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The effects of Ramadan intermittent fasting on sleep-wake behaviour and daytime sleepiness in team sport referees

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ABSTRACT

The aim of the present study was to evaluate the impact of Ramadan fasting on sleep quality and daytime sleepiness in team sport referees. Seventy-eight male amateur team sport referees (age: 31.1 ± 10.8 years) participated in this study. Participants responded to the Arabic version of the Pittsburgh Sleep Quality Index (PSQI) and the Epworth sleepiness scale (ESS) questionnaires before (10-days prior) and during (last 7-days) the month of Ramadan.

PSQI and ESS scores increased significantly during Ramadan (both $p < .001$, ES = 0.56 and 0.54, respectively) with 83.3% of participants scoring ≥5 in the PSQI. The percentage of participants suffering from severe excessive daytime sleepiness (ESS score ≥ 16) was 3.8% before *vs*. 7.7% during Ramadan ($p < 0.001$). Sleep duration decreased by ~ 1 h during Ramadan ($p < .001$, ES = 0.61) and was associated with a delay in bedtime of ~ 2 h ($p < 0.001$, ES = 0.7) and of wake-up time of ~ 1 h ($p < 0.001$, ES = 0.5). The score for daytime dysfunction and subjective sleep perception, as components of the PSQI, increased (both $p < 0.001$; ES = 0.79, ES = 0.57, respectively), whereas the score for the use of sleep medication decreased during *vs*. before Ramadan ($p = 0.041$, ES = 0.47). Ramadan fasting impaired sleep quality and increased daytime sleepiness in team sport referees. Future studies, using objective assessment tools, are warranted.

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KEYWORDS
Sleep habits; sleep quality; drowsiness; intermittent fasting; officials

Introduction

Fasting during the month of Ramadan (i.e., lasts 29 or 30 days), the fourth pillar of Islam, is practiced deliberately every year by more than 1.8 billion Muslims, worldwide (Mosaferchi et al., 2020). The fasting during Ramadan is unique in its intermittent nature (Bahammam et al., 2014); indeed, during each day of Ramadan, Muslims abstain from eating and drinking, smoking, and certain other behaviours (e.g., sexual intercourse) between dawn and sunset. Zeitgebers (external cues) such as food intake (both quality, quantity and timing) are generally influenced by Ramadan fasting. Indeed, a sudden shift in the meal timing to the period between sunset and dawn (Bahammam & Almeneessier, 2020), the consumption of two main meals (Trabelsi et al., 2018), and the preference for fatty foods characterizes the month of Ramadan (Trabelsi et al., 2018). Furthermore, changes in day/night activity patterns, such as the rising for the pre-dawn meal (*Suhour*) and increased nocturnal social activities (*e.g.*, Quran reading groups, social meetings, shopping) and prayers (e.g., *Attarawih*), often observed during Ramadan, can act as entrainment cues (Faris et al., 2019).

Such marked changes can elicit numerous negative effects upon an individual´s sleep-wake behaviour. Indeed, the beneficial effects of optimal sleep on human cognition and motor functioning are well documented (Daviaux et al., 2014; Frey et al., 2004). Disturbances in sleep–wake behaviour, common among sedentary subjects (Yang et al., 2017) and athletes (Rae et al., 2017; Roberts et al., 2019; Romdhani et al., 2019) outside of Ramadan, could be exacerbated during Ramadan (Faris et al., 2019; Trabelsi et al., 2020). In a recent systematic review and meta-analysis conducted in a sample of sedentary (i.e., low level of physical activity) and active individuals (i.e., high level of physical activity), Faris et al. (2019) reported that, compared to before Ramadan, sleep duration decreased by approximately 1 hour during Ramadan. In addition, sleep duration was impacted to a greater extent by Ramadan fasting in active vs. sedentary individuals. Further, Faris et al. (2019) found that the score of the Epworth sleepiness scale, indicative of daytime sleepiness levels, increased during Ramadan. Similarly, in another recent systematic review and meta-analysis, Trabelsi et al. (2020) reported that when athletes (≥18 years) continued

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to train at least two times/week during Ramadan, their sleep duration dropped below their baseline levels.

To date, most studies that have evaluated the impact of Ramadan fasting on sleep-wake behaviours have focused on athletes (Chamari et al., 2016; Herrera, 2012), sedentary (Bahammam, 2004) and physically active individuals (Boukhris et al., 2019a; Hsouna et al., 2019), individuals with type 2 diabetes (Alghamdi, Alghamdi, Jenkins, Alghamdi & Haris, 2020), but, no studies have been conducted in sport referees (officials). Indeed, sport referees, with the main duty of implementation of the game rules, should have an optimal level of physical fitness and mental readiness, ensuring split-second correct decisions pertaining to competitive incidents (Helsen & Bultynck, 2004; Lastella et al., 2021, 2020; Reilly & Gregson, 2006). Many Muslim referees from multiple disciplines are required to observe Ramadan during periods of competition (e.g., the national championship and cup) and training preparations for major events (e.g., the Qatar 2022 FIFA World Cup). As sleep behaviour has been consistently acknowledged to influence decision-making (Demos et al., 2016; Lastella et al., 2020; Scott et al., 2006), clarifying the relationships between Ramadan fasting and changes in sleep-wake patterns of Muslim referees, in order to optimize their lifestyle during this period of intermittent fasting, is strongly warranted. Therefore, the aim of this study was to evaluate the impact of Ramadan fasting on sleep quality and daytime sleepiness in team sport referees. It was hypothesized that Ramadan fasting would negatively affect sleep duration and quality, and would increase daytime sleepiness in Muslim referees.

Methods

Male amateur team sport referees (n = 78, mean ± standard deviation, age 31.1 ± 10.8 years, officiating for 7.2 ± 4.6 years), from three sports (soccer: n = 33; basketball: n = 25; handball: n = 20), residing in three Arabic countries (Tunisia = 42; Egypt = 19; Algeria = 17), and with various employment status (employed = 59; unemployed = 11; student = 8) volunteered to participate in this study.

G * power software (version 3.1.9.2; Kiel University, Kiel, Germany) (Faul et al., 2007) was utilized to calculate *a priori* the required sample size. Values for α were set at 0.05 and power at 0.90. Based on the study of Herrera (2012), Cohen d was estimated to be 0.55. The required sample size was 30 for PSQI parameters. Concerning daytime sleepiness, based on the study of Herrera (2012), Cohen d effect size was estimated to be 0.39. The required sample size was 68 for daytime sleepiness.

Team sport referees were recruited via professional and personal contacts with sporting organizations, social media channels and public websites. Team sport referees were included in the study if they were over 18 years of age, fasted and continued training during the whole month of Ramadan, residing in an Arabic country and not receiving specific advice on methods of minimizing the effects of Ramadan. Given the known disturbances to sleep and the limitation for participation in sports (Atkinson et al., 2008), shift workers and referees who have sleep disorders were excluded from the analysis. The present study was conducted in accordance with the Declaration of Helsinki. The study protocol was fully approved by the local research ethics committee (CPP: 0098/2018).

Procedure

A cross-sectional study design was followed using an online survey (i.e., Google forms®). Before commencing the online survey, participants received a web-link displaying an information sheet that detailed the purpose, benefits, risks, and requirements of participation in the study. Informed consent was obtained once participants proceeded to the online survey. The survey was distributed, firstly, during the 10 days preceding the month of Ramadan (7 to 17 May 2018) and, secondly, to the same participants during the last seven days of Ramadan (8 to 15 June 2018).

The first section of the survey included questions related to demographic characteristics and information concerning the sport officiated by participants. Participants subsequently responded to the validated Arabic version of (*i*) the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989; Suleiman et al., 2010) for the assessment of the subjective sleep quality over the previous month, and (*ii*) the Epworth sleepiness scale (Riachy et al., 2012; M. W. Johns, 1991) for the measurement of daytime sleepiness over the last seven days. PSQI scores were interpreted based on the reference ranges adopted for PSQI questionnaire: <5 indicates a good sleep quality and ≥5 indicates a poor sleep quality (Buysse et al., 1989). ESS scores were interpreted based on the reference ranges adopted for ESS (M. Johns, 2019): 0–5 indicates lower normal daytime sleepiness, 6–10 indicates higher normal daytime sleepiness, 11–12 indicates mild excessive daytime sleepiness (EDS), 13-15, 13–15 indicates moderate EDS, and 16–24 indicates severe EDS.

Statistical analysis

Data were reported as means (±standard deviations) for continuous variables or percentages for categorical variables. All statistical analyses were performed using the statistical software JASP v0.13.1 (Netherlands) (JASP Team, JASP, Team. JASP (Version 0.13.1) [computer software], 2020) and Microsoft Excel 2016. Using the Shapiro–Wilks W-test, normality of the data distribution was not confirmed. Therefore, Wilcoxon signed-rank tests were conducted to compare values before and during Ramadan.

Effect size (ES) for non-parametric tests was calculated by the matched rank biserial correlation (King et al., 2011), and were interpreted as follows: small (0.10 – <0.30), medium (0.30 – <0.50), and large (≥0.50). Statistical significance was accepted at $p < 0.05$.

Changes between measures recorded before and during Ramadan (delta (Δ) scores) were calculated as during Ramadan value minus the before Ramadan value. Percent changes were also calculated as follow:

$$\Delta(\%) = \left[\frac{(\text{During Ramadan value} - \text{before Ramadan value})}{\text{Before Ramadan value}}\right] \times 100$$

Table 1. Effects of Ramadan fasting on PSQI parameters and daytime sleepiness.

Parameters	Means±SD		Δ (Δ%)	T (Wilcoxon)	p-value	ES
	Before-R	During-R				
Sleep latency (min)	31.2 ± 21.4	33.7 ± 18.0	2.5 (7.4%)	935	0.072	0.24
Subjective sleep perception (A.U)	1.11 ± 0.83	1.52 ± 0.59	0.41 (27%)	231	<0.001	0.57
Sleep efficiency (%)	91.3 ± 8.11	89.7 ± 10.8	−1.6 (−1.75%)	808	0.101	0.26
Sleep disturbance (A.U)	1.12 ± 0.65	1.14 ± 0.41	0.02 (1.7%)	272	0.870	0.03
Daytime dysfunction (A.U)	0.66 ± 0.59	1.17 ± 0.71	0.51 (43.6%)	102	<0.001	0.79
Use of a sleep medication (A.U)	0.23 ± 0.48	0.11 ± 0.39	−0.12 (−52.2%)	140	0.041	0.47
Total score of PSQI (A.U)	5.65 ± 3.15	7.60 ± 2.66	1.95 (25.7%)	545	<0.001	0.56
Total ESS score (A.U)	7.56 ± 4.09	9.57 ± 4.04	2.01 (21%)	518	<0.001	0.54

Before-R = before Ramadan; During-R = during Ramadan; PSQI = Pittsburgh Sleep Quality Index; ESS = Epworth sleepiness scale; ES = effect size; Δ = difference between during and before Ramadan; SD = standard deviation; A.U = arbitrary unit

Results

Effects of Ramadan on sleep quality and daytime sleepiness

The mean scores of the PSQI and ESS are presented in Table 1. The values during Ramadan were significantly higher compared with before Ramadan ($p < 0.001$), and were of large magnitude. There was a higher percentage of participants with a PSQI score above five during (83.3%) compared to before Ramadan (57.7%). The percentage of participants suffering from severe EDS was 3.8% before vs. 7.7% during Ramadan.

Quantitative sleep measures

Table 1 includes mean values for TST, sleep onset latency (SOL), sleep disturbances, use of sleep medication, sleep efficiency, daytime dysfunction, and subjective sleep perception. The increase in SOL and sleep disturbances was not significant ($p = 0.072$, $p = 0.801$, respectively) and of small magnitude. The decrease in sleep efficiency was not significant ($p = 0.101$) and of small magnitude. The decrease in the use of sleep medication was significant ($p = 0.041$) and of medium magnitude. There was a significant ($p < 0.001$), large, and robust increase in daytime dysfunction and subjective sleep perception during vs. before Ramadan. There was a significantly large and robust ($p < 0.001$; ES = 0.61) reduction (□1 h) in sleep duration during (6.13 ± 1.8 h) vs. before (7.17 ± 1.14 h) Ramadan.

Bedtime was delayed by 2.2 h during vs before Ramadan (23:37 ± 01:21 before Ramadan vs. 01:51 ± 01:53 during Ramadan; $p < 0.001$, ES = 0.7). Participants awakened 1.1 h later during vs before Ramadan (07:27 ± 01:18 before Ramadan vs. 08:31 ± 01:55 during Ramadan; $p < 0.001$, ES = 0.5) (Figure 1).

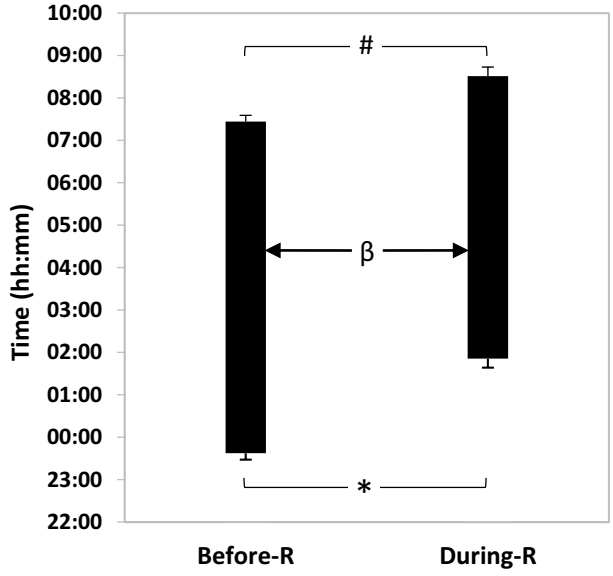

Figure 1. Wake-up time and bedtime before (before-R) and during Ramadan (during-R). * bedtime is significantly different from Before-R at $p < 0.001$; # wake-up is significantly different from Before-R at $p < 0.001$; β sleep duration is significantly different from Before-R at $p < 0.001$

Discussion

The results show that Ramadan fasting significantly impaired sleep quality and increased daytime sleepiness in team sport referees. The reported values of PSQI and ESS indicate that a significant percentage of referees suffer from poor sleep quality and severe EDS, respectively, irrespective of Ramadan.

In the present study, the PSQI and ESS questionnaires represent the diagnostic tests to identify referees who may benefit from further quantitative sleep assessment and/or sleep-specific medical support (Halson, 2019). Indeed, sleep duration, a component of the PSQI questionnaire, is a key factor in determining the recuperative outcome of sleep (Samuels, 2008). In the present study, sleep duration decreased markedly by ~1 h during Ramadan. Our results are in accordance with those of Herrera (2012), Boukhris et al. (2019a), and Chennaoui et al. (2009), but not with others (Boukhris et al., 2019b; Hsouna et al., 2019; Leiper et al., 2008). Despite using the same sleep assessment tool (i.e., PSQI questionnaire), Hsouna et al. (2019) and Boukhris et al. (2019b) reported the lack of change in sleep duration before vs. during Ramadan. The discrepancy could possibly be explained by the stress associated with officiating compared to physically active men not engaged in official competitions.

It is well documented that the recommended sleep duration is between seven and nine hours for healthy adults (Watson et al., 2015). However, athletes require more sleep than the general population due to increased mental and physical demands (Halson, 2014; Lastella et al., 2015). In the present study, the average sleep duration is well below the recommended seven hours for healthy adults (6.1 h), indicating insufficient amount of sleep during Ramadan in team sport referees.

Insufficient amount of sleep (6.4 h ± 0.7 h) was previously reported, outside of Ramadan, in Australian referees across the in-season (Lastella et al., 2021, 2020). The reduced sleep duration may impair some specific domains of cognitive performance (i.e., decreased vigilance, attention, response time, capability) (Chua et al., 2014), which could, consequently, negatively affect the decision-making of team sport referees during Ramadan.

The reduced sleep duration during Ramadan fasting could be explained by several zeitgeber factors. Indeed, the large amount of food consumed at night could have negatively affected circadian rhythms and hormone secretion (Almeneessier et al., 2018). Further, it has been shown that eating close to bedtime could decrease sleep duration (Roky et al., 2001). Sleeping with a full stomach during Ramadan may have increased core body temperature and consequently promoted night wakefulness (Bahammam, 2003). The reduced sleep duration may also be explained by the increase in nighttime social activities (Faris et al., 2019; Trabelsi et al., 2020) and/or the nocturnal light exposure (Almeneessier et al., 2018; Faris et al., 2019). In this context, when athlete's sleep/wake schedule, sleep duration, light exposure, and energy expenditure were controlled, although difficult to achieve during Ramadan, no effect of fasting on circadian rhythms would be expected. However, Qasrawi et al. (2017) reported sudden and significant delays in bedtime and wake time could occur during Ramadan when there is no control for lifestyle changes. Indeed, our results showed a shift in the sleep/wake rhythm, characterised by a change of ~ 2 hours in the bedtime and of ~ 1 hour for awaking. Previous data indicate that a reduction in night time sleep duration during Ramadan may also result in an increased duration of daytime sleep (Margolis & Reed, 2004). Nevertheless, there is a lack of evidence to support this suggestion. Indeed, previous studies conducted in medical students (Bahammam, 2003) and healthy workers (Bahammam, 2005) found no significant change in the duration of naps or the percentage of subjects who napped before and during Ramadan. Interestingly, another study in university students in Morocco found a decrease in nap duration during Ramadan (Taoudi Benchekroun et al., 1999). Therefore, it is plausible that the reduced night sleep time during Ramadan may be due to zeitgebers factors rather than daytime napping. Unfortunately, our study did not provide enough findings to support this assumption in referee's population, as napping duration was not assessed. Thus, further large studies simultaneously evaluating the effects of Ramadan fasting on night sleep time, zeitgebers and daytime napping in referee's population are warranted.

The use of sleep medication to aid sleep onset decreased during Ramadan. The reduced sleep duration during Ramadan fasting could be related to the decrease in the use of sleeping pills. Thus, sleep restriction leads to increased sleep pressure, which is a common behavioural therapy for patients with insomnia (Sharma & Andrade, 2012). Indeed, an increase in the SOL would be expected; however, in accordance with the results of previous studies conducted in physically active men (Boukhris et al., 2019ab, Hsouna et al., 2019) and athletes (Herrera, 2012), SOL did not change during compared to before Ramadan. It is worth noting that average SOL values reported before and during Ramadan in our participants were higher than (*i*) the cut-off of 20 min indicative of usual SOL (Kushida, 2012), and (*ii*) those reported in other studies (Boukhris et al., 2019ab, Herrera, 2012; Hsouna et al., 2020b), suggesting that team sport referees have difficulty initiating sleep, irrespective of the changes during Ramadan.

Sleep efficiency remained unchanged from before to during Ramadan, which is confirmatory of previous data (Boukhris et al., 2019ab, Herrera, 2012; Hsouna et al., 2020ab). Moreover, the average sleep efficiency values were higher than the cut-off of 85% (Reed & Sacco, 2016), indicative of good sleep efficiency during Ramadan in team sport referees. Surprisingly, the perceived sleep quality, another component of the PSQI questionnaire, was significantly worsened during Ramadan. Our findings are in accordance with those of Hsouna et al. (2020ab), whilst, recently, Vincent et al. (2020) concluded that sport officials are vulnerable to reduced quantity and quality of sleep before and after competition, with impaired perceived decision-making ability following nights of less than average sleep. Clearly, future studies investigating the relationships between sleep-wake patterns and decision-making in team sport referees during Ramadan are warranted.

Sleep quality, represented by the overall PSQI score, decreased significantly during Ramadan. However, the presented findings are discordant with previous data showing that the overall PSQI score of athletes (Herrera, 2012) and physically active men (Hsouna et al., 2019) are not influenced by Ramadan. The maintenance of sleep quality (i.e., overall PSQI score) during Ramadan was previously attributed to the close monitoring of athletes by the technical/medical staff during the training camp (Boukhris et al., 2019b). Chamari et al. (2016) was the only study that incorporated the "gold standard" of polysomnography for sleep assessment before and during Ramadan. Accordingly, the authors demonstrated that light sleep stage duration increased during, compared to before Ramadan (Chamari et al., 2016). Indeed, this may be attributed to an increase in the number of awakenings and may reflect increased night time metabolism, due to the late *Suhour* meal and/or increased food-seeking behaviours (Chamari et al., 2016).

Although the average overall PSQI score was greater than five before and during Ramadan, our results showed that the percentage of referees with overall PSQI score greater than five increased from 57.7% before to 83.3% during Ramadan. These findings indicate that Ramadan fasting may have worsened the sleep quality of team sport referees. Poor sleep quality prevalence of 47% (Drew et al., 2018) and 78% (Samuels, 2008) have been previously reported, outside of Ramadan, in summer and winter Olympic athletes, respectively. This could be attributed to the high level of anxiety and stress associated to major competitions (Erlacher et al., 2011).

Daytime sleepiness scores recorded during Ramadan, indicating higher normal daytime sleepiness, were noticeably higher compared to those before Ramadan. Comparable increases in daytime sleepiness levels were reported in the meta-analysis of Faris et al. (2019). Previous studies (Aziz et al., 2012, 2010; Roky et al., 2001) speculated that a loss of 1–2 h sleep/day accumulates, resulting in chronic EDS towards the end of the month. This potentially elicits a negative effect upon

the individual's daytime fatigue, behaviour, lethargy, and mood (Aziz et al., 2012), which could have increased daytime dysfunction in our participants during Ramadan. A major finding in the present study is that 7.7% of the sample suffered from severe EDS during Ramadan. The month of Ramadan is characterized by an increase in daytime sleepiness (Qasrawi et al., 2017); thus, it is not surprising that severe EDS occurs during this month in team sport referee's population. However, the proportion of affected individuals was acute, and changes of sleep schedule, habits and routines, sleeping environment or stress management could help to manage EDS during Ramadan. For example, it was reported that napping after partial sleep restriction (Romdhani et al., 2020) and a night of normal sleep (Boukhris et al., 2020; Romdhani et al., 2021), or listening to high tempo music after sleep deprivation and normal sleep (Khemila et al., 2021), could increase alertness and reduce daytime sleepiness. Further investigations evaluating the effectiveness of these strategies in reducing daytime sleepiness during Ramadan in team sport referees are warranted.

Limitations

Despite its novelty, the results of the present study should be interpreted with caution. First, we did not use any objective measurement for the evaluation of sleep quality and daytime sleepiness. However, sleep quality could be considered as a subjective perception, with no consensus on what good sleep, in fact, implies (Åkerstedt et al., 2009). In this study, the PSQI questionnaire was used to evaluate the sleep quality of team sport referees. Interestingly, this tool includes a standardized scoring method which could offer greater reproducibility and reliability across future studies. Second, daily naps, known for their beneficial effect for physical and cognitive performance during (Hsouna et al., 2020ab) and outside of Ramadan (Boukhris et al., 2020; Ammar et al., 2021), cannot be assessed using PSQI questionnaire. Therefore, future studies assessing, or at least considering, daily nap duration during Ramadan are needed. Third, our survey was advertised online; therefore, it may be subject to volunteer bias (i.e., people particularly interested in sleep-wake patterns during Ramadan could be more prone to participate and to perceive differences between before and during Ramadan). Last, team sport referees were amateur, and thus, it remains unclear whether the results can be applied to professional referees.

Conclusion

Ramadan fasting negatively affected sleep quality and increased daytime sleepiness in team sport referees. In addition, it is plausible that referees would benefit from further objective sleep assessment methods and/or sleep-specific medical support.

Disclosure of potential conflicts of interest

No potential conflict of interest was reported by the author(s).

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