep loss and reduced recovery in team-sport athletes (Fullagar et al., 2015; Skein, Duffield, Minett, Snape, & Murphy, 2013). Furthermore, it is not known whether footballers' sleep quality and quantity differs following training days (TD) and match play. Therefore, further research investigating the behavioural sleeping patterns of elite footballers is warranted.

Sleep issues experienced by team-sport athletes are postulated to be predominately situational and sport-dependant, though explicit evidence is minimal (Juliff et al., 2015). For instance, on the night of an Australian football match sleep duration was significantly decreased to a similar degree whether home or away by 68 and 64 min, respectively (Fowler et al., 2014). Of the various team sports, association football is one which comprises numerous situations which may disrupt players' sleeping patterns; including periods of travel, congested fixture scheduling and training or playing at night (Fullagar et al., 2015). However, data to support these perceptions, especially with regards to training and playing at night, are unclear. For instance, whilst football players' sleep volume is reportedly reduced following a night match (NM) (Meyer, Wegmann, Poppendieck, & Fullagar, 2014; Nédélec et al., 2012), some have reported no effect of NM (Roach et al., 2013) or early evening high-intensity training (Robey et al., 2013) on sleep duration and quality in elite junior players. Therefore, more research is required to confirm whether football players' sleep is hindered following NM. Perhaps more importantly, whilst studies have investigated player sleeping patterns in comprising situations that is travel and NM (Fullagar et al., 2015), there is no study at present which has monitored *elite* footballers for more than an acute period (i.e., 1 week) during the regular season to give an accurate indication of a professional player's normal sleeping behaviour.

The lack of data surrounding sleep following match play is concerning, since these periods of sleep loss could potentially compromise the recovery process (Skein et al., 2013). Fowler et al., (2014) reported significant reductions in sleep duration and quality, along with an impaired stress–recovery balance, on the night of a match compared to the night prior for away matches in elite Australian footballers. Nonetheless, the evidence as to what are normal sleep and recovery responses within elite football is currently lacking. Accordingly, the

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Supplemental data for this article can be accessed here.

purpose of the present study was to monitor the sleeping patterns of elite football players and to assess whether differences in sleep indices occurred in association with an altered perceptual recovery status. If sleep issues were present, we aimed to identify any potential factors within the professional sporting environment (e.g., stress, physical or psychological load) which contributed to these poor sleeping patterns, with a specific focus on the presentation of individual results.

Methods

Participants

Sixteen elite male football players participated in the present investigation (mean standard deviation (SD) age 25.9 ± 7.5 years, body mass 74.8 ± 8.9 kg, height 179.5 ± 12.1 cm). The players were representatives of three UEFA© clubs within the top division in either Germany (Bundesliga) or the Netherlands (Eredivisie). Players were given information regarding the synopsis of the study and the associated risks, and if they wished to participate they provided written informed consent. The study was conducted in accordance with the Declaration of Helsinki and was approved by the institutional Human Research Ethics Committee (Saarland University).

Study design

The present study was a descriptive, observational design. All players were familiarised with the study procedures prior to the collection of data, which was obtained over a 21-day period during either the second half of the 2013/2014 or the first half of the 2014/2015 season. Measures were obtained twice per day, whereby participants were asked to complete a sleep and sporting activity questionnaire (SosciSurvey™) in the morning after awakening, and at night prior to sleeping. This questionnaire was completed online, on the player's personal laptop or smart phone, and accessed through individual case-protected web URL links, ensuring complete confidentiality. Training schedules were set at the discretion of the team coaches and conditioning staff. Matches were scheduled by the respective external football organisations. Within this 21-day period, players did not complete the questionnaire on "rest" days (e.g., days which they were away from the football club). Each player had approximately one designated rest day per week. Thus, players completed the questionnaire for 18 days/nights. At the end of the collection period, data sets which had an overall completion rate of 90% or greater were retained for analyses. These data sets were also required to include at least three matches for each player during this period (two day matches (DM), one NM) where the player played at least 60 min of match play. Within these included data sets, days were categorised into "training days" (day in which the player attended and participated in structured training), "day matches" (matches which concluded before 6 pm) and "night matches" (matches which kicked off after 6 pm; see Sections 2 and 2.4) for final analyses. If a participant experienced a prolonged injury or illness during the data collection period (>1 weeks), he was also excluded from analyses. Furthermore, players who were recovering from an injury incurred immediately prior to data collection were also excluded. From the 25 players originally recruited for the study, 16 were retained for final analyses. In total, 235 TD, 32 DM and 16 NM responses were analysed.

Study procedures

A subjective sleep questionnaire was used to assess players' sleep habits, perceptual fatigue and stress prior to and following training and matches. This questionnaire was previously created as part of the Regman™ recovery project, in which the authors' institute is a co-partner. Although measures of sleep were subjective in nature, the sleep indices within the questionnaire have previously been validated against objective measures of actigraphy, with time in bed (ICC = 0.93–0.95) and total sleep time (ICC = 0.90–0.92) revealing strong agreement (Kölling, Endler, Ferrauti, Meyer, & Kellmann, 2015). This questionnaire (provided as Supplemental data) also included an evaluation of the numerous variables within a professional football team environment (i.e., non-exercise stressors such as press conferences) which could potentially affect recovery following training or match play (Nédélec et al., 2013). The morning section was used to ascertain information about the previous night's sleep including questions relating to "restfulness" (sleep quality: 1 = very restful, 5 = not at all restful), "reasons for un-restfulness", details about sleep disturbances (if they were present), the duration of total sleep time and a short scale of general perceptual recovery (0 = not recovered at all, 6 = fully recovered; Kölling et al., 2014). Total sleep time was calculated as:

[(Δ of sleep duration between bedtime and awakening time) – duration of sleep onset latency – total wake episode duration].

For example [(23:15 – 07:15) – 15 min – 15 min] = 7 h 30 min of sleep.

Comparatively, the evening section asked closed-response questions such as how "relaxed" and "exhausted" the players felt, how they rated their "overall performance" for the day, whether they slept during the day (naps; this was calculated outside total sleep time at night), and then required them to provide open-response details of any "additional stress or non-exercise loads" they experienced that day. In addition, if participants played in a match, they provided details regarding kick-off time, personal playing time, sessional rating of perceived exertion (s-RPE = min played × RPE (Borg, 1998; Foster et al., 2001), match location (home or away), result (win, lose, draw), sleeping location (home, hotel, other) and travel duration from stadium to place of sleep (all closed response questions). When players trained, but didn't play, they provided s-RPE.

Statistical analyses

Data are presented as means ± SD for bedtime, awakening time, sleep duration, sleep onset latency, wake episodes, wake episode duration, sleep restfulness (SR) and recovery. Means ± SD were also used to describe the internal load from both training and matches (min of activity × RPE) and the average non-exercise induced stress (scale 0–100). The percentage (%) of each answer for the closed response questions relating to "tenseness", "exhaustion", "general overall performance" was calculated. For comparative statistics, three different conditions were assessed: TD, DM (matches which concluded before 6 pm) and NM (matches which kicked off after 6 pm). Repeated measures analysis of variance were calculated between conditions (TD vs. DM, DM vs. NM, NM vs. TD) for bedtime, awakening time, sleep duration, sleep onset latency, wake episodes, wake episode duration, SR and recovery. When a significant main effect was found, a post hoc Bonferroni adjustment was used to assess pairwise comparisons of the estimated marginal means. Independent *t*-tests were utilised to analyse sleep duration differences between home and away locations for DM and NM (all home vs. all away matches). Additional descriptive data that listed reasons for un-restfulness were used for the presentation of individual case reports. All statistical analyses were calculated using SPSS (v27, SPSS Inc., Chicago, IL, USA) with significance set at $P < 0.05$. Furthermore, standardised effect size (Cohen's *d*; ES) analyses were used to interpret the magnitude of the mean differences between conditions for all sleep and recovery parameters with $d < 0.20$ (trivial), $d = 0.20$ (small), $d = 0.50$ (medium) and $d \geq 0.80$ (large) (Cohen, 1988).

Results

Sleep variables

All sleep variables are presented in Table 1, with mean and individual data for sleep duration for TD, DM and DM in Figure 1. Bedtime was significantly later for NM compared to both DM (+189 min; $P < 0.001$, $d = 2.61$) and TD (+248 min; $P < 0.001$, $d = 3.70$) and for DM compared to TD (+59 min; $P = 0.007$, $d = 1.95$), whilst awakening time was significantly earlier for TD compared to both DM (–45 min; $P < 0.001$, $d = 2.01$) and NM (–70 min; $P < 0.001$, $d = 2.45$). Sleep onset latency was significantly greater for NM compared to TD (+10 min; $P = 0.03$, $d = 1.60$) but not different between DM and NM ($d = 0.64$) or TD and DM, despite a large ES being present ($P = 0.42$, $d = 0.96$). Sleep duration for NM was significantly less than DM (–157 min; $P < 0.001$, $d = 3.71$) and TD (–181 min; $P < 0.001$, $d = 4.31$), although there were no differences between DM and TD ($P = 0.33$, $d = 0.60$). No significant differences were evident between any condition for wake episodes ($P > 0.05$). SR was significantly poorer following NM than both TD ($P < 0.001$, $d = 3.56$) and DM ($P = 0.007$, $d = 3.16$).

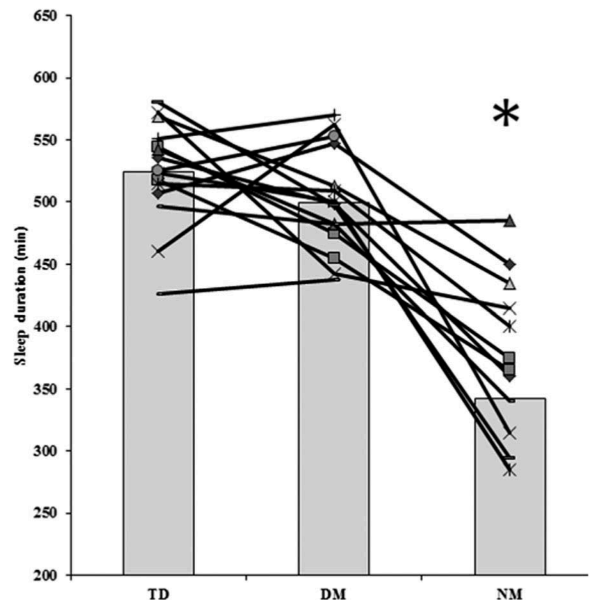

Figure 1. Mean (shaded bars) and individual cases ($n = 16$) of sleep duration for a training day (TD), day match (DM) and a night match (NM).*Significant difference between NM and both TD and DM ($P < 0.05$).

Table 1. Subjective sleep responses following a normal training day (TD), day match (DM) and night match (NM) in elite soccer players collected over a 21-day period during the regular season.

$n = 16$	TD	DM	NM
Bedtime	23:19 ± 0:49	00:18 ± 1:24#	03:27 ± 1:56*
Awakening time	08:24 ± 1:07	09:09 ± 1:10#	09:34 ± 0:47***
Sleep onset latency	16 ± 7	22 ± 13	26 ± 15***
Sleep duration (h)	8:44 ± 0:40	8:20 ± 0:41	5:43 ± 1:36*
Wake episodes (*n*)	2.0 ± 1.2	2.8 ± 1.1	0
Total wake episode duration (min)	22.0 ± 39.1	11.4 ± 4.4	N/A
Sleep restfulness (1 = very restful, 5 = not at all restful)	1.8 ± 0.7	2.3 ± 0.8	3.8 ± 1.1*
Number of players whom napped (at least once)	10**	1	3
Average duration of naps (min)	57 ± 36	30 ± –	77 ± 29

* Significant difference between NM and both DM and TD conditions ($P < 0.05$).
** Significant difference between TD and both DM and NM conditions ($P < 0.05$).
*** Significant difference between TD and NM condition ($P < 0.05$).
# Significant difference between TD and DM condition ($P < 0.05$).
NB: Napping data for TD was recorded during the day but *following* training, whereas napping data for DM and NM was recorded on the same day but *prior* to match play.

Subjective responses to exercise (training and matches)

All subjective wellness responses for TD, DM and NM are presented in Table 2. Perceptual recovery the following morning for NM was significantly less than both TD ($P < 0.001$, $d = 3.09$) and DM ($P = 0.007$, $d = 1.78$), whilst a large effect was present for TD compared to DM ($d = 1.31$). Subjective exercise load was significantly greater for both DM and NM than TD (both $P < 0.001$; DM: $d = 4.04$; NM: $d = 4.79$), although there were no significant differences between DM and NM ($P = 0.42$, $d = 0.74$). Comparatively, players ranked perceptual performance similar across conditions (Table 2). There were no significant differences between sleep durations for matches played at home or away (home: 290 ± 73 min, away: 316 ± 185 min, $P = 0.95$: two further players were excluded because they did not play both home and away). Players did not provide sufficient amount of details regarding sleeping location (home, hotel, other) and travel duration from stadium to place of sleep (these questions were optional); thus, these analyses were abandoned.

Individual case reports

As a practical example of the individualised nature of sleep responses, individual nightly sleep responses for four separate players (A–D), including duration and occurrences and reasons for "average-poor restfulness", are presented in Figure 2. For

Table 2. Subjective wellness responses for a normal training day (TD), day match (DM) and night match (NM) in elite soccer players collected over a 21-day period during the regular season. Means ± SD.

n = 16	TD	DM	NM
Tenseness (%)			
Tense	1	6	6
Pretty tense	8	16	38
Rather tense	7	31	6
Rather relaxed	22	16	6
Pretty relaxed	29	19	25
Relaxed	34	13	19
Performance (%)			
Good	27	22	25
Pretty good	34	38	44
Rather good	27	16	25
Rather bad	10	19	6
Rather bad	1	6	0
Bad	0	0	0
Exhaustion (%)			
No, not at all	38	19	25
A little	38	41	44
Quite	16	28	13
Yes, very	8	9	19
Recovery (0 = not recovered at all, 6 = fully recovered)	4.5 ± 0.7	3.4 ± 1.3	1.9 ± 1.1*
Non-exercise induced stress (n reported at least once; 0–100)	5; 47 ± 30	–	–
Training load (AU)	292 ± 195**	659 ± 195	698 ± 254
Listed reasons for sleep un-restfulness	Unfamiliar sleeping environment, nervousness, urination, children, wind, confrontation with coach, troubles with personal relationship	Children, urination, strenuous game	Adrenaline after the game, pain, strenuous game

* Significant difference between NM and both DM and TD conditions ($P < 0.05$).
** Significant difference between TD and both DM and NM conditions ($P < 0.05$).
Abbreviations: AU: arbitrary units (Training Load (TL) = session rating of perceived exertion (s-RPE) × duration in min).

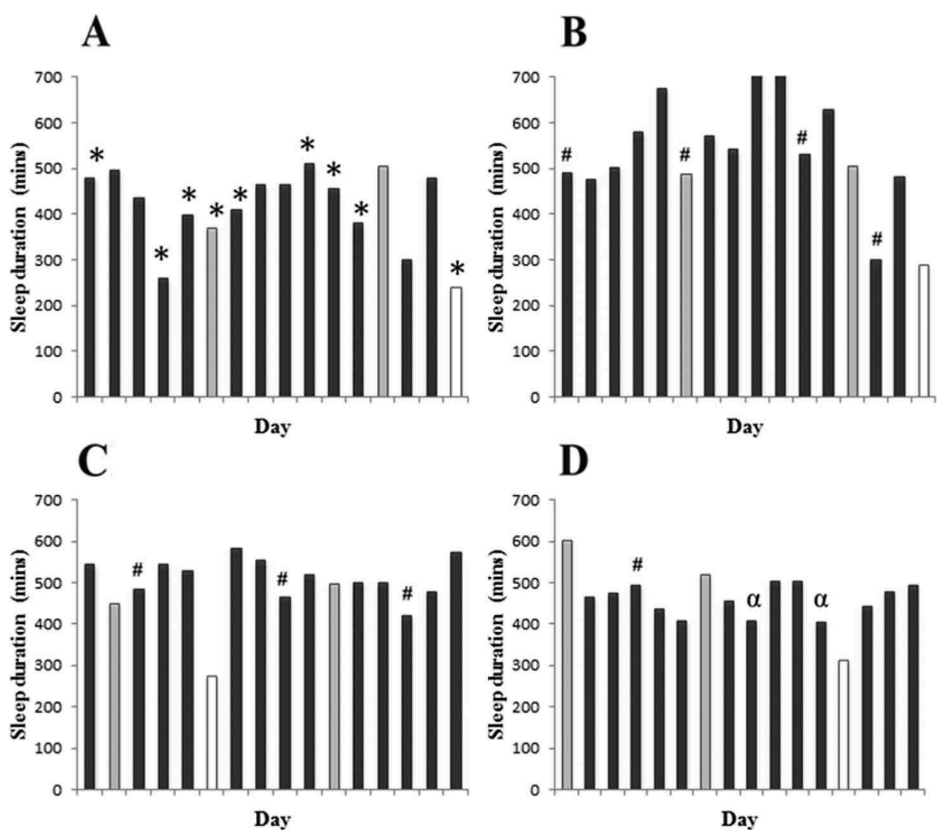

Figure 2. Examples of individual sleep duration responses (min) per night for four separate players (A–D) for the duration of the study. Abbreviations: training day in black bars; day match in light grey bars; night match in white bars.

* Indicates average-poor sleep restfulness with the reason provided being "newborn children".
# Indicates average-poor sleep restfulness with the reason provided being "urination".
α Indicates average-poor sleep restfulness with the reason provided being "nervousness".

instance, mean sleep duration for Player A was 476 ± 75 min (range 260–510 min) for TD, with the player reporting "average-poor restfulness" on 10 occasions all of which the reason was given due to "newborn children".

Discussion

The present investigation aimed to monitor the sleeping patterns of elite football players and to assess when reductions in sleep indices occurred; in addition to the perceptual recovery status. The main finding of this study was the significant reduction in sleep duration and later bedtime following NM compared to both TD and DM. Following these NM, there was also a significant reduction in perceived recovery (PR) compared to both DM and TD. Players subjectively reported several reasons for poor sleep such as children, nervousness, pain and adrenaline following a match. Overall, our results suggest that elite football players lose sleep and report reduced perceptual recovery following NM play; however, players appear to report adequate sleep durations (i.e., 7–10 h; National-Sleep-Foundation, 2013) and qualities following TD and DM.

Bedtime and total sleep duration were extended and reduced, respectively, following NM, supporting the idea that sleep indices are likely dependent on the situational demands and scheduling of the particular sport (Juliff et al., 2015; Sargent, Lastella, Halson, & Roach, 2014). These present observations of reduced sleep quantity in elite footballers are supported by objective evidence that elite rugby union players sleep less on game compared to non-game nights (Eagles, Mclellan, Hing, Carloss, & Lovell, 2014). Furthermore, professional Australian soccer players can lose 2–4 h of sleep following matches compared to non-match nights (Fowler et al., 2014), and a recent study states that 52.3% of elite (individual and team-sport) athletes subjectively report sleep disturbances following a late match or training session (Juliff et al., 2015). Comparatively, sleep duration on TD and following DM was within the presumed normal healthy range of 7–10 h in our study (National-Sleep-Foundation, 2013). Furthermore, match loads (calculated from s-RPE) were similar between DM and NM, and there were no significant differences between home and away matches. Thus, these data would suggest that there are particular nuances about a NM (compared to a DM) which cause this reduction in sleep duration outside reasons arising from the match/exercise itself. The most predictable reason for this would be the pure extension of a later bedtime caused by the timing of the match. The later bedtime, coupled with the environmental circumstance of a NM driving wakefulness over sleep at a time when the drive for sleep is normally stronger, likely explains the reduced sleep durations. Additionally, the evening exposure to light (depending on seasonal period) could also prolong sleep onset and reduce total sleep time (Malone, 2011). Another factor which is harder to control and report, but may play just as an important role, could be socialising (Fullagar et al., 2015). Collectively, these data suggest that although "normal" player sleep patterns may be sufficient, under specific circumstances (i.e., NM) there are cases for reduced sleep durations in professional footballers.

Following a similar trend to sleep duration, there were also significant reductions in perceptual recovery following NM compared to TD and DM. Since no difference was evident for subjective exercise loads between DM and NM, it might be speculated this subsequent altered recovery state could be attributed to the reduction in sleep quantity. Indeed, sleep deprivation following exercise can lead to reductions in the recovery of psychological or perceptual performance (Fullagar et al., 2015; Skein et al., 2013). For instance, Fowler and colleagues (2014) reported significant reductions in sleep duration and quality in six professional footballers, along with an impaired stress–recovery balance, on the night of a match compared to the night prior for away matches. The present result of a reduction in perceptual recovery may represent concerns for the practitioner, especially since the competitive match load may suggest the homeostatic need for recovery sleep would be higher compared to rest days (Romyn, Robey, Dimmock, Halson, & Peeling, 2015); and this appears to not have been provided here. Although speculative, this could have important repercussions for players during subsequent training and competition where this reduction in wellbeing could unnecessarily add to an already suppressed overall psychological state. More research which focuses on the interaction between sleep loss and a suppressed psychological state is required, especially in elite footballers, and whether any subsequent associations affect the acute recovery–stress balance and ensuing performance.

Sleep is certainly an individual response, and grouping players may not capture the nuances of such individuality. Consequently, we depict this in Figure 2, where four players' mean-sleep duration ranged from 460 to 581 min, with some players sleeping 2 h more than others on any given TD. Similarly, players' reasons for "average – unrestfulness" varied with contrasting answers such as "newborn children" (Player A) and "urination" (Player B). Clearly in this context, these two players will need contrasting approaches in order to address these issues. We believe this is a good example of how very simple data could potentially inform and change practice. Further analysis and presentation of individual cases within original scientific publications in the football science field is a proposal that is supported by coaches and practitioners. Indeed, quantifying, predicting and the overall understanding of the inter-individual differences in the "magnitude of responses" to matches or training ("the individual response") is gaining considerable applied and scientific interest (Hecksteden et al., 2015). All players reported reductions in sleep duration following NM. Thus, an improvement in sleep indices through such measures as sleep hygiene protocols following NM may seem advisable for these players. Indeed, sleep hygiene protocols have been shown to improve sleep duration and perceived soreness in elite tennis players (Duffield, Murphy, Kellett, & Reid, 2014); however, evidence of their efficacy in football is lacking. Another possible management strategy would be to implement napping strategies to supplement sleep, repay sleep debt and possibly improve the subsequent performance (Waterhouse, Atkinson, Edwards, & Reilly, 2007).

Although the primary aim of the present investigation was to monitor the subjective sleeping patterns of elite football players, an additional focus was to identify factors within their environment which could possibly contribute to poor sleeping quality. Juliff et al. (2015) reported from a sample of 283 individual and team-sport athletes the main reasons responsible for poor sleep were “thoughts about the competition” and “nervousness”. The players in our study also reported “nervousness” as one of the most common problems for average-poor SR during TD, along with “unfamiliar sleeping environment” and “urination”. For DM and NM, “strenuous game”, “pain” and “adrenaline after a game” were consistently present. Whilst the existing data set does not have the strength to determine whether a relationship (either correlation or causative) exists between these reasons for un-restfulness and various sleep indices, the description of these issues may provide important insight for practitioners or coaches. For instance, in Figure 2 it can be observed that Player A had higher mean sleep durations for TD (~8 h); however, there were some nights where he lost almost 4 h (lowest 4.3 h). This high variation was attributed to Player A’s newborn children, with the player listing this 10 times throughout the duration of the study. This provides a good practical example of additional issues which may not come under the realm of the “normally” considered reasons for disturbances to sleep quality and duration.

One of the limitations of the present study was the use of a subjective measure (online survey) of sleep. Such a measure makes it difficult to estimate sleep quantity and quality compared to objective measurements, including actigraphy and the “gold standard” polysomnography (PSG). Indeed, the previous work has shown subjective measurements can be imprecise (Kawada, 2008) and can be influenced by mood, memory bias and personality characteristics (Jackowska, Dockray, Hendrickx, & Steptoe, 2011). However, it has been shown that respondents are capable of estimating total sleep duration with significant accuracy (Armitage, Trivedi, Hoffmann, & Rush, 1997). Furthermore, subjective measurements of sleep are preferred within these elite football environments as they are less invasive or burdening than actigraphy or PSG. The present study entailed a fairly short sampling period (21 days), though still longer than other reported actigraphy data. However, we acknowledge that this makes it difficult to extrapolate our results, especially across different time points throughout a season. Furthermore, the sample size used in this study was low, limiting the significance of the results; however, this is not uncommon in studies with professional players. Indeed, it should be acknowledged that all players were first division elite players, making these results very practically applicable to elite football. Finally, players were comprised from different teams and countries where situations relating to team environment (e.g., travel, style and intensity of training) can differ.

Conclusion

The primary findings of this study were the significant reduction in sleep duration and later bedtime following NM compared to both TD and DM. Following NM, there was also a significant reduction in PR compared to both DM and TD. Players subjectively reported several reasons for poor sleep such as children, nervousness, and pain and adrenaline following a match. More research is required to objectively quantify and confirm that TD results in “normal” sleep durations, similarly that this sleep volume is severely hampered following NM. In addition, the effect of reduced sleep duration and quality on the recovery of exercise performance following NM in elite players is warranted. The present findings suggest that elite players lose significant amounts of sleep volume and quality following NM; however, these variables appear within healthy ranges for TD and DM.

Perspective

Our results suggest that elite soccer players have normal sleep durations during TD and match days; however, they lose sleep and report reduced perceptual recovery following NM play. Thus, suitable intervention strategies (e.g., sleep hygiene, napping the following day) following these NM should be investigated forthwith to alleviate these issues. Practitioners should also be aware of the possible altered physiological load in subsequent training sessions following sleep loss. This is obviously dependant on numerous factors including scheduling, travel and team/coach preference. Furthermore, it is important to understand the intra-individual variability in sleep requirement and duration. Given some players will respond differently to sleep compromising situations, such as a NM, considering the monitoring of sleep for periods during the season and interpreting worthwhile changes in data on the individual level would appear the most beneficial practice for elite players.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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