Original article

Influence of Physical Activity and Nutrition on Sleep Quality of Romanian Students: A Case Study

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Abstract. *Backgrounds ad aims:* Sleep problems are associated with poorer quality of life, as well as mental and physical health issues, especially in people who are overweight or obese. Numerous studies have shown that there is a link between sleep and diet and between sleep and physical activity (PA). The present study aimed to show the connection between physical activity, diet, and the quality and duration of sleep in Romanian students. *Methods:* The main study was conducted on 876 students (435 women and 441 men) aged 19–26. Three weeks after the start of the main study, a subset of 83 male and female students aged 19–25 years were randomly selected to participate in an ancillary study. A questionnaire survey was conducted in order to determine the quality of sleep (PSQI), nutritional habits (HEI Index 2005), and physical activity (IPAQ), while anthropometric measurements were performed to determine body mass index (BMI). *Results:* For students involved in the main study, PSQI varied between 6.4(2.3) and 4.5(1.7) and PA from 409.15(108.12) to 5834.54(2548.32) MET. The number of hours of sleep varied between 6.8(2.2) and 7.6(1.8). The HEI index varied between 52.1(12.2) and 55.3(11.4), being directly proportional to the increase in sleep quality and the number of daily sleep hours. Similar results were obtained for the ancillary study. Statistical analyses were performed using SPSS version 23 (SPSS, Inc. Chicago, IL); a value of 5% was set as the conventional significance level. ANOVA was used to identify statistically significant differences between averages of variables for the groups. For all variables analyzed, t tests showed no significant differences between females and males as $p > \alpha = 0.05$ and the 95% confidence interval contained the value 0. *Conclusions:* The quality and duration of sleep can be improved through balanced nutrition and constant and sustained physical activity.

Key words*:* PSQI, HEI index 2005, IPAQ, BMI

Introduction

The appearance of numerous diseases related to the appearance of obesity in children and young people has determined many researchers to focus their attention on the aspects that lead to the appearance of obesity; nutrition and physical activity. Sleep is an indispensable process to restore the body after exertion, and lack of sleep can lead to disease and disruption metabolic. Sleep disturbances and short sleep duration are behavioral risk factors for inflammation, associated with increased risk of illness and disease (1). Sleep disorders affect physical and cognitive performance and are associated with a number of mental and physical disorders (2,3). The effect of sleep disorders on quality of life means that individuals may require pharmacological or psychotherapeutic intervention (4,5). However, pharmaceutical treatments for insomnia often have negative side effects, while psychotherapeutic treatment requires specialized intervention (6). As an alternative, some sleep experts recommend physical activity in order to improve sleep

quality (7). There are also numerous studies that show the link between physical activity and sleep quality, even showing that the secretion of melatonin, one of the hormones responsible for quality sleep is favored by physical activity (8). The conclusion of these studies is that exercise offers a potentially attractive alternative or adjuvant treatment for insomnia (9). Two main theories have been proposed to explain the effects of physical activity on sleep; the first claims that physical activity produces physiological changes favorable to sleep regulation (8,9), while the second focuses on the psychological effects of physical activity, which have been shown to diminish stress and anxiety levels by reducing the effects of depression, thus leading to improved sleep quality (10–15).

There are numerous studies that show a link between dietary patterns and diet and the duration and quality of sleep. There are numerous studies that support the results of the study analyzed here, namely the idea that adequate nutrition rich in omega 3 and omega 6 fatty acids, as well as certain amino acids such as tryptophan or Gamma-aminobutyric acid (GABA) leads to good sleep and sleep quality. Also, the presence of vitamins D, C and B6 / B12 have a beneficial effect on the duration and quality of sleep (16).

Research has confirmed that lack of sleep leads to increased food intake, while a preference for foods high in fat and carbohydrates can lead to obesity (17–20).

In addition, a number of studies indicate that a healthy diet can improve the quantity and quality of sleep (21-24), e.g., the consumption of milk, fish, fruits, and vegetables has been shown to promote sleep quality (25). On the other hand, some studies have noted that frequent consumption of fats, rapidly digestible carbohydrates, energy drinks, and sugary drinks is associated with poor sleep quality (26–28).

Methods

Participants and procedures

A sample of 876 male and female Romanian students (Tab. 1) completed a series of questionnaires related to physical activity (PA), sleep, and nutrition. Anthropometric measurements (weight and height) were used to calculate the body mass index (BMI).

Sleep evaluation

The PSQI assessed sleep quality over a one-month period. The questionnaire consisted of 19 self-rated questions categorized into seven components, graded on a score ranging from 0 to 3. The sum of scores for these seven components yielded one global score, which ranged from 0 to 21, where the highest score indicated the worst sleep quality. A global PSQI score greater than 5 indicated major difficulties in at least two components or moderate difficulties in more than three components (29).

Anthropometric measurements.

Weight assessments were performed using In Body 720(Bio space Co. Ltd, Korea) equipment, capable of measuring with a sensitivity of ± 0.1 kg.

For body height, measurements of the subjects (barefooted) were taken between the vertex point of the head and the feet with ± 0.1 cm sensitivity, using a stadiometer device (Seka 217, Germany).

PA (Physical Activity).

PA of the students was assessed based on the short version of the IPAQ questionnaire, translated

Table 1. Demographic characteristics of students participating in the main and ancillary study by gender PA levels and BMI.

Study	**Main study**			**Ancillary study**		
Age, Median value (SD)	22.3 (1.6)			21.8 (1.7)		
Gender	Male	Female	Total	Male	Female	Total
Number (%)	441(50.34%)	435(49.66%)	876 (100%)	41 (49.40%)	42 (50.60%)	83 (100%)
Sport activity level	Low	Moderate	Intense	Low	Moderate	Intense

into Romanian. Total weekly activity was expressed in metabolic equivalent task (MET) minutes/week. Students were classified into three main categories: low physical activity (<600 MET minutes/week), moderate physical activity (600–2,999 MET minutes/week), and high physical activity (>2,999 MET minutes/week) (30).

Food habits.

Food habits were assessed using the HEI 2015 score, a tool developed by the US Department of Agriculture. The HEI 2015 score is a 13-component 100-point scale that assesses the adequacy and moderation components of the diet. Higher scores are associated with better dietary compliance. The HEI 2015 score was calculated by means of a self-reported DHQIII questionnaire (31).

Statistical analysis.

Analyses of data were performed using SPSS 23 (SPSS Inc., USA). The level of significance $\alpha = 0.05$ was used to check the hypothesis. The difference in results was considered statistically significant when a p value obtained was less than or equal to 0.05. Statistical analysis used ANOVA test was used in order to identify statistically significant differences between the averages of the variables for the groups determined by physical activity (low, medium and high), Pearson Correlation index, and equality of variance was verified with the Levene test.

Results and Discussion

The study population consisted of 876 male and female students (aged 18–25 years); socio-demographic and anthropometric characteristics are reported in Table 1.

In order to be able to represent all data points on the same graph, we divided each one by the maximum value in order to obtain normalized values between 0 and 1.

For male students involved in the main study, PSQI varied between 6.3(2.1) and 4.6(1.3) and was inversely proportional to PA, which ranged from 411.26(113.15) to 5834.54(2548.32) MET. The number of hours of sleep varied between 6.9(2.1) and 7.6(1.8) per day. The HEI index varied between 52.1(12.2) and 55.3(11.4), being directly proportional to the increase in sleep quality index and the number of daily sleep hours. BMI ranged from 25.12(2.35) to 22.48(2.36) (Figure 1). Similar results have been obtained in other studies (32–34).

For female students involved in the main study, PSQI varied between 6.2(2.3) and 4.4(1.6), and was inversely proportional to the PA of the students, which ranged from 454.16(128.58) to 4446.38(1945.19) MET. The number of hours of sleep varied between 6.9(2.7) and 7.5(2.6) per day. The HEI index varied between 52.3(11.9) and 56.1(12.6), being directly proportional to the increase in PSQI and the number of daily sleep hours. BMI ranged from 24.14(2.28) to 21.34(2.14) (figure 2). Similar results have been reported by other authors (35–38).

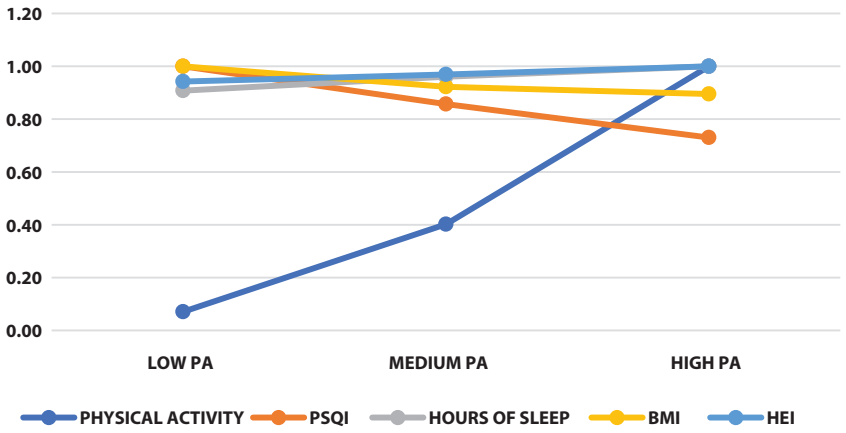

Figure 1. Correlation between PA, HEI index 2015, and sleep quality and duration for male students involved in the main study.

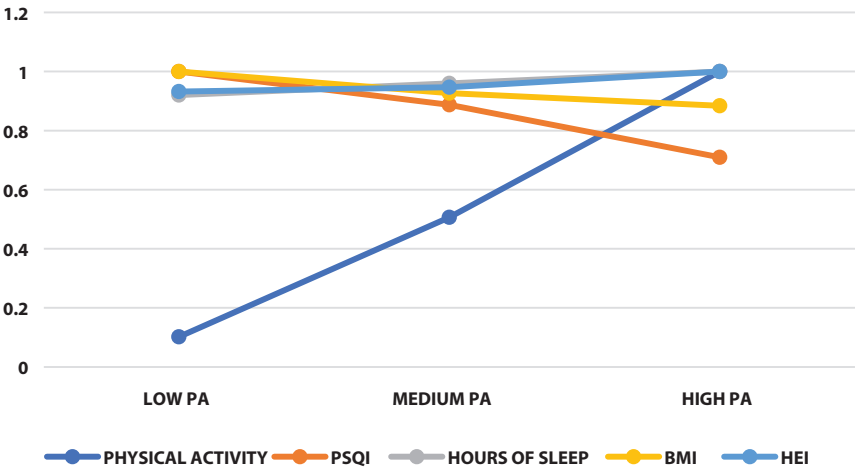

Figure 2. Correlation between PA, HEI index 2015, and sleep quality and duration for female students involved in the main study.

Very strong negative correlations existed between PA and PQSI (r = -0.969, p = 0.001) and PA and BMI (r = -0.822 and p = 0.0045 <α = 0.05). There was a significant positive correlation between BP and the number of hours of sleep (r = 0.867, p = 0.025). Very strong negative correlations were obtained for HEI and PQSI (r = -0.983, p <0.001) and HEI and BMI (r = -0.940 and p = 0.005). For HEI and number of hours of sleep, a very strong positive correlation was observed (r = 0.843, p = 0.035)(table 2). We obtained the same results for the ancillary study (table 3).

ANOVA analysis. ANOVA test was used in order to identify statistically significant differences between the averages of the variables for the groups determined by physical activity (low, medium and high).

For the main study, the ANOVA test reported a p value of <0.05; thus, there were significant differences between the group averages for PA (p = 0.008), HEI

Table 2. Correlations between PA, HEI, PSQI< BMI, and hours of sleep per day; main study.

		PSQI	Hours of sleep per day	BMI index
Physical Activity	Pearson Correlation	-0,957**	0,978**	-0,796*
	Sig. (2-tailed)	0,003	0,001	0,048
HEI index	Pearson Correlation	-0,985**	0,937**	-0,861*
	Sig. (2-tailed)	0,000	0,006	0,028

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 3. Correlations between PA, HEI, PSQI< BMI, and hours of sleep per day; ancillary study.

		PSQI	Hours of sleep per day	BMI index
Physical Activity	Pearson Correlation	-0,969**	0,867*	-0,822*
	Sig. (2-tailed)	0,001	0,025	0,045
HEI index	Pearson Correlation	-0,983**	0,843*	-0,940**
	Sig. (2-tailed)	0,000	0,035	0,005

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

(p = 0.007), PSQI (p = 0.001), and the number of hours of sleep (p = 0.004). There were no statistically significant differences for BMI (p = 0.063 > α = 0.05)(table 4).

For the ancillary study, the results were confirmed by the ANOVA test. There were significant differences between group averages for BP (p = 0.004), HEI (p = 0.013), PSQI (p = 0.001), and number of hours of sleep (p = 0.007). There were no statistically significant differences for BMI (p = 0.080> α = 0.05)(table 5).

Comparison between females and males

We wanted to see if there were significant differences between the variables analyzed for the female and male groups. We used the t test for two independent samples to test the difference between the averages of the same variable (PA, HEI, PSQI, BMI) measured for two groups of different subjects (females and males). Equality of variance was verified with the Levene test.

For the main study, the Levene test confirmed the equality of variances for the two groups (females and males) for PA (F = 0.389, p = 0.567 > α = 0.05), HEI (F = 0.390, p = 0.566 > α = 0.05), PSQI (F = 0.032, p = 0.868 > α = 0.05), number of hours of sleep (F = 0.093, p = 0.776 > α = 0.05) and BMI (p = 0.993 > α = 0.05). For all variables analyzed, t tests showed no significant differences between females and males, as p > α = 0.05 and the 95% confidence interval contained the value 0 (PA: p = 0.819, 95% CI for the mean difference: [4969,05234, 5927,39234], mean difference = 479.17; HEI: p = 0.916, 95% CI for the mean difference:

Table 4. ANOVA analyses for the main study

		Sum of Squares	Mean Square	F	Sig.
Physical Activity	Between Groups	22479499,127	11239749,564	34,810	0,008
	Within Groups	968669,329	322889,776		
HEI	Between Groups	12,730	6,365	41,065	0,007
	Within Groups	0,465	0,155		
PSQI	Between Groups	3,070	1,535	153,500	0,001
	Within Groups	0,030	0,010		
Hours of sleep per day	Between Groups	0,423	0,212	63,500	0,004
	Within Groups	0,010	0,003		
BMI	Between Groups	7,732	3,866	7,998	0,063
	Within Groups	1,450	0,483		

Table 5. ANOVA analyses for the ancillary study

		Sum of Squares	Mean Square	F	Sig.
Physical Activity	Between Groups	22132870,392	11066435,196	56,426	0,004
	Within Groups	588365,448	196121,816		
HEI	Between Groups	9,053	4,527	26,115	0,013
	Within Groups	0,520	0,173		
PSQI	Between Groups	3,810	1,905	190,500	0,001
	Within Groups	0,030	0,010		
Hours of sleep per day	Between Groups	0,413	0,207	41,333	0,007
	Within Groups	0,015	0,005		
BMI	Between Groups	7,191	3,595	6,599	0,080
	Within Groups	1,635	0,545		

[-4,27751, 3,94418], mean difference = -0.16667; PSQI: p = 0.930, 95% CI for the mean difference: [-1.9269, 2.0602], mean difference = 0.0667; number of hours of sleep: p = 0.815, 95% CI for the mean difference: [-0.6737, 0.8071], mean difference = 0.0667; BMI: p = 0.400, 95% CI for the mean difference: [-2.18431, 4.13098], mean difference = 0, 97333)(table 6).

We obtained similar conclusions for the ancillary study. The Levene test indicated the equality of variances between females and males for BP (F = 0.301, p = 0.613 > α = 0.05), HEI (F = 0.480, p = 0.527 > α = 0.05), PSQI (F = 0.010, p = 0.924 > α = 0.05), number of hours of sleep (F = 0.842, p = 0.411 > α = 0.05), and BMI (F = 0.527, p = 0.508 > α = 0.05).

t tests showed that there were no significant differences between the group of females and the group of males for the ancillary study, as p > α = 0.05 and the 95% confidence interval contained the value 0 (PA: p = 0.889, 95% CI for the mean difference: [-5098,95265, 5677,06598], mean difference = 289,05667; HEI: p = 0.842, 95% CI for the mean difference: [-3,75415, 3,22082], mean difference = -0.26667; PSQI: p = 0.875, 95% CI for the mean difference: [-2.0801, 2.3468], mean difference = 0.1333; number of hours of sleep: p = 0.907, 95% CI for the mean difference: [-0.7071, 0.7737], mean difference = 0.0333; BMI: p = 0.464, 95% CI for the mean difference: [-2.21136, 4.03136], mean difference = 0.910)(table7).

Table 6. Equality of variance (Levene test); main study.

		t-test for Equality of Means – Main study					
		t	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Physical Activity	Equal variances assumed	0,244	0,819	479,1700	1962,30148	-4969,05234	5927,39234
HEI	Equal variances assumed	-0,113	0,916	-0,16667	1,48062	-4,27751	3,94418
PSQI	Equal variances assumed	0,093	0,930	0,0667	0,7180	-1,9269	2,0602
Hours of sleep per day	Equal variances assumed	0,250	0,815	0,0667	0,2667	-0,6737	0,8071
BMI	Equal variances assumed	0,856	0,440	0,97333	1,13730	-2,18431	4,13098

Table 7. Equality of variance (Levene test); ancillary study.

		t-test for Equality of Means – Ancilar study					
		t	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Physical Activity	Equal variances assumed	0,244	0,819	479,1700	1962,30148	-4969,05234	5927,39234
HEI	Equal variances assumed	-0,113	0,916	-0,16667	1,48062	-4,27751	3,94418
PSQI	Equal variances assumed	0,093	0,930	0,0667	0,7180	-1,9269	2,0602
Hours of sleep per day	Equal variances assumed	0,250	0,815	0,0667	0,2667	-0,6737	0,8071
BMI	Equal variances assumed	0,856	0,440	0,97333	1,13730	-2,18431	4,13098

Conclusion

The present study confirmed the direct link between nutrition, level of physical activity, and sleep duration and quality and identified a link between sleep quality and BMI. Statistical analysis showed no significant differences between male and female students in terms of nutrition, physical activity, duration and quality of sleep, and BMI. The results obtained are supported by other specialized studies that clearly show the importance of balanced nutrition and regular physical activity to achieve quality sleep and ensure good health among young people.

As a significant number of students in Romania have been shown to suffer from poor sleep quality, comprehensive measures should be taken improve this situation. Students should be informed that sleep duration influences nutrition and quality of life. The quality and duration of sleep can be improved through balanced nutrition and constant and sustained physical activity.

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Authors' contributions: All authors contributed equally to this manuscript.

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