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Acute Effects of In-Season Sleep Hygiene Education on Elite Rugby Union Athletes

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Abstract: *The present study aimed to address the influence of a single group, sleep hygiene education session on sleep parameters in elite athletes during the competition phase of the season. Fourteen elite male rugby union players were monitored for three weeks to gain an understanding of baseline measures of sleep variables (PRE). Subsequently, players received a single group sleep hygiene and education session. Sleep variables were monitored for a further three weeks to assess the impact of the intervention (POST). Moreover, data was collected for a two-week follow-up period (FU) to assess changes in sleep habits. Sleep data were collected using wrist actigraphy via the Fatigue Science Readiband. There were no significant changes in any of the sleep variables measured throughout the eight-week study period ($P < 0.05$). The present study raises the concern of the effectiveness of a single group, sleep hygiene education session on elite male rugby union players during the competitive phase of the competition calendar.*

Keywords: *Recovery, Team Sport, Actigraphy, Athletic Performance*

1. Introduction

Success in elite sport is underpinned by optimal preparation and sufficient recovery between training sessions and competition (O'Donnell and Driller, 2017), with athletes and teams looking to gain an edge over their competition. Thus, the role that sleep plays on enhancing recovery and human performance is gaining increased attention, as the level of participation in sports increases (Mah *et al*., 2011; Halson, 2013). Previous work advocates sleep quality and quantity to be the single best psychological and physiological recovery mechanisms available for elite athletes (Leeder *et al*., 2012; Halson, 2013). Nevertheless, research suggests that elite athletes experience insufficient sleep in comparison to their non-athlete counterparts (Driller, Dixon and Clark, 2017; Simpson, Gibbs and Matheson, 2017). A review by Gupta, Morgan and Gilchrist (2017) found that elite athletes commonly display a high prevalence of deprived sleep characterised by longer sleep latencies, more significant sleep fragmentation, non-restorative sleep, and excessive daytime fatigue. Specific to the population of the present study, Dunican *et al*., (2019) found that sleep disorders and excessive daytime sleepiness are common in elite rugby union players, warranting the need for an effective means of addressing this issue.

The difficulties elite athletes face when trying to improve sleep are attributed to several contributing factors, including scheduling of training sessions (Sargent *et al*., 2014), an increase in post-exercise core body temperature (Nédélec *et al*., 2015), and increased muscle tension and pain after training and competition (Halson, 2014). A study of 283 elite athletes reported that 64% experience sleep disruption the night before an important game or competition (Juliff, Halson and Peiffer, 2015), attributed to difficulty initiating sleep due to nervousness and pre-competition anxiety. More than half of the athletes also reported sleep disturbance following late training or competition. Additional sleep disturbances that appear to be magnified among the elite population include napping excessively in the afternoon, which detrimentally impacts sleep at night, consumption of caffeine, frequent travelling, sleeping in unfamiliar environments such as hotels, overhydration and dehydration before sleep (Driller, Mah and Halson, 2018). Despite the importance that sleep has on both psychological and physiological recovery and knowledge of sleep complications in elite athletes, there are limited data on the use of sleep interventions to improve sleep in elite sport (Eagles *et al*., 2014; Juliff, Halson and Peiffer, 2015; Nédélec *et al*., 2015). To understand how sleep interventions may assist in improving sleep, research examining sleep loss provides findings as to how individuals respond to sleep restriction.

Sleep restriction may occur when an individual either falls asleep later or wakes up earlier than usual, thus disrupting their regular sleep-wake cycle. Sleep deprivation, however, refers to a lack of sleep for an extended period (Boonstra *et al*., 2007; Fullagar *et al*., 2015). Current research predominantly examines the impact of total sleep deprivation on measures of athletic performance. However, this is often unrealistic and incompatible to real-world situations, where athletes are more susceptible to partial sleep restriction, due to jet lag or a poor night's sleep, rather than to prolonged sleep deprivation (Bonnar *et al*., 2018).

Sleep hygiene (SH) education can be defined as practising behaviours that facilitate sleep and avoiding behaviours that interfere with sleep (Mastin, Bryson and Corwyn, 2006; Halson, 2014; Driller, Lastella and Sharp, 2019). Although means of improving an individual's sleep are limited, SH education has been used to improve sleep behaviour in both male (Caia *et al*., 2018) and female (O'Donnell and Driller, 2017) elite athletes. Only limited research has examined the effects of SH education on elite athletes, but recent findings are encouraging. A study conducted by Driller, Lastella and Sharp (2019) on elite cricketers showed significant improvements in sleep behaviour following personalised SH education using the athlete sleep behaviour questionnaire (ASBQ; Driller, Mah and Halson, 2018). Furthermore, O'Donnell and Driller (2017), showed significant improvements in sleep measures in response to SH education in elite female netball athletes. A study by Caia *et al*., (2018) on elite rugby league players showed positive changes in sleep behaviour as a result of SH group education seminars, which increased total sleep time. However, the authors of this study highlight that these positive changes in behaviour were not sustained following the intervention period but returned to baseline measures, highlighting the importance of regular reinforcements of SH strategies to athletes.

Therefore, this study aimed to address the effectiveness of a single SH education session on sleeping parameters in a group of elite rugby union players during the competitive phase of the season. Additionally, post-intervention sleep behaviour was monitored post-intervention (Caia *et al*., 2018). It was hypothesised that a single SH education session would significantly improve sleep parameters in elite rugby union players, but that improvements would not be sustained post-intervention period.

2. Materials and Methods

Participants

A total of 14 elite male rugby union players volunteered to participate in the study (mean age = 24 ± 4.3 years). All participants were recruited from the Cardiff Blues professional rugby union team who compete in the Guinness Pro 14 and the European Challenge Cup. A typical week would include between six and nine training sessions comprising of the different disciplines of rugby union. The Cardiff School of Sport Ethics Committee granted ethical approval and written informed consent was obtained from all participants before any data collection.

Experimental Protocol

Data collection occurred over eight weeks during the competitive phase of an elite rugby union playing calendar with athletes undergoing their routine commitments of rugby practice, strength and conditioning training, and match fixtures. Multiple fixtures required athletes to travel abroad and across time zones. Sleep data were collected and monitored via a wrist actigraphy device (Readiband™, Fatigue Science, Vancouver) worn on either the dominant or non-dominant wrist (Driller, O'Donnell and Tavares, 2017) at all times excluding training, competing and submerging underwater. Raw activity data were collected and translated to a sleep-wake score based on computerised scoring algorithms (Sadeh, 2011).

The first three weeks of the eight-week study were used for collecting baseline sleep data (PRE) followed by an SH education session. The participants were instructed to sustain their usual sleep schedules to reflect an accurate representation of sleep measures during this phase. Weeks four to six of data collection (POST) allowed participants to address and apply the sleep education information for improving their sleeping habits and hygiene. During this period, participants were granted access to daily feedback of sleep measurements via a unique login to the fatigue science mobile phone application (Readi by Fatigue Science, Version 3.0.0. Sleep Performance, Inc). The final two weeks (FU) were monitored to address how effectively participants retained the information and newly formed habits. During this phase, no additional sleep education or support was provided, other than daily feedback from the mobile application.

Sleep Education

Following the initial three weeks of data collection where baseline measures were recorded, all participants were required to attend an SH education session that was structured into their daily training to interfere as minimally as possible. The SH intervention was delivered by the lead researcher and lasted approximately 20 minutes, with a further 10 minutes of questioning and open discussion. Previous research has implemented SH education using a longer seminar duration of between 50-60 minutes (O'Donnell and Driller, 2017; Driller, Lastella and Sharp, 2019). However, this was not possible in the present study due to time restraints through the busy in-season training schedule.The intervention was delivered using Apple Keynote presentation and focused on the importance of routine and consistency of sleep/wake times, the potential of increased risk of injury and illness associated with reduced sleep, blue light exposure and its effects on melatonin secretion (specifically pre-bed), and implications of caffeine use pre-bed.

Sleep Monitoring

Sleep indicators recorded by wrist actigraphy consisted of total sleep time, total time in bed, sleep efficiency, sleep latency, wake after sleep onset, wake episodes per night, wake episode duration, sleep onset time, wake time, sleep onset variance, wake variance and sleep quality. The definitions for all variables can be found in Table 1. Wrist actigraphy has been validated and found to be an effective method for measuring and monitoring sleep (Conley *et al*., 2019). Moreover, wrist actigraphy is the most commonly used method for assessing and monitoring an individual's sleeping patterns and habits in a non-laboratory-based environment (Claudino*etal*., 2019). Polysomnography (PSG) is the gold standard method for sleep assessment, but it is a costly and intrusive process (Van De Water, Holmesand Hurley, 2011). The accuracy of the Fatigue Science Readiband has been validated and deemed acceptable when compared to PSG (Dunican*et al*., 2018). Moreover, according to Driller, McQuillan and O'Donnell (2016) the inter-device reliability of the Readiband is acceptable and reliable for researchers using multiple devices in sleep studies.

Table 1. *Description of sleep variables measured by fatigue science wrist actigraphy (Table adapted from Driller, McQuillan and O'Donnell 2016).*

Sleep Indicators	Units Measured	Definition
Total Sleep Time	Minutes	Total time spent asleep
Total Time in Bed	Minutes	Total time spent in bed
Sleep Efficiency	%	Total time in bed divided by total sleep time
Sleep Latency	Minutes	Time taken for sleep onset
Wake After Sleep Onset	Minutes	Estimated wake minutes between sleep onset and wake time
Wake Episodes per Night	Number Count	Total number of awakenings per night
Wake Episode Duration	Minutes	Mean wake episode duration
Sleep Onset Time	Time of day	Time of transition from wakefulness into sleep
Wake Time	Time of day	Wake up time for the sleep period
Sleep Onset Variance	Minutes	Sleep onset consistency relative to mean
Wake Variance	Minutes	Wake time consistency relative to mean
Sleep Quality	Score (0-10)	Frequency and length of estimated awakenings (via Readiband algorithm)

Statistical Analysis

Data are expressed as means±standard deviation (mean±SD). The Shapiro-Wilks test was used to determine whether data were normally distributed. For normally distributed data, a one-way repeated measure analysis of variance (ANOVA) with a Bonferroni adjustment was used to examine differences on sleep variables across the three time points (PRE/POST/FU). Non-parametric data were analysed using the Freidman Test, with Wilcoxon Signed-Rank Test used for post hoc analysis. Effect sizes between PRE and POST, POST and FU and PRE and FU were calculated using Cohen's *d* and interpreted using thresholds <0.2 = trivial, 0.2 – 0.49 = small, 0.5 – 0.79 = moderate and ≥ 0.8 = large (Cohen, 1988). All statistical tests were conducted using Statistical Package for Social Science (V. 26.0, SPSS Inc., Chicago, IL, USA), with statistical significance for all tests set at $P<0.05$.

3. Results

No statistical significance was revealed in total sleep time, total time in bed, sleep efficiency, sleep latency, wake after sleep onset, wake episodes per night, wake episode duration, sleep onset time, wake time, sleep onset variance, wake variance or sleep quality between PRE, POST and FU (P > 0.05). However, mean wake time increased non-significantly (P = 0.08) between PRE (07:29 ± 0:44) and POST (07:46 ± 0:35; Table 2), with a small effect size (*d*=0.43).Sleep latency also improved non-significantly from PRE (25.73 ± 9.01) to FU (22.78 ± 8.34; P = 0.140; Table 2),with a small effect size (*d*= -0.34),and decreased POST (26.06 ± 9.50) to FU (22.78 ± 8.34; P = .084; Table 2), with a small effect size (*d* = -0.37).

Table 2. *Mean (± SD) values and effect sizes (ES) for sleep variables PRE, POST intervention and the follow-up (FU) period*

Sleep Indicators	Units Measured	PRE	POST	ES1	FU	ES2	ES3
Total Sleep Time	Minutes	429.2 ± 41.53	432.5 ± 36.84	0.08 Trivial	428.0 ± 39.85	-0.01 Trivial	0.00 Trivial
Total Time in Bed	Minutes	512.74 ± 35.83	516.64 ± 37.64	0.11 Trivial	511.83 ± 53.99	-0.10 Trivial	-0.02 Trivial
Sleep Efficiency	%	83.95 ± 7.58	84.00 ± 5.33	0.01 Trivial	84.29 ± 5.37	0.05 Trivial	0.05 Trivial
Sleep Latency	Minutes	25.73 ± 9.01	26.06 ± 9.50	0.04 Trivial	22.78 ± 8.34	-0.37 Small	-0.34 Small
Wake After Sleep Onset	Minutes	40.23 ± 34.06	38.81 ± 19.36	-0.05 Trivial	39.82 ± 29.39	0.04 Trivial	-0.01 Trivial
Wake Episodes per Night	Number Count	3.84 ± 2.45	3.75 ± 1.51	-0.04 Trivial	3.66 ± 1.87	-0.05 Trivial	-0.08 Trivial
Wake Episode Duration	Minutes	9.04 ± 2.13	9.90 ± 2.77	0.35 Small	9.16 ± 3.21	-0.25 small	0.04 Trivial
Sleep Onset Time	Time of day	23:38 ± 0:40	23:43 ± 0:38	0.13 Trivial	23:42 ± 0:36	-0.03 Trivial	0.11 Trivial
Wake Time	Time of day	07:29 ± 0:44	07:46 ± 0:35	0.43 Small	07:41 ± 0:37	-0.14 Trivial	0.30 Small
Sleep Onset Variance	Minutes	-1.46 ± 12.89	-0.86 ± 24.87	0.03 Trivial	-2.41 ± 17.92	-0.07 Trivial	-0.06 Trivial
Wake Variance	Minutes	-3.57 ± 9.29	-3.02 ± 15.64	0.04 Trivial	-13.16 ± 36.24	-0.36 Small	-0.36 Small
Sleep Quality	Score (0-10)	6.58 ± 2.11	6.60 ± 1.41	0.01 Trivial	6.58 ± 1.66	-0.01 Trivial	0.00 Trivial

ES1 = effect size from PRE to POST intervention. ES2 = effect size from POST to Follow-up period. ES3 = effect size from PRE to FU period.

4. Discussion

The findings from the present study suggest that a single SH and education intervention has no significant impact on sleeping parameters in elite rugby union players during the competitive phase of the season. Though no statistical significance was found between any time points for sleep variables in the present study, athletes did display a later, but non-significant wake time confirmed with a small effect size, suggesting the potential for more time in bed and, consequently, longer sleep time. Nevertheless, the non-significant findings of this study may prove useful for coaches and practitioners in the field looking to maximise athletic performance.

Similar research has shown improvements in objective and subjective sleep measures in elite male cricketers following a single individualised SH education session (Driller, Lastella and Sharp, 2019). Likewise, O'Donnell and Driller (2017) found that a single one-hour SH education session has a positive effect on increasing sleep quantity in elite female netball athletes. However, both of these studies were conducted during the pre-season phase of their athletes' competition calendar. The present study highlights that a single SH education session may only be beneficial for elite athletes during a less busy, preparatory phase of the competition calendar. The additional stressors that athletes face daily during a competition period, such as selection, fixture importance, or injury may be too demanding to influence behavioural change in a habitual routine like sleep during this time. Mellalieu *etal.* (2009) provide a comprehensive insight into the stressors experienced by athletes during competitionas they may play a role when looking to influence behavioural change during busy periods of the competition calendar.

A recent study by Caia *et al*. (2018) found significant improvements in measures of sleep variables in elite rugby league players during the competitive phase of the season. However, the methodology differed from that of the present study. Caia *et al*. (2018) implemented two SH education seminars over two weeks, which provides an opportunity for considerably more information to be provided to athletes. Furthermore, this study used a control group that enabled a comparison between groups. Similarly, to the present study, Caia *et al*. (2018) collected sleeping measures of baseline data for two weeks and allocated groups based on average sleep duration across the baseline period. Those who slept less received SH education, while those who slept more received no SH education (control group).

Understandably, this approach is appropriate from a practical perspective, as individuals who sleep less are in a greater need for improvement. However, this may not give an accurate representation of the effectiveness of SH education. Furthermore, initial improvements in sleep time were not sustained from post-intervention to the follow-up period, highlighting the challenge of coaches and practitioners in influencing behavioural change among elite athletes during busy periods of the competition season. Indeed, according to a review by Bonnar*etal*., (2018), SH is not recommended as a standalone treatment for behavioural sleeping problems, and implementation of long-term SH education may be more beneficial.

It is vital to consider not only what is pertinent to research, but also what is viable from a practical application perspective. Until research can identify the most effective means and time for delivering SH education to elite athletes, coaches and practitioners may strategically focus their time on factors that can be controlled within their coaching environments. Research by Sargent, Halson and Roach (2014) on elite swimmers leading into the 2008 Olympic Games found that the earlier athletes were required to start training, the less sleep they obtained the night before that training session. Additionally, Sargent *et al*., (2014) reported comparable results, where 70 elite athletes displayed less time in bed and less sleep on days before training when compared to rest days. Moreover, the findings were attributed to earlier wake times where, on average, athletes woke 84 minutes earlier on training days compared to rest days (06:30 versus 07:54). The authors further stated that it seems rational to expect athletes to sleep earlier to accommodate for an earlier wake time; however, there may be a rationale for why this may be problematic. Firstly, from a social perspective, family commitments may not allow for an earlier bedtime (Folkard and Barton, 1993; Tucker *et al*., 1998). Secondly, from a physiological perspective, individuals may struggle to initiate or maintain sleep even if they are in bed (Sargent *et al*., 2012). Here, the authors stress the importance of coach awareness of the potential implications that the timing of training sessions may have on athletes' sleep and fatigue. Specifically, schedules that require athletes to train in the morning will reduce total sleep time the preceding night and increase pre-training levels of fatigue.

An understanding of effective scheduling and its influence on total sleep time, levels of fatigue and, consequently, a potential in increased athletic performance may prove vital for coaches and practitioners looking to maximise their athletes' on-field performance. It may be of benefit to focus on creating a training schedule that avoids both early morning and late-night training to provide athletes with an opportunity to obtain appropriate sleep time for health and performance benefits. Until the research identifies the most effective means of delivering SH education to athletes, this may not only prove to be more effective for increasing total sleep time but more cost and time-effective for coaches and athletes within elite sport.

One of the limitations of the present study is that sleep variables were measured using wrist actigraphy alone. The use of an athlete-specific sleep questionnaire and self-reported sleep logs/diaries would have presented the opportunity to compare both objective and subjective measures of sleep and the potential impact of SH education. Additionally, due to the small sample size available, we were not able to use a control intervention. Future research may consider comparing the effectiveness of a single SH education session throughout different stages of an elite athlete's competition calendar, which would allow coaches, practitioners and athletes the opportunity to strategically plan and implement SH education during beneficial times for all involved.

The present study is the first to address the impact of SH education on improving objective sleep measures in elite rugby union athletes during the competitive phase of the season. SH education may not be an effective means of improving sleeping parameters in elite rugby union athletes through a busy competition period of the season. Therefore, coaches and practitioners should pursue changes in sleep behaviour during a less busy, preparatory phase of the season for achieving habitual, chronic effects.

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