European Journal of Sport Science

ISSN: 1746-1391 (Print) 1536-7290 (Online) Journal homepage: http://www.tandfonline.com/loi/tejs20

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To cite this article: David A. Shearer, Rhys M. Jones, Liam P. Kilduff & Christian J. Cook (2015) Effects of competition on the sleep patterns of elite rugby union players, European Journal of Sport Science, 15:8, 681-686, DOI: 10.1080/17461391.2015.1053419

To link to this article: http://dx.doi.org/10.1080/17461391.2015.1053419

European Journal of Sport Science, 2015
Vol. 15, No. 8, 681–686, http://dx.doi.org/10.1080/17461391.2015.1053419

ORIGINAL ARTICLE

Effects of competition on the sleep patterns of elite rugby union players

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Abstract

No published research has assessed sleep patterns of elite rugby union players following match-play. The present study examined sleep patterns of professional rugby union players, prior and post-match-play, to assess the influence of competition. Twenty-eight male rugby union players (24.4 ± 2.9 years, 103.9 ± 12.2 kg) competed in one of four competitive home matches. Player's sleep behaviours were monitored continuously using an Actiwatch® from two days before the match, until three days post-match. Repeated measures of analysis of variance (ANOVA) showed significant differences across the time points measured for time to bed ($F = 26.425$, $\eta^2 = 0.495$, $p < .001$), get up time ($F = 21.175$, $\eta^2 = 0.440$, $p < .001$), time spent in bed ($F = 10.669$, $\eta^2 = 0.283$, $p < .001$), time asleep ($F = 8.752$, $\eta^2 = 0.245$, $p < .001$) and percentage of time moving ($F = 4.602$, $\eta^2 = 0.146$ $p < .05$). Most notable, *post hocs* revealed a significant increase for time in bed the night before the match ($p < .01$; 95% CI = 0 : 10–1 : 28 h; 9.7 ± 13.5%) compared with the reference night sleep. Furthermore, time asleep significantly decreased post-match ($p < .05$; 95% CI = −0:03 to −1:59 h; −19.5 ± 19.8%) compared to two nights pre-match. Across all time points, sleep latency and efficiency for most players were considered abnormal compared to that expected in normal populations. The results demonstrate that sleep that is deprived post-match may have detrimental effects on the recovery process.

Keywords: *recovery, fatigue, monitoring, actigraphy*

Introduction

Rugby union is a physically demanding sport that results in disruptions to both physiological and psychological functions following competition (Twist & Worsfold, 2014; West et al., 2014). Within the UK, teams typically play 35 games per season, with some individuals playing more through international appearances. With accumulation of training and competitive performance, insufficient recovery prior to the training week may compromise the quality of an individual's training, thus reducing the stimulus for adaptation and/or maintenance of physiological attributes. The knock-on effect can compromise preparation for subsequent competitive performances (Mclean, Coutts, Kelly, McGuigan, & Cormack, 2010), can lead to overtraining syndrome (Kellman, 2010), and predispose an individual to greater risk of injury (Lazarim et al., 2009).

Sleep is a requirement for human health and important for athletes' physiological and psychological recovery (Dattilo et al., 2011; Meerlo, Sgoifo, & Suchecki, 2008). When disrupted (i.e. total or partially deprived and/or fragmented), studies have demonstrated negative effects on the autonomic nervous system, endocrine system, biochemical function (Spiegel, Leproult, & Van Cauter, 1999), gene expression regulation (Möller-Levet et al., 2013), cognitive factors (Belenky et al., 2003), neuromuscular function (HajSalem, Chtourou, Aloui, Hammouda, & Souissi, 2013) and mood states (Sinnerton & Reilly, 1992). Research also demonstrates that training volume (Jürimäe, Mäestu, Purge, & Jürimäe, 2004), training times (Sargent, Halson, & Roach, 2014) and competition itself (Lastella, Lovell, & Sargent, 2014; Richmond, Dawson, Hillman, & Eastwood, 2004) all have negative consequences on athlete's sleep quality.

Rugby union is a contact sport characterized by frequent collisions often resulting in pain following competition and training. This pain is often not

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resolved before subsequent games and in some instances is cumulative and chronic. Sleep is likely disrupted by this pain (Nicassio et al., 2012), and sleep disturbance caused by pain is cyclical, with poor sleep leading to lower pain threshold (Chiu et al., 2005). Sleep disruption, caused by pain or otherwise, has other serious potential consequences for rugby players. For instance, disruptions in sleep affect scores of neurocognitive tests for concussion, indicating that poor sleep before a game could lead to misdiagnosis of concussion following an impact/collision (McClure, Zuckerman, Kutscher, Gregory, & Solomon, 2014). With pain and concussion management representing a serious welfare issue, understanding sleep as a recovery modality is of particular importance in rugby union.

To date no research has assessed the sleep patterns of elite rugby union players with respect to match-play using actigraphy. The aim of the present study was to examine the potential influence of competition on sleep patterns of elite rugby union players. Data were collected both prior to and post-match-play to assess difference in a variety of sleep measures. Based on previous research (Lastella et al., 2014), it was hypothesised that significant differences from baseline measures would be observed for all measures both during the night sleep immediately preceding, and immediately post-competition. Given the exploratory nature of this study with regards to the unique characteristics of rugby union, no hypotheses were made with regards to specific measures of sleep (e.g. sleep latency or sleep efficiency).

Method

Participants

Twenty-eight male rugby union players volunteered for the study (age: 24.4 ± 2.9 years; weight: 103.9 ± 12.2 kg) and provided written informed consent. All participants were elite standard, playing for a region in Wales, UK, and competed in the Celtic League competition.

Measures

Players were monitored continuously (with exception of exercise involving physical contact) using an Actiwatch® worn on the non-dominant hand (Actiwatch 2; Phillips Respironics, UK). Actigraphy is a non-intrusive tool used to estimate sleep quantity and quality when polysonography is not feasible or suitable (e.g. applied studies). It has validity and reliability in assessing sleep–wake patterns in normal individuals with average or good sleep quality. Actigraphy is also more sensitive to awakenings when compared to self-reported sleep measures (Kushida et al., 2001); however, there are some reported limitations in measuring periods of wakefulness in those with poor sleep quality (Sadeh, 2011). The following measures were taken: time in bed, sleep latency (time to fall asleep from 'time to bed'), time asleep, time awake, sleep efficiency (ratio between total sleep time and time in bed), actual sleep percentage, percentage of time moving, and sleep restlessness (fragmentation index), as previously described by Leeder, Glaister, Pizzoferro, Dawson, and Pedlar (2012).

Procedures

Ethical approval was granted by the Swansea University Ethics Committee. Subsequently, four matches were identified for the study due to their similarities in location (all home games), kick-off times (1830–1930 h) and training schedules prior and post-match. Although no GPS data were recorded, across all games attacking contacts (145), tackles made (87), and minutes and seconds in play (32:39) indicated that the matches were comparable with international fixtures (International Rugby Board, 2015). Players were approached to volunteer for the study based on their selection for one of the matches. Participants were given information outlining the rationale, potential applications, procedures and asked to provide informed consent. Players conducted a strength (0900–0945h) and rugby (1000–1115 h) training session two days prior to the match, and a 'captains run' session (1000–1020 h) the day before the match. No training or recovery sessions were prescribed during the observed post-match period. During the sleep period, activity outside of prescribed training was not restricted; however, players were asked to refrain from consuming alcohol.

Actigraph data were recorded two days prior to each of the selected matches until 3 days post-match to observe sleep behaviour and whether it was altered with respect to competition. For the purpose of clarity, these sleeps were coded as follows: S1 (reference night sleep), S2 (pre-game), S3 (post-game), S4 (post-game +1), and S5 (post-game +2). Each night immediately before switching lights off players pressed the marker button on the Actiwatch® for 3 s to begin measurement, and repeated this immediately upon waking to mark the end of their sleep period. This allowed the manufacturers' software (Respironics Actiware 5; Phillips Respironics, UK) to calculate sleep behaviour based on manually determined time in bed, and time asleep detected via 1 min epoch periods. No qualitative measures of sleep hygiene or other sleep activity (e.g. napping) were made during this period.

Data Analysis

To determine ‘sleep quality’ by actigraphy, measures of sleep efficiency and fragmentation index were used (Leeder et al., 2012). All variables are presented as mean ± SD. To assess changes in sleep patterns, sleep variables from each night were compared to two nights prior to the match (S1) using repeated measures ANOVA. Significant differences were determined using Bonferroni corrected pair-wise comparisons ($p < .05$). Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS for Windows, version 14.0; SPSS, Inc., Chicago, IL, USA).

Results

Sleep data prior and post-competitive match-play are presented in Table I. Significant time-dependent differences for time to bed ($F = 26.425$, $\eta^2 = 0.495$, $p < 001$), get up time ($F = 21.175$, $\eta^2 = 0.440$, $p < .001$), time spent in bed ($F = 10.669$, $\eta^2 = 0.283$, $p < .001$), time asleep ($F = 8.752$, $\eta^2 = 0.245$, $p < .001$) and percentage of time moving ($F = 4.602$, $\eta^2 = 0.146$, $p < .05$) were observed.

Post hoc tests revealed significant differences from the reference night sleep (S1) were largely due to changes in pre- and post-match sleep behaviour. For example, compared to the reference night sleep, time in bed increased at S2 ($p < .01$; 95% CI = 0:10–1:28 h; 9.7 ± 13.5%), but returned to similar durations to the reference night at S3 ($p > .05$; −9.7 ± 19.8%). Furthermore, time asleep at S3 decreased ($p < .05$; 95% CI = −0:03 to 1:59 h; −19.5 ± 19.8%) compared to S1, but returned to similar durations to the reference night at S4 the following evening ($p > .05$; −3.4 ± 17.3%) (Figure 1).

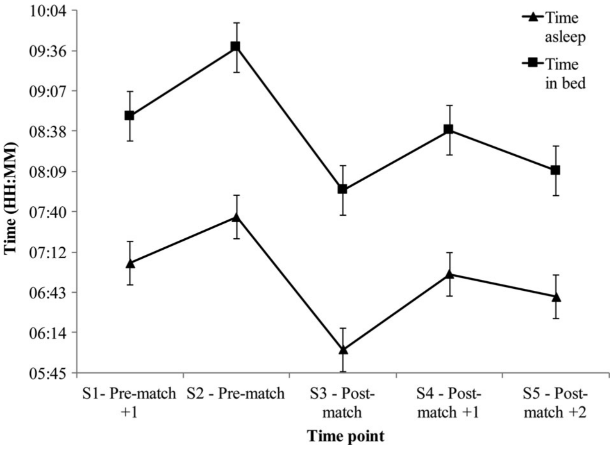

Figure 1. Graph displaying the mean changes in “time asleep” across the five measured sleeps.

Despite descriptive statistics suggesting a tendency for sleep efficiency to reduce at S3 post-match compared to S1, no significant changes were observed ($p > .05$, Table I). Furthermore, no significant changes in sleep latency, time awake, actual sleep percentage, or percentage of time moving were observed on any night compared to S1 (Table I). Finally, it was observed that the values for sleep latency and sleep efficiency across all time points (Table I) were above populations norms, indicating that all players took much longer to fall asleep regardless of time point compared with non-athletic populations and that their quality of sleep across these time points was compromised.

Discussion

This study aimed to examine the sleep patterns of professional rugby union players pre- and post-high-intensity competition. Significant differences in several sleep measures were observed pre- and post-competition compared to the reference night sleep. Notably, players spent significantly less time asleep post-match, which may have had detrimental consequences on post-match recovery. Despite this, large standard deviations (SDs) for all sleep variables indicated that significant inter-individual differences in sleep patterns existed within the sample. Finally,

Table I. Sleep actigraphy data of professional rugby union players prior and post-match

Night of sleep	Time to bed	Get up time	Time in bed	Sleep latency	Time asleep	Time awake	Sleep efficiency (%)	Actual sleep (%)	Moving time (%)
S1 – pre-match +1	22:43 ± 0:42	7:40 ± 0:31	8:49 ± 0:49	0:34 ± 0:40	7:04 ± 1:01	1:05 ± 0:39	79.0 ± 9.2	85.4 ± 8.7	18.64 ± 6.63
S2 – pre-match	23:02 ± 0:45	8:48 ± 0:58*	9:38 ± 1:11*	0:28 ± 0:25	7:37 ± 1:14	1:30 ± 1:02	78.3 ± 11.3	83.7 ± 11.1	19.07 ± 5.67
S3 – post-match	0:49 ± 1:11*	8:56 ± 1:11*	7:56 ± 1:48	0:38 ± 0:34	6:02 ± 1:27*	1:03 ± 1:03	74.7 ± 11.1	87.0 ± 11.3	21.75 ± 5.86
S4 – post-match +1	23:46 ± 1:27*	8:30 ± 1:28	8:39 ± 1:10	0:29 ± 0:30	6:56 ± 1:09	1:07 ± 0:45	79.3 ± 8.0	86.7 ± 8.4	18.46 ± 6.02
S5 – post-match+2	22:45 ± 0:37	7:02 ± 0:37*	8:10 ± 0:57*	0:24 ± 0:25	6:40 ± 1:18	0:59 ± 0:52	80.2 ± 11.8	86.6 ± 11.9	16.46 ± 6.98

Note: Presented as mean ± SD; *significant difference from pre-match+1 ($p < .05$), 24-h clock used for “time to bed” and “get up time”. All other time measures in hours:minutes.

it was observed that across all time points, sleep latency and sleep efficiency were compromised compared with population norms.

For S2 (pre-match), players spent on an average 49 ± 68 min longer in bed compared to the previous night ($p < .05$). This finding is similar to Richmond et al. (2004), who reported increased sleep duration the night before an Australian Rules football match compared to the average of five night's non-match related sleep. This increase was proposed to reflect a belief that a good night's sleep will maximize match performance the next day (Richmond et al., 2004). Research has demonstrated that extended periods of sleep (five to seven weeks; minimum 10 h) improves physical and cognitive performance, and well-being (Mah, Mah, Kezirian, & Dement, 2011). However, short-term sleep extension (three days) does not return physiological (Pejovic et al., 2013) or cognitive (Belenky et al., 2003) performance levels to pre-sleep-deprived levels following a period of restriction. Nonetheless, increasing pre-match sleep duration may be important preparation as there is a relationship between perceptions of recovery and subsequent performance (Cook & Beaven, 2013).

Similar to Richmond et al. (2004), we found significant reductions in time spent asleep post-match (S3) compared to the reference night (S1) (Table I). Acute or chronic sleep disruptions may be detrimental for recovery and preparation for exercise as they impinge several physiological (e.g. autonomic nervous system; Sargent et al., 2014) and cognitive functions (Belenky et al., 2003). Considering players can take up to 60 h to recover post-match in rugby union (West et al., 2014), sleep deprivation at S3 (post-match) may exacerbate physiological and psychological recovery rates. Disrupted sleep post-match (not just S3) may be related to several factors connected to match-play. For example, increased pro-inflammatory cytokines from match-play (Cunniffe et al., 2010) may directly affect sleep regulation, or indirectly, by their action on hypothalamic-pituitary-axis activation to increase body temperature, increase cortisol secretion, decrease nREM sleep and increase wakefulness (Vgontzas & Chorousos, 2002). Furthermore, sleep patterns post-match may be affected by disruptions in mood and other psychological factors (e.g. worried about consequences of performance; Lastella et al., 2014). Finally, specific to the games measured here some players ingested caffeine as an ergogenic aid pre-game, but this was not monitored (Youngstedt, O'Connor, Crabbe, & Dishman, 2000), and the time of kick-off and associated post-match activities (e.g. media interviews) may have disrupted both time to bed and time asleep (Youngstedt, O'Connor, & Dishman, 1997). The physical exertion of a late match may also have caused disruptions to circadian rhythms caused by a phase delay in the production of melatonin (Atkinson, Edwards, Reilly, & Waterhouse, 2007).

Sleep patterns observed two days prior to match-play were similar to Leeder et al. (2012). They found significant differences between groups of athletes and non-athlete controls for variables including sleep latency, sleep efficiency and fragmentation index, suggesting that quality of sleep was inferior for athletes. However, they also found larger SDs in the athletes for each sleep variable compared with the control group. When they assessed individuals on a case-by-case basis, many individuals had comparable sleep to the control group and only certain individuals displayed signs of sleep disruption. Standard deviation values from rugby players within our study were on average greater than those reported by Leeder et al., with greater inter-individual variation at S3 (post-match) than on other nights for several variables. Therefore, although it may be suggested that rugby players have inferior quality of sleep compared to non-sporting controls, sleep quality might also be expected to vary considerably between individuals, particularly immediately before and after match-day, when athletes might, for example, have excitement/anxiety symptoms or painful injuries.

Although not an explicit aim, we observed sleep deficiencies across all recorded sleeps for sleep latency and efficiency that exceeded population norms. In normal young adults, sleep efficiency is usually around 90% measured using PSG (Ohayon, Carskadon, Guilleminault, & Vitiello, 2004) and in our study, the average was 78%. Similarly, population norms for sleep latency in healthy adults is around 11 min (Chokroverty, 2013), and in our study, the average sleep latency was 29 min. Large SDs withstanding, closer scrutiny revealed only eight players had an average sleep efficiency score greater than 85%, with some players scoring less than 65%. Similarly, only 5 players had average sleep latency scores less than 15 min, with 10 players taking 30 min or more to fall asleep. Although the 5 days across which data were obtained are relatively small, if these measures are representative of normal sleep patterns, they present a concern for the long-term health of the players.

Our study has a number of limitations that lend to future research directions. First, it was not possible to generate data for a longer baseline of sleeps when the athletes were considered fully recovered, as the training and competition schedule did not allow for this. Ideally, we would collect data for at least five reference sleeps to ensure the changes observed were a function of competition load. This data would preferably have been collected on consecutive days, but could also have been taken on isolated occasions. We recommend future investigations into sleep patterns in elite rugby players control for this. Second, we only collected data for one match for each participant, and although the fluctuations in sleep variables around the competition are consistent with the patterns of recovery previously observed in elite rugby players (e.g. West et al., 2014), a longitudinal approach would allow a deeper understanding of the impact of competition on sleep. Finally, no objective measures of physiological load during the game were made. For example, in-game GPS monitoring would allow the measurement of high-intensity sprinting during the match, which is known to increase release of inflammatory cytokines; a physiological marker of fatigued states (Jones et al., 2014). These data could then be correlated to subsequent sleep measures.

The results demonstrate that sleep that is deprived post-match may have detrimental effects on the recovery process. Large SDs observed for all variables pre- and post-match suggest that sleep quality, quantity and patterns vary considerably between individuals. Therefore, sport scientists should address each individual's post-match sleep in an attempt to enhance recovery and preparations for subsequent training and/or performance. Individualized assessment of sleep and sleep hygiene using actigraphy and sleep diaries/questionnaires, with consideration to physiological (e.g. caffeine intake), behavioural (e.g. screen use/viewing 1 h before bed), environmental (e.g. room temperature) and psychological (e.g. life stressors) factors, is recommended. Based on this assessment process, individualised sleep interventions that focus on education, awareness and practical guidance can be provided to each athlete.

Disclosure statement

No potential conflict of interest was reported by the authors.

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