The effect of sleep quality on academic performance

Ismail Topal

Erzincan Binali Yildirim University, Faculty of Medicine, Department of Pediatrics, Erzincan, Turkey

Abstract

Aim: Sleep problem is a common issue among children. Insufficient sleep leads to inattention and behavior disorders and thus adversely affects academic performance. In this study, it is aimed to research the effect of sleep quality on the academic performance of eighth-grade students who are going to take the national exam (TEOG) designed for the transition to secondary education from primary education.

Material and Methods: Population of the research consists of 272 8th grade students attending eight different schools in Erzincan province. Pittsburgh Sleep Quality Index (PSQI) was applied in research questionnaire and Bodymedia's Armband Sense Wear Metabolic Holter (SWA) device was utilized to measure sleep effectiveness.

Results: It is found that TEOG scores of the students, whose PSQI score <5 and who has a high sleep quality measured by the Bodymedia's Armband Sense Wear Metabolic Holter, are high.

Conclusion: Students who have a good quality of sleep have better academic performance in the school. Body Media Sense Wear Metabolic Holter is an effective and practical method to measure sleep quality.

Keywords: Student; sleep quality; PSQI; SWA; academic performance.

INTRODUCTION

In addition to being a state of unconsciousness that can be reversed, sleep is not only a state of inactivity that allows the body to rest but an active renewal period that prepares the whole body for new life and has restorative processes such as learning or memory consolidation (1,2). Quality sleep, as well as sleep schedule, is related to the students' learning abilities and academic performance (3,4). Sleep quality is; that the individual is feeling fit and ready for a new day, after awakening. Sleep quality; is influenced by a variety of factors such as lifestyle, environmental factors, work, social life, economic situation, stress and overall health condition (5). In fact, sleep disorders are one of the most striking problems of modern-day. The incidence of sleep disorders during childhood and adolescence is reported to be 25-30% (6). Insufficient sleep results in irritability and lack of attention in children, which leads to poor academic performance (7). Success is a measure or an indication of how much an individual benefits from a class or an academic program. The grades or average scores a child gets within an academic program (8), on the other hand, can evaluate academic performance. It is known that the completeness of learning and memory processes have fundamental importance especially for children in developmental stages and for adolescents, in terms of school and academic performance (9). Polysomnography is considered to be the gold standard for sleep assessment. However, an expensive method requires time, special equipment and keeping the child in the hospital. Body Media Sense Wear Metabolic Holter (SWA) is a cheaper, easy-to-use device that does not require any other equipment. For this reason, we used the Pittsburgh Sleep Quality Index (PSQI) and SWA to measure sleep quality and compared them with TEOG scores of 8th-grade students who were to take the TEOG exam to pass from primary school to secondary school with the aim of showing the effect of sleep quality on school performance.

MATERIAL and METHODS

The research population consists of 272 8th grade students attending eight different secondary schools who are chosen within 1700 students attending 17 secondary schools of Erzincan province, taking the national (TEOG) exam for passing from primary to secondary education. (The sample size of sleep quality variability is calculated based on the capacity to represent on a provincial basis).

When choosing schools, the city's socioeconomic status was taken into consideration and one school was selected from each region. The first step of the study was to take the approval of Erzincan Binali Yildirim University Faculty of Medicine Ethics Committee and the permission of Erzincan Governorate for the research that will be carried out in the schools. The schools chosen for the study are visited and the 8th-grade students who are going to take the TEOG exam are informed about the research. Then the family information form prepared was distributed to get permission from the parents of the students. The children whose families gave permission are included in the study. The height and weight of the children who are included in the study are measured; Pittsburgh Sleep Quality Index (PSQI) and Bodymedia's Armband Sense Wear Metabolic Holter (SWA) device are used to measure the sleep effectiveness. On the weekdays, the unclear items were explained and the PSQI questionnaire was filled by asking 5 students face-to-face questions, then every morning at 9.00 o'clock the SWA device was attached on the right arm's triceps muscle of all participating children whose questionnaires are completed, according to the instructions of the SWA machine manufacturer. The children are warned not to take the device off or wet it until next morning. The schools are visited again next day to remove the devices from the children's arms at 9.00 o'clock at the school. The data from the devices are transferred to the computer environment and the devices are put on another set of 5 children. The study was conducted in the spring semester of the 2016-2017 academic year and it took approximately 3.5 months to complete. The study is finalized by collecting this data, as well as recording the TEOG scores of the students at the year-end.

Within the total 24 questions included in the PSQI, the individual answered 19 of them and five of them were answered by the spouse or a roommate. In this study, the last five questions were excluded from the study. There are 7 sub-dimensions of the scale used for 19 questions that the individual answered himself (subjective sleep quality, sleep latency, sleep duration, usual sleep activity, sleep disturbance, sleep medicine usage, daytime dysfunction), and each subscale has scores between 0 and 3 points. The total score of the scale has a value between 0-21 and if the PSQI score is higher than 5, it shows that sleep quality is low. The higher the score gets, it indicates that sleep quality is deteriorating even more (10,11). The subdivisions of the scale are not analyzed; the PSQI assessment is done based on the total score. For the adolescent age group, the minimum sleep duration was assessed as 8.5-9 hours (12).

Sense Wear Arm Band is a motion sensor that is placed on the triceps at the back of the dominant arm. It operates with a 3-volt battery and collects data from the outside. It measures the heat flow, the response of the skin to the electric current, the temperature of the skin and the medium around the device, and measures the movements of the individual. In order to do these, it uses a two axial accelerometer, a thermal flow sensor, a skin reaction sensor, a skin temperature sensor and a sensor that perceives the medium's temperature on the skin. The data collected are then processed with advanced algorithms to calculate and report the sleep time and sleep quality in the free-living environment. The collected data was analyzed with the algorithms of Body Media Armband Metabolic Holter Software (version 8.1) (Figure 1).
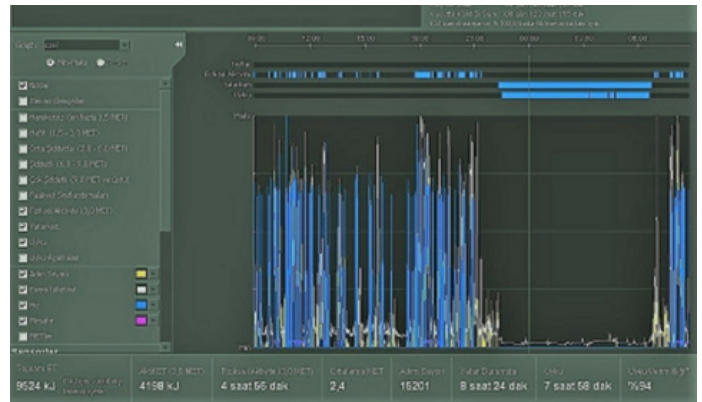

Figure 1. Data obtained with the Bodymedia's Armband Sense Wear Device

The limitation of the study is that sleeping habits and problems are obtained based on self-reporting of the students and that the SWA stays with the students for 24 hours.

Statistical Analysis

This research is a cross-sectional study. The results were presented for continuous variables as a mean ± standard deviation, median and minimum–maximum. The normality of continuous variables was tested using the Kolmogorov – Smirnov test. For comparison of independent continuous variables between two groups, the Student's t-test or Mann–Whitney U test was used depending on whether the statistical hypotheses were fulfilled or not. To evaluate the correlations between measurements, Pearson's correlation coefficient was used. While performing ROC analysis on sleeping efficiency (SQ), Pittsburgh sleep quality index was used as a gold standard test. Youden's index was used to determine the most appropriate threshold and optimal sensitivity and specificity. The statistical level of significance for all tests was considered to be 0.05. Statistical analysis was performed using the IBM SPSS ver. 19 package program ((IBM Corp. Released 2010. IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp).

RESULTS

The study included 272 8th grade students of which 132 (48.5%) are males and 140 (51.5%) are females. The descriptive statistics based on gender are obtained and presented in Table 1. When the results were examined; the age and BMI of male and female students are similar (respectively; p=0.953, p=0.054), however height, weight, PSQI score, SQ and TEOG scores are different.

When the relation between the variables is analyzed, it is found that there is a moderate negative correlation

between SQ and PSQI. That means when the quality of sleep increases, PSQI score decreases. Similarly, the negative correlation between TEOG score and PSQI score is weak. It is found that the correlation between TEOG score and SQ is moderately positive. When SQ increases, TEOG score increases. The correlation matrix of the variables is presented in Table 2.

When the gold standard for the Pittsburgh sleep quality index is taken, the interception points related to the SQ measurements have been obtained, as a result of the ROC analysis (AUC=0.824; p<0.001). The optimum interception point is determined to be 85.5 by using the Youden index. It can be said that the ones who have SQ below 85.5 have a low sleep quality (sens=0.77; spec=0.77). The sens and spec values to determine poor sleep quality for some threshold values are presented in Table 3.

Table 1. Descriptive statistics based on gender

	Gender		P
	Male	**Female**	
Age	14.0±0.1 14.0 (14.0-15.0)	14.0±0.1 14.0 (14.0-15.0)	0.953
Height	163.2±7.9 163.0 (143.0-180.0)	160.3±6.1 160.0 (140.0-176.0)	0.001
Weight	54.2±11.2 53.0 (35.0-88.0)	50.4±8.4 50.0 (30.0-85.0)	0.001
PSQI	4.9±2.1 5.0 (1.0-14.0)	4.5±2.5 4.0 (0.0-17.0)	0.014
SQ	81.8±10.3 84.0 (8.0-97.0)	85.4±7.2 87.0 (66.0-97.0)	0.001
TEOG Score	349.0±78.2 347.5 (157.0-495.0)	389.0±78.6 407.5 (183.0-496.0)	<0.001
BMI	20.3±3.3 19.9 (13.6-29.4)	19.6±2.7 19.4 (13.5-27.4)	0.054

Table 2. Correlation Matrix for the variables

	Height	**Weight**	**PSQI**	**SQ**	**TEOG Score**	**BMI**
Height	1 -					
Weight	0.58 <0.001	1 -				
PSQI	0.08 0.219	0.06 0.361	1 -			
SQ	−0.05 0.373	-0.11 0.074	-0.54 <0.001	1 -		
TEOG Score	0.10 0.099	-0.08 0.178	-0.20 0.001	0.61 <0.001	1 -	
BMI	0.14 0.025	0.89 <0.001	0.02 0.710	-0.10 0.113	-0.04 0.524	1 -

Table 3. Sensitivity and specificity of appropriate thresholds

	Sensitivity (95% CI)	**Specificity (95% CI)**
< 84.50*	0.73 (0.65 - 0.80)	0.81 (0.73 - 0.87)
< 85.50*	0.77 (0.69 - 0.84)	0.77 (0.69 - 0.84)
< 86.50*	0.85 (0.78 - 0.91)	0.68 (0.59 - 0.76)

*Bad sleeping quality if less than or equal to, CI: confidence Imterval

DISCUSSION

In this study, Pittsburgh Sleep Quality Index (PSQI) and Bodymedia's Armband Sense Wear are utilized to research the effect of sleep quality on academic performance. The result of the study showed that quality sleep has an effect on school performance. Sleep is a fundamental factor in the physical growth and in strengthening academic performance. It is stated that adequate levels of sleep and resting are necessary for children to achieve their developmental functions (13). The causal links between sleep disturbances, attention, learning, and memory have been well established for adults, however, there are very few researches done on children. When there is insomnia, problems related to memory, decision-making, learning, and concentration, as well as bad mood start to emerge (14). It is highlighted in the literature survey that long and short sleep problems can negatively affect children's cognitive, behavioral, academic and social functions and may lead to accidents resulting in injuries (15). Another study showed us that sleep quality and quantity are closely related to the students' learning capacity and academic performance; in studies where sleep is restricted or actively optimized, neurocognitive and academic performance was positively and negatively affected, respectively (16). Koçoğlu and his colleagues showed that among the 2nd-grade primary school students in Ankara, the ones who have sleep problems experience negative effects on their functions at the school (17).

In a study, the effect of sleep quality on school success was shown by asking questions of the Pittsburgh sleep quality index to medical students who were going to take an exam (18). The Epworth Sleepiness Scale and the Pittsburgh sleep quality index were used in a study on Portuguese adolescents and the adverse effects of sleep problems on school performance were reported (19). In concurrence with the literature survey, it was found in our study that TEOG scores of the students, whose PSQI score <5, are also higher.

Sunseri and his colleagues showed that SWA device is a valid tool for sleep recognition (20). Furthermore, M Shin and his colleagues, to validate SWA, have compared Polysomnography (PSG) in different environmental temperatures and reported that there were no significant differences found, thus SWA was considered a valid method (21). Sharif MM and Bahammam AS; In their study on patients with obstructive sleep apnea, they published that SWA is more effective than PSG in determining sleep estimates (22). It was found in our study that the students, whose SQ are higher as measured by SWA, also have higher TEOG scores.

When the study data was evaluated in general, it was seen that there was a negative correlation between PSQI and SQ. This was an expected outcome since low scores in PSQI mean good sleep quality, while high scores in SQ mean good sleep quality. When we examine the correlation between the measurements and TEOG scores which we assumed to indicate academic performance; it was found

that there is a negative correlation between PSQI and TEOG score, while a positive correlation was found between the SQ and TEOG score. The negative correlation between PSQI and TEOG scores was low because of PSQI values indicating good sleep quality as we mentioned earlier. The positive correlation between SWA (SQ) values and TEOG scores indicates that there is a relation between sleep quality and academic performance. This correlation is at a higher-level relation compared to the correlation between TEOG and PSQI. In order to be able to say that sleep is of good quality or poor quality by setting an interception point related to SQ value, we used PSQI, whose reliability study was conducted in our country, as gold standard and the optimum cut-off point was determined to be 85.5.

CONCLUSION

As a result, SWA is a simple and effective method of measuring sleep quality, such as the Pittsburgh Sleep Quality Index (PSQI) questionnaire. Students who have good sleep quality has better school performance, therefore, school presidents and health workers should actively work on the identification of the sleep quality of students in schools to determine children with sleep problems and work together with their families to search for the reasons and develop solutions.

Ismail Topal ORCID: 0000-0002-8763-4860

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