
ORIGINAL ARTICLES. PHYSICAL EDUCATION

Adolescent sleep quality as critical component of healthy lifestyleAdamčák Štefan^{1BCD}, Michal Marko^{2BCD}, Pavol Bartík^{1ABE*}¹Faculty of Sports, Science and Health, Matej Bel University in Banská Bystrica, Slovak Republic²Faculty of Performing Arts, Academy of Arts in Banská Bystrica, Slovak Republic

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract**Background and purpose**

Adolescence is a critical period for physical, emotional, and cognitive development. High-quality sleep during this phase is essential for healthy growth, emotional well-being, optimal weight, and learning. These factors significantly influence the academic achievements of young people. Purpose: to develop and experimentally justify the methodology of training basketball teams of humanitarian higher educational institutions, taking into account the psychophysiological capabilities of the players.

Material and methods

The sample consisted of 626 secondary vocational school students aged 17 years from the Central Slovakia region (353 girls and 273 boys). Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). The questionnaires were distributed electronically via Google Forms from October 2023 to March 2024. The results were analyzed with an emphasis on gender differences using the chi-square test (χ^2), F-test, and independent t-test at significance levels of $p < 0.01$ and $p < 0.05$, respectively.

Results

Most students, both boys and girls, fell asleep between 11:00 PM and midnight. The average bedtime was 10:54 PM for girls and 10:50 PM for boys, with no significant differences between genders. Significant differences were found in wake-up times, with nearly 40% of girls waking up before 6:00 AM, compared to only 24% of boys ($p < 0.01$). Boys experienced fewer difficulties falling asleep, with 21% falling asleep within 15 minutes ($p < 0.05$). The average sleep duration was 6 hours and 28 minutes for girls and 6 hours and 55 minutes for boys, a statistically significant difference ($p < 0.01$). Sleep efficiency was higher in boys (84.25%) compared to girls (78.75%). Sleep problems, daytime dysfunction, and mood changes were more frequent among girls ($p < 0.01$). Only 28.33% of girls and 39.19% of boys had good sleep quality ($p < 0.01$), while 17.00% of girls and 4.40% of boys exhibited severe sleep disturbances

Conclusions

Our findings indicate significant gender differences in sleep habits and quality, consistent with existing literature. These results highlight the need for increased attention to sleep issues among adolescents and the implementation of preventive and intervention measures to improve sleep quality, which could have a positive impact on their overall health and well-being.

Keywords

adolescence, gender differences, PSQI, questionnaire, sleep quality, physical exercises

Анотація

Стефан Адамчак, Міхал Марко, Павол Бартік. Якість сну підлітків як критична складова здорового способу життя

Обґрунтування і мета	Підлітковий вік є критичним періодом для фізичного, емоційного та когнітивного розвитку. Високоякісний сон під час цієї фази необхідний для здорового росту, емоційного благополуччя, оптимальної ваги та навчання. Ці фактори суттєво впливають на навчальні досягнення молоді. Мета: розробити та експериментально обґрунтувати методику підготовки баскетбольних команд гуманітарних вищих навчальних закладів з урахуванням психофізіологічних можливостей гравців.
Матеріал і методи	Вибірку склали 626 учнів середніх професійно-технічних шкіл віком від 17 років із регіону Центральної Словаччини (353 дівчата та 273 хлопці). Якість сну оцінювали за допомогою Піттсбурзького індексу якості сну (PSQI). Анкети розповсюджувалися в електронному вигляді через Google Forms з жовтня 2023 року по березень 2024 року. Результати аналізували з акцентом на гендерні відмінності за допомогою тесту хі-квадрат (χ^2), F-тесту та незалежного t-тесту на рівнях значущості $p < 0,01$ та $p < 0,05$ відповідно.
Результати	Більшість студентів, як хлопців, так і дівчат, засинали з 23:00 до півночі. Середній час сну становив 22:54 для дівчат і 22:50 для хлопчиків, без істотних відмінностей між статями. Значні відмінності були виявлені в часі пробудження: майже 40% дівчат прокидаються до 6:00 ранку, порівняно з лише 24% хлопчиків ($p < 0,01$). Хлопчики відчували менше труднощів із засипанням: 21% засинали протягом 15 хвилин ($p < 0,05$). Середня тривалість сну становила 6 годин 28 хвилин для дівчат і 6 годин 55 хвилин для хлопчиків, статистично значуща різниця ($p < 0,01$). Ефективність сну була вищою у хлопчиків (84,25%) порівняно з дівчатками (78,75%). Проблеми зі сном, денна дисфункція та зміни настрою частіше спостерігалися у дівчат ($p < 0,01$). Тільки 28,33% дівчат і 39,19% хлопців мали хорошу якість сну ($p < 0,01$), тоді як 17,00% дівчат і 4,40% хлопців демонстрували серйозні порушення сну.
Висновки	Наші висновки вказують на значні гендерні відмінності у звичках і якості сну, що відповідає наявній літературі. Ці результати підкреслюють необхідність приділяти підвищену увагу проблемам сну серед підлітків і впроваджувати профілактичні та інтервенційні заходи для покращення якості сну, що може позитивно вплинути на їхнє загальне здоров'я та самопочуття.
Ключові слова	підлітковий вік, гендерні відмінності, PSQI, анкета, якість сну, фізичні вправи

Introduction

Adolescence is one of the most critical and risky periods in human life. Individuals undergo rapid and radical changes in the bio-psycho-social sphere. During this time, they begin to act independently, their personalities take shape, and habits such as eating, physical activity, and sleep patterns become established and stabilized [1]. Several studies [2-3] indicate that the recommended sleep duration for the 13 to 18 age group is between 8 to 10 hours daily. Reducing this range [4] can lead to metabolic changes associated with obesity across all age groups, particularly in children, and the development of numerous chronic diseases, including type 2 diabetes, hypertension, cardiovascular diseases, and depression, which are risk factors for stroke [5]. Sleep during childhood and adolescence is crucial for brain development and insufficient sleep in young people can adversely affect the function of the brain region (hypothalamus) that regulates appetite and energy expenditure. Optimizing sleep duration and quality may be a key factor in improving blood sugar control [6].

Quality of sleep is more important than its duration [7]. Although sleep quality is a subjective measure, certain principles of good sleep can be described. These include uninterrupted sleep throughout the night without premature awakenings, feeling refreshed in the morning and not experiencing fatigue or reduced mental performance during the day. Healthy sleep patterns as including a morning chronotype, 7 to 8 hours of sleep daily, the absence or rarity of insomnia symptoms, no snoring, and little or no daytime sleepiness [8].

The quality of sleep significantly affects emotions and cognitive abilities, particularly memory and learning capacity, as well as the ability to concentrate. Numerous studies confirm the crucial role of sleep quality in proper brain function [9]. High-quality sleep plays a vital role in memory consolidation, enhancing long-term memory and significantly supporting learning [10]. Other research suggests that sleep quality and quantity are closely linked to learning ability and academic performance [11]. Students' academic performance declines when they experience sleep deficits or reduced sleep quality [12]. Study of 388 adolescents revealed that those with insufficient sleep duration

during weekends exhibited poorer academic performance and incidence of risky behavior [13]. Reduced sleep duration and late bedtimes on weekends are negatively associated with students' academic performance [14].

Sleep patterns change throughout life, and the need for sleep generally decreases with age [15]. Several studies also describe sleep differences from the perspective of gender. Generally, women require more sleep than men. The quantity and quality of sleep in women are often influenced by hormonal changes in their bodies, whether during the 28-day menstrual cycle or due to changes during pregnancy and menopause [16]. Women need an average of 11 minutes more sleep each night, more frequently experience insomnia, anxiety, and depression, which can lead to sleep problems, and that hormonal changes can affect circadian rhythms and influence women's sleep needs [17]. Similar findings are described [18] as a lack of quality sleep or the presence of sleep disorders (women are more prone to restless legs syndrome (RLS), obstructive sleep apnea (OSA) and insomnia) can significantly affect women's daily lives, including their social roles in the workplace and as primary caregivers in the family. Quality of sleep is better in women than in men; women have longer sleep durations, shorter time to fall asleep, and higher sleep efficiency [19].

Sleep quality and physical activity are interconnected in various ways, especially during adolescence, a critical period of physical and mental development. Numerous studies have demonstrated a link between regular physical activity and improved sleep quality among adolescents, highlighting the potential of physical activity as a tool to promote healthy sleep patterns. Researchers have explored this relationship from multiple perspectives, seeking to understand the underlying mechanisms through which physical activity may impact sleep quality and vice versa. A study from 2018 explored the long-term connections between physical activity and sleep quality in adolescents. The findings revealed that consistent physical exercise led to better sleep outcomes compared to less active peers. Additionally, the research highlighted a bidirectional relationship, indicating that while physical activity improves sleep, sufficient sleep can also boost motivation and energy for maintaining regular physical activity [20].

Recent research from 2024 investigated the combined effects of physical activity, stress levels, and sleep quality in adolescents. The study found that stress often plays a mediating role in the link between physical activity and sleep quality. Adolescents with higher levels of physical activity were better at managing stress, which, in turn, contributed to improved sleep quality. The findings emphasize the importance of considering psychosocial factors when exploring the relationship between sleep and physical activity [21]. Another relevant study focused on how screen-based sedentary time interacted with physical activity and sleep quality in adolescents. The researchers discovered that while sedentary behaviors, particularly those involving screens, were associated with poor sleep quality, physical activity served as a protective factor, mitigating the negative impact [22].

Purpose: The objective of this study is to analyze and compare the quality of sleep among 17-year-old adolescents in the Central Slovak region.

Material and Methods

Participants

The study sample consisted of 626 students enrolled in vocational secondary schools located in the Central Slovak region, all of whom were 17 years of age. Of these participants, 353 were female, representing 56.4% of the total sample, while 273 were male, accounting for 43.6%. The sample was designed to ensure representation across different vocational institutions in the region, providing a diverse demographic profile that reflects the student population of these schools. Further details on the composition of the sample, including the specific types of secondary schools attended by the students and the gender distribution within these institutions, are presented in Table 1.

Ethics Committee Statement

This study was approved by the local Ethics Committee of Matej Bel University in

Banská Bystrica (2024/11). All procedures were in accordance with the latest amendment of the Declaration of Helsinki (Human Studies).

Questionnaire method

To assess sleep quality, we utilized the Pittsburgh Sleep Quality Index (PSQI) questionnaire [23] with the Slovak version [24]. The questionnaire was distributed via Google Forms between October 2023 and March 2024. Prior to completing the questionnaire, students were given instructions. The questionnaires were completed voluntarily by the students without any financial incentive, independently of any material benefits, and with the consent of the school principal. The PSQI questionnaire consists of 19 questions focusing on various aspects of sleep, which are individually assessed through seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. These components are then used to calculate a global score ranging from 0 to 21, with scores higher than 5 indicating poor sleep quality [23].

Statistical analysis

For the statistical analysis, we utilized several methods to assess the significance of our results. The chi-square test (χ^2) was applied to evaluate associations between categorical variables, with significance levels set at $p < 0.01$ and $p < 0.05$. This test was chosen due to its suitability for testing the independence or goodness of fit in contingency tables. To assess the homogeneity of variances between two independent samples, we conducted an F-test, which allowed us to determine whether the assumption of equal variances was met. In instances where we needed to compare the means of two independent samples, we employed the two-sample t-test, considering both the scenarios of equal and unequal variances. The t-test was conducted at two significance thresholds, $p < 0.01$ and $p < 0.05$, ensuring a robust analysis of the data's variability and differences between sample means. Each of these statistical tests was chosen based on the characteristics of the data, providing a comprehensive framework for assessing the relationships, variances, and differences within our sample groups.

Table 1

Distribution of Respondents by Gender and School Type

School Type	Gender		Total
	Girls	Boys	
Gymnasium	181	134	315
Vocational Secondary School	172	139	311
Total	353	273	626

Results

In terms of sleep onset time, our findings indicate that the majority of students, both boys and girls, tend to fall asleep between 11:00 PM and 12:00 AM, with response frequencies in both groups reaching nearly 40%. Additionally, our data reveal that 14.16% of girls and 11.36% of boys fall asleep after 12:00 AM. The average sleep onset times were similar between genders, with girls falling asleep at approximately 10:54 PM and boys at 10:50 PM, showing no significant gender differences.

When evaluating wake-up times, significant differences were observed between boys and girls at a significance level of $p < 0.01$ (Table 2). Specifically, almost 40% of girls wake up before 6:00 AM, compared to only 24.01% of boys. Regarding students' self-assessed sleep quality (Table 2), nearly half of the girls (52.97%) and 60.44% of boys rated their sleep as "quite good." However, 30.88% of girls and 23.08% of boys described their sleep as "quite poor," with an average of 7% of students rating their sleep as very poor.

In the sleep latency category, we found that boys generally had fewer problems with falling asleep, with 21% of them falling asleep within 15 minutes. Gender differences in sleep

latency were statistically significant at the $p < 0.05$ level (Table 2).

From the perspective of sleep duration, our findings indicate that nearly 75% of students of both genders do not achieve the recommended amount of sleep for their age (Table 2). Particularly concerning is the health risk posed to a subgroup comprising 11.05% of girls and 5.13% of boys who report sleeping less than 5 hours per day. Furthermore, our results show that the average sleep duration among girls is 6 hours and 28 minutes, while for boys, it is nearly 7 hours (6 hours and 55 minutes). These differences in average sleep duration between genders were statistically significant at the $p < 0.01$ level (Table 3).

The fourth component of the PSQI questionnaire assesses sleep efficiency, which refers to the actual time spent sleeping while in bed. The results suggest (Table 3) that boys exhibit higher sleep efficiency, with 84.25% achieving an efficiency rate above 85%. Among girls, 78.75% demonstrate sleep efficiency greater than 85%. Sleep disturbances, another component assessed by the PSQI, were found to be more prevalent among girls than boys, with gender differences being significant at the $p < 0.01$ level (Table 3).

Table 2

Components: Bedtime, Wake-up Time, Sleep Quality, Sleep Latency (n = 626)

Time	Girls	Boys	Chi-square Test/ t-Test
Bedtime			
≤ 22:00	19,26%	25,27%	0,225 (p) 4,354 ($\chi^2_{(3)}$)
22:00 - 23:00	29,18%	25,27%	
23:00 - 24:00	37,39%	38,10%	
≥ 24:00	14,16%	11,36%	
Average time (hours,min.)	22:54	22:50	p=0,450
Wake-up Time			
≤ 6:00	37,96%	24,18%	8,156 E-06 (p)** 26,324 ($\chi^2_{(3)}$)
6:01 – 6:30	40,79%	52,01%	
6:31 - 7:00	15,58%	22,71%	
≥ 7:01	5,67%	1,10%	
Average time (hours,min.)	6:02	6:06	p=0,233
Sleep Quality			
Very good (0)	7,93%	10,26%	0,082 (p) 6,693 ($\chi^2_{(3)}$)
Fairly good (1)	52,97%	60,44%	
Fairly bad (2)	30,88%	23,08%	
Very bad (3)	8,22%	6,23%	
Sleep Latency			
0 Σ (0)	14,45%	21,98%	0,021 (p)* 9,647 ($\chi^2_{(3)}$)
1 - 2 Σ (1)	38,53%	38,46%	
3 - 4 Σ (2)	37,68%	28,21%	
5 - 6 Σ (3)	9,35%	11,36%	

Table 3

Components: Sleep Duration, Sleep Efficiency, Sleep Disturbance, Sleep Medication, Daytime Dysfunction (n = 626)

Time	Girls	Boys	Chi-square Test/ t-Test
Sleep Duration			
≥ 7 hours (0)	32,86%	46,15%	6,667 E-04 (p)** 17,120 ($\chi^2_{(3)}$)
6 - 7 hours (1)	48,16%	38,83%	
5 - 6 hours (2)	7,93%	9,89%	
≤ 5 hours (3)	11,05%	5,13%	
Average time (hours,min.)	6:28	6:55	p=2,121 E-04**

Sleep Efficiency			
≥ 85% (0)	78,75%	84,25%	0,320 (p) 3,503 ($\chi^2_{(3)}$)
85% - 75% (1)	14,45%	9,89%	
75% - 65% (2)	2,55%	2,56%	
≤ 65% (3)	4,25%	3,30%	
Sleep Disturbance			
0 Σ (0)	1,98%	4,40%	3,851-04 (p)** 10,987 ($\chi^2_{(3)}$)
1 - 9 Σ (1)	68,27%	77,66%	
10 - 18 Σ (2)	25,50%	17,58%	
19 - 27 Σ (3)	4,25%	0,37%	
Sleep Medication			
0/ month (0)	90,65%	90,84%	0,001 (p)** 14,928 ($\chi^2_{(3)}$)
< 1/ week (1)	4,25%	2,20%	
1 - 2/ week (2)	3,97%	1,47%	
> 3/ week (3)	1,13%	5,49%	
Daytime Dysfunction			
0 Σ (0)	5,10%	7,69%	2,346 E-05 (p)** 24,130 ($\chi^2_{(3)}$)
1 - 2 Σ (1)	31,16%	40,66%	
3 - 4 Σ (2)	43,06%	44,32%	
5 - 6 Σ (3)	20,68%	7,33%	

Table 4

Global Score PSQI of survey group (n = 626)

Sleep quality	Girls	Boys	Chi-square Test/ t-Test
Global Score [23]			
bad sleep quality (> 5)	71,67%	60,81%	0,004 (p)** 8,211 ($\chi^2_{(1)}$)
good sleep quality (≤ 5)	28,33%	39,19%	
Global Score [49]			
good sleep quality (≤ 5)	28,33%	39,19%	1,489 E-06 (p)** 26,834 ($\chi^2_{(2)}$)
poor sleepers (6-10)	54,67%	56,41%	
severe sleep disorders (> 10)	17,00%	4,40%	

Additionally, our survey revealed significant differences at the $p < 0.01$ level in the use of sleep medication, primarily influenced by the fact that 5.49% of boys use sleep medication more than three times per week (Table 3). A positive finding is that 90% of students (both boys and girls) do not use sleep medication at all.

In terms of daytime dysfunction, we also identified significant gender differences at the $p < 0.01$ level (Table 2), with 20.68% of girls scoring 5-6 Σ (higher scores indicate more

problems affecting daily functioning and mood). It is noteworthy that only 5.10% of girls and 7.69% of boys report no daytime dysfunction or mood changes influenced by sleep.

In the summary evaluation of the PSQI questionnaire, it was found that only 28.33% of girls and 39.19% of boys exhibit good sleep quality. Conversely, sleep disturbances are observed in as many as 71.67% of girls and 60.81% of boys. These differences are statistically significant at the $p < 0.01$ level (see Table 4).

Discussion

Sleep is influenced by an individual's chronotype, with morning types predominating in childhood, adolescents leaning towards evening types, and older individuals showing a greater prevalence of morning types [25]. Our findings indicate that nearly 40% of the adolescents we observed fall asleep after 11 PM, and nearly 13% after midnight. This aligns with other findings [26] as adolescents often fall asleep late at night, which may be associated with social and academic activities, as well as biological changes in circadian rhythms during puberty.

Factors that negatively affect sleep quality, such as noise, light, room temperature, stress, hunger, lack of physical activity, and increased food intake (especially simple carbohydrates) before sleep or upon waking [27]. However, the importance of regular bedtime, ideally before 10 PM, which only 19.26% of girls and 25.27% of boys in our sample adhered to.

Regarding sleep duration, only 40% of the students we observed (32.86% of girls and 46.15% of boys) slept more than seven hours, indicating that most students already have a sleep deficit at this young age, especially among girls. In the United States, only 27.3% of students met the AASM-recommended sleep duration, with the difference being that nearly 4% more girls (38.72%) adhered to these recommendations [28]. Sleep durations of six hours or less were recorded in nearly 20% of the adolescents we observed, which is concerning since. Adolescents with five hours of sleep exhibit significantly higher rates of depression, mood swings, and lack of energy [29]. Sleep deprivation in adolescents is linked to increased risks to both physical and mental health, a weakened immune system, and frequent mood disorders [30]. The negative consequences of sleep deprivation, including increased risks of depression and anxiety disorders among adolescents, are also documented [31].

Extending sleep duration among students who sleep less than seven hours significantly improves academic performance [32]. Students with better academic outcomes tend to sleep longer on average than their peers [33]. Gender also plays a role in sleep, with women generally needing more sleep

and more frequently reporting sleep problems than men [7]. However, our findings show that the average sleep duration among girls is 27 minutes shorter than that of boys. Adolescents exhibit significant differences in sleep regularity between school days and days when they can choose their sleep and wake times [34]. Sleep is more regular on school days, as adolescents have fixed wake times determined by school schedules—our findings indicate that 40% of girls and nearly 25% of boys wake up before 6 AM. While school days may shorten sleep duration, they increase sleep regularity [30]. Adolescents tend to compensate for sleep deficits during the week by sleeping up to two hours more on weekends.

Differences in sleep duration and quality among 16-, 18-, and 20-year-olds show only a slight decline with age [35]. However, intra-individual variability in sleep duration and latency increases significantly with age. Regarding sleep latency, we found significant intersex differences ($p < 0.01$), with boys showing more favorable results—nearly 22% fall asleep within 15 minutes. Optimal time to fall asleep is within 30 minutes, ideally between 10 and 20 minutes [36-37], which forms the foundation for quality nighttime sleep [38]. However, only 14.45% of the girls in our sample met this criterion. In recent decades, modern technologies and the associated blue light emissions, which suppress melatonin production—crucial for inducing sleepiness—have negatively impacted sleep latency in both adolescents and adults [39]. More than one-third of adolescents and adults (42%) use such technologies less than one hour before sleep [40-41]. The results indicate a negative relationship between technology use and sleep, with sleep characteristics significantly differing between users who do and do not use these devices before bed ($p < 0.001$).

Despite women reporting more sleep problems [7], they exhibit better sleep efficiency – a finding not supported by our research, as we observed higher sleep efficiency among boys. This may be due to higher levels of stress and anxiety, as well as hormonal changes during adolescence [42]. Girls are more frequently affected by sleep disruptions due to greater sensitivity to stressors [9].

Health behaviors of schoolchildren conducted in England in 2014, girls more

frequently reported sleep problems (at least once a week) than boys [43]. The largest difference was observed among 15-year-old respondents, with 30% of boys and 49% of girls complaining of sleep problems.

The use of sleep medication among adolescents should be minimized due to the risks of dependency and side effects [44]. Other studies suggest that long-term use of hypnotics can lead to worsening sleep quality and dependency [45]. Our findings indicate that 90% of students do not use sleep medications, which we consider a positive finding. Only 6.1% of college students use sleep medications [46]. The study also revealed that 48.1% of students experience poor sleep quality, with 58% consuming stimulants associated with various indicators of poor sleep quality. Poor sleep quality subsequently manifests as daytime dysfunction – sleepiness, fatigue, and inability to concentrate – leading to reduced performance and impaired learning ability among adolescents [11]. As a result, students often resort to readily available stimulants—regularly consuming highly caffeinated energy drinks and other stimulants, which frequently cause further sleep disturbances [46-47]. Energy drinks are consumed by 30% to 50% of the adolescent population [48], with 46% of the 5,448 caffeine overdoses reported in the United States in 2007 occurring in individuals under 19 years of age.

PSQI composite score can be divided into three categories for more detailed quantification of sleep disorders – good sleep quality with a total score ≤ 5 , poor sleepers with scores ranging from 6 to 10 (54.67% of girls and 56.41% of boys), and severe sleep disorders with scores ≥ 10 (Table 4) [49]. Our findings indicate that 17.00% of girls and 4.40% of boys exhibit severe sleep disorders. This may indicate the need for specific interventions aimed at improving sleep habits and sleep quality, particularly among girls [50]. Similar results are reported by other studies, which emphasize the importance of psychological and behavioral interventions to improve sleep habits among adolescents [51].

Conclusions

Based on the research findings, it can be concluded that there are significant differences in sleep habits and sleep quality between girls

and boys. Although the average time to fall asleep does not differ significantly between genders ($p>0.05$), girls wake up earlier than boys, contributing to their shorter overall sleep duration. The average sleep duration is shorter for girls compared to boys ($p<0.01$), with a difference of up to 27 minutes. Furthermore, girls exhibit a higher prevalence of sleep problems, including lower sleep efficiency, more frequent sleep disturbances, and higher levels of daytime dysfunction and mood changes affected by sleep.

The research highlights that a significant portion of students, particularly girls, do not achieve the recommended sleep duration, which may negatively impact their physical and mental health. Only one-third of students have good sleep quality, with the remaining two-thirds showing signs of sleep disorders, underscoring the need for interventions aimed at improving sleep habits. Based on these findings, it is clear that there is a need to focus on education and the promotion of healthy sleep habits among students (in schools, families, etc.) to improve their overall sleep quality and ultimately, their quality of life.

The integration of physical education tools and strategies into students' daily routines can play a significant role in enhancing sleep quality. Research shows that regular physical activity positively influences sleep patterns by reducing the time it takes to fall asleep, increasing total sleep duration, and improving overall sleep quality. The type, intensity, and timing of exercise are important factors in determining these benefits, with moderate to vigorous aerobic activities showing the most consistent positive effects. Additionally, programs that include flexibility and mindfulness exercises, such as yoga or stretching, can support relaxation and help individuals fall asleep more easily, particularly for those dealing with high levels of stress.

To maximize sleep-related improvements, schools should focus on a balanced physical education curriculum that incorporates both aerobic and relaxation exercises. It is also advisable that physical activities are scheduled earlier in the day, as engaging in intense exercise close to bedtime may interfere with sleep by increasing arousal. Furthermore, promoting good sleep hygiene alongside physical education can reinforce the

benefits of exercise on sleep. Future programs should consider individual differences in sleep needs and encourage personalized approaches to physical activity to ensure effectiveness across diverse student groups.

Conflict of interest

The author declares no conflict of interest.

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