International Journal of Asian Social Science
ISSN(e): 2224-4441
ISSN(p): 2226-5139
DOI: 10.18488/journal.1.2017.710.793.802
Vol. 7, No. 10, 800-809.

URL: www.aessweb.com

ASSOCIATION BETWEEN SLEEP QUALITY AND PHYSICAL FITNESS COMPONENTS AMONG 13-14 YEARS MALE STUDENTS

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Article History
Received: 3 July 2017
Revised: 4 August 2017
Accepted: 7 September 2017
Published: 25 September 2017

Keywords
Sleep quality
Physical fitness components
SEGAK
Fitness level
BMI
Cardiovascular fitness

ABSTRACT

This study aimed to determine the association between sleep quality (SQ) and physical fitness components among 13-14 years old male students in a secondary school in Kota Kemuning Selangor, Malaysia. The sample consist of 162 students purposively selected according to their physical fitness levels (SEGAK test score). They were in three categories; higher (A score: 4.33±0.21, N=54), intermediate (B score: 3.27±0.26, N=54) and lower (C score: 2.35±0.36, N=54). The SEGAK tests were consist of BMI, step test, push-up, curl-up, and sit and reach. Pittsburgh Sleep Quality Index (PSQI) self-reported questionnaire was used to measure SQ. The descriptive analysis and Pearson Product Moment test were used to analyze the data. The results showed 51.8% of the students with higher fitness level, and 42.6% of the intermediate level reported "very good" SQ while only 25.9% of the lower fitness level had "very good" SQ. The correlation between overall SQ score and total fitness score was (r=-.282; p <0.001). The physical fitness components which significantly associated with SQ were BMI (r=.211; p=0.007), cardiovascular fitness (r=.319; p <0.001), endurance and strength of abdominal muscles (r=-.197; p =.012), and lower back muscles flexibility (r=.315; p <0.001). These findings illustrated no significant association between SQ and "endurance and strength of shoulder muscles" (r=-.142; p =0.072). The findings suggest that, cardiovascular fitness level and lower back muscles flexibility can improve overall SQ, similarly normal BMI, and endurance and strength of abdominal muscles among secondary school children. Physical educators should be encouraging students to improve their physical fitness components for higher fitness level to enhance their SQ as an important part of healthy life.

Contribution/ Originality: This study is one of very few studies which investigated association between sleep quality (SQ) and physical fitness components. SQ is essential for health and wellbeing. Many school children cannot achieve excellence in academic and sports because of weak physical condition due to poor SQ. It showed which physical fitness component can significantly improve SQ among school children.

1. INTRODUCTION

According to the Centers for Disease Control and Prevention (CDC) insufficient sleep was increasingly accepted as a public health epidemic (CDC, 2014) while it is still an unsolved public health problem (Aye *et al.*,

2017). Moreover, many studies have evidenced that poor quality of sleep can impair cognitive processes and school performance in a variety of ways, such as disrupt attention, concentration, focus, and can affect thought processes, and over 60% of colleges students were categorized as poor quality sleepers (Dewald *et al*., 2010; Lund *et al*., 2010). Increasing epidemiological and laboratory evidence support previous findings of an association between short sleep duration and poor sleep quality increase risk of obesity (Beccuti and Pannain, 2011). One out of five primary school-age children in Malaysia was found to be overweight which consistent with the global trend of childhood obesity in a developing country (Naidu *et al*., 2013).

In addition, findings by Benloucif *et al*. (2004) state that increasing exposure to physical activity may be a useful intervention to improve sleep quality and daytime function in older adults (Benloucif *et al*., 2004). According to Shapiro *et al*. (1984) fitness facilitates sleep increase in fitness, sleep onset latency and wake time during sleep decreased and sleep efficiency improved (Shapiro *et al*., 1984).

Although there were many studies that examined the relationship between sleep quality and physical activity, exercise and obesity, most of them focus on overall fitness or only one component of physical fitness (Tworoger *et al*., 2003; Lee and Lin, 2007; Reid *et al*., 2010; Iftikhar *et al*., 2014). Currently while teachers' in secondary (SMK) schools, reported sleep problems among students are common and it diminishes student's performance, the physical education teachers by interview at SMK Kota Kemuning found that weak students physically and academically suffer from inadequate sleep problems and they are sleepy in the classroom.

Moreover, recently some studies reported epidemiology of insomnia in Malaysian adults (Zailinawati *et al*., 2008) and habitual sleep length is prospectively and independently associated with obesity and mortality with children who sleep less than adequate time more likely to be obese (Shi *et al*., 2010; Firouzi *et al*., 2014). Meanwhile, many studies have indicated that people who had poor sleep quality are mostly adolescences, adults, night shift jobs and students from colleges universities (Liu *et al*., 2005; Lund *et al*., 2010).

Consequently, it can be prospective that the quality of sleep and physical fitness level has a very close relationship in building healthy lives and quality of life. Furthermore, Iftikhar *et al*. (2014) stated that exercise promotes sleep when fatigue caused by physical activity. The body and mind are easier to sleep and children who are physically active have a higher level self-esteem and a healthy body (Iftikhar *et al*., 2014). Naidu *et al*. (2013) reported high proportion of primary and secondary school children are overweight or obese (28% of them), with more boys (32.9%) overweight than girls (24.7%) (Naidu *et al*., 2013).

Therefore, this study has conducted to determine the sleep quality associated with physical fitness components based on SEGAK test scores and highlight the major findings related to the fitness components among male students aged 13-14 years in secondary school (SMK) Kota Kemuning. This is imperative to identify that physical fitness components can contribute to better sleep quality which can lead to good quality of healthy life in future while our students lifestyle are increasingly going to independent to sedentary life.

2. METHODS AND MATERIALS

2.1. Study Population

A case control study was carried out on 162 male students' aged 13-14 years old (14.13±0.53) in secondary school (SMK) in Kota Kemuning in Selangor, Malaysia. They were healthy and without any abnormality or any medical problems. They were purposively selected based on their physical fitness scores (SEGAK test). They divided in three groups based on their SEGAK scores; "A" as higher level physical fitness (N=54), "B" as intermediate level physical fitness (N=54), and "C" as lower level physical fitness (N=54). The study's sample size was calculated by G*Power 3.0.10 with medium effect size (0.3).

2.2. Physical Fitness Levels and Components

The study was conducted in the following three physical fitness score groups:

(a) High fitness level; score A (excellent),

(b) Intermediate fitness level; score B (good), and

(c) Lower fitness level; score C (satisfactory) which determined by SEGAK test score (table 1).

The components of physical fitness were considered based on SEGAK tests which consist of BMI, three minutes step-test, push-up, curl-up, sit and reach tests. Firstly, SEGAK tests determine their BMI value and categorized them in "underweight", "normal", overweight" and, "obese" based on age and gender. Secondly, this physical fitness battery test consisted of four tests which are three minutes step-test for assessing "cardiovascular fitness", push-up to evaluate the "endurance and the strength of hand and shoulder muscles", curl-up for "durability and strength of the abdominal muscles", and sit and reach test for "lower back muscles flexibility" which normed for each age (SEGAK, 2016). SEGAK data were collected by the physical education teachers in the school during October-November 2016. In this study the students purposively selected only from SEGAK score A, B, and C (Table 1).

Table-1. SEGAK score

Total Score	Grade	Fitness level
18-20	A (5)	Excellent
15-17	B (4)	Good
12-14	C (3)	Satisfactory
8-11	D (2)	Fair
4-7	E (1)	Poor

Sources: National Physical Fitness Standard for Malaysian Students- SEGAK (2016)

2.3. Sleep Quality

The sleep quality of participants was measured by Pittsburgh Sleep Quality Index (PSQI) self-reported questionnaire (Carpenter and Andrykowski, 1998; Foundation National Sleep, 2014). PSQI was translated to Bahasa Malaysia and translated back to English. After translation, it was pretested on a sample of 16 subjects presenting 10% of the entire study population. The Cronbach's alpha of the questionnaire was 0.81 and is considered as highly reliable. All students had 15-20 minutes introductory session. Merely in the special question "bed partner" was excluded and "the taken medicine" or any specific sleep disorder were reported and clarified by their parents.

The questionnaire included questions on seven components, including subjective feelings, sleep efficiency, sleep duration, sleep onset latency, sleep disturbances, use of sleep medication, and day time dysfunction. PSQI score of an answer is based on a '0' to '3' scale, whereby '3; reflects the negative extreme. The global sum of "5" or greater indicates "poor" quality sleeper while less than "5" indicates "good" quality sleeper.

Sleep duration was recorded to the nearest hour. Sleep quality was assessed using the question: "During the past month, how would you rate your sleep quality overall?" with a four point response (very good, fairly good, fairly bad, and very bad) and later recoded into "good" or "bad". Sleep efficiency was calculated by dividing total sleep time by total time spent in bed. Then, overall PSQI score <5 indicates good sleep quality and PSQI score >5 indicates poor sleep quality.

2.4. Data Analysis

The Statistical Package for Social Sciences (SPSS) Version 23.0 was used for data analysis. Normality test was done on the variables and appropriate test was selected and applied based on it. The descriptive analysis was conducted with calculation of means ± standard deviation (SD) and percentages (for categorical variables distributions). The Pearson correlation for parametric data were applied to determine the relationship between

physical fitness component tests scores (SEGAK components test scores) and overall quality sleep (PSQI scores) among 13-14 years male students. The statistical significance was set at $p < 0.05$.

3. RESULTS

Three groups consisting of higher fitness level (A) with BMI 19.1±1.7 ($kg.m^{-2}$), intermediate fitness level (B) with BMI 18.6±1.5 ($kg.m^{-2}$) and lower fitness level (C) with BMI 23.9±3.1($kg.m^{-2}$) were involved in this study with 54 students (14.13±0.53 years) per group. According to SEGAK norm BMI range for group A are categorized in normal range (normal: 15.5-21.8 and >25.9: overweight) and group C is categorized as overweight range. Total score for group A was 4.33±0.21, for group B was 3.27±0.26 and for group C was 2.35±0.36. Table 2 shows the demographic information of the subjects. It can be seen that all tests (step-test, push-up, curl-up and sit and reach) scores were higher for group A then the other groups.

Table-2. Demographic Characteristics of SEGAK components (mean ± SD) adjusted to physical fitness level

	A:Higher fitness level (N=54)	B:intermediate fitness level (N=54)	C:lower fitness level (N=54)
Total score SEGAK score	18.6±0.6 4.33±0.21	16.1±1.1 3.27±0.26	12.8±1.57 2.35±0.36
*BMI ($kg.m^{-2}$)	19.1±1.7	18.6±1.5	23.9±3.1
Step -test (bpm)	82.1±6.9	94.1±8.7	109.2±11.6
Push-up (repetition)	28.35±2.7	23.18±3.0	19.96±3.5
Curl-up (repetition)	25.26±1.91	19.22±.84	14.15±1.5
Sit & reach (cm)	46.2±2.18	40.6±1.96	29.2±2.2

* According to SEGAK norm BMI range for 14years old: underweight ≤ 15.4, normal 15.5-21.8, overweight 21.9-25.9, and >25.9 categorized as obese.

Based on the results, (Table 3) Subjective Sleep Quality (SQ) among students group A were remarkably better than the group C; 53.7% of them reported "very good" compared to group C with 27.7% rated. This component of sleep quality for group B rated 44.4% as "very good", 42.6% "fairly good" and the rest of them (13%) as "fairly bad".

Due to prevalence of sleep latency the majority of students in group A reported usually fall asleep less than 15 minutes (68.5%), and this time for 20.4% of them rated between 16-30 minutes and only 11.1% of them were unable to fall asleep within 31-60 minutes. Group B reported that their sleep latency were less than 15 minutes 48.1% and, 29.6% of them between 16-30 minutes and 13% between 31-60 and 9.3% of them were unable to fall asleep till one hour or more. The students in group C reported their sleep latency less than 15 minutes 38.9%, between 16-30 minutes 22.2%, between 31-60 minutes 22.2% and 16.7% of them could not fall asleep earlier than 60 minutes.

Looking at the Sleep Quality characteristics Table 3, the majority of group A students (90.7%) had sleep duration more than 7 and 6-7 hours, and likewise 81.5% of group B and 79.6% of group C had the same sleep duration. The actual sleep time for the rest of them was less than 6 hours per night. These results illustrated half of the school students had a range of 7-8 hours and above, one in three of them in range of 6-7 hours and rest of them reported their sleep duration less than 6 hours.

The results also showed sleep efficiency among students in groups A and B were considerably more than group C (A: 46.6%, B: 40.7% and C: 26%) which the sleep efficiency rated shows their real sleep times was less than their bed time.

Table-3. Sleep quality characteristics in different physical fitness levels among 13-14years old males' students (Total N=162)

Characteristics	A: Higher Fitness Level Number (%)	B: Intermediate Fitness Level Number (%)	C: Lower Fitness Level Number (%)
SUBJECTIVE SQ	**(N=54)**	**(N=54)**	**(N=54)**
Very good	29 (53.7)	24 (44.4)	15 (27.7)
Fairly good	18 (33.3)	23 (42.6)	22 (40.7)
Fairly bad	6 (11.1)	7(13)	14 (26)
Bad	1 (1.8)	-	3 (5.5)
SLEEP LATENCY			
<15 (min)	37 (68.5)	26 (48.1)	21 (38.9)
16-30	11 (20.4)	16 (29.6)	12 (22.2)
31-60	6 (11.1)	7 (13)	12 (22.2)
>60	-	5 (9.3)	9 (16.7)
SLEEP DURATION			
>7 (hours)	35 (64.8)	24 (44.4)	25 (46.3)
6-7	14 (25.9)	20 (37.1)	18 (33.3)
5-6	2 (3.7)	8 (14.8)	10 (18.5)
<5	3 (5.5)	2 (3.7)	1 (1.8)
SLEEP EFFICIENCY %			
>85	25 (46.3)	22 (40.7)	14 (26)
75-84	17 (31.5)	19 (35.2)	23 (42.5)
65-74	9 (16.7)	8 (14.8)	10 (18.5)
<65	3 (5.5)	5 (9.3)	7 (13)
SLEEP DISTURBANCE			
Not during past month	34 (62.9)	26 (48.1)	16 (29.6)
Less than once a week	16 (29.6)	18 (33.3)	23 (42.6)
Once or twice a week	2(3.7)	6 (11.1)	10 (18.6)
3 or more times a week	2 (3.7)	4 (7.4)	6 (11.1)
OVERALL SQ			
Very good	28 (51.8)	23 (42.6)	14 (25.9)
Fairly good	17 (31.5)	23 (42.6)	23 (42.6)
Fairly bad	7 (13)	8 (14.8)	15 (27.8)
Bad	2 (3.7)	-	2 (3.7)

Regarding sleep disturbance approximately two-third (62.9 %) of group A were found no any disturbance as they reflected in "not during past month", 29.6% of them in "Less than once a week", while two-third of group C rated sleep disturbance at least as "Less than once a week" (42.6%), "once or twice a week" (18.6%) and "three or more a week" (11.1%). The majority group B reported about this item "not during past month" (48.1%), "Less than once a week"(33.3%) and the rest of them (18.8%) reported some problems in their sleep.

The overall sleep quality rating among the participants was shown in Table 3. The overall sleep quality of group A was rated as "very good" and "fairy good" by 51.8% and 31.5% (respectively); and only 16.7% of them reported as "fairly bad" (13%) and a minority of them as "bad" (3.7%). Nearly the students in group B reported as "good" 42.6% and "fairly good" 42.6% and only 14.8% as "fairly bad". While the students of group C reported as "good" 25.9 % and the biggest part 42.6% as "fairly good". The prevalence of poor sleep quality among this group was more than one-third of them; 28.8% as "fairly bad" and" 3.7% as "bad" which this two answer choices categorized as poor sleep quality.

To assess the relationship between sleep quality and each SEGAK physical fitness variables, correlation analyses conducted and summarized in Table 4. The results of this study revealed among the sub-scores of SEGAK physical fitness test, only push-up as a test which measure hand and shoulder muscles' strength and endurance, had statistically no significant association with overall sleep quality according to the PSQI questionnaire (r=-.142 and p value =0.072). The findings illustrated a significant association between overall sleep quality of PSQI scores and total fitness scores (r=-.282 and p value <0.001); those who reported some problems during sleeping had likely lower fitness level. There also appeared a statistically association between sleep quality and BMI (r=.211 and p

value =0.007). The greatest correlation displayed between sleep quality and step-test scores which evaluated the cardiovascular fitness among the students (r=.319 and p value <0.001).

It revealed those who had lower cardiovascular fitness level reported some trouble of inability to fall asleep easily or reported a problem at least once a week during sleeping or another sleep disturbance problem. Similarly there was association between sleep quality and sit and reach test scores of the students (r=.315 and p value <0.001). It probably disclosed that sit and reach test score which evaluated the flexibility of lower back and hamstrings muscles have an effect on sleep quality of the students.

Even though the amount of relation between sleep quality and curl-up test which measured abdominal strength and endurance was less than the associated others components of fitness, there was statistically significant (r=.197 and p value =.012). The results of this study displayed that those who were classified in group A less likely to report poor sleep quality (r=-.282 and p value <0.001).

Table-4. Correlations between sleep quality and physical fitness components test scores of 13-14 years old male students (N=162)

Correlation coefficient *(r value)*						
Overall sleep quality	**Total Fitness Score**	**BMI**	**Step test**	**Push -up**	**Curl-up**	**Sit & reach**
r	-.282**	.211**	.319**	-.142	-.197*	-.315**
p value	.000	.007	.000	.072	.012	.000

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

4. DISCUSSION

The present study investigated relationship between physical fitness level and sleep quality among 162 male students for age 13-14 years old. This survey also determined the relationship between the physical fitness components through SEGAK tests scores and overall sleeps quality among the students. According to the findings nearly one in third of students in group C with lower physical fitness level reported "fairly bad to bad" sleep quality compare to the students group A and B with higher or intermediate physical fitness level. This finding is similarly consistent with another survey reported the relationship between sleep quality and the exercise behavior of College Students in the Central Taiwan Region which the sleep quality of the college students seems poor, and going to physical education class turns out to be the main way of doing exercise (Chang *et al.*, 2013).

In agreement with this findings, Suppiah *et al.* (2015) identified that high level adolescent athletes who participated in the higher intensity sport of badminton have less light sleep and more deep sleep when compared to high level adolescent athletes who partook in the lower intensity sport of bowling (Suppiah *et al.*, 2015).

This study detected the relationship significantly between physical fitness components test scores; step-test, curl-up and sit and reach, exception push-up test, and overall sleep quality among the subjects. The BMI value for groups A and B students were comparable as a set of "normal" BMI category (19.1±1.7 and 18.6±1.5 $kg.m^{-2}$ respectively), which were similar to previous studies that stated association between sleep duration and obesity in children while it was as a set of "overweight" category of group C (23.9±3.1 $kg.m^{-2}$). Our findings were consistent with Lin *et al.* (2010) and Lund *et al.* (2010) outcomes that stated sleep problems are significantly diminished in "normal" BMI subjects, even though their subjects were Students College or adults (Lin *et al.*, 2010; Lund *et al.*, 2010). Likewise, later Firouzi *et al.* (2014) found association between sleep duration with BMI status which is still a matter of debate in the field of childhood obesity (as abnormal BMI category) risk factors (Firouzi *et al.*, 2014). While Theorell-Haglow *et al.* (2010) found inverse association between sleep duration and BMI (Theorell-Haglow *et al.*, 2010) according to Lee and Lin (2007) with the normal BMI subject (19.94 ±2.53) (Lee and Lin, 2007) and Lai and Say (2013) reports, there was not remarkably well association between sleep quality and BMI (Lai and Say, 2013). However, despite many studies reporting a significant U shape relationship in which both short sleepers and long sleepers tend to gain weight (Iglowstein *et al.*, 2003; Bayer *et al.*, 2009; Jiang *et al.*, 2009; Ozturk *et al.*, 2009) students of this study with normal BMI had better sleep quality than those with overweight BMI.

The association between heartbeat of step test score and sleep quality was significant (0.319). This study found the students who had lower heartbeat during three minute step test, which approved higher cardiovascular fitness level, had better sleep quality than those who had higher heartbeat during the test. Even though, a limited data is available to indicate the relationship between cardiovascular fitness and sleep quality, most studies examining the effects of exercise on sleep have focused on young good sleepers or fit athletes (O'connor and Youngstedt, 1995; Ready *et al*., 2005) similarly another study reporting the moderate intensity aerobic physical activity is effective in improving self-reported sleep quality (Reid *et al*., 2010). The findings of this study confirmed another previous study that reported a closed relationship between 800m run/walk test among female young adults (19.3 ±0.6 years old) and global PSQI scores (r=0.57), and recommended cardiovascular fitness as an indicator to improve sleep quality (Lee and Lin, 2007).

Moreover, a meta-analysis of 12 studies indicates that regular exercise increases total sleep time, decrease sleep complaint (Reid *et al*., 2010) and, in some studies, slow wave sleep, and increased physical fitness, as indicated by a higher $\dot{V}O_{2max}$, was a strong indicator of improved sleep quality (Tworoger *et al*., 2003). However, this study found considerable relationship between heartbeat of step test and overall sleep quality self-reported among 13-14 years male students, therefore enhanced cardiovascular fitness can probably improve sleep quality.

While the association of overall sleep quality (PSQI score) with push-up test score as a measurement of "endurance and strength of hand and shoulder muscles" was not significant (r=-.142 and p value =0.072), this study found relationship between overall sleep quality and curl-up score which measuring "durability and strength of the abdominal muscles" (r=-.197 and p value =0.012). A poor curl-up test was associated with sleep quality (PSQI score) in female young adults and it can be associated with good health-related quality of life. The study also found that women with greater waist to- hip ratios (overweight) had more trouble falling asleep than did women with lower ratios (Chen *et al*., 2005).

These findings suggest that students with improved endurance and strength of the abdominal muscles probably had better sleep quality those who were in reduced condition. Likewise, short sleep duration is associated with risk behaviors that are known to reduce physical fitness and promote weight gain abdominal fat and obesity (Beccuti and Pannain, 2011). Obesity and being overweight often occur amongst those who with sleep problems such as sleep apnea and sleepiness (Lin *et al*., 2010).

In the case of short sleep, obesity could be due to subtle sleep loss induced energy-balance impairments linked to insulin resistance or glucose tolerance, and changes to leptin and ghrelin levels which represented 'satiety' and 'hunger' hormones, respectively, which lead to increased craving for high-calorie foods (Lai and Say, 2013). Thus, the students who reported "very bad" or "bad" as a poor sleep quality probably need higher foods calorie during sleep times than those with "very good" or "good" as a normal sleep quality which caused possibly to have sleep disturbances.

Despite the lack of evidence about effect of lower back and hamstrings muscles flexibility on sleep quality, a significant study suggested Yoga and 6 months of silver yoga exercise to improve sleep quality and health status (Oken *et al*., 2006; Cahan and Baharav, 2014) and this exercise increased upper body and trunk dynamic muscular strength and endurance, flexibility, and health perception (Cowen and Adams, 2005; Ross and Thomas, 2010). Therefore, while this significantly associated findings between sleep quality and lower back and hamstring muscles flexibility, it feasibly pointed the beneficial of enhancing the flexibility among school children to get well sleep quality.

This study found the high percentage of students with higher physical fitness level reported premier sleep quality. It appeared that the association between physical fitness score in all tests, although, there was not significantly relationship between endurance and the strength of hand and shoulder muscles (push-up test score) and sleep quality (PSQI score). In the meanwhile, this study explored the higher relationship between

cardiovascular fitness (step test score) and sleep quality, which possibly suggest that the effect of cardiovascular fitness on sleep quality among the school children.

5. CONCLUSION

Overall sleep quality with "very good" and "fairly good" (84%) reported among the secondary male students with higher and intermediate physical fitness level compare to students with physical lower fitness level (68%) in this study. Poor sleep quality among the lower physical fitness students in overweight and obese BMI categories were common. There were three fitness components alike normal BMI which associated with good sleep quality among these students. The findings revealed the notable relationship between sleep quality and 3 fitness components; "cardiovascular fitness", "endurance and strength of the abdominal muscles" and "low back and hamstring muscles flexibility". There was non-significant relationship with endurance and strength of hand and shoulder muscles. This prompts the need for further studies about sleep quality and physical fitness in school children to improve sleep quality and prevent poor physical fitness. The findings suggested that students should improve their physical fitness level particularly cardiovascular fitness and abdominal muscles endurance and strength which effect on body composition and obesity and also hamstrings and lower back muscles flexibility. Physical educators encourage students to increase their fitness level particularly cardiovascular fitness, and durability and strength of abdominal muscles as possible to improve sleep quality. This study hope parents and teachers in dealing with student health motivate students who suffer from sleep and learning problems to be more active in improving physical fitness level and engage in physical activities.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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