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Does self-perceived sleep reflect sleep estimated via activity monitors in professional rugby league athletes?

Johnpaul Caia[a,b], Heidi R. Thornton[c,d], Vincent G. Kelly[a,b], Tannath J. Scott[a], Shona L. Halson[e], Balin Cupples[f,g] and Matthew W. Driller[h]

[a]Performance Sciences Department, Brisbane Broncos Rugby League Club, Brisbane, Australia; [b]School of Human Movement and Nutrition Sciences, University of Queensland, Brisbane, Australia; [c]La Trobe Sport and Exercise Medicine Research Centre, La Trobe University Bundoora Campus, Melbourne, Victoria, Australia; [d]Newcastle Knights Rugby League Club, Mayfield, Australia; [e]Department of Physiology, Australian Institute of Sport, Canberra, Australian Capital Territory; [f]New Zealand Warriors Rugby League Club, Auckland, New Zealand; [g]Faculty of Education and Social Work, The University of Sydney, Sydney, Australia; [h]University of Waikato, Hamilton, New Zealand

ABSTRACT

This study examined agreement between self-perceived sleep and sleep estimated via activity monitors in professional rugby league athletes. 63 athletes, from three separate teams wore actigraphy monitors for 10.3 ± 3.9 days. During the monitoring period, ratings of perceived sleep quality (on a 1–5 and 1–10 Likert scale), and an estimate of sleep duration were recorded daily. Agreement between sleep estimated via activity monitors and self-perceived sleep was examined using mean bias, Pearson correlation (*r*) and typical error of the estimate (TEE). 641 nights of sleep were recorded, with a very large, positive correlation observed between sleep duration estimated via activity monitors and subjective sleep duration (r = 0.85), and a TEE of 48 minutes. Mean bias revealed subjective sleep duration overestimated sleep by an average of 19.8 minutes. The relationship between sleep efficiency estimated via activity monitors and self-perceived sleep quality on a 1–5 (r = 0.22) and 1–10 Likert scale (r = 0.28) was limited. The outcomes of this investigation support the use of subjective measures to monitor sleep duration in rugby league athletes when objective means are unavailable. However, practitioners should be aware of the tendency of athletes to overestimate sleep duration.

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Sleep duration; team sport; recovery; self-report

Introduction

For an athlete, recovery is a regenerative process involving the compensation of fatigue that occurs as a result of training or competition (Nedelec et al., 2012). Fatigue can present acutely following a strenuous training session or match (McLean, Coutts, Kelly, McGuigan, & Cormack, 2010), or chronically as a result of accumulated efforts over an extended period of time (i.e. the duration of a competitive season) (Nedelec et al., 2012). Sleep is considered fundamental to the recovery process, as inadequate or unsatisfactory sleep may have the ability to negatively influence physical performance, cognitive function, mood state, immunity, and injury occurrence (Fullagar et al., 2015). Research has shown sleep to be often compromised in athletes (Leeder, Glaister, Pizzoferro, Dawson, & Pedlar, 2012; Swinbourne, Gill, Vaile, & Smart, 2016), while athletic populations exhibit a high prevalence of insomnia symptoms distinguished by prolonged sleep latency, sleep fragmentation, and non-restorative sleep, leading to excessive daytime fatigue (Gupta, Morgan, & Gilchrist, 2016). As such, regularly monitoring athletes' sleep seems worthwhile to ensure sufficient and satisfactory sleep is obtained. Indeed, recent research has shown that sleep hygiene education may lead to improved sleep in athletes (O'Donnell & Driller, 2017). While the importance of sleep to recovery and performance for athletes seems clear (Fullagar et al., 2015; Gupta et al., 2016), how sleep is best monitored in this population is less certain.

Polysomnography (PSG) is considered the gold standard for monitoring the composition and depth of sleep (Van De Water, Holmes, & Hurley, 2011). However, PSG is largely impractical for regular use in athletes as it is expensive, can be considered invasive, requires considerable resources and is typically performed in a laboratory, thus limiting its ecological validity. As such, PSG is too laborious and not suited for use as a consistent monitoring tool for sleep in athletes. Actigraphy offers a valid and reliable substitute for PSG (Driller, McQuillan, & O'Donnell, 2016). These activity monitors infer sleep and wakefulness from the presence of movement using pre-determined algorithms. Concordance between PSG and actigraphy appears good, with previous work yielding agreement rates in the range of 78–95% (Kushida et al., 2001). Despite this, access to activity monitors within athletic populations is not widespread, and may be considered impractical to monitor large numbers of athletes longitudinally, or during certain periods (e.g. on nights prior to a competitive event).

Subjective measures may offer an alternative when monitoring sleep in athletes, as they are inexpensive and simple to implement when compared to objective measures (Saw, Main, & Gastin, 2016). Indeed, recent analysis provides support for the use of subjective measures to monitor changes in the well-being of athletes (Saw et al., 2016). However, the usefulness of

CONTACT Johnpaul Caia johnpaul.caia@gmail.com Brisbane Broncos Rugby League Club, 92 Fulcher Rd, Red Hill QLD 4059, Australia

subjective measures to monitor sleep in athletes is unclear, with few studies comparing subjective sleep parameters with those collected via actigraphy or PSG. In clinical populations, subjective sleep measures appear to introduce bias, with evidence showing individuals with depression (Rotenberg, Indursky, Kayumov, Sirota, & Melamed, 2000) and a diagnosed sleep disorder (Kushida et al., 2001) to have difficulty in assessing their own sleep, with sleep duration overestimated. In contrast, research involving German physical education students demonstrates good agreement between objective and subjective measures when considering time in bed (r = 0.82 – 0.86) and sleep duration (r = 0.82 – 0.86) (Kolling, Endler, Ferrauti, Meyer, & Kellmann, 2016). These findings suggest that self-perceived data can be useful for monitoring sleep in certain populations.

Currently, data comparing self-perceived and actigraphy-derived measures of sleep are lacking for athletic populations, with little understood about athletes' perceptions of their own sleep. A lack of agreement between subjective and objective methods of sleep would pose a problem for practitioners who rely on subjective sleep monitoring in their athletes. Therefore, the purpose of the current study was to assess if self-perceived sleep reflects sleep estimated via wrist activity monitors in professional rugby league athletes.

Methods

Participants

Sixty-three professional rugby league athletes volunteered to participate in the study. Participants were professional rugby league athletes contracted to one of three teams competing within the Australian-based National Rugby League competition. Prior to the commencement of the investigation, all participants were educated regarding the study procedures, and informed written consent was given. The Institutional Human Ethics Committee approved all experimental procedures, with all research conducted in accordance with the Declaration of Helsinki. Data collection took place during a non-competition, training phase of the rugby league season. Athletes slept in their normal home-based environment within the home city of their respective team or in their own dorm-style room during a training camp.

Activity monitors

Sleep was assessed using wrist activity monitors collected in one-minute epochs for a minimum of three nights per participant (mean ± SD: 10.3 ± 3.9 nights). Participants wore an activity monitor on their non-dominant wrist, and were advised to wear the monitor at all times, except during training involving contact and when bathing or showering. Data derived from the monitors were used to estimate sleep duration and sleep efficiency, with sleep efficiency defined as the percentage of time in bed that was spent asleep (Lastella et al., 2015). Specifically, participants wore either an Actiwatch 2 (Philips Respironics, PA, USA) (25 athletes, 300 nights), Readiband (Fatigue Science, HI, USA) (8 athletes, 39 nights), or ActiGraph wGTX3 (ActiGraph, Pensacola, FL, USA) (30 athletes, 302 nights), with all three monitors previously showing acceptable levels of reliability and validity (Cellini, Buman, McDevitt, Ricker, & Mednick, 2013; Driller et al., 2016; Sargent, Lastella, Halson, & Roach, 2016). All athletes wore the same monitor throughout the duration of their respective monitoring period.

Subjective sleep monitoring

Throughout the data collection period, each morning within two hours of waking, all participants (n = 63) were required to rate their perceived sleep quality on a five-point Likert scale (1 = very poor, 5 = excellent). Further to this, participants from two of the three rugby league teams (n = 32) also provided a sleep quality rating on a ten-point Likert scale (1 = very poor, 10 = excellent), and an estimate of sleep duration (hh:mm). Likert scales of 1–5 and 1–10 were chosen to indicate sleep quality as participants were familiar with such scales as part of multi-component wellness questionnaires used by their respective rugby league team.

Statistical analyses

The level of agreement between sleep estimated via activity monitors and self-perceived sleep was examined by determining mean bias, the typical error of the estimate (TEE) and Pearson correlation (r). Specifically, a Bland Altman plot of error in self-perceived sleep from the mean of activity monitor and self-perceived sleep for duration was conducted. This allowed simple assessment of the agreement between two measurement methods, and the evaluation of any bias. The TEE examined the typical amount by which subjective sleep estimates were inaccurate. Finally, Pearson correlations examined the relationship between sleep duration estimated via activity monitors and subjective sleep duration, and between sleep efficiency estimated via activity monitors and subjective sleep quality, with magnitudes interpreted as trivial; 0.0–0.1, small; 0.1–0.3, moderate; 0.3–0.5, large; 0.5–0.7, very large; 0.7–0.9; nearly perfect; 0.9–1.0 (Hopkins, 2002). All statistical analyses were conducted using R statistical software (R.3.3.2, R Foundation for Statistical Computing) and a specialised excel spreadsheet to calculate mean bias and TEE (Hopkins, 2010).

Results

A total of 641 nights of sleep were recorded across all participants in the study, with sleep duration as estimated via activity monitors averaging 416.2 ± 84.0 min per night across 264 nights (Table 1).

A very large, positive correlation was observed between sleep duration estimated using activity monitors and subjective sleep duration (r = 0.85; ±0.03, P < 0.0001), with a TEE of 48 minutes (Table 1). Mean bias revealed that compared to sleep duration estimated using activity monitors, subjective sleep duration overestimated by an average of 19.8 minutes (Figure 1).

When considering sleep quality, a mean of 3.4 ± 0.9 was reported on a five-point scale, with small positive relationship between subjective sleep quality on a five-point scale and

Table 1. Comparison of sleep duration estimated via activity monitors and self-perceived estimates in professional rugby league athletes.

	n	Activity monitor	Self-perceived	Mean bias	Pearson's r	TEE	P
Sleep duration (hh:mm)	264	06:56 ± 01:24	07:16 ± 01:12	18.2 ± 4.6	0.85 ± 0.03	00:48	<0.0001

Mean bias and Pearson correlation (r) presented as mean ± 90% CL. All other data presented as mean ± SD.

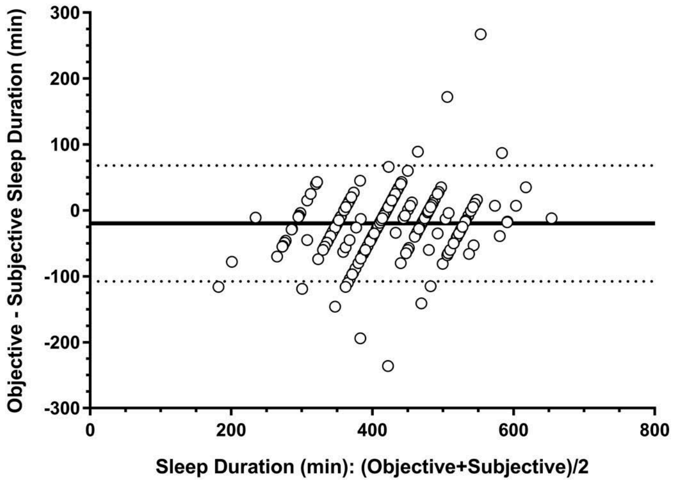

Figure 1. Bland-Altman plot comparing sleep duration estimated via wrist activity monitors with self-perceived estimates in professional rugby league athletes. The horizontal axis indicates mean sleep duration from both subjective and objectively estimated measures, while the vertical axis shows the difference in sleep duration between subjective and objectively estimated measures. The solid line indicates the mean bias from activity monitors, while the dotted lines indicate 95% LOA (1.96 SDs).

sleep efficiency estimated using activity monitors across 641 nights (r = 0.22; ±0.06, P = 0.73). Sleep quality on a ten-point scale averaged 7.4 ± 1.7, with a small positive association between subjective sleep quality on a ten-point scale and sleep efficiency estimated using activity monitors across 264 nights (r = 0.28; ±0.06, P = 0.65). The two Likert scales behaved in a comparable manner, with a nearly perfect relationship exhibited between the 1–5 and 1–10 scales of sleep quality (r = 0.95; ±0.02, P < 0.0001).

Discussion

This study examined the agreement between objective and subjective estimates when monitoring sleep in professional rugby league athletes. The primary findings of this investigation indicate strong agreement between self-perceived sleep duration and sleep duration estimated via activity monitors, albeit discrepancies do exist with rugby league players appearing to overestimate their sleep duration.

If sleep is to be restorative it needs to be of suitable duration and satisfactory quality, with insufficient sleep having the ability to decrease physical performance (Fullagar et al., 2015). This is particularly pertinent for athletes, who are often exposed to circumstances such as early morning training (Caia, Scott, Halson, & Kelly, 2017; Sargent, Halson, & Roach, 2014), late-night competition (Caia et al., 2017; Fullagar et al., 2016), and training camps (Pitchford et al., 2017; Thornton et al., 2016) that may lead to reduced sleep duration (Caia et al., 2017; Fullagar et al., 2016; Sargent et al., 2014; Thornton et al., 2016), lowered sleep quality (Caia et al., 2017; Pitchford et al., 2017; Thornton et al., 2016) and compromised recovery (Fullagar et al., 2016). As such, regular monitoring of athletes' sleep seems advisable to ensure sufficient and satisfactory sleep is obtained, and to allow support and intervention in circumstances of compromised sleep.

Subjective measures provide an inexpensive, easy to administer and non-invasive method to monitor athlete responses (Saw et al., 2016). Indeed, recent work provides evidence for the worth of subjective measures to monitor changes in the well-being of athletes (Saw et al., 2016). The findings of the current study support this notion, and suggest that when more sophisticated methods such as actigraphy are inaccessible or inappropriate to monitor sleep, self-perceived sleep provides data agreeable to those collected via activity monitors. However, this study does reveal some limits of self-perceived sleep, with rugby league players displaying a tendency to overestimate their sleep duration. Indeed, the mean bias of approximately 18 minutes and TEE of 48 minutes indicates imprecision between subjective sleep duration and sleep duration estimated via wrist actigraphy. As such, practitioners using subjective data unaided by objective means to monitor their athletes should be wary of this constraint, as not to use such measures for the evaluation or diagnosis of sleep difficulties. In such cases, objective tools and further communication with the respective athlete may be appropriate. As has been noted previously, little classification of acceptable levels of agreement exist between objective and subjective sleep data (Kolling et al., 2016), with differences of one hour or less between self-perceived and actigraphy-derived data previously speculated as reliable (Van Den Berg et al., 2008), while other papers have considered variances of less than 30 minutes as acceptable (Werner, Molinari, Guyer, & Jenni, 2008). Ultimately, the difference between subjective sleep duration and sleep duration estimated via activity monitors is consistent with recent work exploring a comparable relationship in physically active university students, with a difference of 33 to 47 minutes reported (Kolling et al., 2016). Moreover, in this study subjective and objectively estimated sleep duration showed very large correlation (r = 0.85), akin to earlier studies showing high associations between subjective and objective sleep estimates collected using both actigraphy (Kolling et al., 2016) and PSG (Armitage, Trivedi, Hoffmann, & Rush, 1997) in healthy individuals.

Based on the findings of the present study, subjective sleep quality is not directly indicative of sleep efficiency. This may have been anticipated, given that sleep efficiency is the ratio of time spent sleeping to the time spent in bed (Lauderdale, Knutson, Yan, Liu, & Rathouz, 2008) while sleep quality is a term commonly used and reported despite a lack of consensus of its actual definition (Libman et al., 2016). Poor sleep quality appears to encompass a number of sleep related issues including difficulty falling asleep, fragmented sleep, impaired daytime functioning, as well as insufficient sleep duration and efficiency (Libman et al., 2016). In contrast, good sleep quality denotes sleeping through the night with only brief awakenings, waking refreshed and good daytime functioning (Libman et al., 2016). Indeed, it seems that self-perceived sleep quality represents several sleep characteristics, including, but not limited to sleep efficiency. As such, when using sleep quality to monitor sleep in athletes, practitioners should understand that ratings of poor sleep quality may be indicative of a range of sleep related issues. Therefore, subsequent communication with the athlete is seemingly sensible to allow delineation of the causative issues, as well as suitable interventions where appropriate.

To our knowledge, the current study is the first to examine the agreement between subjective and objective sleep in professional athletes. It is worthy to note that this study assumes that self-perceived sleep is not influenced by wearing activity monitors. It is plausible that athletes report sleep more precisely when they know they are being objectively monitored (Carney, Lajos, & Waters, 2004). It is also important to note that this study involved subjective and objective estimates from athletes across three professional rugby league teams. As such, athletes were not all residing within the same environmental conditions, while the specific training undertaken by athletes is likely to have varied somewhat across each team. Such factors can influence the amount and quality of sleep obtained (Taylor, Rogers, & Driver, 1997) and subsequently may have impacted sleep perception. However, this is a strength of this investigation as the data presented is representative of the wider rugby league cohort, as opposed to individuals from one team. Further work encompassing athletes across teams, and sports, in other areas of recovery and performance are encouraged and may provide practitioners more meaningful data.

Conclusion

These findings indicate strong agreement between self-perceived sleep and actigraphy-derived sleep duration in professional rugby league athletes, while the relationship between self-perceived sleep quality and sleep efficiency estimated via activity monitors appears limited. As such, if objective means to estimate sleep are not accessible and appropriate, self-perceived sleep duration appears to provide insight into the quantity of sleep obtained by an athlete. However, practitioners should be cognisant of the apparent tendency of professional rugby league athletes to overestimate their sleep duration. Self-perceived estimates of sleep quality should not be used as a direct indicator of sleep efficiency. In circumstances of poor self-perceived sleep quality, communication with the respective athlete is encouraged so the causative issue can be elucidated, allowing appropriate intervention.

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Disclosure statement

No potential conflict of interest was reported by the authors.

Conflict of interest

The authors have no conflicts of interest to declare.

ORCID

Heidi R. Thornton http://orcid.org/0000-0002-5818-4450
Matthew W. Driller http://orcid.org/0000-0002-9990-8830

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