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ORIGINAL PAPER

Sleep quality and its association with waist circumference among undergraduate students

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Abstract

Background: Poor sleep quality has been associated with metabolic disturbances and behavioural changes that promote obesity, with growing evidence linking inadequate sleep to increased central adiposity. Waist circumference (WC), a key indicator of abdominal fat and cardiometabolic risk, has also been implicated in disrupted sleep through mechanisms such as hormonal imbalance and sleep-disordered breathing. Exploring the relationship between WC and sleep quality among undergraduate students is important to better understand early risk factors for obesity and related health outcomes.

Objective: This study aimed to examine sleep quality and its association with Body Mass Index (BMI) and Waist Circumference (WC) in an undergraduate population.

Methods: A total of 277 undergraduate students from Universiti Sultan Zainal Abidin (UniSZA), Gong Badak Campus, Malaysia, aged 18 to 25 years, were recruited for this cross-sectional study using non-probability proportionate stratified sampling. The students were weighed, and their BMI and WC were measured. The Pittsburgh Sleep Quality Index (PSQI) was completed to assess sleep quality.

Results: The results of the multiple linear regression analysis revealed that sleep quality did not significantly predict BMI (p>0.05). However, sleep quality significantly predicted WC (p=0.026), indicating a significant influence of sleep quality on WC.

Conclusion: While sleep quality was not significantly associated with body mass index, it was significantly associated with waist circumference. These findings highlight the potential importance of promoting a consistent sleep schedule as a preventative strategy to enhance sleep quality and mitigate weight-related risks in undergraduate students.

Keywords: sleep quality, body mass index, waist circumference, undergraduates

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Introduction

According to the World Obesity Atlas 2023 report, 38% of the population worldwide, presently are either overweight or obese,[1] having a body mass index (BMI) higher than 25kg/m^2. Regardless of social standing, Malaysia is currently seeing a geometric increase in the prevalence of obesity. The National Health and Morbidity Survey (NHMS) in 2019, reported that the prevalence of obesity has increased substantially from 15.1% in 2011 to 17.7% in 2015, and finally to 19.9%.[2]

Good sleep quality is described when one falls asleep during the night in 30 minutes or less with a sound sleep. On the other hand, poor sleep quality is when there is an issue of falling asleep and remaining asleep.[3] Sleep has recently been found to be an important modulator of cardiovascular activity, glucose regulation, and neuroendocrine function. The effects of deficiency in restorative sleep are severe, affecting the health, function and wellbeing of human.[4] Previous studies have reported that sleep problems caused by insufficient sleep are linked with a variety of adverse outcomes, including obesity,[5] cognitive dysfunction,[6] depression,[7] and heart disease.[8]

A study conducted among participants of the Early Life Exposure in Mexico to Environmental Toxicants study found that adolescents with consistently insufficient sleep exhibited higher levels of adiposity across all four measures - BMI-for-age Z score, triceps skinfold thickness, waist circumference, and body fat percentage - as well as a higher prevalence of obesity.[9] While, a study among Malaysian university students reported that overweight and obese (OW-OB) students exhibited poorer sleep quality, longer sleep latency, and more frequent sleep disruptions compared to their underweight and normal-weight (UW-NW) counterparts.[10] These findings emphasize the need for targeted wellness interventions that address both obesity prevention and the promotion of healthy sleep habits among university students. Waist circumference (WC) refers to the abdominal measurement taken at the midpoint between the lowest palpable rib and the upper border of the iliac crest.[11] It is a simple and convenient anthropometric measure that correlates well with body fat mass and serves as an indicator of intra-abdominal and total body fat,[12] particularly suitable for Asian populations. Abdominal obesity assessed by WC has been strongly associated with poor sleep quality, as excess central fat contributes to metabolic disturbances and sleep-disordered breathing, leading to reduced sleep duration and efficiency. This highlights a bidirectional relationship in which central adiposity impairs sleep quality, while inadequate sleep further promotes fat accumulation.[13] WC is strongly associated with higher risks of type 2 diabetes, heart disease, metabolic syndrome, and increased all-cause mortality, even among individuals with normal BMI.[14]

Research on the association between sleep quality, BMI, and WC in early adulthood is still limited, as most existing studies focus on children and adolescents. Examining both BMI and WC is important for understanding how sleep influences obesity risk, yet findings – especially on WC – have been inconsistent across populations and methods. In Malaysia, research in this area among early adulthood remains scarce. This study aims to fill that gap by assessing sleep quality and its relationship with BMI and WC among undergraduate students, providing evidence to guide health strategies and promote healthier lifestyles.

Methods

Design, location, and time

This study was conducted between January 2022 to February 2023 using cross-sectional study design. Participants were undergraduate students at Universiti Sultan Zainal Abidin (UniSZA), Gong Badak Campus, Terengganu, Malaysia. Prior to the study, ethical approval was obtained from the UniSZA Human Research and Ethics Committee (UHREC) (Ref. No. UniSZA/UHREC/2019/121), and informed consent was obtained from all students before data collection. The confidentiality of the students was ensured, as the data was used solely for the purpose of this research study and was not disclosed to the public. Students were selected from five faculties: *Fakulti Ekonomi dan*

Sains Pengurusan (FESP), *Fakulti Kontemporari Islam* (FKI), *Fakulti Sains Sosial Gunaan* (FSSG), *Fakulti Undang-Undang dan Hubungan Antarabangsa* (FUHA), *and Fakulti Bahasa dan Komunikasi* (FBK). The inclusion criteria encompassed healthy Malaysian early adults aged 18 to 25 years, enrolled in diploma or bachelor's degree programs at the UniSZA Gong Badak Campus, and literate in the Malay language. Exclusion criteria included individuals with severe psychopathological or medical conditions, pregnant or breastfeeding women, physically disabled students, those undergoing structured weight management or dietary control programs, athletes, and students from other UniSZA campuses.

Sampling

The sample size was calculated using G*Power version 3.1.9.7, and a total of 277 students were recruited. A non-probability proportionate stratified sampling method was employed, with students selected from each faculty based on their representation in the total population and according to predetermined eligibility criteria. Randomisation was not applied within each faculty.

Data collection

Students underwent anthropometric assessments (weight, height, and waist circumference) and completed a set of questionnaires that included sociodemographic information and sleep quality.

Sociodemographic information

This section consisted of questions on students' personal information such as gender, age, ethnicity, faculty, study program, and duration of study.

Anthropometric measurement

Anthropometric data, including weight and height, were measured for each student. Body weight was measured to the nearest 0.1 kg using a SECA digital weighing scale, while standing height was measured to the nearest 0.1 cm using a SECA stadiometer. Each measurement was taken twice, with a third measurement conducted if discrepancies were observed. Calibration was performed periodically following standard protocols to ensure accuracy. Body Mass Index (BMI) was then calculated based on World Health Organization (WHO) BMI classification chart. Waist Circumference (WC) was measured using a measuring tape at the narrowest point between the lowest rib and the iliac crest. Abdominal obesity was determined according to WC cut-off point as proposed by WHO.[11]

Pittsburgh Sleep Quality Index (PSQI)

The Malay version of the PSQI was used in this study to assess students' sleep quality.[15,16] The questionnaire consisted of 10 items, utilizing a 4-point frequency scale to evaluate sleep quality over the past month. The PSQI score was derived from seven components, each rated from 0 (no difficulty) to 3 (severe difficulty). These components included subjective sleep quality (C1), sleep latency (C2), sleep duration (C3), habitual sleep efficiency (C4), sleep disturbances (C5), use of sleep medications (C6), and daytime dysfunction (C7). The seven component scores were summed to generate a global score ranging from 0 to 21, with higher scores indicating poorer sleep quality. A total PSQI score greater than 5 was classified as "poor sleep quality," while a score of 5 or below was categorized as "good sleep quality." The results were then grouped accordingly into poor or good sleep quality categories.

Data analysis

Data analysis was performed using IBM SPSS for windows version 25. Descriptive statistics, including frequencies, percentage, mean and standard deviation, were used to summarize the students' socio-demographic characteristics, anthropometric measurements, and sleep quality. Simple linear regression was performed to examine the association between the independent and dependent variable. Multiple linear regression analysis was then used to assess the relationship

between sleep quality, BMI, and WC. Statistical significance was set at a $p<0.05$.

Results

Sociodemographic characteristics

A total of 277 students participated in the study, with 34.7% (n=96) being male and 65.3% (n=181) female (**Table 1**). 87.7% of the students were aged between 18 and 21 years, while 12.3% were between 21 and 25 years. The mean age of students was 21.53±2.22 years. In terms of ethnicity, 58.9% were Malays, 20.2% were Chinese, and 20.9% were Indian. Faculty distribution showed that 9.0% of students were from FBK, 22.4% from FKI, 24.9% from FESP, 20.6% from FUHA, and 23.1% from FSSG. The majority of students (63.5%) were enrolled in diploma programs, while 36.5% were pursuing a degree. Regarding the study period, most students were in their second year (63.9%), followed by third-year (19.1%) and first-year students (17.0%).

Table 1. General characteristics of the students

Characteristics	n (%)	Mean/SD
Gender		
Male	96 (34.7)	
Female	181 (65.3)	
Age (year)		21.53±2.22
18–21	243 (87.7)	
21–25	34 (12.3)	
Ethnicity		
Malay	163 (58.9)	
Chinese	56 (20.2)	
Indian	58 (20.9)	
Faculty		
FBK	25 (9.0)	
FKI	62 (22.4)	
FESP	69 (24.9)	
FUHA	57 (20.6)	
FSSG	64 (23.1)	
Study program		
Diploma	176 (63.5)	
Bachelor's degree	101 (36.5)	
Duration of study		
Year 1	47 (17.0)	
Year 2	177 (63.9)	
Year 3	53 (19.1)	
Weight (kg)		59.77±12.61
Height (m)		1.59±0.08
Body mass index (kg/m^2)		23.38±4.45
Underweight (<18.5)	34 (12.3)	
Normal (18.5–24.9)	157 (56.7)	
Overweight (25–29.9)	61 (22.0)	
Obese ≥30	25 (9.0)	
Waist circumference (cm)		
Male		73.78±10.29
Low risk (<94cm)	94 (97.9)	
High risk (≥94cm)	2 (2.1)	
Female		73.39±11.97
Low risk (<80cm)	141 (77.9)	
High risk (≥80cm)	40 (22.1)	

Anthropometric measurement

As shown in **Table 1**, the students' average weight was 59.77±12.61 kg and their average height was 1.59±0.08 m. The mean BMI of the students was 23.38±4.45 kg/m^2. A total of 56.7% of the students had a normal BMI (18.5–24.9 kg/m^2), while 12.3% (n=34) were classified as underweight, 22.0% (n=61) as overweight, and 9.0% (n=25) as obese. On the other hand, 2.1% (n=2) of the male students had a high central fat distribution and an elevated risk of co-morbidities, while 97.9% (n=94) had normal fat distribution and a low risk. Among female students, 22.1% (n=40) had a high central fat distribution and increased risk of co-morbidities, while 77.9% (n=141) had normal fat distribution and a low risk of co-morbidities.

Sleep quality characteristics

Results from the PSQI are presented in **Table 2.** The mean global PSQI score was 9.32±3.45 with 87.0% of the participants reporting extremely poor sleep quality (>5), and 13.0% experiencing good sleep quality (<5). However, when asked to subjectively rate their sleep quality, 22.4% described it as fairly bad, while 26.0% rated it as very bad. The key contributors to poor sleep quality included restricted sleep duration, prolonged sleep latency, low sleep efficiency, and daytime dysfunction. Overall, the majority of students reported insufficient sleep, with only 17.7% meeting the recommended seven or more hours of sleep per night. 42.6% slept for 6–7 hours per night, 21.3% for 5–6 hours, and 18.4% for less than 5 hours. Additionally, 16.2% of students took more than 60 minutes to fall asleep, and 72.2% had sleep efficiency below 85% (i.e., the percentage of time spent asleep from the moment they went to bed until they woke up). As a potential consequence of poor sleep quality, 25.6% of students reported experiencing daytime dysfunction at least once a week. Furthermore, 16.2% took sleep medication three or more times a week, while 19.1% used sleep medication at least once a week. Regarding sleep disturbances, 12.6% experienced disturbances three or more times a week, and 23.5% reported disturbances at least once a week.

Association between body mass index (BMI) and waist circumference (WC) with sleep quality among undergraduate students

Table 3 presents the results of the analysis examining the association between BMI and WC with sleep quality. Regression analysis was conducted to examine whether sleep quality predicts BMI and WC. For BMI, the regression model was not statistically significant (p>0.05), indicating that sleep quality does not have a significant influence on BMI. In contrast, the regression analysis for WC showed a significant association with sleep quality (p=0.026). However, the model explained only 1.9% of the variance in WC (R^2=0.019), suggesting that while the association is statistically significant, the effect size is small.

Table 2. Descriptive results of sleep quality

Characteristics	(n)%	Mean/SD
Sleep quality (Global score)		9.32±3.45
Good (<5)	36 (13.0)	
Poor (>5)	241 (87.0)	
Subjective sleep quality		
Very good	49 (17.7)	
Fairly good	94 (33.9)	
Fairly bad	62 (22.4)	
Very bad	72 (26.0)	

Characteristics	(n)%	Mean/SD
Sleep duration		
>7 hours	49 (17.7)	
6–7 hours	118 (42.6)	
5–6 hours	59 (21.3)	
<5 hours	51 (18.4)	
Sleep latency		
≤15 minutes / not during past month	60 (21.7)	
16–30 minutes / not during past month	75 (27.1)	
16–30 minutes / less than once a week	97 (35.0)	
>60 minutes / three or more times a week	45 (16.2)	
Sleep efficiency		
>85%	77 (27.8)	
75–84%	77 (27.8)	
65–74%	64 (23.1)	
<65 %	59 (21.3)	
Daytime dysfunction		
Not during past month	84 (30.3)	
Less than once a week	122 (44.1)	
Once or twice a week	43 (15.5)	
Three or more times a week	28 (10.1)	
Use of sleep medication		
Not during past month	70 (25.3)	
Less than once a week	109 (39.4)	
Once or twice a week	53 (19.1)	
Three or more times a week	45 (16.2)	
Sleep disturbances		
Not during the past week	82 (29.6)	
Less than once a week	95 (34.3)	
Once or twice a week	65 (23.5)	
Three or more times a week	35 (12.6)	

Table 3. Regression result of association between BMI and WC with sleep quality

	Sleep quality with BMI		Sleep quality with WC	
	Simple regression	Multiple regression	Simple regression	Multiple regression
β coefficients	0.155	0.145	0.059	0.067
p value	0.206	0.085	0.177	0.026*
R^2	-	0.019	-	0.019
F	(1,275) 2.42	(3,273) 2.54	(1,275) 0.46	(3,273) 0.92

Note: Independent variable included sleep quality; dependent variables included BMI and WC, *p<0.05 indicates statistically significant, BMI: Body Mass Index, WC: Waist Circumference. Multiple regression was adjusted for physical activity level.

Discussion

Our research identified a significant issue with the sleep quality of UniSZA undergraduate students, who experienced fragmented and poor sleep as measured by the PSQI. Referring to the hypothesis that sleep quality is associated with Body Mass Index (BMI) and Waist Circumference (WC), our findings indicated no significant association between sleep quality and BMI; however, sleep quality was significantly linked to WC.

While earlier research has demonstrated correlations between waist-to-hip ratio, BMI, and sleep duration in both children and adults,[17] our study specifically focused on the relationship between WC, BMI, and sleep quality in early adulthood. Consistent with our findings, a previous study has also reported no significant relationship between sleep quality and BMI. [18] One population-based study comparing adults with good and poor sleep quality found no differences in BMI or WC across groups.[19] Similarly, Öçal et al.[20] reported no significant variation in BMI when examining the effects of sleep quality on anthropometric measures.

In contrast, another study among students observed that those with poor sleep quality had lower mean BMI and WC,[21] suggesting that findings may differ depending on the population and study context.

In alignment with previous research, our study supports the notion that poor sleep quality is associated with increased central adiposity in early adults.[22,23] These findings underscore the importance of addressing sleep quality in young adults as part of comprehensive strategies to prevent obesity and related metabolic conditions.

Numerous studies have proposed an ideal sleep duration, noting that sleeping less than eight hours per day is associated with a higher risk of obesity and adiposity.[24] In addition, previous research has suggested that sleep disruption may contribute to the accumulation of body fat.[25] Specifically, the build-up of visceral fat in the abdominal region has been linked to the elevated release of adipokines and cytokines, which may further disrupt sleep patterns and reduce sleep quality.[26] Previous studies have also reported varying effects of sleep restriction on leptin levels. For instance, Spiegel et al.[27] reported an 18% reduction in daytime leptin following partial sleep deprivation compared to a rested state. In contrast, other studies have reported increased leptin levels following sleep restriction.[28]

A more recent study found that leptin secretion was higher in participants with poor sleep quality than in those with normal sleep quality, although further research is needed to clarify the directionality and mechanisms underlying this relationship.[29] The conflicting findings may be due to differences in study design, participant characteristics, and how sleep and leptin were measured. Factors like the duration of sleep restriction, timing of blood sampling, and individual variations in health and lifestyle can all influence leptin levels, making the relationship complex and not yet fully understood.

In addition to physiological mechanisms, psychosocial factors may also contribute to poor sleep quality and its relationship with adiposity.[30] Among university students, stress has been identified as one of the most frequent contributors to poor sleep quality. [31] Disrupted sleep alters circadian rhythms and may promote adiposity through various mechanisms, including changes in dietary habits and hormonal imbalances.[32] While some studies found no significant association between body composition parameters and subjective sleep quality as measured by the Pittsburgh Sleep Quality Index (PSQI),[33] others reported a negative association between lean BMI and sleep quality.[34] Subjective sleep quality has also been linked to psychological and cognitive functioning.[35] Additionally, a study among youth highlighted that PSQI and accelerometers may capture different dimensions of sleep, as accelerometers are limited in detecting wakefulness - leading to potential overestimation of sleep when individuals lie still but remain awake.[36] It is important to note that one limitation of the current study is the lack of control for psychosocial stress, which may have influenced both sleep quality and adiposity outcomes.

In addition to its impact on academic performance and daily activities, poor sleep quality places undergraduate students at risk for long-term health consequences, including excessive body

weight. In turn, excess body weight increases the likelihood of developing chronic conditions such as diabetes, cardiovascular diseases, and certain cancers. For instance, a recent meta-analysis identified 18 comorbidities associated with excess body weight, with type 2 diabetes posing the greatest burden, followed by cardiovascular diseases and various cancers, including oesophageal, colon, endometrial, gallbladder, and breast cancer.[37]

The interplay between poor sleep quality, adiposity, and nutritional behaviours highlights the need for a multidimensional health approach, as disrupted appetite-regulating hormones (ghrelin and leptin) may increase caloric intake and preference for unhealthy foods.[38] Irregular sleep further exacerbates central adiposity, compromises nutrient intake, and disrupts healthy eating patterns, thereby affecting overall diet quality and metabolic health.[39] The associations observed in this study highlight the importance of integrating sleep hygiene into public health strategies targeting obesity prevention, dietary behaviours, and chronic disease risk among young adults. Recognizing sleep as a modifiable lifestyle factor underscores its potential role in shaping long-term health outcomes beyond adiposity alone.

One of the strengths of our study is the use of validated and relevant questionnaires to assess sleep quality and its association with adiposity. However, this study has certain limitations, particularly the use of the Pittsburgh Sleep Quality Index (PSQI) instead of actigraphy, an objective measure of sleep quality. While the PSQI is widely validated and commonly applied in research, it remains a self-reported tool and is therefore subject to recall bias and individual perception differences, which may lead to underreporting or overreporting of sleep behaviours. To minimize these issues, validated instruments were employed and participants were assured of confidentiality to encourage accurate and honest responses.

Conclusion

This study concludes that sleep quality is not significantly associated with Body Mass Index (BMI); however, a significant association was found between sleep quality and Waist Circumference (WC) among UniSZA undergraduate students. By reviewing relevant studies, we identified both positive and negative influences on sleep quality, emphasizing the impact of lifestyle, mental health, social, and physical factors in university population. This study provides further evidence to clarify the key predisposing factors for poor sleep quality. The issue of poor sleep quality, which is a significant or first cause of disruption to normal physiological functioning, supports the conclusion that this disturbance merits serious consideration as a major public health concern.[40] Given the influence of lifestyle factors, future sleep quality intervention research should account for potential confounders. Furthermore, future studies with larger or stratified samples are recommended to explore subgroup-specific associations between sleep quality and anthropometric measures. In particular, further investigations into social jetlag that integrate the identified determinants are highly warranted among university students. Such efforts can inform targeted interventions to enhance sleep quality, which, in turn, may contribute to improved overall health and academic performance in university populations.

Conflict of interest

The authors declared no conflict of interest regarding this article.

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