Journal of Sports Sciences

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rjsp20

A bespoke sleep monitoring and sleep hygiene intervention improves sleep in an U18 professional football player: A case study

Luke Edinborough, Jessica Hill, Mark Jarvis, Stewart Bruce-Low & Charles R Pedlar

To cite this article: Luke Edinborough, Jessica Hill, Mark Jarvis, Stewart Bruce-Low & Charles R Pedlar (2023) A bespoke sleep monitoring and sleep hygiene intervention improves sleep in an U18 professional football player: A case study, Journal of Sports Sciences, 41:4, 350-357, DOI: 10.1080/02640414.2023.2213032

To link to this article: https://doi.org/10.1080/02640414.2023.2213032

Published online: 14 May 2023.

JOURNAL OF SPORTS SCIENCES
2023, VOL. 41, NO. 4, 350–357
https://doi.org/10.1080/02640414.2023.2213032

Routledge
Taylor & Francis Group

SPORTS PERFORMANCE

OPEN ACCESS Check for updates

A bespoke sleep monitoring and sleep hygiene intervention improves sleep in an U18 professional football player: A case study

Luke Edinborough [a,b], Jessica Hill [a], Mark Jarvis [b], Stewart Bruce-Low [c] and Charles R Pedlar [a,d]

[a]Faculty of Sport, Allied Health and Performance Sciences, St Mary's University, Twickenham, UK; [b]Department of Sport Science, Southampton Football Club, Southampton, UK; [c]School of Health Sport & Bioscience, University of East London, London, UK; [d]Institute of Sport, Exercise and Health, Division of Surgery and Interventional Science, University College London (UCL), London, UK

ABSTRACT

This case study reports on a professional football player (age: 17.6 years) who was referred for sleep monitoring and intervention after reporting excessive night-time awakenings. The player undertook a series of subjective sleep assessments and objective sleep monitoring (activity monitor). Based on the data presented, a sleep hygiene intervention was prescribed. Numerical comparisons were made between pre-intervention (Pre) and post-intervention (Post) values. Objective values were also compared to reference data from a similarly aged professional cohort from the same club ($n = 11$). Wake episodes per night (Pre: 7.9 ± 3, Post: 4.5 ± 1.9; −43%) and wake after sleep onset (WASO; Pre: 74.3 ± 31.8 mins, Post: 50.0 ± 22.8 mins, −33%) were improved from Pre to Post. Compared to the reference data, mean wake episodes per night (Pre: 7.9 ± 3.0, reference: 4.6 ± 2.6; −42%) and WASO (Pre: 74.3 ± 31.8 mins, reference: 44.3 ± 36.5 mins; −40%) were all lower compared to Pre levels. Whilst causality cannot be proven, we observed multiple sleep metrics improving following an intervention. This provides a potential framework for practitioners looking to provide targeted sleep assessment and intervention.

ARTICLE HISTORY
Received 21 December 2022
Accepted 3 May 2023

KEYWORDS
Recovery; objective; subjective; wrist-actigraphy; athlete

Introduction

During competitive fixtures, professional football players engage in considerable amounts of high-intensity running and decelerations that can result in exercise-induced muscle damage and physiological disruption (Harper et al., 2019; Varley et al., 2017). Numerous recovery methodologies are employed to mitigate the symptoms of exercise-induced muscle damage and restore muscle function (Walsh et al., 2021), however, adequate sleep remains a pivotal factor in the restoration of both physiological and psychological homoeostasis (Walsh et al., 2021). Nevertheless, studies have highlighted suboptimal sleep quality in football players (Rijken et al., 2016), and observational studies have reported several factors that may influence sleep quality or quantity in footballers, including day type (e.g., match day, training day, start time etc.) (Edinborough et al., 2022), and/or travel commitments (Lastella et al., 2019).

Practitioners have a diverse range of methodologies at their disposal that are reported to support sleep in footballers. These range from mindfulness (Murawski et al., 2018), behavioural (Biggins et al., 2019; Murawski et al., 2018), or nutritional (Walsh et al., 2021) interventions to more novel cryotherapy (Douzi et al., 2019) and thermoregulatory (Aloulou et al., 2020) techniques. Interventions that support sleep hygiene have also gained prominence (Biggins et al., 2019) and refer to the practice of adhering to behaviours that facilitate sleep while avoiding behaviours that interfere with sleep. For example, warm showers before bed reduced sleep onset latency in academy football players (Whitworth-Turner et al., 2017) (control: 24 ± 15 mins, intervention: 17 ± 15 min), and one meta-analysis suggested that the ingestion of melatonin-rich foods before bedtime may improve sleep quality scores in adolescents (Yeh et al., 2022). In semi-professional footballers, a sleep hygiene strategy that maintained a dimly lit and cool room close to bedtime and limited electronic device use 30 minutes before lights-out successfully improved sleep duration (d = 1.5) (Fullagar et al., 2016). Similarly, a sleep hygiene intervention that focused on generic practical sleep habit guidance (McCloughan et al., 2014), followed by an individualised session was successful in improving sleep latency (~30 mins) in healthy professional cricket players who had not previously reported sleep issues (Driller et al., 2019).

Sleep is a highly variable phenomenon. Notwithstanding the interindividual differences in the physiological and cognitive responses to sleep loss (Nedelec et al., 2018), studies have also reported more prominent intraindividual variation in sleep efficiency and onset latency in professional footballers, as well as wider athletic populations (Leeder et al., 2012), compared to age-matched non-athletic controls (Whitworth-Turner et al., 2018). The cause of the variation is likely multifaceted, nevertheless, individual differences in chronotype and habitual tendencies render the prescription of generic sleep recommendations illogical (Fullagar & Bartlett, 2016). Consequently, an individualised approach developed in consensus with a multidisciplinary team (MDT) may be more suitable compared to team-wide interventions (Driller et al., 2019).

To the author's knowledge, there have been no reports examining the use of individualised interventions on professional athletes reporting sleep issues. Therefore, this case study

CONTACT Charles R Pedlar charles.pedlar@stmarys.ac.uk Faculty of Sport, Allied Health and Performance Sciences, St Mary's University, Twickenham, UK

reports on the results of an individualised monitoring and intervention strategy aimed at improving the subjective and objective sleep in a professional U18 football player who was referred after reporting perceived excessive night-time awakenings and excessive night-time sweating.

Methods

Participant

The participant (age: 17.6 yrs, height: 174 cm, weight: 73 kg), was a professional (full-time, contracted) footballer representing a category one English Premier League Academy. He played primarily as a central attacking midfielder and was referred for sleep monitoring and bespoke intervention after reporting perceived excessive night-time awakenings and perceived excessive night-time sweating to a member of the psychology team. Written informed consent was obtained before data collection, and this study was approved by the ethics committee at St Mary's University, Twickenham.

Case study procedure

Following referral, the procedures for the case study were agreed by an MDT (Figure 1) and were based on a sleep optimisation flow chart published in a consensus statement (Walsh et al., 2021). The player attended a consultation and underwent an objective sleep monitoring period before the MDT analysed the data and formulated a bespoke intervention. Finally, the player received the intervention and attended a debrief to ascertain its success and determine if any further support was needed. The purpose of this approach was to ensure that the player received the appropriate individualised support. The duration of each phase was dependent on the player's schedule and the nature of their bespoke intervention (Figure 1). In this instance, the MDT analysed and collaboratively formed the intervention package 14 days after the initial consultation and the intervention was delivered after 48 hours. The final debrief took place 28 days after the delivery of the intervention. All phases took place in-season, and the player continued their normal playing and training schedule throughout.

Subjective and objective sleep monitoring

To assess changes in the player's perceived sleep quality, insomnia severity, and daytime sleepiness, the player completed the Pittsburgh Sleep Quality Index (PSQI (Buysse et al., 1989)), Insomnia Severity Index (ISI (Bastien et al., 2001)), and Epworth Sleepiness Scale (ESS (Kendzerska et al.,)), respectively, during both the initial consultation and the final debrief. To gain holistic insights, the global score of each assessment was considered alongside individual components. If the player scored a component negatively, then this triggered further conversation around that topic. Furthermore, the player also completed the Morningness-Eveningness Questionnaire (MEQ (Natale et al., 2006)) and the Sleep Hygiene Index (SHI (Mastin et al., 2006)) to assess chronotype and sleep hygiene, respectively. These assessments were chosen based on the MDT experience.

The player was also given a wrist-worn activity monitor (ReadiBand, Fatigue Science, Vancouver BC, Canada) that detected nocturnal movements and used proprietary algorithms to estimate sleep quantity, awakenings per hour, total awakenings, wake after sleep onset (WASO), and sleep latency. The player was given the activity monitor during the initial consultation and asked to wear it as frequently as possible on his non-dominant wrist. The data was synced to cloud-based software via Bluetooth, and a tablet computer was used to examine the status of the activity monitor. This enabled the player to continue their normal schedule without interruption. If it required charging, then the activity monitor was collected from the player, charged, and returned later the same day. ReadiBands have demonstrated good inter-device reliability and accuracy compared to polysomnography (Chinoy et al., 2021; Driller et al., 2016). The player was objectively monitored for a total of 28 days and was only able to provide data from training days due to activity monitor adherence. All data provided was at least 1 day removed from competition.

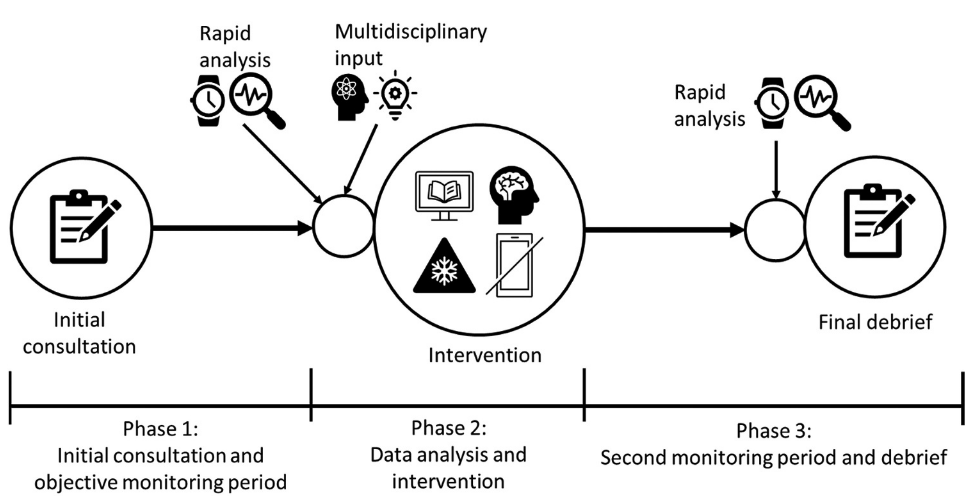

Figure 1. Case study schematic. Multidisciplinary input was provided by a panel consisting of a sports psychologist, a clinical psychologist (with a background in sleep referral), a strength and conditioning coach, and a sports physiologist.

The player's objective data was compared to data collected from a sample of U18 professional players ($n = 11$; 17.3 ± 0.7 yrs) from the previous year's cohort who were monitored using the same devices over a 10-week in-season period (reference data (Edinborough et al., 2022)). Considering the player in this study was only able to provide data on nights proceeding training days, only data from training days were included in the analysis from the reference data. The authors do not claim that the reference data is an example of good sleep for this population. Nevertheless, it does provide a proxy to establish what is normally experienced by players of the same demographic.

Bespoke sleep intervention

The intervention was formed collaboratively by the MDT. The meeting took 25 minutes and included a short case review of the baseline data and an open discussion. Potential interventions that were discussed included sleep hygiene education, mindfulness and/or cognitive therapy, and a thermal mattress to support nocturnal heat dissipation (Aloulou et al., 2020). All members of the MDT unanimously agreed that an individualised sleep hygiene education session, followed by further evaluation and intervention (if appropriate) would be the most efficacious, cost-effective, and quickest intervention to deploy.

The sleep hygiene intervention session took place 48 hours after the collaborative MDT meeting in the form of an informal presentation that covered the physiology of sleep initiation and evidence-based techniques to support sleep onset, as well as a discussion on their bedtime habits and evidence-based behaviours that supported sleep. The session content was tailored to the player based on the data collected from the initial consultation and advised on a regular bedtime routine, melatonin-rich foods, and showers before bed.

This session was provided by a sports physiologist with 3 years of experience in sleep research. Generalised sleep hygiene advice was also provided based on published recommendations (Halson, 2014; Vitale et al., 2019; McCloughan et al., 2014; Walsh et al., 2021). This guidance had previously been shown to improve sleep in professional athletes (Driller et al., 2019) and specific emphasis was placed on elements, raised during the consultation, that the MDT thought would have a targeted impact. A summary of the bespoke sleep hygiene strategy can be found in Table 1. The final debrief took place 28 days after the delivery of the intervention.

Analysis

Comparisons were made between Pre and Post-scores, as well as between Pre and Post-scores and the reference data.

Results

Pre-intervention observations

The SHI raised several areas of concern including, going to bed with psychological stress, using the bed for other activities rather than sleep or intimacy (e.g., sitting in bed watching television), and thinking or planning when in bed. During the consultation, the player also reported spending a large amount of time in the evening watching television or using electronic devices (Table 2). The player was rated as having poor sleep quality (PSQI: 22) and moderate insomnia (ISI: 15). Components that related to sleep onset latency, wake after sleep onset, feeling too hot, daytime sleepiness, enthusiasm, and overall sleep quality were rated most negatively. The

Table 1. Summary of the individualised and general advice provided to the player as part of their sleep hygiene strategy.

Targeted advice			
Player response		Strategy	Justification
1	The player reported getting into bed hours (e.g., to watch television) before attempting to sleep and was noted as having a moderate evening chronotype.	Advised player not to get into bed until he intended to sleep and to attempt sleep when he is tired.	This can reinforce a regular sleep routine and sleep onset attempts will occur during periods when melatonin release increases (Walsh et al., 2021).
2	The player typically showered in the morning or after training (approx. 1500 to 1700).	Advised to have a warm shower or bath within one hour of getting into bed. No specific temperature was advised as this could not feasibly be determined within the player's home. The player was advised to self-select a temperature that they perceived to be appropriate.	A warm shower before bed can improve sleep onset latency and may support the thermoregulatory process associated with sleep onset (Whitworth-Turner et al., 2017).
3	The players' secondary sleep complaints included night-time sweats.	Advised maintaining a cool sleeping environment. Methods discussed included opening widows and modulating central heating	Sleep onset has a thermoregulatory component. A cool sleeping environment may support this (Fullagar et al., 2016).
4	The player mentioned melatonin-rich foods (walnuts, almond milk) were in his most recent nutrition plan when several examples were presented.	Suggested consuming melatonin-rich foods, in line with their nutrition plan, closer to bedtime.	Melatonin initiates processes that are associated with sleep onset and depth (Yeh et al., 2022).
Additional general advice (Halson, 2014; Vitale et al., 2019; McCloughan et al., 2014; Walsh et al., 2021)			
1	Don't go to bed until you are sleepy. If you aren't sleepy, get out of bed and do something else until you become sleepy.		
2	Regular bedtime routines/rituals help you relax and prepare your body for bed (reading, warm bath, etc.).		
3	Try to get up at the same time every morning (including weekends and holidays).		
4	Try to get a full night's sleep every night and avoid naps during the day if possible (if you must nap, limit to 1 h and avoid napping after 15:00 p.m.).		
5	Use the bed for sleep and intimacy only; not for any other activities such as TV, computer, or phone use, etc		
6	Avoid caffeine if possible (if caffeine is consumed, avoid after lunch)		
7	Avoid alcohol if possible (if must use alcohol, avoid right before bed).		
8	Avoid blue light emitted from screens at least 2 h before bed (smartphones, laptop, monitors).		
9	Meditation/mindfulness may be helpful		

Table 2. Sleep hygiene index responses. A self-reported assessment of sleep hygiene behaviours (Mastin et al., 2006).

	Component	Response
1	I take daytime naps lasting two or more hours	Frequently
2	I go to bed at different times from day to day.	Sometimes
3	I get out of bed at different time from day to day.	Sometimes
4	I exercise to the point of sweating within 1 hour of going to bed.	Rarely
5	I stay in bed longer than I should two or three times a week.	Rarely
6	I use alcohol, tobacco, or caffeine within 4 hours of going to bed or after going to bed.	Never
7	I do something that may wake me up before bedtime (for example: play video games, use the internet, or clean).	Frequently
8	I go to bed feeling stressed, angry, upset, or nervous.	Sometimes
9	I use my bed for things other than sleeping or sex (for example: watch television, read, eat, or study)	Always
10	I sleep on an uncomfortable bed (for example: poor mattress or pillow, too much or not enough blankets).	Never
11	I sleep in an uncomfortable bedroom (for example: too bright, too stuffy, too hot, too cold, or too noisy)	Sometimes
12	I do important work before bedtime (for example: pay bills, schedule, or study).	Rarely
13	I think, plan, or worry when I am in bed.	Frequently
	Global Score	**24**

MEQ suggested that the player's chronotype was a moderate evening type.

The player provided 7 days of objective sleep data after the initial consultation. The days were not consecutive, and all recorded nights proceeded training days. The objective supported what was reported by the player. Specifically, the activity-monitor reported mean awakenings per night, awakening per hour, WASO, and sleep efficiency that was greater than the reference data (Figure 2).

Post-intervention observations

The player's Post-PSQI score improved compared to Pre- (Pre: 22, Post: 9), however, both remained above the threshold for "*poor*" sleep quality (>5). Components relating to sleep latency and WASO (Pre: once or twice a week, Post: less than once a week), and feeling too hot (Pre: three or more times a week, Post: less than once a week) were improved (Table 3). ISI classification was reduced from moderate insomnia to sub-threshold insomnia (Pre: 15, Post: 8). Components relating to sleep latency and WASO were both reduced from "*Moderate*" to "*Mild*", and the player's perceived satisfaction of his current sleep pattern improved from "*Dissatisfied*" to "*Satisfied*" (Table 4). Finally, the player's ESS classification also improved from "*Moderate*" to "*Mild*" daytime sleepiness (Pre: 15, Post: 11; Table 5). During the final debrief, the player self-reported a reduction in night-time awakenings and improved, but not absent, perceived night-time sweating.

The player provided 7 and 8 nights of objective data for Pre and Post, respectively. From Pre to Post, the player's WASO (Pre: 74.3 mins ±31.9 mins, Post: 50.0 mins ±22.8 mins, −33%), sleep latency (Pre: 12.6 mins ±6.5 mins, Post: 8.9 mins ±1.3 mins, −29%), sleep efficiency (Pre: 79.2% ± 6.0%, Post: 85.3% ± 5.4%, 8%), awakenings per hour (Pre: 1.2 ± 0.5, Post: 0.6 ± 0.2, −50%), and awakening per night (Pre: 7.9 ± 3, Post: 4.5 ± 1.9, −43%) all improved. Compared to the reference data, WASO (Pre: 74.3 mins ±31.8 mins, reference: 44.3 mins ±36.5 mins, −40%), awakenings per hour (Pre: 1.2 ± 0.5, reference: 0.7 ± 0.4, −42%), awakenings per night (Pre: 7.9 ± 3.0, reference: 4.6 ± 2.6, −42%) were greater at Pre, whereas Post scores only presented with seemingly trivial differences compared to the reference data (Figure 2 and Table 6).

Discussion

The primary finding of this study is that the player's primary and secondary sleep complaints were improved after a bespoke sleep hygiene strategy. Notably, the player's awakenings per night (Pre: 7.9 ± 3, Post: 4.5 ± 1.9, −43%) and awakenings per hour (Pre: 1.2 ± 0.5, Post: 0.6 ± 0.2, −50%) improved from Pre to Post. Furthermore, Post data for awakenings per night and awakenings per hour was more similar to the reference data compared to Pre, suggesting that the players sleep was more in line with reference norms. Whilst this case study cannot definitively say that the sleep hygiene strategy mediated the improvements to objectively and subjectively rated sleep metrics (i.e., causality), we observed a positive response to the intervention across several sleep and sleep-related variables, indicating better sleep. It is important to note, nonetheless, that the player's objective data presented with relatively large CI (Figure 2). Whilst the large CI may be due to a low number of data points or the inherently variable nature of sleep (Whitworth-Turner et al., 2018), this may also indicate that the stated response could be in the opposite direction. However, considering the subjective and the objective data overall suggest a beneficial response, it is likely that a positive effect was observed.

Research has highlighted that sleep hygiene in athletes may be sub-optimal (Cameron et al., 2021). In one study, a sample of professional team sport players ($n = 184$) scored lower on the SHI compared to a cohort of age-matched controls ($n = 101$). Notably, athletes scored significantly lower in components relating to bedtime/wake time regularity, sleep environment, and nap behaviour suggesting that athletes, in general, may benefit from sleep hygiene interventions.

There is little data examining the effectiveness of personalised or individualised sleep hygiene interventions in athletic populations (M. W. Driller et al., 2019). However, the limited amount of data that has been collected aligns with this case study. In international standard cricket players ($n = 9$) (M. W. Driller et al., 2019), a one-on-one education session resulted in significantly improved activity-monitor derived sleep latency, which also like caused an improvement in sleep efficiency (+5%). In this case study, sleep efficiency improved by a similar magnitude. However, in this instance, improved WASO scores were likely the primary driver. Results

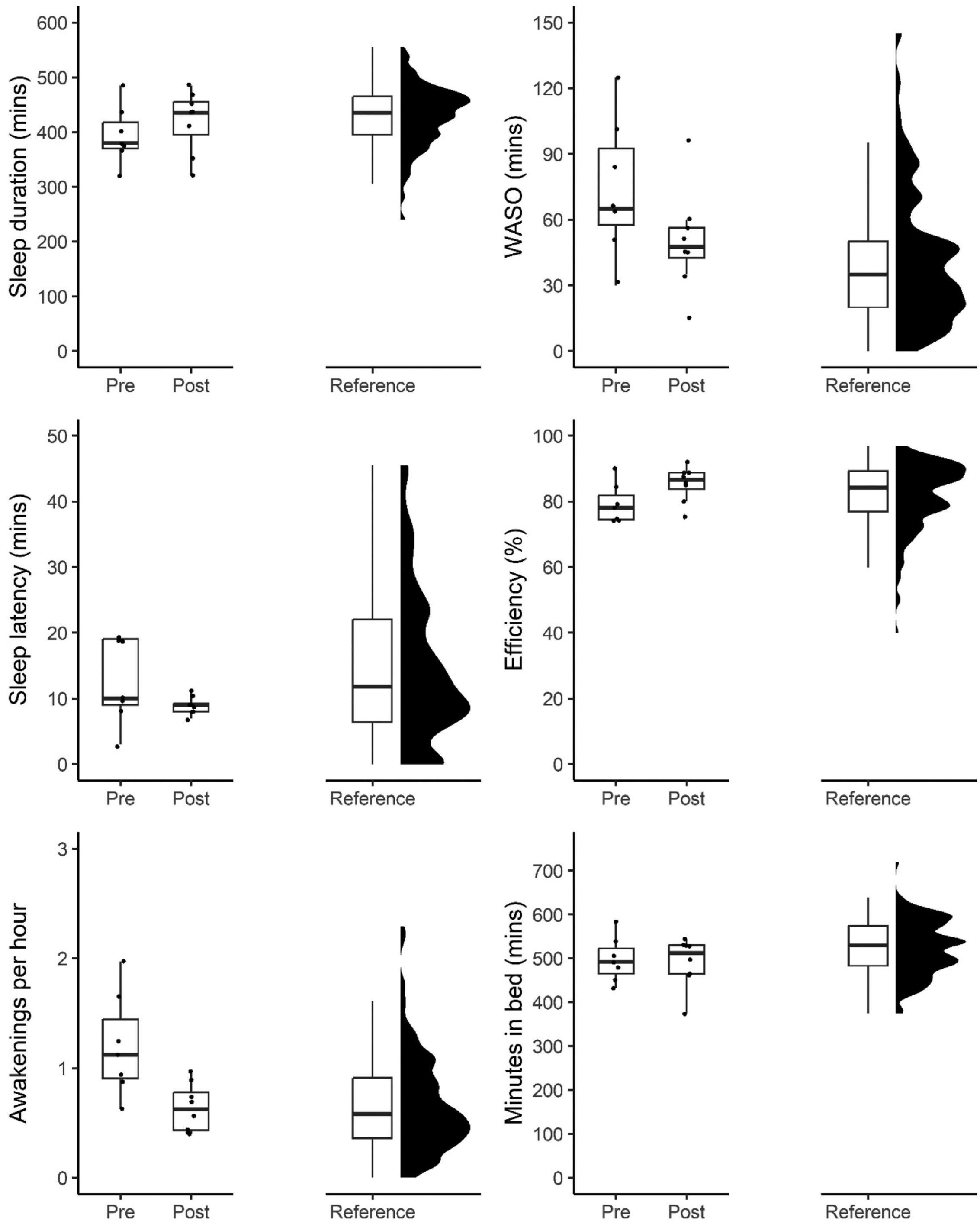

Figure 2. Box and whisker plots for Pre, Post, and the reference data. The reference data is shown alongside a cloud plot to highlight distribution. Outliers have been removed from the box and whisker plots.

from more generalised, group-based sleep hygiene interventions have also reported improved sleep, with positive results reported in both professional rugby league players (Caia et al., 2018) and non-professional football players (Vitale et al., 2019). Furthermore, in highly trained footballers (Fullagar et al., 2016), a sleep hygiene strategy that directly restricted ambient light, limited electronic device use, and controlled room temperature (~17°C) resulted in significantly improved post-fixture sleep duration compared to a control.

Where previous research has observed benefits to sleep duration (Caia et al., 2018; Fullagar et al., 2016), sleep efficiency (Driller et al., 2019), and sleep onset latency (J. A. Vitale et al., 2019; Driller et al., 2019), this case study also observed a benefit to WASO, awakenings per hour, and awakenings per night, which appears unique in the literature base thus far. However, the studies involving professional or elite athletes (Caia et al., 2018; Fullagar et al., 2016) have excluded participants that have reported historic sleep issues,

Table 3. Pre and Post-PSQI responses. The PSQI is a self-rated questionnaire which assesses sleep quality and disturbances over a 1-month time interval (Buysse et al., 1989).

	Component	Pre-	Post
1	When have you usually gone to bed?	22:00	23:00
2	How long (in minutes) has it taken you to fall asleep each night?	25 minutes	18 minutes
3	When have you usually gotten up in the morning?	07:00	07:00
4	How many hours of actual sleep do you get at night?	7hrs	8hrs
5	During the past month, how often have you had trouble sleeping because you …		
5a	Cannot get to sleep within 30 minutes	Once or twice a week	Less than once a week
5b	Wake up in the middle of the night or early morning	Once or twice a week	Less than once a week
5c	Have to get up to use the bathroom	Once or twice a week	Not during the past month
5d	Cannot breathe comfortably	Less than once a week	Not during the past month
5e	Cough or snore loudly	Not during the past month	Not during the past month
5f	Feel too cold	Less than once a week	Not during the past month
5g	Feel too hot	Three or more times a week	Less than once a week
5h	Have bad dreams	Once or twice a week	Less than once a week
5i	Have pain	Not during the past month	Not during the past month
6	During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?	Not during the past month	Not during the past month
7	During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?	Once or twice a week	Less than once a week
8	During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?	Once or twice a week	Less than once a week
9	During the past month, how would you rate your sleep quality overall?	Once or twice a week	Fairly good
	Global score	**22**	**9**

Note: *PSQI (Pittsburgh Sleep Quality Index)*.

Table 4. Pre and Post-ISI responses. The ISI is an instrument to assess the severity of both night-time and daytime components of insomnia (Bastien et al., 2001).

	Component	Pre-	Post
1	Difficulty falling asleep	Moderate	Mild
2	Difficulty staying asleep	Moderate	Mild
3	Problems waking up too early	Severe	Moderate
4	Problems waking up too early	Dissatisfied	Satisfied
5	How noticeable to others do you think your sleep problem is in terms of impairing the quality of your life?	Somewhat	A little
6	How worried/distressed are you about your current sleep problem?	A little	A little
7	To what extent do you consider your sleep problem to interfere with your daily functioning (e.g., daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, mood, etc.) currently?	Somewhat	A little
	Global score	**15**	**8**

Note: *ISI (Insomnia Severity Index)*.

Table 5. Pre and Post-ESS. The ESS is a self-reported questionnaire which provides a measurement of the subject's genera level of daytime sleepiness (Kendzerska et al., 2014).

Situation	Pre-	Post
Sitting and reading	3	2
Watching TV	2	1
Sitting inactive in a public place	1	1
As a passenger in a car for an hour without a break	2	1
Lying down to rest in the afternoon when circumstances permit	3	3
Sitting and talking to someone	1	1
Sitting quietly after lunch without alcohol	1	1
In a car, while stopped for a few minutes in traffic	2	1
Global score	**15**	**11**

Note: *ESS (Epworth Sleepiness Scales)*.

whereas this case study investigated a professional player that was specifically referred after reporting excessive night-time awakenings. Therefore, this case study may have observed improvements in WASO, awakenings per hour, and awakenings per night because the player's scores were already suboptimal, compared to other age-matched footballers.

Alongside improvements to objective sleep metrics, this case study also reports improved PSQI, ISI, and ESS scores after the sleep hygiene intervention. Whilst the ESS rates the perception of sleepiness at the time of completion (Kendzerska et al., 2014), the PSQI (Buysse et al., 1989) and ISI (Bastien et al., 2001) give a more general interpretation. Components relating to sleep onset latency, night-time awakenings, and overall sleep quality,

Table 6. Means ± SD for Pre, Post, and Reference data alongside Pre, Post, and Reference percentage change. Negative/positive values indicate the direction of change.

	Pre	Post	Reference	Pre vs Post	Pre vs Reference	Post vs reference
Sleep duration (mins)	394.3 ± 53.0	419.4 ± 57.4	433.4 ± 68.0	6%	10%	3%
MiB (mins)	497.4 ± 51.6	491.1 ± 56.6	533.0 ± 81.5	−1%	7%	9%
WASO (mins)	74.3 ± 31.8	50 ± 22.8	44.3 ± 36.5	−33%	−40%	−11%
Sleep latency (mins)	12.6 ± 6.5	8.9 ± 1.2	23.6 ± 26.1	−29%	87%	165%
Sleep efficiency (%)	79.2 ± 6	85.3 ± 5.4	81.9 ± 10.3	8%	3%	−4%
Awakenings per hour	1.2 ± 0.5	0.6 ± 0.2	0.7 ± 0.4	−50%	−42%	17%
Awakenings per night	7.9 ± 3	4.5 ± 1.9	4.6 ± 2.6	−43%	−42%	2%

Note: Wake after sleep onset (WASO).

in addition to issues with daytime sleepiness and enthusiasm were perceived to improve. Together with the objective data, this may suggest that the player perceived a benefit to their daytime functioning. Similar results have also been observed in professional cricket players (Driller et al., 2019) and non-professional footballers (Vitale et al., 2019) who received a sleep hygiene intervention.

It is challenging to deduce which element, or combination of elements, of the sleep hygiene intervention mediated changes to the player's objective and subjective sleep metrics. During the final debrief, the player inferred that he perceived the consumption of melatonin-rich foods (specifically walnuts and other nuts), a shower before bed, and a more regular bedtime routine were notably beneficial. Walnuts are considered to be melatonin-rich and randomised placebo-controlled trials suggest that consumption of walnut-derived peptides can significantly improve PSQI scores in adolescent and elderly populations (Yeh et al., 2022). Whilst research is still emerging, it does indicate that the consumption of walnuts close to bedtime may increase melatonin and aid in sleep initiation. There is a more established research base surrounding the use of warm baths or showers close to bedtime to aid sleep, particularly regarding sleep initiation. This has been observed in professional adolescent football players (Whitworth-Turner et al., 2017), where the application of a warm shower 20 minutes before bedtime resulted in significantly improved sleep efficiency and sleep onset latency. Whilst it is beyond the scope of this case study to investigate the effectiveness of individual components on the player's sleep, this case study suggests that a combined approach is efficacious.

This case study used a combination of subjective (PSQI, ISI, ESS) and objective measures (wrist-activity monitors) to gain a holistic view of the player's sleep. However, the efficacy of such an approach should be questioned. The player was referred because they self-reported sleep disruption. This was subsequently discussed in the initial consultation and confirmed through both subjective and objective monitoring. However, the sleep assessments did not reveal anything new that the player had not already verbally stated. Therefore, if data from the initial consultation was viewed in isolation, then the sleep hygiene intervention could have been applied in the first instance, without the need for a period of objective monitoring. However, subjective assessments are potentially limited by subjective biases, although, one advantage of utilising wrist-activity monitors is their ability to reconcile the subjective assessments. Compared to polysomnography, activity monitors have demonstrated validity (Chinoy et al., 2021) and their use in research has helped to elucidate several factors that may influence sleep in professional players (Whitworth-Turner et al., 2019). Therefore, whilst objective measures offered little additional information compared to the subjective assessments, it did offer an opportunity to collaborate the data.

This case study has several limitations. Firstly, this was not a controlled study with a suitable comparator, thus results can neither support nor refute the efficacy of an individualised sleep hygiene intervention in professional football players reporting sleep issues. Nevertheless, it offers a potential guide to the decision-making process and provides a real-world example framework for sport science and medicine professionals when they encounter sleep issues within their practice. Further, whilst the intervention was formulated by an MDT with a wealth of applied experience and on the guidance of the data available, its formulation is still likely influenced by subjective individual biases. Therefore, the most efficacious intervention may not have been applied. Also, this case study did not monitor or re-evaluate sleep after the final debrief and it is not known if sleep metrics continued to improve or relapsed, nor was it able to elucidate sleep architecture. Finally, while the player also identified night sweats as a sleep complaint, this could not be objectively determined so did not form a central part of the discussion.

In conclusion, this case study applied an individualised sleep hygiene intervention to a player who was referred after reporting excessive night-time awakenings and night-time sweats. The player's subjective and objective sleep metrics subsequently improved. Whilst this case study cannot definitively say the intervention caused the changes to the sleep metrics, a player reported excessive night-time awakenings, an intervention was applied, and then the player reported improvement. This case study provides a potential framework for coaches and sports practitioners who may encounter reported sleep issues as part of their practice.

Acknowledgments

The authors would like to thank Dr Amy Spencer, Charles Quigley, and Dr Greg Clarke for supporting this project.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This case study was completed as part of the lead author's PhD at St Mary's University, which was funded in full by Southampton Football Club.

ORCID

Luke Edinborough http://orcid.org/0000-0002-2806-9478
Jessica Hill http://orcid.org/0000-0001-9720-3469
Stewart Bruce-Low http://orcid.org/0000-0002-4178-1160
Charles R Pedlar http://orcid.org/0000-0002-3075-9101

References

Aloulou, A., Leduc, C., Duforez, F., Piscione, J., Cheradame, J., Bieuzen, F., Thomas, C., Chennaoui, M., VAN Beers, P., & Nedelec, M. (2020). Effect of an Innovative Mattress and Cryotherapy on Sleep after an Elite Rugby Match. *Medicine & Science in Sports & Exercise*, *52*(12), 2655–2662. https://doi.org/10.1249/MSS.0000000000002403

Bastien, C. H., Vallières, A., & Morin, C. M. (2001). Validation of the insomnia severity index as an outcome measure for insomnia research. *Sleep Medicine*, *2*(4), 297–307. https://doi.org/10.1016/S1389-9457(00)00065-4

Biggins, M., Purtill, H., Fowler, P., Bender, A., Sullivan, K. O., Samuels, C., & R, C. (2019). Sleep in elite multi-sport athletes: Implications for athlete health and wellbeing. *Physical Therapy in Sport*, *39*, 136–142. https://doi.org/10.1016/J.PTSP.2019.07.006

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Caia, J., Scott, T. J., Halson, S. L., & Kelly, V. G. (2018). The influence of sleep hygiene education on sleep in professional rugby league athletes. *Sleep Health*, *4*(4), 364–368. https://doi.org/10.1016/J.SLEH.2018.05.002

Cameron, A. F. M., Perera, N., & Fulcher, M. (2021). Professional athletes have poorer sleep quality and sleep hygiene compared with an age-matched cohort. *Clinical Journal of Sport Medicine*, *31*, 488–493. https://doi.org/10.1097/JSM.0000000000000795

Chinoy, E. D., Cuellar, J. A., Huwa, K. E., Jameson, J. T., Watson, C. H., Bessman, S. C., Hirsch, D. A., Cooper, A. D., Drummond, S. P. A., & Markwald, R. R. (2021). Performance of seven consumer sleep-tracking devices compared with polysomnography. *Sleep*, *44*(5). https://doi.org/10.1093/SLEEP/ZSAA291

Douzi, W., Dupuy, O., Theurot, D., Boucard, G., & Dugué, B. (2019). Partial-body cryostimulation after training improves sleep quality in professional soccer players. *BMC Research Notes*, *12*(1). https://doi.org/10.1186/S13104-019-4172-9

Driller, M. W., Lastella, M., & Sharp, A. P. (2019). Individualized sleep education improves subjective and objective sleep indices in elite cricket athletes: A pilot study. *Journal of Sports Sciences*, *37*(17), 2021–2025. https://doi.org/10.1080/02640414.2019.1616900

Driller, M., McQuillan, J., & O'Donnell, S. (2016). Inter-device reliability of an automatic-scoring actigraph for measuring sleep in healthy adults. *Sleep Science*, *9*, 198–201. https://doi.org/10.1016/j.slsci.2016.08.003

Edinborough, L., Bruce-Low, S., Hill, J., Woodhouse, J., Jarvis, M., & Pedlar, C. (2022, November). Day type and start time may influence sleep in adolescent professional football players. *International Journal of Sports Medicine*, *44*(05), 336–343. https://doi.org/10.1055/A-1974-5441

Fullagar, H. H. K., & Bartlett, J. D. (2016). Time to wake up: Individualising the approach to sleep promotion interventions. *British Journal of Sports Medicine*, *50*(3), 143–144. https://doi.org/10.1136/BJSPORTS-2015-095759

Fullagar, H., Skorski, S., Duffield, R., & Meyer, T. (2016). The effect of an acute sleep hygiene strategy following a late-night soccer match on recovery of players. *Chronobiology International*, *33*(5), 490–505. https://doi.org/10.3109/07420528.2016.1149190

Halson, S. L. (2014). Sleep in elite athletes and nutritional interventions to enhance sleep. *Sports Medicine*, *44*(S1), 13. https://doi.org/10.1007/S40279-014-0147-0

Harper, D. J., Carling, C., & Kiely, J. (2019). High-intensity acceleration and deceleration demands in elite team sports competitive match play: A systematic review and meta-analysis of observational studies. *Sports Medicine*, *49*(12), 1923–1947. https://doi.org/10.1007/s40279-019-01170-1

Kendzerska, T. B., Smith, P. M., Brignardello-Petersen, R., Leung, R. S., & Tomlinson, G. A. (2014). Evaluation of the measurement properties of the Epworth sleepiness scale: A systematic review. *Sleep Medicine Reviews*, *18*(4), 321–331. https://doi.org/10.1016/j.smrv.2013.08.002

Lastella, M., Roach, G. D., & Sargent, C. (2019). Travel fatigue and sleep/wake behaviors of professional soccer players during international competition. *Sleep Health*, *5*, 141–147. https://doi.org/10.1016/j.sleh.2018.10.013

Leeder, J., Glaister, M., Pizzoferro, K., Dawson, J., & Pedlar, C. (2012). Sleep duration and quality in elite athletes measured using wristwatch actigraphy. *Journal of Sports Sciences*, *30*(6), 541–545. https://doi.org/10.1080/02640414.2012.660188

Mastin, D. F., Bryson, J., & Corwyn, R. (2006). Assessment of sleep hygiene using the sleep hygiene index. *Journal of Behavioral Medicine*, *29*(3), 223–227. https://doi.org/10.1007/S10865-006-9047-6

McCloughan, L., Hanrahan, S., Anderson, R., & Halson, S. (2014). Progressive muscle relaxation (PMR), sleep, and recovery in elite performers. *Journal of Science & Medicine in Sport*, *18*, e113. https://doi.org/10.1016/j.jsams.2014.11.071

Murawski, B., Wade, L., Plotnikoff, R. C., Lubans, D. R., & Duncan, M. J. (2018). A systematic review and meta-analysis of cognitive and behavioral interventions to improve sleep health in adults without sleep disorders. *Sleep Medicine Reviews*, *40*, 160–169. https://doi.org/10.1016/J.SMRV.2017.12.003

Natale, V., Esposito, M. J., Martoni, M., & FABBRI, M. (2006). Validity of the reduced version of the Morningness-Eveningness Questionnaire. *Sleep and Biological Rhythms*, *4*(1), 72–74. https://doi.org/10.1111/J.1479-8425.2006.00192.X

Nedelec, M., Aloulou, A., Duforez, F., Meyer, T., & Dupont, G. (2018). The variability of sleep among elite athletes. *Sports Medicine - Open*, *4*(1). https://doi.org/10.1186/s40798-018-0151-2

Rijken, N. H., Soer, R., Maar, E., Prins, H., Teeuw, W. B., Peuscher, J., & Oosterveld, F. G. J. (2016). Increasing performance of professional soccer players and elite track and field athletes with peak performance training and biofeedback: A pilot study. *Applied Psychophysiology and Biofeedback*, *41*(4), 421–430. https://doi.org/10.1007/s10484-016-9344-y

Varley, I., Lewin, R., Needham, R., Thorpe, R. T., & Burbeary, R. (2017). Association between match activity variables, measures of fatigue and neuromuscular performance capacity following elite competitive soccer matches. *Journal of Human Kinetics*, *60*(1), 93–99. https://doi.org/10.1515/hukin-2017-0093

Vitale, J. A., la Torre, A., Banfi, G., & Bonato, M. (2019). Acute sleep hygiene strategy improves objective sleep latency following a late-evening soccer-specific training session: A randomized controlled trial. *Journal of Sports Sciences*, *37*(23), 2711–2719. https://doi.org/10.1080/02640414.2019.1661938

Vitale, K. C., Owens, R., Hopkins, S. R., & Malhotra, A. (2019). Sleep hygiene for optimizing recovery in athletes: review and recommendations. *International Journal of Sports Medicine*, *40*(08), 535. https://doi.org/10.1055/A-0905-3103

Walsh, N. P., Halson, S. L., Sargent, C., Roach, G. D., Nédélec, M., Gupta, L., Leeder, J., Fullagar, H. H., Coutts, A. J., Edwards, B. J., Pullinger, S. A., Robertson, C. M., Burniston, J. G., Lastella, M., Le Meur, Y., Hausswirth, C., Bender, A. M., Grandner, M. A., & Samuels, C. H. (2021). Sleep and the athlete: Narrative review and 2021 expert consensus recommendations. *British Journal of Sports Medicine*, *55*(7), 356–368. https://doi.org/10.1136/BJSPORTS-2020-102025

Whitworth-Turner, C. M., diMichele, R., Muir, I., Gregson, W., & Drust, B. (2019). Training load and schedule are important determinants of sleep behaviours in youth-soccer players. *European Journal of Sport Science*, *19*(5), 576–584. https://doi.org/10.1080/17461391.2018.1536171

Whitworth-Turner, C., diMichele, R., Muir, I., Gregson, W., & Drust, B. (2017). A shower before bedtime may improve the sleep onset latency of youth soccer players. *European Journal of Sport Science*, *17*(9), 1119–1128. https://doi.org/10.1080/17461391.2017.1346147

Whitworth-Turner, C., diMichele, R., Muir, I., Gregson, W., & Drust, B. (2018). A comparison of sleep patterns in youth soccer players and non-athletes. *Science and Medicine in Football*, *2*(1), 3–8. https://doi.org/10.1080/24733938.2017.1366040

Yeh, A. -L., Chao, C. -L., Huang, W. -F., Lin, H. -C., & Wang, C. -J. (2022). Walnut (Juglans regia L.) oligopeptide effects on enhancing memory, cognition and improving sleep quality in teenagers and elderly people in a randomized double-blind controlled trial. *Natural Product Communications*, *17*(3), 1–8. https://doi.org/10.1177/1934578X221089065