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Early morning sport scheduling is associated with poorer subjective sleep characteristics in British student-athletes

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Abstract

This study presents the sleep characteristics of British student-athletes and examines the relationships between sport scheduling and time demands on sleep outcomes. Student-athletes ($n = 157$, 51% male) completed the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and the Sleep Hygiene Index (SHI). Self-reported sleep characteristics on weekdays and weekends, weekly frequencies of early morning and late evening sport sessions, and academic-related and sport-related time demands were also collected. Questionnaires revealed a high prevalence of undesired sleep characteristics including poor sleep quality (global PSQI >5 in 49.0%) and low sleep durations on weekdays (25% reporting <7 h). Paired t-tests revealed significant differences in bedtime, waketime, sleep duration, and sleep onset latency between weekdays and weekends (all $p < 0.01$). Hierarchical regression analyses indicated that early morning sport frequency was a significant predictor of PSQI ($\beta = 0.30$) and SHI ($\beta = 0.24$) global scores, weekday waketimes ($\beta = -0.17$), and weekday sleep durations ($\beta = -0.25$; all $p < 0.05$) in models adjusted for participant characteristics. Late evening sport frequency, and academic-related and sport-related time demands, were not significant predictors of any sleep outcome. Adjusting sport scheduling to avoid early start times could provide a means to improve sleep outcomes and may improve sporting performance and academic attainment.

KEYWORDS

scheduling, sleep, social jetlag, student-athlete

1 | INTRODUCTION

Previous research has highlighted suboptimal sleep outcomes among both University student and elite athlete populations,[1,2] prompting increased interest in the sleep characteristics of student-athletes. While various physiological processes underpin sleep regulation, a complex interplay with the social-environmental context influences sleep behaviors and can help elucidate why certain populations, such as student-athletes, may exhibit poorer sleep characteristics.[3] For example, athletes encounter sport-specific risk factors related to training, travel, and competition that can disrupt sleep,[4] while emotional and academic stress contribute towards poor sleep among

University students.[2] Studies on student-athletes have consistently shown a significant proportion to report a nocturnal sleep duration of under 7 h,[5,6] with 61% falling below this threshold when assessed using actigraphy.[7] Approximately half of American student-athletes are classified as poor-quality sleepers when assessed using the Pittsburgh Sleep Quality Index,[5,8] and a high prevalence of excessive daytime sleepiness and poor sleep hygiene behaviors in response to environmental barriers has been observed.[5]

Previous research on student-athlete sleep has predominantly focused on American cohorts. While British student-athletes likely share many characteristics, notable differences in sports, academics, and culture may contribute to distinct sleep outcomes, as indicated by a higher sleep duration previously reported in British counterparts.[9] The typical British student-athlete sporting schedule runs from Monday to Friday with competitions held on Wednesdays, in contrast to the more varied National Collegiate Athletic Association (NCAA) schedule. However, sport training often needs to be scheduled around the academic timetable, resulting in either early morning or late evening sessions. In elite athletes, training timing has been identified as a factor causing social jetlag,[10] which is the inconsistency in sleep/wake timing between work days and free days driven by misalignment of the social and circadian clocks,[11] with social jetlag associated with poorer health outcomes.[12] For instance, Sargent et al.[13] demonstrated that on nights preceding early morning training at 06:00, bedtime was 2.5 h earlier, waketime was 4.0 h earlier, and sleep duration was 2.2 h shorter compared to nights preceding free days in swimmers. The impact of late evening training on sleep in athletes is less clear, although sleep duration has been shown to be shortened following evening competitions.[14] While a small social jetlag effect has been demonstrated between weekdays and weekends in student-athletes,[5,9] this warrants further investigation.

In addition to sport scheduling, another perceived sleep risk factor unique to student-athletes is the challenge of balancing the demanding workload inherent in excelling both in sports and academics.[15] NCAA athletes have reported a combined sport and academic workload exceeding 60 h per week, with only 54–66% of Division I athletes believing they were able to find a balance between academics and extracurricular activities, and felt able to keep up with classes in-season.[16] However, it has been contested that workload is responsible for poor sleep in student-athletes.[17] Currently, it remains unknown whether the sporting and academic time demands in British student-athletes are comparable to those of NCAA counterparts. However, differences in academic structure and sporting culture between countries provide grounds to investigate the impact of time demands on sleep among British student-athletes.

Given the paucity of existing sleep research in British student-athletes, there is a need to gain further insight into this group and how they compare to previous findings. This study aimed to utilize questionnaires as a recommended tool to screen and assess sleep outcomes in an athlete populations,[18] with the following objectives: (1) assess the sleep outcomes of a cohort of British student-athletes to enable comparisons with other athlete and student-athlete populations; (2) examine differences in sleep outcomes between weekday and weekend nights; and (3) investigate the association between sport scheduling and time demands on sleep, and whether these variables serve as significant predictors of sleep outcomes. It was anticipated that sleep outcomes in British student-athletes would align with those observed in student-athletes of other nationalities. Furthermore, it was anticipated that sleep outcomes would exhibit significant differences between weekday and weekend nights and that both sport scheduling and time demands would emerge as significant predictors of sleep outcomes.

2 | MATERIALS AND METHODS

2.1 | Participants

Participants were recruited from a single University and College center located in the South-West United Kingdom. Informed consent was obtained from each participant, and study approval was obtained from the Hartpury University Ethics Committee (ETHICS2021-117). The criteria to be classified as a student-athlete was defined as: (1) enrolled on an academic course for the 2022/23 academic year, and (2) registered with the center's performance sports academy, inferring a minimum performance level of British Universities and Colleges Sport (BUCS) competition. Participants were excluded if they disclosed any previous or current history of a medically diagnosed sleep-related disorder prior to the study.

All academic and sporting activities, including matches, took place on weekdays, with no scheduled activities on weekends. Training and match schedules for sports teams varied. University students typically had training sessions scheduled outside the academic timetable (Monday, Tuesday, Thursday, and Friday from 08:30 to 20:30). The college academic timetable ran from 09:00 to 15:30, with some college student-athletes having training sessions integrated into their academic timetable.

2.2 | Protocol

Participants completed an online survey during Autumn 2022 over a 2-week period. This timeframe was during academic teaching weeks but outside any examination periods, and all sports were in-season. Convenience sampling was used to recruit participants through emails sent directly from the lead researcher to student-athletes on two occasions, and signposting from head sports coaches. The survey was administered through Qualtrics XM online platform (Qualtrics, Provo, UT).

2.3 | Content

Participant characteristics were gathered through questions related to age, sex, level of study, sport, and residential status. Self-assessed chronotype was captured using the reduced Morningness-Eveningness questionnaire (rMEQ).[19] The rMEQ consists of 5 items relating to sleep–wake preferences and alertness to estimate circadian phase, scored from 1–5 (Q1-4) or 0–6 (Q5) with items summed for a global score between 4 and 26. Higher scores indicate an earlier circadian phase. Cutoff scores were used to categorize evening-type (<12), neither-type (12–17), and morning-type (>17) groups, but were kept as a continuous variable for regression analyses.

The Pittsburgh Sleep Quality Index (PSQI) was used to measure subjective sleep quality.[20] The PSQI consists of 19 items relating to habitual sleep over the previous month. These items form seven equally weighted components scored 0–3, and are summed for a global score from 0 to 21. A threshold score of >5 is used to identify poor-quality sleepers.[20] A threshold of ≥8 is also reported and has been used to indicate highly disturbed sleep in athletes.[4] PSQI questions 1–4 relating to typical bedtime, sleep onset latency (SOL), waketime, and total sleep time (TST) were split into separate questions for weekdays and weekends and used separately for further analyses. For PSQI global scoring, a 5:2 ratio of weekday to weekend responses was calculated to reflect the original questionnaire.

The Epworth Sleepiness Scale (ESS) was used to measure subjective daytime sleepiness.[21] The ESS consists of 8 items regarding sleep propensity in different scenarios. These are scored on a range from 0 to 3 and summed for a global score between 0 and 24, with higher scores reflecting higher daytime sleepiness. A threshold score of ≥10 indicates excessive daytime sleepiness.[21]

The Sleep Hygiene Index (SHI) was used to assess the practice of sleep hygiene behaviors.[22] The SHI consists of 13 items on the presence of behaviors that can facilitate or hinder sleep. These are scored on a range from 1–5 and summed for a global score between 13 and 65, with higher scores indicative of poorer sleep hygiene practices.

The scheduling of early morning (AM) and late evening (PM) sport was assessed by asking for the typical weekly frequency of training or competition before 09:00 and after 21:00 respectively, to capture training sessions that were placed prior to the academic timetable and may require an earlier awakening than preferred, or were placed close to typical weekday bedtimes and may interrupt sleep onset.[23] Sporting and academic time demands were assessed by asking for the typical weekly hours spent on academic-related and sport-related activities. Participants were also asked whether they believed balancing sporting, academic, employment, and social activities restricted sleep opportunities below personal preference.

2.4 | Statistical analysis

Raw data from Qualtrics XM was exported to Microsoft Excel (Microsoft, Redmond, WA), and then uploaded to IBM SPSS version 26 (IBM, Chicago, IL) for all statistical analyses. Preliminary data screening was performed using guidelines outlined by Tabachnick and Fidell (2013).[24] Seven participants were removed for reporting a current or previous sleep disorder. Six data points from three cases were considered invalid responses (e.g., out-of-range values) and treated as missing data. As Little's missing completely at random test was non-significant ($\chi^2 = 24.893$, $df = 33$, $p = 0.844$), data was replaced using multiple imputations as to not greatly influence the variation in data.[24] Eight data points from five cases were considered univariate outliers assessed using standardized z-scores ($z > 3.29$, $p < 0.001$). These were manually screened and deemed to be valid responses. To minimize the impact of outliers on correlation and regression analyses, these outliers were assigned to the next most extreme non-outlier score in the distribution. Scores were considered normally distributed through visual inspection of normal Q–Q plots and assessment of skewness and kurtosis (z_{skew} and $z_{kurt} < 3.29$). No multivariate outliers were identified through Mahalanobis distances using a $p < 0.001$ criterion for Mahalanobis D^2. Reliability analysis was performed on validated questionnaires (PSQI, $\alpha = 0.62$; SHI, $\alpha = 0.72$; ESS, $\alpha = 0.71$; rMEQ, $\alpha = 0.58$).

Descriptive data are presented as mean ± SD, with bias-corrected and accelerated 95% confidence intervals (10 000 bootstrapped samples) reported. Differences in sleep outcomes, categorized by participant characteristics, were assessed using independent t-tests (for two factors) or one-way ANOVAs (for three or more factors). Paired t-tests were employed to evaluate differences between self-reported weekday and weekend sleep as derived from the

PSQI. Pearson correlations were conducted between sport scheduling, time demand predictor variables, and sleep outcomes. Multiple regression analyses were employed to investigate the predictive ability of sport scheduling and time demands on sleep outcomes while controlling for fixed predictor variables (participant characteristics showing differences in sleep outcomes). Each sleep outcome was assessed in a separate model using the enter method, with fixed predictors entered at step 1, followed by the inclusion of sport scheduling and time demand predictors at step 2.

3 | RESULTS

3.1 | Sleep characteristics

A total of 157 participants, with a mean age of 18 ± 2 years (range 16–25), were included in the analyses. Participant characteristics and differences in sleep outcomes based on participant characteristics are summarized in Table 1. In addition, age was significantly associated with PSQI ($r = 0.171$, $p = 0.032$, 95%CI [0.014, 0.319]), ESS ($r = 0.189$, $p = 0.018$, 95%CI [0.033, 0.355]), weekday waketime ($r = -0.428$, $p = <0.001$, 95%CI [−0.540, −0.315]), and weekday TST ($r = -0.257$, $p = 0.001$, 95%CI [−0.381, −0.146]). The proportion of participants reporting poor perceived sleep quality (PSQI >5) was 49.0% ($n = 77$), while 23.6% ($n = 37$) had a PSQI score above the higher threshold (PSQI ≥8). Regarding perceived daytime sleepiness, 22.9% ($n = 36$) exceeded the clinical threshold (ESS ≥10).

When considering the difference between PSQI-derived sleep outcomes on weekdays and weekends, a statistically significant mean difference was observed for all sleep outcomes. On average, participants went to bedtime 38 min earlier ($t(156) = -8.45$, $p < 0.001$, $d = 0.67$ (0.50, 0.85)), a waketime 118 min earlier ($t(156) = -16.93$, $p < 0.001$, $d = 1.35$ (1.13, 1.57)), had a TST 67 min shorter ($t(156) = -11.59$, $p < 0.001$, $d = 0.93$ (0.74, 1.11)), and had a SOL 3 min longer ($t(156) = 3.90$, $p < 0.001$, $d = 0.31$ (0.15, 0.47)) on weekdays when compared to weekends (Figure 1). A total of 39 participants (24.8%) reported a weekday TST <7 h compared to 13 (8.3%) at weekends.

3.2 | Sport scheduling and time demands

The frequency of AM and PM sport sessions were 2.7 ± 2.0 and 0.7 ± 1.1 per week, respectively. In total, 132 participants (84%) participated in at least one AM or PM sport session, with 63 participants (40%) reporting both AM and PM sport sessions. The weekly time spent on academic-related activities was 17.7 ± 8.8 h, while 13.2 ± 6.5 h were spent on sport-related activities. A total of 52.2% ($n = 82$) of participants believed that balancing sport-related and academic-related activities in addition to social and employment activities restricted sleep opportunity below their personal preference.

A correlation matrix showing the relationships between predictor variables and sleep outcomes is presented in Table 2. A higher frequency of AM sport sessions was associated with shorter weekday TST ($p < 0.001$, 95%CI [−0.415, −0.167]), earlier weekday waketimes ($p < 0.001$, 95%CI [−0.474, −0.213]), and higher PSQI ($p < 0.001$, 95%CI [0.169, 0.436]), ESS ($p = 0.005$, 95%CI [0.059, 0.371]), and SHI ($p = 0.023$, 95%CI [0.000, 0.320]) global scores. The frequency of PM sport sessions was not associated with any sleep outcome. Increased academic-related time demands were associated with higher weekend TST ($p = 0.025$, 95%CI [0.048, 0.308]), while increased sport-related time demands were associated with earlier weekday bedtimes ($p = 0.036$, 95%CI [−0.314, −0.021]) and weekday waketimes ($p = 0.039$, 95%CI [−0.321, −0.005]).

For the linear regression analyses, the fixed predictors entered into the models at Step 1 were age, chronotype (rMEQ global score), residential status, and sex. The level of study was omitted due to the high correlation with age ($r = 0.76$, $p < 0.001$) and the presence of multicollinearity when included in regression models, as assessed by variance inflation factors. Type of sport was excluded based on the absence of significant differences in sleep outcomes observed in earlier ANOVAs.

Regression models revealed four sleep outcomes for which the frequency of AM sport sessions was a significant predictor of the model when fixed predictors were included. Specifically, AM sport frequency significantly predicted PSQI ($p < 0.001$) and SHI global scores ($p = 0.005$), alongside weekday TST ($p = 0.003$) and weekday waketime ($p = 0.024$). However, the frequency of PM sport sessions and academic-related and sport-related time demands did not emerge as significant predictors in these models. The complete regression models for these four sleep outcomes are detailed in Table 3.

The regression models for ESS global score ($F(3, 153) = 2.811$; $p = 0.009$, $R^2 = 0.117$), weekday bedtime ($F(3, 153) = 6.911$; $p < 0.001$, $R^2 = 0.245$), weekend bedtime ($F(3, 153) = 4.778$; $p < 0.001$, $R^2 = 0.183$), and weekend waketime (F(3, 153) = 3.664; $p = 0.001$, $R^2 = 0.147$) were statistically significant, but were only predicted by the fixed predictors entered into the models. The models for the remaining sleep outcomes (weekday SOL, weekend SOL, and weekend TST) did not reach statistical significance ($p > 0.05$). The full regression analyses for these seven sleep outcomes are available in the Supplemental File Tables S1 and S2.

TABLE 1 Sleep parameters split by participant characteristics.

Variable		PSQI	ESS	SHI	Weekday bedtime	Weekday SOL	Weekday waketime	Weekday TST	Weekend bedtime	Weekend SOL	Weekend waketime	Weekend TST
All ($n=157$)		5.7 ± 2.6	6.7 ± 3.7	31.9 ± 6.6	23:01 ± 00:56	22 ± 14	07:00 ± 01:04	7.3 ± 1.1	23:39 ± 01:19	19 ± 12	08:58 ± 01:26	8.4 ± 1.3
Sex	Male ($n=80$)	5.2 ± 2.5	6.5 ± 3.3	29.9 ± 6.2	22:59 ± 00:57	21 ± 14	06:49 ± 01:03	7.1 ± 1.1	23:36 ± 01:11	17 ± 12	08:29 ± 01:35	8.2 ± 1.3
	Female ($n=77$)	6.2 ± 2.7	6.9 ± 4.0	33.9 ± 6.4	23:03 ± 00:52	23 ± 14	07:11 ± 00:56	7. 3 ± 1.1	23:43 ± 01:16	21 ± 13	09:07 ± 01:16	8.5 ± 1.1
	Effect size	**$d=0.39$ (0.07, 0.70)***	$d=0.10$ (−0.21, 0.41)	**$d=0.63$ (0.31, 0.95)****	$d=0.07$ (−0.25, 0.38)	$d=0.14$ (−0.18, 0.45)	**$d=0.37$ (0.06, 0.69)***	$d=0.24$ (−0.07, 0.56)	$d=0.10$ (−0.21, 0.42)	**$d=0.38$ (0.06, 0.69)***	$d=0.21$ (−0.11, 0.52)	$d=0.24$ (−0.08, 0.55)
Level of study	College ($n=89$)	5.2 ± 2.6	6.0 ± 3.4	31.6 ± 7.0	23:06 ± 00:51	20 ± 13	07:19 ± 00:56	7.5 ± 1.0	23:45 ± 01:16	18 ± 13	09:01 ± 01:25	8.4 ± 1.2
	University ($n=68$)	6.3 ± 2.6	7.6 ± 3.8	32.2 ± 6.1	22:55 ± 00:59	24 ± 14	06:35 ± 00:57	7.0 ± 1.1	23:32 ± 01:08	19 ± 12	08:54 ± 01:29	8.4 ± 1.4
	Effect size	**$d=0.40$ (0.08, 0.72)****	**$d=0.44$ (0.12, 0.75)****	$d=0.09$ (−0.23, 0.41)	$d=0.21$ (−0.10, 0.53)	$d=0.24$ (−0.08, 0.56)	**$d=0.79$ (0.46, 1.12)****	**$d=0.53$ (0.20, 0.85)****	$d=0.18$ (−0.13, 0.50)	$d=0.07$ (−0.24, 0.39)	$d=0.08$ (−0.24, 0.39)	$d=0.03$ (−0.29, 0.34)
Sport	Rugby ($n=86$)	5.8 ± 2.7	6.5 ± 3.8	31.8 ± 7.2	23:07 ± 00:59	22 ± 14	07:06 ± 00:56	7.3 ± 1.1	23:37 ± 01:12	19 ± 13	09:03 ± 01:17	8.4 ± 1.2
	Football ($n=42$)	5.1 ± 2.3	6.6 ± 3.3	30.4 ± 5.7	22:58 ± 00:43	19 ± 13	06:49 ± 00:54	7.3 ± 1.0	23:39 ± 01:11	16 ± 12	08:48 ± 01:40	8.4 ± 1.4
	Netball ($n=13$)	6.2 ± 3.2	9.2 ± 4.1	35.0 ± 6.2	22:48 ± 00:35	19 ± 11	07:14 ± 01:17	7.4 ± 1.1	23:42 ± 01:01	21 ± 13	09:29 ± 01:19	8.7 ± 0.8
	Other ($n=16$)	6.1 ± 2.0	6.0 ± 3.0	33.4 ± 5.1	22:50 ± 01:11	29 ± 15	06:45 ± 01:18	7.0 ± 1.1	23:53 ± 01:36	23 ± 14	08:31 ± 01:38	7.7 ± 1.5
	Effect size	$\eta^2=0.02$ (0.00, 0.07)	$\eta^2=0.04$ (0.00, 0.11)	$\eta^2=0.04$ (0.00, 0.10)	$\eta^2=0.02$ (0.00, 0.06)	$\eta^2=0.05$ (0.00, 0.11)	$\eta^2=0.03$ (0.00, 0.08)	$\eta^2=0.01$ (0.00, 0.03)	$\eta^2=0.00$ (0.00, 0.02)	$\eta^2=0.02$ (0.00, 0.07)	$\eta^2=0.03$ (0.00, 0.08)	$\eta^2=0.04$ (0.00, 0.09)
Residential status	On-site ($n=48$)	5.1 ± 2.3	6.5 ± 3.5	32.6 ± 6.9	23:15 ± 00:54	19 ± 11	07:36 ± 00:50	7.5 ± 0.9	23:46 ± 01:18	17 ± 11	09:10 ± 01:17	8.5 ± 1.1
	Off-site ($n=109$)	6.0 ± 2.7	6.8 ± 3.8	31.5 ± 6.5	22:55 ± 00:54	23 ± 15	06:44 ± 00:58	7.2 ± 1.1	23:36 ± 01:11	20 ± 13	08:53 ± 01:30	8.3 ± 1.3
	Effect size	**$d=0.35$ (0.01, 0.69)***	$d=0.06$ (−0.28, 0.40)	$d=0.16$ (−0.18, 0.50)	**$d=0.38$ (0.03, 0.72)***	**$d=0.32$ (−0.03, 0.65)***	**$d=0.92$ (0.56, 1.27)****	$d=0.33$ (−0.01, 0.67)	$d=0.13$ (−0.20, 0.48)	$d=0.24$ (−0.10, 0.58)	$d=0.19$ (−0.15, 0.53)	$d=0.10$ (−0.24, 0.44)
Chronotype	Morning-type ($n=28$)	5.2 ± 2.1	5.6 ± 3.7	29.9 ± 6.7	22:12 ± 01:01	22 ± 17	06:20 ± 01:04	7.6 ± 0.9	22:51 ± 01:05	20 ± 16	08:08 ± 01:10	8.2 ± 1.1
	Intermediate-type ($n=105$)	5.7 ± 2.6	7.2 ± 3.6	32.2 ± 6.1	23:07 ± 00:46	21 ± 12	07:04 ± 00:56	7.2 ± 1.0	23:41 ± 01:07	17 ± 10	09:00 ± 01:21	8.4 ± 1.2
	Evening-type ($n=24$)	6.2 ± 3.2	5.6 ± 3.7	32.8 ± 8.3	23:22 ± 00:49	26 ± 16	07:31 ± 00:52	7.1 ± 1.4	00:29 ± 01:14	24 ± 16	09:49 ± 01:38	8.3 ± 1.5
	Effect size	$\eta^2=0.01$ (0.00, 0.06)	**$\eta^2=0.04$ (0.00, 0.11)***	$\eta^2=0.02$ (0.00, 0.07)	**$\eta^2=0.20$ (0.09, 0.30)****	$\eta^2=0.02$ (0.00, 0.08)	**$\eta^2=0.12$ (0.04, 0.22)****	$\eta^2=0.02$ (0.00, 0.07)	**$\eta^2=0.15$ (0.06, 0.25)****	**$\eta^2=0.04$ (0.00, 0.11)***	**$\eta^2=0.12$ (0.03, 0.21)****	$\eta^2=0.00$ (0.00, 0.03)

Abbreviations: ESS, Epworth Sleepiness Scale; PSQI, Pittsburgh Sleep Quality Index; SHI, Sleep Hygiene Index; SOL, sleep onset latency; TST, total sleep time.

Statistical significance: $^*p<0.05$; $^{**}p<0.01$.

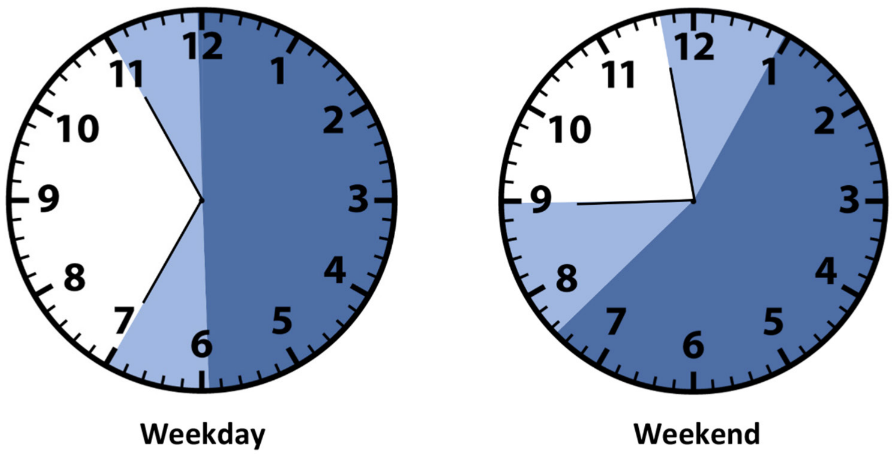

FIGURE 1 Graphical illustration of sleep time on weekday and weekend nights. All shaded segments reflect the self-reported sleep window, with lighter shading reflecting the SD.

TABLE 2 Correlation table showing the relationship between predictor variables and sleep parameters.

Sleep parameter	AM sport	PM sport	Academic time	Sport time
PSQI	**0.30****	0.03	−0.05	−0.02
ESS	**0.23****	0.15	0.09	0.11
SHI	**0.18***	0.12	0.13	0.04
Weekday bedtime	−0.12	−0.04	−0.15	**−0.17***
Weekday SOL	0.07	−0.08	−0.09	0.02
Weekday waketime	**−0.35****	0.00	0.07	**−0.16***
Weekday TST	**−0.29****	−0.03	0.14	−0.02
Weekend bedtime	−0.06	0.02	−0.11	−0.04
Weekend SOL	0.08	−0.11	−0.03	−0.04
Weekend waketime	−0.13	−0.11	0.05	−0.01
Weekend TST	−0.12	−0.03	**0.18***	0.07

Abbreviations: ESS, Epworth Sleepiness Scale; PSQI, Pittsburgh Sleep Quality Index; SHI, Sleep Hygiene Index; SOL, sleep onset latency; TST, total sleep time.

Statistical significance: $^{*}p<0.05$; $^{**}p<0.01$.

4 | DISCUSSION

This study aimed to present the sleep characteristics of a cohort of British student-athletes, explore differences in sleep outcomes between weekdays and weekends, and investigate the association and predictive value of sport scheduling and time demands on sleep outcomes. The primary findings are: (1) British student-athletes exhibited a high prevalence of poor sleep characteristics, aligning with previous research in other student-athlete cohorts; (2) significant differences in sleep outcomes were observed between weekday and weekend nights; and (3) early morning training frequency emerged as the sole significant predictor of multiple sleep outcomes when controlling for participant characteristics influencing sleep. Therefore, refraining from scheduling training in the early morning may be a prudent measure to improve sleep outcomes within student-athlete populations.

The poor sleep characteristics identified through questionnaires in this study align with previous research findings. For instance, the 49% exhibiting poor sleep quality (PSQI >5) is comparable to the 42–55% observed in mixed-sport, mixed-gender samples of American student-athletes during the competitive season.[5–8] Although there have been suggestions that the PSQI may overestimate sleep problems in athletes,[25] the widespread use in research enables comparisons across populations and indicates that poor sleep quality in student-athletes exceeds many other non-clinical groups.[26] The prevalence of excessive daytime sleepiness (ESS ≥10, 23%) substantially differs from the 51% observed by Mah et al. (2018) despite comparable PSQI scores.[5] This variation may be explained

TABLE 3 Hierarchical regression models with AM training as a significant predictor of sleep outcome.

	PSQI				SHI				Weekday waketime				Weekday TST			
	B	B_{SE}	β	t	B	B_{SE}	β	t	B	B_{SE}	β	t	B	B_{SE}	β	t
Step 1: Fixed predictors																
(Intercept)	3.68	2.11		1.74	21.83	5.47		**3.99****	648.02	43.02		**15.06****	548.18	53.78		**10.19****
Age	0.34	0.12	0.24	**2.88****	0.29	0.30	0.08	0.94	−8.25	2.40	−0.25	**−3.44****	−10.15	3.00	−0.28	**−3.38****
Chronotype	−0.20	0.06	−0.25	**−3.22****	−0.41	0.16	−0.20	**−2.49***	−5.84	1.28	−0.31	**−4.56****	4.60	1.60	0.23	**2.87****
Residential status	−0.94	0.45	−0.17	**−2.11***	0.21	1.16	0.01	0.18	34.37	9.11	0.26	**3.77****	10.36	11.39	0.07	0.91
Sex	−1.49	0.40	−0.29	**−3.72****	−4.33	1.04	−0.33	**−4.17****	−12.09	8.16	−0.10	−1.48	−4.76	10.20	−0.04	−0.47
Model fit	$F(4,152)=7.304$, $R^2=0.161$**				$F(4,152)=5.617$, $R^2=0.129$**				$F(4,152)=20.388$, $R^2=0.349$**				$F(4,152)=5.315$, $R^2=0.123$**			
Step 2: Added scheduling and time demand predictors																
(Intercept)	6.49	2.21		**2.94****	25.67	5.79		**4.43****	616.88	46.52		**13.26****	491.39	57.27		**8.58****
Age	0.16	0.13	0.11	1.27	−0.06	0.33	−0.02	−0.17	−5.77	2.64	−0.17	**−2.18***	−6.29	3.25	−0.18	−1.93
Chronotype	−0.22	0.06	−0.27	**−3.55****	−0.50	0.16	−0.24	**−3.08****	−5.37	1.32	−0.28	**−4.08****	5.16	1.62	0.25	**3.18****
Residential status	−0.93	0.44	−0.17	**−2.15***	0.04	1.14	0.00	0.03	35.09	9.18	0.27	**3.82****	10.51	11.30	0.07	0.93
Sex	−1.54	0.42	−0.30	**−3.69****	−4.03	1.10	−0.31	**−3.68****	−14.27	8.81	−0.12	−1.62	−4.54	10.84	−0.04	−0.42
AM sport	0.40	0.11	0.30	**3.64****	0.81	0.29	0.24	**2.84****	−5.22	2.29	−0.17	**−2.28***	−8.45	2.82	−0.25	**−2.99****
PM sport	0.12	0.18	0.05	0.65	0.61	0.48	0.10	1.28	1.00	3.84	0.02	0.26	−2.40	4.72	−0.04	−0.51
Academic time	−0.02	0.02	−0.06	−0.74	0.03	0.06	0.05	0.52	−0.20	0.52	−0.03	−0.38	0.24	0.64	0.03	0.37
Sport time	−0.01	0.03	−0.03	−0.32	0.03	0.08	0.03	0.35	−0.17	0.66	−0.02	−0.25	0.01	0.82	0.00	0.01
Model fit	$F(8,148)=5.402$, $R^2=0.241$**				$F(8,148)=4.457$, $R^2=0.194$**				$F(8,148)=10.982$, $R^2=0.372$**				$F(8,148)=4.044$, $R^2=0.179$**			

Abbreviations: B, unstandardized coefficient; B_{SE}, standard error of unstandardized coefficient; β, standardized coefficient; PSQI, Pittsburgh Sleep Quality Index; SHI, Sleep Hygiene Index; TST, total sleep time.
Statistical significance: *$p<0.05$; **$p<0.01$.

by the previous study collecting responses immediately before or after training where perceived tiredness may be heightened, compared to this study where responses were collected online and ESS scores are comparable to previous research in University students that adopted a similar approach.[2] Similarly, the SHI global score reflects previous research indicating poor sleep hygiene practices in student and athlete populations,[22,27] while the high prevalence of short sleep durations also align with past research in student-athletes.[5]

The discrepancy in bedtimes and waketimes between weekdays and weekends indicates social jetlag in this population.[11] This phenomenon is commonly observed in educational settings, where morning lessons on weekdays enforce an earlier waketime not fully compensated by shifting bedtime earlier,[28] and has also been demonstrated in student-athletes.[5] Social jetlag has been associated with adverse effects such as impaired cognitive performance and metabolic disruption,[12] emphasizing the need to minimize fluctuations in sleep timing where possible. While this research highlights differences in sleep outcomes between weekdays and weekends, it remains unclear how sleep may vary between weekdays. The wide range of morning and evening sport frequencies reported in this study suggests there are variations in sport scheduling throughout the week to allow for preparation for competition and recovery from physical demands. Consequently, the timing of the student-athlete day may vary substantially between weekdays. Previous research has indicated that student-athletes display greater sleep/wake irregularity than other populations,[9,29] a factor potentially detrimental to health outcomes and deserving further exploration in empirical research.

Regression analyses exploring the impact of sport scheduling on sleep outcomes revealed that a higher frequency of morning (AM) sport was predictive of elevated PSQI and SHI global scores, earlier weekday wake times, and shorter weekday sleep durations. This aligns with findings in elite athletes, indicating that scheduling training early in the morning detrimentally affects sleep outcomes, leading to reduced total sleep time the preceding night.[10] The organizational structure of the education provider in this study – common in many British institutions – often mandates scheduling training around the academic timetable. While allowing for a later start in the morning, whether through a delay in the academic timetable or improved integration between sport and academic schedules, presents logistical challenges, it may profoundly impact sleep. For instance, an acute change in training timing from 06:30 to 09:30 improved sleep duration by 46 min in Judo athletes.[30] In contrast, the frequency of evening (PM) sport was not predictive of any sleep outcome. This aligns with evidence suggesting that evening exercise is unlikely to impair subsequent sleep unless performed within an hour of bedtime.[23] However, sleep disruption after evening competition in athletes, often attributed to increased arousal, is common.[14] It remains unclear whether high-intensity evening sport may elicit a similar effect.

This study found that neither academic-related nor sport-related time demands predicted any sleep outcome. These results are consistent with a previously published research abstract, which indicated that scheduled sporting and academic commitments are not associated with sleep duration in American student-athletes.[17] This finding contrasts with the common perception that the balance between academic and sport demands restricts sleep opportunity in student-athletes. This perception was echoed in our study, where over half of the participants reported that the workload associated with being a student-athlete restricted their sleep below their personal preference. Interestingly, student-athletes in our study reported a combined academic and sporting workload of 30.9 h per week, sharply contrasting with NCAA findings reporting a median of 68 h per week spent on academic and athletic requirements across all three divisions.[16] While sport-related time demands did not predict sleep outcomes in this study, it is important to note that, although physical activity is generally beneficial for sleep outcomes,[31] the physiological arousal from high training loads can act as a sport-specific sleep risk factor in performance athletes.[1] Therefore, it appears that the placement of these student-athlete demands poses a greater threat to sleep than the overall time devoted to student-athlete commitments.

These results suggest that morning sport scheduling may play a crucial role in contributing to poor sleep characteristics in British student-athletes, and efforts should be made to avoid scheduling sports activities during this time. In the United Kingdom, the academic structure typically involves lessons spread throughout the day rather than in consolidated blocks, a format that students often find challenging to adapt to.[32] Aligning academic and sport schedules into a shorter, more consistent period could offer a solution to both streamline the student-athlete day and improve sleep outcomes by eliminating early morning training sessions. In situations where structural changes are impractical due to logistical challenges (e.g., timetabling restrictions or lighting conditions), it becomes essential to equip student-athletes with resources to enhance sleep within the existing framework. Walsh et al.[1] recommend that all athletes receive sleep education due to its limited current implementation, with previous sleep education interventions showing promise in both athlete and student populations.[33,34] Meanwhile, student-athletes displaying poor sleep characteristics should undergo screening to identify whether they require referral to a sleep specialist. If not, efforts should focus on identifying individual-level factors and behaviors driving poor sleep and addressing them.[1]

4.1 | Limitations

The cross-sectional design employed means that findings can only be applied to the time of data collection. Sleep characteristics are temporally sensitive and fluctuate in response to various factors that can influence sleep; for example, higher PSQI scores have been observed in student-athletes during months with increased academic and sporting stressors,[35] while the prevalence of PSQI scores >5 was higher pre-exam than post-exam or during the semester in students.[36] While the sleep questionnaires employed are widely used and generic in their application, they have yet to be validated in student-athlete populations. Validated athlete-specific sleep questionnaires exist, such as the Athlete Sleep Screening Questionnaire.[26] However, they may not be suitable for student-athletes as academic-specific risk factors are not considered that may also contribute to poor sleep in this population. Finally, this study pooled all weekdays together for self-reported sleep timing and duration. While all sporting and academic activities were placed on weekdays in this sample, the timing and placement of these are likely to fluctuate day-to-day, and as such sleep may shift accordingly between weeknights. Therefore, there is a need for longitudinal study designs in future research to investigate social jetlag and sleep regularity throughout the week. Additionally, employing alternative sleep measurement methodologies, such as actigraphy, will offer a deeper understanding of sleep in student-athlete populations.[18]

5 | CONCLUSION

In summary, British student-athletes exhibit a high prevalence of poor sleep characteristics based on self-reported measures, aligning with previous findings in student-athletes from various nationalities. The sport and academic schedules occurring on weekdays, contributed to a pattern of social jetlag characterized by a phase advance in sleep timing and reduced sleep duration on weekdays compared to weekends. Logistic regression analyses revealed that the frequency of early morning training sessions (before 09:00) significantly predicted several sleep outcomes, even when controlling for participant characteristics. However, the frequency of late evening training sessions (after 21:00), as well as both academic-related and sport-related time demands, did not emerge as predictive factors for sleep outcomes.

6 | PERSPECTIVE

The key finding of this study was that an increased frequency of morning training sessions was predictive of poorer sleep outcomes. Therefore, it is important that sports coaches and administrators are aware of the impact of early morning sport on sleep, and the potentially harmful downstream effects of poor sleep on performance on the sports field and academic attainment in the classroom,[37,38] in addition to general health and wellbeing. Where sporting activity in the morning before academic lessons cannot be avoided, it is important to design alternative interventions that are specific to the student-athlete population and help improve sleep outcomes within a challenging structure.

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CONFLICT OF INTEREST STATEMENT

The authors report no competing interests to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, SMBW, upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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