Northumbria Psychology Bulletin (ISSN 3033-4225)
https://www.northumbriajournals.co.uk/index.php/npb/article/view/1471

Published date: 1 August 2024

Research Article

The association between subjective sleep and stress in recreational athletes

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Abstract

Subjective sleep and stress are strongly associated, at multiple levels, and the current body of evidence highlights a bi-directional association. Previous research has highlighted that issues with sleep can impact on several stress responses. On the other side of this relationship, research has shown that stress-inducing factors can significantly impact sleep. The present study examined this association in a sample of recreational athletes, a population that has received little to no research focus to date Recreational athletes are defined as individuals who exercise >4 hours per week for health, fitness, or unofficial competitions. Recreational athletes (n = 34) completed online measures of subjective sleep, subjective stress, subjective anxiety/depression and training load (PSQI, PSS, HADS and DALDA). Pearson correlations were carried out to examine associations between variables. There was a significant positive correlation between subjective sleep quality and subjective stress. There was a significant positive correlation between subjective stress and training load. There was a significant positive correlation between subjective sleep quality and training load. The positive associations between sleep, stress and training load are consistent with previous research, but the present study adds to the literature by highlighting the associations in recreational athletes. Recreational athletes should proactively manage their sleep and stress, as due to the bi-directional relationship, improving sleep may benefit stress, and improving stress may benefit sleep quality. This is also likely to benefit overall mood and reduce the likelihood of overtraining in recreational athletes.

Keywords: Sleep, Stress, Athletes, Recreational Athletes, Recovery

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Introduction

Sleep has an essential role in human health, due to its vital role in physical and cognitive performance, as well as physical and mental well-being (Kolling *et al.,* 2016; Simpson *et al.,* 2017). Sleep has been previously reported as the most important recovery tool at the disposal of elite, sub-elite and recreational athletes (Venter, 2012). The growing body of research literature suggests that sleep is the new frontier in performance enhancement among an athletic population (Leeder *et al.,* 2012). Despite the self-reported importance of sleep, the athletic population appears to sleep poorly when compared to gender and age matched, non-athletic or non-exercising control groups (Gupta *et al.,* 2017). Poor sleep is reflected by shorter sleep durations, elevated wake after sleep onset (WASO) and lower levels of sleep efficiency (Tuomilehto *et al.,* 2017). It is evident from the current body of literature that athletes consistently report high levels of sleep inadequacy due to sport-specific and lifestyle factors. Such factors explaining this clear sleep inadequacy are high training loads, evening competitions and early morning training start times, as well as lifestyle sacrifices in order to complete training. For these reasons, it is likely that athletes may have a higher need for physical and mental recovery when compared to non-athletes (Walsh *et al.,* 2021).

There is a large amount of literature which has assessed elite and sub-elite athletic populations, but there is a lack of research pertaining to recreational athletes. In elite sport, balancing competing time demands and making personal sacrifices are common psychological stressors (McKay *et al.,* 2008). However, less is known about the considerable time investment and sacrifices which have been made by recreational athletes. Recreational athletes have been previously defined as individuals who exercise >4 hours per week for health, fitness, or unofficial competitions (McKinney *et al.,* 2019). In recreational athletes, stressors include time demands and lifestyle sacrifices. In a study by McCormick *et al.,* (2018), the stressor of time demands emerged as the main theme of psychological stress, as participants estimated that they trained for an average of 11 hours per week. The researchers noted that this is a considerable amount of time invested in training for individuals who train and compete recreationally, as opposed to professionally in an elite or sub-elite division of sport (McCormick *et al.,* 2018). These findings are consistent in other studies which also highlight that recreational athletes dedicate a considerable amount of time to training, and this is prioritised over other interests such as family time or socialising with friends (Appleby & Dieffenbach, 2016; Simpson *et al.,* 2014). The schedule of recreational athletes including training and lifestyle demands can negatively affect their sleep and recovery, and the repetitive demands of training can also place stressful demands on the individuals physiological and psychological capacities, which further highlights the value of quality sleep (Tuomilehto *et al.,* 2017).

The term ‘stress’ refers to one’s experiences that are deemed to be a psychological or physiological demand or ‘stressor’. Stress also refers to the adaptative response which involves multiple physiological systems (Elder *et al.,* 2023; Lo Martire *et al.,* 2020; McEwen, 2007). Stress is consistently associated with disturbances to both subjective and objective sleep (Elder *et al.,* 2020). Athletes are subjected to stress for a variety of different reasons such as training and lifestyle demands. Stressors such as acute and residual fatigue may occur due to the demands of training schedules (Borresen & Lambert, 2009). The general consensus in comprehensive reviews (e.g. Gupta *et al.,* 2017; Youngstedt, 2005) is that physical exercise positively influences sleep, and this is expressed as longer sleep durations, reduced sleep onset latencies, reductions in WASO, fewer sleep stage disruptions and an increase in consistency in rapid eye movement (REM) to non-REM transitions. However, there is also strong evidence that shows the training demands of athletes and individuals who partake in regular physical exercise can negatively impact sleep (Gupta *et al.,* 2017). Specifically, increases in the intensity of exercise has been shown to worsen sleep quality and sleep quantity, expressed as increases in wakefulness and decreased REM sleep (Driver & Taylor, 2000).

Subjective sleep and stress are strongly associated, at multiple levels, including biological, psychological, behavioural, and social contexts (Martire *et al.,* 2020) and the current body of evidence highlights a bi-directional association between sleep and stress (Kalmbach *et al.,* 2018). Several studies have highlighted that stress-inducing factors can significantly impact the sleep-wake cycle. On the other side of the relationship, researchers have highlighted that issues with sleep can affect several stress responses, biological pathways and overall quality of life (Martire *et al.,* 2020). Recent research has begun to present evidence of the bi-directional relationships between subjective sleep and stress in an athletic population. Research from Hrozanova *et al.,* (2020) showed that increases in sleep onset latency were significantly associated with a subsequent increase in mental strain. Previous studies have found that individuals from an athletic population are poor sleepers, which among other maladaptive responses, leads to negative stress (Biggins *et al.,* 2018). However, Hrozanova *et al.,* (2019) note that very few studies have examined the direction of the sleep-stress relationship. Hrozanova *et al.,* (2019) investigated how emotional and cognitive reactions to perceived stress contributed to the quality of sleep in a large sample of 632 athletes. The researchers note that even though the evidence of insufficient sleep in an athletic population is well-known, there is a lack of research aimed at explaining the reasons for this finding. The researchers found that perceived stress was negatively associated with sleep quality. The researchers concluded that the capacity of athletes to manage perceived stress and worry is important to enhance their sleep quality and subsequent performance.

Research from Biggins *et al.,* (2018) examined the sleep profiles of Gaelic Athletic Association (GAA) athletes and to compare wellbeing measures such as stress between self-reported good sleepers and poor sleepers. They found that self-reported poor sleepers reported significantly higher levels of stress when compared to self-reported good sleepers. The researchers also found significant associations between poor sleep and subjective health concerns. Levels of inadequate sleep quality among athletes may be attributed to the many features of the stress response, including the reaction and evaluation of stressors. Previous research from Drake *et al.,* (2014) suggests that the important mechanism may involve sleep reactivity. Sleep reactivity refers to the predisposition to exhibit sleep disturbances in response to stress. Sleep reactivity is the trait-like degree to which stress disrupts sleep, which leads to issues around falling asleep and remaining asleep. Individuals who present with a reduction in total sleep time, increased WASO, or difficulty in falling asleep when stressed are considered to have high sleep reactivity while individuals who present with uninterrupted sleep when stressed are considered to have low sleep reactivity (Kalmbach *et al.,* 2018).

Previous research has highlighted that an athlete's sleep may be negatively impacted by training load increases (Kolling *et al.,* 2016) and the stressor of scheduling of training in the early morning (Sargent *et al.,* 2014). However the literature is contrasting with some research studies finding no significant associations between training load and sleep (Knufinke *et al.,* 2018; O'Donnell *et al.,* 2019; Lastella *et al.,* 2020) while other research studies highlight that an increase in training load leads to a subsequent reduction in subjective sleep efficiency (Teng *et al.,* 2011) and sleep duration (Kolling *et al.,* 2016) presenting a significant association between training load and sleep. Despite some of the findings presented above, overall, the body of research examining the bi-directional association between training load and sleep is small and presents contrasting findings. The current study aims to add to the existing body of research that highlights the association between sleep and stress in athletes by examining an unexplored population of recreational athletes. This may help recreational athletes manage their sleep and stress, which are likely to be closely associated, benefit overall mood and reduce the likelihood of overtraining.

The overall aim of this study is to examine the association between subjective sleep quality and subjective stress levels in recreational athletes. The secondary aims of this study are to examine associations between subjective stress and training load, and between subjective sleep quality and training load. It is hypothesised that there will be a positive correlation between subjective sleep and subjective stress. It is also hypothesised that there will be a positive correlation between subjective stress and training load, and a positive correlation between subjective sleep and training load.

Method

A cross-sectional non-experimental study was carried out. Participants took part in an online study delivered using Qualtrics XM (Qualtrics, Provo, UT).

Participants

A total of 40 individuals participated. To determine the sample size for this study, an *a priori* power analysis was conducted using G*Power (Faul *et al.,* 2007). A large effect size was used (r = 0.5) at 80% power. This showed that a minimum sample size of 29 individuals was needed.

The sample group consisted of both male and female recreational athletes, which in the present study was defined as individuals who exercise >4 hours per week for health, fitness, or unofficial competitions (McKinney *et al.,* 2019), who were aged over

18. Participants were recruited using social media and the Northumbria University Sona System. There were no exclusion criteria for this research study. This study was ethically approved by the Northumbria University Faculty of Health and Life Sciences ethics committee (Reference: 2044). All participants provided electronic informed consent.

Measures

The Pittsburgh Sleep Quality Index (PSQI; Buysse *et al.,* 1989) was used to measure subjective sleep quality. This provides a global score of between 0-21 with higher scores indicating lower subjective sleep quality. The Perceived Stress Scale (PSS; Cohen *et al.,* 1983) was used to measure subjective levels of stress. PSS scores range from 0-40 with higher scores indicating higher levels of subjective stress. The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) was used to measure subjective mood. The HADS assesses subjective anxiety and depression and higher HADS scores represent greater levels of subjective anxiety and depression. The Daily Analysis of Life Demands for Athletes tool (DALDA) (Rushall, 1990) was used to measure training load. Responses to the DALDA are: "*worse than normal*", "*normal*" or "better *than normal*". High frequencies of " *worse than normal*" responses indicate high levels of overtraining.

Procedure

Participants provided demographic information (self-reported age and gender) and the PSQI, PSS, HADS and DALDA. Upon completion, participants were debriefed and thanked. Participation took approximately 15 minutes.

Data analysis

A total of 6 participants had not fully completed the study and were excluded from the final data set. Data were analysed using SPSS. Data were visually examined for normality. In order to examine associations between variables (PSQI, PSS, HADS Anxiety/Depression and DALDA), a series of Pearson correlation tests were used.

To assess the main aim, a Pearson correlation test examined between subjective sleep quality (PSQI) and subjective stress (PSS). To assess the secondary aims, Pearson correlation tests examined the association between subjective stress (PSS) and training load (DALDA), and between subjective sleep quality (PSQI) and training load (DALDA).

Results

The final data set was comprised of 34 participants. On the basis of the PSQI, 67.6% (*n* = 23) of participants were good sleepers (PSQI scores < 5) and 32.3% (*n* = 11) were classified as poor sleepers (PSQI scores ≥ 5). Males accounted for 55.9% (*n* = 19) of participants and females for 44.1% (*n* = 15) of participants (Table 1).

Table 1: participant demographic and summary data (n = 34)

	Mean	**SD**
Age	31.06	5.78
Male / female (*n* / %)	19 (55.9) / 14 (44.1)	
PSQI	5.35	3.68
Good / poor sleepers (PSQI; *n* / %)	23 (67.6) / 11 (32.3)	
PSS	14.56	7.26
HADS Anxiety	6.68	4.24
HADS Depression	2.71	3.13
DALDA	5.41	6.14

Abbreviations: DALDA: Daily Analysis of Life Demands for Athletes; HADS: Hospital Anxiety and Depression Scale; PSS: Perceived Stress Scale; PSQI: Pittsburgh Sleep Quality Index; SD: Standard Deviation

There was a significant positive correlation between subjective sleep quality (PSQI) and subjective stress (PSS) ($r(32) = .35$, $p < .05$). These results show that better sleep quality is associated with reduced subjective stress. There was a significant positive correlation between subjective stress (PSS) and training load (DALDA; $r(32) = .66$, $p < .001$). These results show that higher subjective stress is associated with higher training load / level of overtraining. There was a significant positive correlation between subjective sleep (PSQI) and training load (DALDA) ($r(32) = .47$, $p < .01$). These results show that better sleep quality is associated with a reduced training load / level of overtraining.

Discussion

In line with the primary research aim, an association was found between subjective sleep quality and subjective stress. These results indicate that recreational athletes who report better subjective sleep quality also report lower levels of stress. The association between sleep and stress has previously been described as bi-directional (Kahn *et al.,* 2013; Kalmbach *et al.,* 2018) which suggests that an individual's exposure to stressors may develop a reciprocal cycle between sleep and stress. The association between subjective sleep and subjective stress is consistent within the literature examining an athletic population. Research from Biggins *et al.,* (2018), who had a similar proportion of good sleepers (50%) in their study, found that GAA athletes who reported poor sleep quality and quantity also reported significantly higher levels of perceived stress. On the other side of the relationship, athletes who reported good sleep quality and quantity reported significantly lower levels of perceived stress (Biggins *et al.,* 2018).

One possible mechanism that may explain the association between subjective sleep and stress which was outlined in previous research by Drake *et al.,* (2014) is sleep reactivity. Sleep reactivity is an individual's predisposition to exhibit sleep disturbances in response to stress. Sleep reactivity is the trait-like degree to which stress disrupts sleep, which leads to issues around falling asleep and remaining asleep. Individuals who are considered to have low sleep reactivity present with uninterrupted sleep when stressed (Kalmbach *et al.,* 2018). Previous research efforts are consistent in their findings of a bi-directional association between sleep and stress in a variety of different populations, including an athletic population. However, the present study adds to the body of literature, by highlighting the association in recreational athletes, a population which has received little to no attention in this research area.

Numerous studies have consistently found links between poor sleep and psychological concerns, including symptoms of anxiety, depression, anger and psychological distress (Freeman *et al.,* 2017; Ramsey *et al.,* 2019). In the present study, PSS scores were relatively low. A possible explanation for these low scores in the present study is that most participants (67.6%) were classified as 'good sleepers' and previous research has consistently highlighted the role of good quality sleep in the management and reduction of stress (Thun *et al.,* 2015).

In line with the secondary research aim, a positive association was found between subjective stress and training load. These results indicate that recreational athletes who report better subjective stress scores also report lower training load levels. These findings are consistent with previous research: researchers monitored training load and stress levels in competitive athletes and found that higher scores which indicate overtraining were associated with worsening levels of stress (Gomes *et al.,* 2013). A significant positive association was found between subjective sleep quality and training load. These results indicate that recreational athletes who report better subjective sleep scores also report lower levels of overtraining. Previous research has shown that increases in training loads and levels of overtraining can negatively impact athlete sleep (Kolling *et al.,* 2016). Recreational athletes in particular may have the additional stressor of having to schedule training in the early morning (Sargent *et al.,* 2014) which further highlights how the stressor of training itself can negatively impact sleep quantity and quality. Sleep quality has been found to be a key component of the management of training load and in reducing the likelihood of maladaptive training responses such as overtraining syndrome (OTS) (Hooper *et al.,* 1995). OTS is a maladaptive response to excessive training without adequate rest, which leads to negative effects on multiple physiological systems (neurological, endocrinological, immunological) coupled with psychological effects such as mood disturbances (Kreher & Schwartz, 2012) Despite the positive association found in the present study between subjective sleep quality and overtraining, the research examining the bi-directional association between sleep and training load is small and presents contrasting findings.

The positive association between subjective sleep quality, perceived stress, and levels of overtraining in this study highlight the importance of consistent quality sleep for recreational athletes. These findings may begin to inform educational content for a group that have previously received little research focus. Individualised sleep hygiene practices tailored to the constraints of recreational athletes who must balance their training with other life stressors may enhance their quality of sleep, which is critical for physiological and psychological recovery. Sleep hygiene interventions, although only having recently been applied in an athletic setting, have been shown to improve sleep quality and sleep quantity, in a variety of samples and contexts (O'Donnell *et al.,* 2018). To our knowledge, this is the first study to specifically examine if there is an association between subjective sleep quality and subjective stress in recreational athletes, with the majority focusing on elite and sub-elite athletes. Recreational athletes have similar demanding training schedules to elite and sub-elite athletes and often compromise on sleep to fit their training schedule into lifestyles that may already include other competing responsibilities such as work, school and family. The initial novel findings presented in this study may provide justification for future research in this area. Studies that are longitudinal in their design may be able to explore the bi-directional relationship between sleep, stress, mood and training load over a longer period and include interventions aimed at improving these key health variables.

The current research study does present some methodological limitations that need to be acknowledged. Firstly, the present research study used a cross-sectional design, therefore the direction of causality cannot be reliably inferred. It is likely that the association between sleep and stress observed is bi-directional due to the consistent evidence of sleep affecting stress and stress affecting sleep. However, this is the first study of its kind to find an association between subjective sleep and stress in a population of recreational athletes. Although the PSQI is validated as a reliable measure of sleep quality, the use of sleep diaries may have provided further information regarding the cause of good or bad sleep.

The positive associations between sleep, stress and overtraining levels found in this study are supported by previous research but the present study adds to the body of literature by highlighting the associations in recreational athletes, a population that has previously not been explored in this area. Recreational athletes should strive to proactively manage their sleep and stress. This is also likely to benefit mood and reduce the likelihood of overtraining. The bi-directional interaction between these variables is still not fully understood and further research into this area is needed.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and/or its supplementary materials.

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