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Context is Key: University Sports Practice and its Influence on Sleep Patterns

Pedro Pinheiro Paes[1], Frederico Camarotti Júnior[1], Wlaldemir Roberto dos Santos[2], Rubem Cordeiro Feitosa[1], Pedro Henrique da Silva Zeferino[3], Bruna Daniele Monteiro Lima[1], Byanka Santos Cavalcante de Oliveira[1], Marlene Salvina Fernandes da Costa[2]

AFFILIATIONS

[1]Federal University of Pernambuco, Department of Physical Education, Recife, Brazil
[2]University of Pernambuco, School of Physical Education, Recife, Brazil
[3]Federal University of Pernambuco, Department of Psychology, Recife, Brazil

CORRESPONDENCE

Frederico Camarotti Júnior, Federal University of Pernambuco, Department of Physical Education, 1235 Professor Moraes Rego Avenue, Cidade Universitária, Recife, PE 50740-540, Brazil, *frederico.camarottijunior@ufpe.br*

Abstract

Sleep is an essential component of health and is subject to deprivation in university and sports contexts. Its relationship with physical activity can be beneficial or harmful, depending on intensity and volume. This study investigated the influence of sports practice on the sleep patterns of university students, comparing athletes and non-athletes. Sixty UFPE students took part, 30 athletes (15 men and 15 women) and 30 non-athletes (15 men and 15 women), who answered the International Physical Activity Questionnaire (IPAQ), the Pittsburgh Sleep Quality Index (PSQI) and the Epworth Sleepiness Scale (ESS). Statistical analyses were carried out using parametric and non-parametric tests (p<0.05). Athletes had longer total sleep time (6.88±1.32 h vs. 6.03±1.07 h; p=0.01; ES=0.70) and better overall sleep quality (6.87±3.05 vs. 8.40±3.06; p=0.04; ES=0.78) compared to non-athletes. Analysis by gender indicated that male athletes had longer sleep times (6.90±1.34 h vs. 6.00±1.13 h; p=0.05; ES=0.72), better subjective (0.46±0.69 vs. 1.07±0.70; p=0.02; ES=0.89) and global sleep quality (5.87±3.50 vs. 8.13±3.04; p=0.04; ES=0.69) than male non-athletes , while among women there was a trend towards better patterns in the athlete group, with no significant differences. No differences were found in daytime sleepiness between the groups. The study concludes that regular sports practice is associated with healthier sleep patterns, especially among men, reinforcing the importance of institutional actions that encourage sport in the university environment as a health promotion strategy.

Keywords: *university students, sport, physical activity, sleep quality*

Introduction

Sleep is an essential physiological process for maintaining health and the proper functioning of bodily and mental functions (Irwin & Opp, 2017). Characterized by a reduction in consciousness and neuromuscular activity, sleep plays a fundamental role in memory consolidation, hormonal modulation and general body repair (Logan & McClung, 2019). Poor sleep quality and associated disorders can increase the risk of obesity, cardiovascular disease, impaired learning and cognition, as well as compromising mental health and quality of life and promoting physical inactivity (Fattinger et al., 2017; Ghrouz et al., 2019; Velasquez-Melendez et al., 2021; Wang & Bíró, 2021).

Physical activity, in turn, can significantly influence sleep, affecting aspects such as subjective perception, efficiency, latency, duration and quality, according to the frequency, intensity and type of exercise performed (Oliveira et al., 2018). Santiago et al. (2022) showed that adolescents involved in regular sports and exercise programs had better quality and longer duration of sleep compared to those who did not practice physical activities. Physical activity is defined as any bodily movement that results in an energy expenditure greater than the resting state (De Araujo Vasconcelos et al., 2024).

However, the relationship between sleep and physical activity is bidirectional. Depending on the intensity and duration of the exercise or modality practiced, different repercussions can be observed on sleep patterns (Ghrouz et al., 2019). While moderate physical activity tends to promote improvements in sleep quality, high levels of effort, such as those observed in athletes, can be associated with sleep disorders, including insomnia and excessive daytime sleepiness (Memon et al., 2021; Santiago et al., 2022).

In the university context, students face a series of challenges, such as academic demands, family pressures and socioeconomic difficulties, factors that can compromise sleep quality. Such conditions increase daytime sleepiness, reduce adherence to physical activity and contribute to a more sedentary lifestyle (Almutairi et al., 2018). Evidence indicates that many university students do not meet the minimum recommendations for sleep and physical activity, which negatively impacts their general health and academic performance (Martins et al., 2020; Nikolic et al., 2023).

In the case of university athletes, this relationship requires an even more specific analysis. In addition to academic demands, these individuals face intense training and competition routines, which can result in sleep deprivation and deterioration in sleep quality (Leduc et al., 2020). These factors are directly associated with deficits in physical and cognitive performance, as well as increasing the risk of injury (Irwin & Opp, 2017; Leduc et al., 2020).

Excessive daytime sleepiness is an important indicator of sleep-related disorders, characterized by difficulty staying awake during the day and the occurrence of unintentional naps (Schlarb et al., 2017). Regular physical activity has been shown to improve sleep quality and reduce levels of daytime sleepiness in students and young athletes (Ghrouz et al., 2019; Oliveira et al., 2018; Rosi et al., 2020).

Despite recent scientific interest in the relationship between physical activity and sleep patterns among university students, there is still a gap in studies that analyze these variables in an integrated and comparative manner in student athletes and non-athletes within institutions.Investigations with this focus are essential to better understand this association and to guide interventions aimed at improving sleep quality, especially in populations exposed to high levels of physical and mental stress (Almutairi et al., 2018).

In view of the above, the aim of this study was to investigate the influence of sports practice on sleep patterns among athletes and university students. The hypothesis is that involvement in sports is associated with higher levels of physical activity and better sleep patterns. The results could support health promotion strategies aimed at both the general university public and athletes, helping to formulate institutional policies that encourage regular physical activity and promote a balance between academic and sporting demands and adequate rest.

Materials and methods

Participants and design

This is an observational, cross-sectional, descriptive study with a quantitative approach (Thomas, Nelson, & Silverman, 2012). The project was approved by the Research Ethics Committee (CEP) of the Health Sciences Center of the Federal University of Pernambuco (CCS-UFPE), under opinion no. 3.492.898, and followed the guidelines established by Resolution 466/12 of the National Health Council. All participants signed the Free and Informed Consent Form (FICF) and voluntarily agreed to take part in the study, and could withdraw at any time.

For inclusion, volunteers had to be aged 18 or over, enrolled in an undergraduate course at UFPE and be part of a university sports team or not. University athletes were those who had been part of a sports team for at least three months. Individuals who did not fill in the questionnaires completely, missed any stage of the investigation or were taking sleep-inducing or sleep-regulating medication were excluded.Participants were recruited by advertising on social media, as well as by distributing pamphlets placed in strategic locations in UFPE and given to the coaches of university sports teams. The pamphlets contained instructions on how to contact those responsible for the research, via telefone or in person.

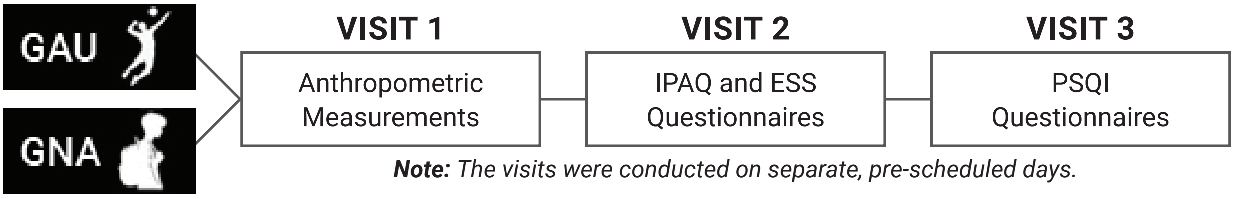
The total number of participants was defined by sample calculation using the G*Power software (Faul et al., 2007), considering an effect size of 0.8, a statistical power of 90% and a significance level of 5%. This estimated a number of 56 participants, 28 in each group, to be able to identify significant differences. Initially, 88 students expressed an interest in taking part, 40 of whom were university athletes. After applying the inclusion and exclusion criteria, 28 students were disregarded, 10 athletes and 18 non-athletes. The final sample comprised 60 students, divided into two groups: a group of university athletes (GAU), with 30 participants, and a group of non-athletes (GNA), also with 30 participants.

Procedures

Both groups (GAU and GNA) underwent three visits, each on different and previously scheduled days, as illustrated in Figure 1. On the first visit, participants went to the research group's laboratory for anthropometric measurements. On the second visit, the International Physical Activity Questionnaire (IPAQ) and the Epworth Sleepiness Scale (ESS) were administered. And on the third visit, the Pittsburgh Sleep Quality Index (PSQI) was administered. The researchers were present to answer any questions regarding the questionnaires. This division was due to the size of the instruments, since the PSQI is more extensive compared to the IPAQ and ESS. The aim was to have as little impact as possible on the daily routine of students and university athletes.

In order to avoid potential interference in the variables of interest, in the GNA group, data collection took place during periods without exams or academic work. In the GAU group, a specific sport was chosen in order to standardize the demands and inherent characteristics. The duration and intensity of training on the days scheduled for data collection were standardized with the respective coaches in advance. The procedures were explained, and the date and time for data collection were set by mutual agreement, taking into account the training schedule of the men's and women's volleyball teams. Data collection took place during periods of the season without games or competitions, which could generate high levels of stress and anxiety, potentially compromising the analysis of this investigation.

Figure 1. Procedures



Note: *The visits were conducted on separate, pre-scheduled days.*

Instruments

Body mass was measured using a portable scale (model PL 200, Filizola S.A., São Paulo, Brazil), and height was assessed using a portable stadiometer (Sanny, São Paulo, Brazil). With these two values, the Body Mass Index (BMI) was calculated, obtained by dividing the body mass (kg) by the height squared (m²) of each participant (Peterson et al., 2016).

To assess the volunteers' PAL, we used the IPAQ, short version, validated and adapted for the Brazilian population by Matsudo et al. (2001). It is a self-administered instrument made up of seven questions referring to the previous week. The IPAQ estimates the duration (minutes per day), intensity (in metabolic equivalents of tasks - METs) and frequency (days per week) of the physical activities performed, making it possible to classify the participants into the categories "very active", 'active', "irregularly active" (A and B) and "sedentary".

Sleep quality was measured using the PSQI, adapted and validated for the Brazilian population by Bertolazi et al. (2011). This questionnaire covers the last 30 days and assesses seven domains: sleep duration, sleep efficiency, sleep latency, subjective sleep quality, sleep disturbances, daytime dysfunctions and use of sleep medication. Each item is scored from 0 to 3, and the total score is obtained by adding up the scores of the seven domains, ranging from 0 to 21 points. Values between 0 and 4 indicate good sleep quality; between 5 and 10, poor sleep quality; and scores above 10 suggest the presence of sleep disorders.

Daytime sleepiness was assessed using the ESS, adapted and validated for Brazil by Bertolazi et al. (2009). This instrument contains eight questions describing everyday situations likely to cause sleepiness (napping). The ESS classifies sleepiness into normal, moderate and excessive levels. The total score ranges from 0 to 24 and is interpreted as follows: 1 to 6 indicates normal sleepiness; 7 to 8, moderate sleepiness; and 9 to 24, excessive or abnormal sleepiness (Johns, 1991).

Statistics

Initially, the sample was characterized using descriptive statistics, using means and standard deviations. The data was then submitted to the Shapiro-Wilk normality test. Variables with a normal distribution were analyzed using Student's t-test for independent samples, while those with a non-normal distribution were analyzed using the Mann-Whitney test. In addition, the effect size for the comparisons was calculated using Cohen's d, with the following interpretation parameters: very small effect (between 0.0 and 0.19), small effect (between 0.20 and 0.49), medium effect (between 0.50 and 0.79) and large effect (equal to or greater than 0.80).

The analyses included inter-group comparisons (between GAU and GNA, in total and stratified by sex) and intra-group comparisons (male vs. female within GAU and GNA, male GAU vs. male GNA, female GAU vs. female GNA), considering NAF, sleepiness and sleep parameters. The correlation between NAF, sleepiness and sleep parameters was assessed using Pearson's correlation test for variables with a normal distribution and Spearman's correlation test for variables with a non-normal distribution. All statistical analyses were carried out using IBM SPSS Statistics for Windows software, version 20.0 (Armonk, NY: IBM Corp). The significance level adopted was 5% ($p<0.05$).

Results

The sample consisted of 60 participants, 30 university athletes (GAU; 15 men and 15 women) and 30 non-athlete university students (GNA; 15 men and 15 women). The participants had an average age of 21.80±2.58 years, an average height of 170±24.20 cm, an average body mass of 72.90±12.70 kg and an average Body Mass Index (BMI) of 24.50±3.36 kg/m², with no significant difference in these variables between the GAU and GNA groups ($p>0.05$). The groups were homogeneous. The complete characterization of the sample is shown in Table 1.

Table 1. General characteristics of the sample

	Total (n=60) **Mean ± SD**	**GAU (n=30)** **Mean ± SD**	**GNA (n=30)** **Mean ± SD**	***p***
Age (years)	21.80±2.58	22.40±2.72	21.10±2.30	0.05
Height (cm)	170.00±24.20	175.00±10.50	165.00±32.00	0.09
Body mass (kg)	72.90±12.70	75.30±11.00	70.60±14.00	0.15
BMI (kg/m²)	24.50±3.36	24.60±3.08	24.50±3.67	0.88

GAU: Group of university athletes; GNA: Group of non-athletes; BMI: Body Mass Index

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In the following tables, Cohen's effect size was used with the following interpretation parameters: very small (between 0.0 and 0.19), small (between 0.20 and 0.49), medium (between 0.50 and 0.79), and large (equal to or greater than 0.80). Table 2 shows thatthere was a difference in total sleep time (p=0.01; ES=0.70), with GAU reporting approximately 12.35% more sleep time. In addition, there was a significant difference in overall sleep quality (p=0.04; ES=0.78), with GAU reporting 22.27% better sleep quality than GNA. The lower the PSQI score, the better the sleep quality (Bertolazi et al., 2011).

Table 2. Inter-group comparison between GAU and GNA in terms of level of physical activity, sleepiness and sleep patterns

Variable	Group	Mean ± SD	Δ (Δ %)	p	(ES)
IPAQ (score)	GAU	1.84±0.83	0.19 (10.33)	0.37	0.23
	GNA	2.03±0.89			
Sleepiness (score)	GAU	1.30±0.87	0.03 (2.31)	0.88	0.03
	GNA	1.33±0.84			
Total sleep time (h)	GAU	6.88±1.32	0.85 (12.35)	0.01	0.70*
	GNA	6.03±1.07			
Sleep latency (min)	GAU	39.10±37.90	13.1 (33.50)	0.11	0.41
	GNA	26.00±23.90			
Sleep efficiency (%)	GAU	88.70±12.10	4.00 (4.51)	0.14	0.38
	GNA	84.70±8.34			
Subjective sleep quality (score)	GAU	0.80±0.66	0.33 (41.50)	0.06	0.49
	GNA	1.13±0.68			
Overall sleep quality (score)	GAU	6.87±3.05	1.53 (22.27)	0.04	0.78*
	GNA	8.40±3.06			

*GAU: Group of university athletes; GNA: Group of non-athletes; p<0.05; * Mean effect*

In table 3, among the men, there was a significant difference on total sleep time (p=0.05; ES=0.72), with GAU having 13.04% more total time. Similarly, statistically significant differences were found in subjective sleep quality (p=0.02; ES=0.89) and global sleep quality (p=0.04; ES=0.69), with GAU showing a 6.19% better subjective quality and a 38.50% better global quality than GNA, respectively. In addition, sleep latency was 47.95% greater in the GAU (ES=0.65).

Among the women, there were no statistically significant differences between the groups; however, there was a trend towards better sleep patterns in the GAU, especially in relation to total time and sleep efficiency. Women in the GAU had 11.64% longer total sleep time (ES=0.66) and 5.70% higher sleep efficiency (ES=0.46) compared to those in the GNA. On the other hand, the level of physical activity was 33.13% higher in GNA compared to GAU (ES=0.61).

Table 3. Inter-group comparison between participants of the same sex from the UAG and the NAG in terms of physical activity level, sleepiness and sleep patterns

Variable	GAU Mean ± SD	GNA Mean ± SD	Groups	Δ(Δ%)	p	ES
IPAQ (score)	2.07±0.79	1.93±0.88	Mal vs Mal	6.76 (1.93)	0.66	0.15
	1.60±0.82	2.13±0.91	Fem vs Fem	0.53 (33.13)	0.10	0.61*
Sleepiness (score)	1.20±0.86	1.33±0.81	Mal vs Mal	0.13 (10.83)	0.66	0.15
	1.40±0.91	1.33±0.90	Fem vs Fem	0.07 (5.00)	0.84	0.07
Total sleep time (h)	6,90±1.34	6.00±1.13	Mal vs Mal	0.90 (13.04)	0.05	0.72*
	6.87±1.36	6.07±1.03	Fem vs Fem	0.80 (11.64)	0.08	0.66*

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Table 3. Inter-group comparison between participants of the same sex from the UAG and the NAG in terms of physical activity level, sleepiness and sleep patterns

Variable	GAU Mean ± SD	GNA Mean ± SD	Groups	Δ(Δ%)	p	ES
Sleep latency (min)	51.30±49.70	26.70±18.87	Mal vs Mal	24.60(47.95)	0.08	0.65*
	27.00±13.70	25.30±28.69	Fem vs Fem	1.70 (6.30)	0.84	0.07
Sleep efficiency (%)	89.80±11.20	86.80±9.25	Mal vs Mal	3.00 (3.34)	0.43	0.29
	87.70±13.20	82.70±7.03	Fem vs Fem	5.00 (5.70)	0.21	0.46
Subjective sleep quality (score)	0.46±0.64	1.07±0.70	Mal vs Mal	0.61(132.61)	0.02	0.89**
	1.13±0.51	1.20±0.67	Fem vs Fem	0.07 (6.19)	0.76	0.11
Overall sleep quality (score)	5.87±3.50	8.13±3.04	Mal vs Mal	2.26 (38.50)	0.04	0.69*
	7.87±2.20	8.67±3.15	Fem vs Fem	0.80 (10.17)	0.42	0.29

*GAU: Group of university athletes; GNA: Group of non-athletes; p < 0.05; Mal: Male; Fem: Female; * Medium effect; ** Large effect*

Table 4 shows that inthe GAU, it was observed that men had better sleep quality, with a 145.65% lower subjective quality (p=0.01; ES=1.15), and a 34.07% lower overall quality (p=0.01; ES=0.68). In addition, a medium effect size was observed in the level of physical activity, with men being superior (22.71%; ES=0.54), the same occurring with sleep latency, which showed a medium effect (ES=0.66), being 47.37% higher in men.

In the GNA, no statistically significant differences were found between men and women. However, there was an average effect (ES=0.50) on sleep efficiency, with men showing 4.72% greater efficiency than women. Regarding the correlations between the level of physical activity and sleep and sleepiness patterns, no significant associations were observed in the total group (n=60).

Table 4. Intra-group comparison between male and female UAG and NAG participants in terms of physical activity level, sleepiness and sleep patterns

Variable	Male Mean ± SD	Female Mean ± SD	Δ(Δ%)	p	ES
GAU					
IPAQ (score)	2.07±0.79	1.60±0.82	0.47 (22.71)	0.12	0.54*
Sleepiness (score)	1.20±0.86	1.40±0.91	0.20 (16.67)	0.54	0.22
Total sleep time (h)	6.90±1.34	6.87±1.36	0.03 (0.43)	0.94	0.02
Sleep latency (min)	51.30±49.70	27.00±13.70	24.30(47.37)	0.07	0.66
Sleep efficiency (%)	89.80±11.20	87.70±13.20	2.10 (2.34)	0.63	0.17
Subjective sleep quality (score)	0.46±0.64	1.13±0.51	0.67 (145.65)	0.01	1.15**
Overall sleep quality (score)	5.87±3.50	7.87±2.20	2.00 (34.07)	0.01	0.68*
GNA					
IPAQ (score)	1.93±0.88	2.13±0.91	0.20 (10.36)	0.54	0.22
Sleepiness (score)	1.33±0.81	1.33±0.90	0.00 (0.00)	1.00	0.00
Total sleep time (h)	6.00±1.13	6.07±1.03	0.07 (1.17)	0.86	0.06
Sleep latency (min)	26.70±18.87	25.30±28.69	1.40 (5.24)	0.88	0.05
Sleep efficiency (%)	86.80±9.25	82.70±7.03	4.10 (4.72)	0.17	0.50*
Subjective sleep quality (score)	1.07±0.70	1.20±0.67	0.13 (12.15)	0.60	0.19
Overall sleep quality (score)	8.13±3.04	8.67±3.15	0.54 (6.64)	0.64	0.17

*GAU: Group of university athletes; GNA: Group of non-athletes; p<0.05; * Medium effect; ** Large effect*

Discussion

This study aimed to investigate the influence of sports practice on sleep patterns among university athletes and university students. In academic environments, it is common for undergraduate students to face irregular routines, high cognitive demands and psychosocial stressors, which can compromise sleep duration and quality, as well as increasing daytime sleepiness (Wang & Bíró, 2021). Despite the recognized association between physical activity and improved sleep parameters, few observational studies directly compare student athletes and non-athletes in the university context.

The results of this investigation indicate that there were significant differences in total sleep time, with GAU reporting approximately 12.35% more sleep time. There was also a difference in overall sleep quality, with UAG having a 22.27% higher sleep quality than NAG. This reinforces the hypothesis that the routine and lifestyle linked to sport can act as a protective factor for sleep health in a population known to face routines that compromise sleep (Wang & Bíró, 2021). Furthermore, these findings draw attention to the fact that this improvement in the quality and duration of athletes' sleep was evident during periods outside of competitions and games. It is important to note that competitive moments throughout a season must be monitored and given special attention by the professionals responsible for ensuring adequate recovery, quality sleep, and sufficient sleep duration. In contrast, Leduc et al. (2020) directly compared athletes and non-athletes from a Canadian university during periods of intense training and competition. These authors observed shorter average sleep duration in athletes and no significant difference in the overall PSQI score. The discrepancy with our findings is possibly related to the fact that data collection in our study took place outside of competitive phases, when the training load is more stable and provides more rest time for athletes, while in the Canadian study the competitive load may have reduced TTS and masked any differences in subjective quality.

When comparing the groups of the same sex, some significant differences were observed among the men. GAU males had a higher total sleep time (p=0.05; ES=0.72), subjective sleep quality (p=0.02; ES=0.89) and global sleep quality (p=0.04; ES=0.69) than GNA. Among the women, there were no statistically significant differences between the groups; however, there was a trend towards better sleep patterns in the UAG, especially in relation to total time and sleep efficiency. GAU females had 11.64% longer total sleep time (ES=0.66) and 5.70% higher efficiency (ES=0.46) compared to GNA females. Dolezal et al. (2018) and Gubelmann et al. (2018) agree with these findings when they indicate that individuals with greater objective physical activity have greater sleep efficiency and are associated with better subjective sleep quality, reinforcing that the correlations observed in university students who practice sports reflect trends in the general population.

A particular finding in this study, although not significant, was the result for females, in which those in the GNA had a 33.13% higher level of physical activity than those in the GAU. This raises a few hypotheses: firstly, it's possible that the athletes display a "compensatory sedentary lifestyle". Suggesting that the high volume and intensity of training generates fatigue that needs to be managed, leading to a reduction in non-exercise-related physical activity (e.g. active leisure, domestic activities, commuting) as part of a recovery strategy to balance the total stress load to which athletes are subjected (Hayes-Ortiz et al., 2023). Secondly, the student-athlete's routine can impose an overload of roles that can limit the practice of physical activities beyond structured training, such as the use of active transportation on campus and other unstructured leisure activities in everyday life. The need to reconcile the demands of sport with academic and personal life is a central aspect of athletic career development (Carballo-Fazanes et al., 2020).

As for the sexes in each group, it was observed that men in the UAG had better sleep quality, both subjective (p=0.01; ES=1.15) and global (p=0.01; ES=0.68). In addition, higher levels of physical activity were found in men (22.71%; ES=0.54). This finding, which was absent in the GNA, suggests that factors inherent in the routine of university sport may exacerbate the differences in sleep expected between the sexes. A possible explanation for this disparity may lie in the distinct psychophysiological response to the stress of the double shift found in females. Women tend to have greater reactivity of the hypothalamic-pituitary-adrenal (HPA) axis, which is reflected in an increase in plasma cortisol with a low resolution rate (Graves et al., 2021; Irwin & Opp, 2017). This is associated with increased sleep latency and fragmentation and a reduction in deep sleep, due to the antagonistic feedback between cortisol and melatonin (Logan & McClung, 2019). Recent studies corroborate this line of thought, indicating that female university athletes do, in fact, report significantly higher levels of perceived stress than their male counterparts (Graves et al., 2021), and stress is one of the main factors negatively affecting sleep quality. Additionally, another line to consider involves the hormonal differences of the female menstrual cycle, which influence sleep architecture and recovery, and may have their impact amplified by the high training load (Baker & Lee, 2018). This physiological peculiarity could explain less efficient sleep recovery, combined with a greater perception of effort and stress.

The absence of significant differences between men and women in GNA reinforces the assumption that the competitive environment and the high demands of training are the likely catalysts for these differences, suggesting that university athletes may constitute a subgroup that requires special attention with regard to sleep health. This finding is consistent with Wang and Bíró (2021), who identified in a systematic review that, in university students, behavioral and contextual factors such as chronotype, academic stress or the use of electronics have a greater influence on sleep quality than biological sex alone.

Furthermore, a paradoxical observation from the present study concerns the domains of sleep latency and efficiency. Specifically, the men from the UAG showed a tendency towards longer sleep latency compared to those from the NAG, with a difference of almost 25 minutes (p=0.08; ES=0.65), and also in relation to their female colleagues (p=0.07; ES=0.66). On the other hand, these same male athletes also exhibited a tendency, albeit with a smaller effect, towards greater sleep efficiency compared to non-athletes (p=0.43; ES=0.29). This shows that even though male university athletes took longer to start sleeping, they were able to sleep better and more restoratively. This pattern suggests that, in males, the training load may induce a strong psychophysiological arousal response at the end of the day, which makes it difficult to start sleeping. This hypothesis is plausible, since the literature indicates that intense exercise can increase sympathetic nervous system activity, impacting falling asleep (Santiago et al., 2022). This psychophysiological arousal causes simultaneous activation of central and peripheral systems linked to the regulation of wakefulness and alertness, such as the HPA axis, which can increase latency and reduce sleep time (Logan & McClung, 2019). It also causes a decrease in parasympathetic nervous system activity accompanied by an increase in sympathetic nervous system activity, leading to higher heart rate and body temperature due to the release of catecholamines, e.g., adrenaline (Dolezal et al., 2017; Fattinger et al., 2017).

At the same time, the biological need for more restful sleep for physical recovery, reflected in a tendency towards greater efficiency, is also present, consistent with the increased homeostatic pressure for slow-wave sleep after exercise (Memon et al., 2021).Female athletes exhibited a similar pattern, with GAU taking longer to fall asleep and demonstrating greater sleep efficiency, but with lower latency (ES=0.07) and higher efficiency (ES=0.46). The absence of the "cost" of latency, combined with the "benefit" of efficiency, raises the hypothesis that the female athletes in the present study may have a distinct neurophysiological response to training. It is possible that women are less susceptible to exercise-induced arousal of the sympathetic nervous system, or that hormonal factors may modulate this response, protecting sleep onset (Baker & Lee, 2018). Thus, while male athletes' sleep reflects a balance between the two competing physiological effects, female athletes appear to obtain the restorative sleep benefits associated with exercise without the same penalty in sleep onset.

There were no significant differences between GAU and GNA, and between the sexes in daytime sleepiness, with the groups showing similar values. Kline (2014) found that moderate levels of physical activity are not always associated with changes in daytime sleepiness scores, especially in individuals without clinical insomnia. This is in line with Leduc et al. (2020) who also found no differences in daytime sleepiness between athletes and non-athletes, although they reported a subjective improvement in sleep quality only indirectly.

In summary, this study showed that there was no significant relationship between levels of physical activity and sleep patterns in university students. It was found that the group of belonging, athlete or student, and gender have a more relevant impact on specific aspects of sleep, in terms of duration and quality, reinforcing the hypothesis that the routine and lifestyle associated with regular sports practice can positively influence sleep parameters, especially at times when there is no competitive overload. This finding opens the way for future research to explore whether these differences are maintained in contexts of greater training load or in different age groups.

This study has some limitations to be considered: the cross-sectional design prevents causal inferences between sports practice and sleep indicators; the sample was restricted to students from a single public university and was collected outside of competitive periods, which may have favored the GAU by registering a lower training overload. The use of self-reported instruments (PSQI, ESS, IPAQ) brings the potential for memory and perception biases, although these instruments are validated and have been applied under supervision to minimize misunderstandings. The lack of objective measures of sleep, such as actigraphy, and physical activity, such as quantification in metabolic equivalent of task (MET), which somewhat limits the accuracy of estimates. And some uncontrolled variables that could interfere with the relationship addressed, such as university shift routine, study hours, and internships.

Considering the scarcity of specific experimental and cross-sectional studies in university students and the variability of findings, it is recommended that future research adopt longitudinal and multicenter designs, use objective sleep measures and control for contextual variables such as training load, academic load and the use of electronic devices. This could confirm the direction and magnitude of the associations and effects between sports practice and sleep parameters in different university settings.

The findings of this study reinforce the importance of promoting structured physical activity in the university environment as a non-pharmacological strategy to improve students' sleep. As well as the proper balance between academic and sports demands and adequate rest. Providing subsidies for the formulation of institutional policies aimed at encouraging the practice of sports. Furthermore, it helps physical education health professionals, such as coaches, to take an integrated approach in the pursuit of better health and performance, especially in these contexts of high cognitive demand and academic stress, in which this population is inserted.

Conclusions

Regular sports practice among university students is associated with better sleep patterns in terms of duration and subjective quality, especially among males. The findings reinforce the importance of institutional strategies that encourage and provide greater engagement in sports within universities as an effective means of promoting health in the academic context. Future studies should use objective measures to assess physical activity levels and sleep quality in order to strengthen this body of evidence.

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Conflict of interest
The authors declare no conflicts of interest.

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