ORIGINAL ARTICLE OPEN ACCESS

Body Mass Index and Its Association with Daytime Sleepiness and Risk of Sleep Apnea Among Adults in International Islamic University Malaysia (IIUM) Kuantan

Siti Zuhaidah Shahadan[1]*, Nursyafiqah Nabilah Mustapah[2] & Mohamad Firdaus Mohamad Ismail[3]
[1]Department of Medical Surgical Nursing, Kulliyyah of Nursing, International Islamic University Malaysia, Pahang, Malaysia.
[2]Gleneagles Hospital Kota Kinabalu, Kota Kinabalu, Sabah.
[3]Department of Professional Nursing Studies, Kulliyyah of Nursing, International Islamic University Malaysia, Pahang, Malaysia.

ABSTRACT

Introduction: The prevalence of obesity keeps rising by the year, and Malaysia was revealed as the top country in Southeast Asia that has a high prevalence of obesity. Due to the rising obesity globally is feared that it may be associated with the increasing chance of having sleep apnea and excessive daytime sleepiness. Consequently, it may lead to poor work performance, unfortunate accidents, and premature death if not treated earlier. This research sought to identify the BMI values and their association with the risk of sleep apnea and daytime sleepiness among adults in IIUM Kuantan.
Methods: By applying convenience sampling, 143 respondents were recruited in this cross-sectional study. The Berlin questionnaire and Epworth Sleepiness Scale were used as the research instruments to determine the risk of sleep apnea and daytime sleepiness among the respondents, respectively. Ordinal Logistic Regression and Pearson correlation were used to analyse the associations.
Result: The mean (SD) BMI was 22.3 kg/m^2 (4.33)- normal, and the mean score of daytime sleepiness was 9.92 (4.80)- higher than normal. Most respondents had a low risk of sleep apnea (87.4%), 5.6% showed a slightly increased risk, and 7.0% had a high risk of sleep apnea. There is a significant association between BMI and risk of sleep apnea ($p<0.05$), as an increase in BMI (expressed in kg/m^2) is associated with an increase in the odds of having a risk of sleep apnea. There is no significant association between BMI and daytime sleepiness ($p>0.05$), as these variables are weakly and inversely correlated.
Conclusion: This study found a significant association between BMI and risk of sleep apnea. However, we failed to confirm the association between BMI and daytime sleepiness. Due to the lack of BMI varieties, the researcher recommends focusing on overweight and obese to get a wide variation of BMI.

Keywords: Body mass index; Obesity; Overweight; Daytime sleepiness; Sleep apnea; Adult.

***Corresponding author**
Dr. Siti Zuhaidah Shahadan
Department of Medical Surgical Nursing,
Kulliyyah of Nursing,
International Islamic University Malaysia,
Jalan Sultan Ahmad Shah,
25200 Kuantan, Pahang, Malaysia.
E-mail: sitizuhaidah@iium.edu.my

Article History:
Submitted: 27 June 2023
Revised: 10 August 2023
Accepted: 27 August 2023
Published: 30 November 2023

DOI:10.31436/ijcs.v6i3.311
ISSN: 2600-898X

INTRODUCTION

Body mass index (BMI) is a universal measurement that is popularly used to assess body fat by dividing the body weight (kg) by height square (m^2). This relatively simple and low-cost measure can categorise a person into a different body weight group: underweight, normal, overweight, or obese. According to the portal of MyHEALTH, Ministry of Health Malaysia, a person can be categorised into several groups of BMI (kg/m^2), which are; underweight (<18.5), normal (18.5 - 24.9), overweight (25 - 29.9), and obesity (>30) (1). BMI measurements can be taken as early as childhood and are correlated with health outcomes and cause-specific mortality (2). Besides, BMI is also an essential tool that can measure obesity. The World Health Organization defines obesity as an abnormal or excessive fat accumulation that can bring many health risks (3).

In Malaysia, the increasing global prevalence of obesity is alarming. The National Health Morbidity Survey (NHMS) 2019 with a significant number of respondents (n=16,688) determined the prevalence of overweight and obesity were 32.3% and 33.7%, respectively (4). On top of that, Malaysia was revealed as the top country in Asia that has a high prevalence of obesity, and this fact has been the uppermost concern. According to a statistic analysed by the Economist Intelligence Unit in 2014, Malaysia has the highest obesity and overweight prevalence among all Asian countries: Singapore (6.2%), Malaysia (13.3%), Thailand (8.5%), Philippines (5.1%), Indonesia (5.7%) and Vietnam (3.6%) (5). Among the major diseases associated with obesity are diabetes, hypertension, and heart disease (6).

Sleep apnea is a breathing disorder that happens during sleep where the breathing suddenly pauses repeatedly for a minute or longer which is shown by a few symptoms such as loud and heavy snoring, sudden pause in breathing during sleep, gasping and fatigue during the day (7). Sleep apnea is becoming increasingly prevalent (8). Prior research has demonstrated that BMI is an important risk factor for sleep apnea (8–10). Due to the rising obesity globally, sleep apnea is thought to have become more common (11). However, Usmani et al. believed sleep apnea could affect anyone regardless of body type, age, and gender (12).

Sleep apnea is predicted to cause excessive daytime sleepiness (EDS), corresponding to high BMI. EDS is not a disease but a symptom of a sleep disorder. Characterised by when a person experiences sleepiness and fatigue during the day causing that person to fall asleep (13). EDS could disturb the productivity of a person in a day. It may cause many negative impacts, such as accidents due to microsleep while driving, cooking or any activity that could harm the person (14). Besides, EDS and sleep apnea could be the signs of a chronic disease such as cardiovascular disease and psychiatric disorders (15,16).

However, because of the lack of awareness by the public and healthcare professionals, the vast majority of sleep apnea remains undiagnosed and untreated (8,17). While obesity may be a component that contributes to sleep apnea, it is noteworthy that not all cases of sleep apnea are induced by obesity. For instance, Gray et al. stated that a non-obese patient with sleep apnea has a greater risk for hypertension four times higher than obese adults younger than 65 years old (18). Therefore, more studies need to be conducted to know how BMI is related to the risk of sleep apnea among people with normal and abnormal BMI values. Other than that, some studies show a significant association between BMI and EDS. A study from the Philippines identified a significant association between BMI and EDS. The researchers for this study, King-Chao and Sarte, found that the chance of having EDS is double for obese people as compared to non-obese (19). However, there is still limited literature addressing the potential correlation between BMI on EDS among the Malaysian population (20). Hence, conducting this study to provide the baseline data for the upcoming researchers is crucial. Therefore, this study will investigate the association between BMI with the risk of sleep apnea and EDS.

METHODS

This study uses a cross-sectional study design. In this design, the researcher provided an online survey to the respondents and measured the outcome and the exposures in the study at once. The study is conducted at International Islamic University Malaysia (IIUM), Kuantan Campus, Pahang. A convenience sampling technique is applied in recruiting the respondents in this study. The inclusion criteria

of the respondents are staff or students in IIUM Kuantan, male or female, aged between 20 and 60 years old and with voluntarily informed consent, whereas the exclusion criteria are known cases of sleep apnea and the presence of physical deformities that may obstruct the airway, enlarged tonsil or tumour formation in the airway.

As referred to in this study's objectives, the variables included are BMI, daytime sleepiness score, and risk of sleep apnea. The independent variable is the BMI value which has been presented in numerical. At the same time, the dependent variables are daytime sleepiness score and risk of sleep apnea. A set of questionnaires consisted of three parts: Part I is to obtain the respondent's sociodemographic information, which includes gender, age, marital status, presence of physical deformities that may obstruct the airway, weight, height, and BMI. Part II is the Berlin Questionnaire, used to determine the risk of sleep apnea. It consists of 10 multiple-choice questions divided into three categories. Part III is the Epworth Sleepiness scale questionnaire consists of 8 Likert scale questions, and it is used to assess daytime sleepiness. The questionnaires were spread to respondents in English languages.

The Berlin questionnaire is widely used to check the risk for obstructive sleep apnea (OSA) (21). This questionnaire consists of 10 simple questions divided into three categories. The first category asks about the presence and frequency of snoring behaviour; the second assesses the prevalence of daytime sleepiness and fatigue; and the last is the history of hypertension and BMI value (21). This questionnaire is used to identify the risk of sleep apnea, either low risk, slightly high risk or high risk, based on the responses to each question and overall scores of the questionnaire. Referring to the Berlin questionnaire, the risk of sleep apnea is considered low risk when there is only one or no category with a positive score. Whereas slightly high risk is when one of the categories is positive and the BMI is overweight. On the other hand, high risk if there are two or three categories where the score is positive. Since the questionnaire has three types, Category 1 is positive if the total score is two or more points. Points are given if the respondent answered "Yes" for question 1, "louder than talking" for question 2, "almost every day" or "3-4 times per week" for question 3, "Yes" for question 4 and "almost every day" or "3-4 times per week" for question 5. Category 2 is positive if the total score is two or more points. Points are given if the respondent answered "almost every day" or "3-4 times per week" for questions 6 and 7 and "yes" for question 8. Category 3 is positive if the answer to question 10 is 'Yes' or the patient's BMI exceeds 30 kg/m^2. The higher the score, the higher the risk of sleep apnea. Specifically, total scores between 0 and 5 indicate lower normal daytime sleepiness, while those in the range of 6 to 10 represent higher normal daytime sleepiness. A score of 11 to 12 suggests mild excessive daytime sleepiness, 13 to 15 corresponds to moderate excessive daytime sleepiness, and a score of 16 to 24 indicates severe excessive daytime sleepiness.

In addition, the Epworth Sleepiness Scale (ESS) is reliable and valid for measuring a person's daytime sleepiness (22). The questionnaire consists of eight questions about the usual chances of falling asleep while doing eight different activities (22). The dozing case is on a scale of 0 to 3 points: 0= never, 1= slight chance, 2 = moderate chance, and 3 = high chance. The higher the score, the higher the daytime sleepiness occurrence.

Approval of this study has been attained from Kulliyyah of the Nursing Post Graduate Research Committee (KNPGRC) and the International Islamic University Malaysia Research Ethics Committee (IREC). The permission to utilise the Berlin and Epworth Sleepiness Scale questionnaires has been obtained from the authors. The objectives of this research study were explained to the respondents, and the data obtained is kept confidential and strictly used for academic purposes only.

This study collected data from November 2020 to January 2021. The researcher spread an online survey through emails and other social media platforms to all staff and students of IIUM Kuantan. The respondent had been screened for inclusion and exclusion criteria. Those who fulfilled the inclusion-exclusion criteria were invited to respond to the questionnaire voluntarily. Consent had been obtained from these respondents before they completed the survey. The consent form attached to the questionnaire explains the study's purpose, procedure, confidentiality, right to withdraw, and the researcher's contact

information. The researcher welcomed any questions from the respondents to clear up their misunderstanding.

Data analysis began after receiving all the data. All the respondents' information is kept confidential throughout the research and only aimed for study purposes. The data of this research study were coded and entered in Statistical Package Social Science (SPSS) version 25 for data analysis. Descriptive statistics were computed to describe the respondents' sociodemographic data, BMI, daytime sleepiness score and the risk of sleep apnea. The categorical data from the sociodemographic part, such as gender and marital status, were presented descriptively in percentages and frequencies. At the same time, the numerical data from daytime sleepiness score, age, and BMI (numerical) were shown in the form of mean and standard deviation (SD). Additionally, the association between BMI (numerical) and risk of sleep apnea (low risk, slightly high risk and high risk) will be analysed using ordinal logistic regression. In contrast, the Pearson correlation is used to statistically analyze the association between BMI (numerical) and daytime sleepiness (numerical).

RESULTS

A total of 143 respondents have participated in this study. Most of the respondents are students (90.9%), female (88.8%) and single (90.9%). The respondents' average (standard deviation, SD) age is 23.7 (5.02), ranging from 20 to 51 years old. The average (SD) weight and height of the respondents are 55.4 kg (12.85) and 1.57 m (0.07), respectively. Regarding BMI, the mean (SD) was 22.3 kg/m^2 (4.33), and the finding showed that 20.3% of the respondents are underweight, 55.9% have normal BMI, 16.8% are overweight, and 7.0% are obese (See **Table 1**).

Table 1: Sociodemographic background and BMI status of adults in IIUM Kuantan (N=143)

Variables		Mean (SD)	Frequency (%)
Position	Student		130 (90.9)
	Staff		13 (9.1)
Gender	Female		127 (88.8)
	Male		16 (11.2)
Age (years)		23.73 (5.02)	
Marital Status	Single		130 (90.9)
	Married		13 (9.1)
Weight (kg)		55.38 (12.85)	
Height (m)		1.57 (0.07)	
BMI		22.31 (4.33)	
BMI	Underweight (≤18.4)		29 (20.3)
	Normal (18.5-24.9)		80 (55.9)
	Overweight (25.0-29.9)		24 (16.8)
	Obesity (≥30.0)		10 (7.0)

Risk of Sleep Apnea

Table 2 describes the risk of sleep apnea among the respondents. Based on the Berlin questionnaire, three categories will be measured to determine an individual's sleep apnea risk. The three categories are snoring behaviour, the prevalence of daytime sleepiness and fatigue and a history of hypertension or BMI category. Regarding snoring behaviour, 16.8% of the respondents are snoring, 59.4% are not, and the rest do not know if they are snoring. 0.7% of those who snore are experiencing snoring louder than talking, 2.1% snore as loud as talking and 14% of them are just snoring slightly louder than breathing. Additionally, the findings indicate that 6.3% of the respondents snore almost daily and 3.5% snore 3 to 4 times weekly. 4.2% of the snorer claimed that their snore had bothered another person. Of all respondents who snored, 1.4% experienced stop of breathing during sleep with a frequency of 3 to 4 times per week. For the prevalence of daytime sleepiness and fatigue, the findings showed that 8.4% of the respondents felt tired after sleep almost daily, and 13.3% responded 3 to 4 times per week. 11.2% of the respondents have experienced

fatigue during their waking in the daytime almost daily, and 16.1% experienced the same fatigue 3 to 4 times per week. There are 13.3% of the respondents have nodded off or fallen asleep while driving a vehicle, and 2.8% of them experience that event about 1 to 2 times per week, 3.5% experience 1-2 times per month and the rest rarely experience it. For the history of hypertension and BMI status, 1.4% of the respondents have been diagnosed with hypertension, 7% are obese, and 16.8% are overweight.

Table 2: The frequency table of risk of sleep apnea among adults in IIUM Kuantan (N=134)

Items			Frequency (%)
Category 1: Snoring Behaviour	Do you snore?	Yes	24 (16.8)
		No	85 (59.4)
		Do not know	34(23.8)
	If yes, your snoring is	Slightly louder than breathing	20 (14.0)
		As loud as talking	3 (2.1)
		Louder than talking	1 (0.7)
	How often do you snore?	Almost every day	9 (6.3)
		3-4 times per week	5 (3.5)
		1-2 times per week	6 (4.5)
		Rarely	4 (2.8)
	Has your snoring ever bothered other people?	Yes	6 (4.2)
		No	7 (4.9)
		Do not know	11 (7.7)
	Has anyone noticed you stop breathing during sleep?	3-4 times per week	2 (1.4)
		1-2 times per week	1 (0.7)
		Rarely or never	21 (14.7)
Category 2: Prevalence of daytime sleepiness and fatigue	How often do you feel tired or fatigued after your sleep?	Almost every day	12(8.4)
		3-4 times/week	19 (13.3)
		1-2 times/ week	7 (54.5)
		1-2 times/ month	6 (4.2)
		Rarely or never	28 (19.6)
	During your waking time, do you feel tired, fatigued or not up to par?	Almost every day	16 (11.2)
		3-4 times/week	23 (16.1)
		1-2 times/ week	65 (45.5)
		1-2 times/ month	10 (7.0)
		Rarely or never	29 (20.3)
	Have you ever nodded off or fallen asleep while driving a vehicle?	Yes	19 (13.3)
		No	124 (86.7)
	If yes, how often does this occur?	1-2 times/week	4 (2.8)
		1-2 times/month	5 (3.5)
		Rarely	10 (7.0)
Category 3: History of hypertension and BMI category	Have you been diagnosed with hypertension?	Yes	2 (1.4)
		No	141 (98.6)
	BMI category	Underweight	29 (20.3)
		Normal Weight	80 (55.9)
		Overweight	24 (16.8)
		Obese	10 (7.0)

Based on the Berlin questionnaire response presented in **Table 3**, the result indicates that most respondents have a low risk of sleep apnea (87.4%). Additionally, 5.6% showed a slightly high risk, and 7.0% had a high risk of sleep apnea.

Table 3: Risk of sleep apnea category among adults in IIUM Kuantan (N= 143)

Variable	Frequency (n)	Percentage (%)
Low Risk	125	87.4
Slightly high risk	8	5.6
High Risk	10	7.0

Table 4 shows that staff has a higher risk of getting sleep apnea (46.2%) than students (3.1%). Regarding gender, females stated a higher percentage of increased risk of sleep apnea (7.1%) than males (6.3%). Additionally, older age is having higher risk (50%) of developing sleep apnea than younger age (5.8%). The same goes for married respondents, who have higher risk (46.2%) of developing sleep apnea than unmarried respondents (3.1%).

Table 4: Sociodemographic background and risk of sleep apnea among adults in IIUM Kuantan (N= 143)

Variables		Risk of Sleep Apnea		
		Low risk n (%)	Slightly high-risk n (%)	High risk n (%)
Position	Student	120 (92.3%)	6 (4.6%)	4 (3.1%)
	Staff	5 (38.5%)	2 (15.4%)	6 (46.2%)
Gender	Female	113 (89.0%)	5 (3.9%)	9 (7.1%)
	Male	12 (75.0%)	3 (18.8%)	1 (6.3%)
Age (years old)	<40	125 (89.9%)	6 (4.3%)	8 (5.8%)
	≥40	0 (0.0%)	2 (50.0%)	2 (50.0%)
Marital status	Single	120 (92.3%)	6 (4.6%)	4 (3.1%)
	Married	5 (38.5%)	2 (15.4%)	6 (46.2%)

Table 5 describes the daytime sleepiness score of the respondents. Based on the Epworth Sleepiness scale, most respondents have a high chance of sleeping while resting in the afternoon (44.8%) and being a passenger in a car for an hour without a break (37.8%).

Table 5: The frequency table of daytime sleepiness score among adults in IIUM Kuantan (N=143)

Situation	Chance of Dozing n (%)			
	0	1	2	3
Sitting and reading	24 (16.8)	46 (34.3)	41 (28.7)	29 (20.3)
Watching television	27 (18.9)	65 (45.5)	37 (25.9)	14 (9.8)
Sitting, inactive in a public place (e.g., in a theatre or a meeting)	61 (42.7)	47 (32.9)	23 (16.1)	12 (8.4)
As a passenger in a car for an hour without a break	18 (12.6)	32 (22.4)	39 (27.3)	54 (37.8)
Lying down to rest in the afternoon	10 (7.0)	21 (15.7)	48 (33.8)	64 (44.8)
Sitting and talking to someone	114 (79.7)	22 (15.4)	7 (4.9)	0 (0)
Sitting quietly after lunch	30 (21.9)	51 (35.7)	36 (25.2)	26 (18.2)
In a car, while stopped in traffic	94 (65.7)	30 (21.0)	14 (9.8)	5 (3.5)

**Notes*: 0 = would never fall asleep, 1 = slight chance of falling asleep, 2 = moderate chance of falling asleep, 3 = high chance of falling asleep

Table 6 presents the total daytime sleepiness score, which is interpreted into several categories, which are lower normal (0-5 score), higher normal (6-10 score), mild excessive (11-12 score), moderate excessive (13-15 score) and severe excessive (16-24 score). The findings revealed that 35.7% of the respondents have higher normal daytime sleepiness, followed by lower normal and moderate excessive daytime sleepiness, which shares the same percentage, 21.7%. 11.9% of the respondents have severe daytime sleepiness, and the rest (9.0%) have mild excessive daytime sleepiness. The mean (SD) score of daytime sleepiness adults in IIUM Kuantan is 9.92 (4.80), considered higher than normal.

Table 7 describes the association between sociodemographic background and daytime sleepiness. Based on the table, students experience more mild, moderate, and severe EDS than staff. Also, females experience more excessive daytime sleepiness compared to males. All respondents with age ≥40 have

normal daytime sleepiness (100%), while 56.2% of respondents with age <40 have normal daytime sleepiness. Unmarried respondents stated a higher percentage of excessive daytime sleepiness than married respondents, with 44.6% compared to 23.1%.

Table 6: Daytime sleepiness category among adults in IIUM Kuantan (N=143)

Category	Frequency (%)	Mean (SD)
Lower normal: 0-5	31 (21.7)	9.92 (4.796)
Higher normal: 6-10	51 (35.7)	
Mild excessive: 11-12	13 (9.1)	
Moderate excessive: 13-15	31 (21.7)	
Severe excessive: 16-24	17 (11.9)	

Table 7: Sociodemographic Background and Daytime Sleepiness Category (N=143)

Variables		Daytime Sleepiness Category N (%)				
		Lower normal	Higher normal	Mild excessive	Moderate excessive	Severe excessive
Position	Student	23 (17.7)	48 (36.9)	13 (10)	30 (23.1)	16 (12.3)
	Staff	8 (61.5)	3 (23.1)	0 (0)	1 (7.7)	1 (7.7)
Gender	Female	24 (18.9)	47 (37.0)	11 (8.7)	29 (22.8)	16 (12.6)
	Male	7 (43.8)	4 (25.0)	2 (12.5)	2 (12.5)	1 (6.3)
Age	<40	29 (20.9)	49 (35.3)	13 (9.4)	31 (22.3)	17 (12.2)
	≥40	2 (50.0)	2 (50.0)	0 (0)	0 (0)	0 (0)
Marital status	Single	25 (19.2)	47 (36.2)	13 (10)	31 (23.8)	14 (10.8)
	Married	6 (46.2)	4 (30.8)	0 (0)	0 (0)	3 (23.1)

Association between BMI and the Risk of Sleep Apnea

Table 8 describes the risk of sleep apnea among the respondents according to their BMI. From the data, all respondents who are underweight have a low risk of developing sleep apnea (n = 29). The same goes for the normal-weight respondents, who all have a low risk of sleep apnea (n = 80). However, for overweight respondents, 13 have a low risk, 8 are slightly high risk, and 3 are at high risk of getting sleep apnea. Lastly, the obese group has three low-risk respondents and seven respondents at increased risk of developing sleep apnea.

Table 8: Risk of sleep apnea according to BMI category among adults in IIUM Kuantan (N=143)

Variable	Risk of sleep apnea n (%)		
BMI	Low risk	Slightly high	High risk
Underweight	29 (100)	0 (0)	0 (0)
Normal weight	80 (100)	0 (0)	0 (0)
Overweight	13 (54.2)	8 (33.3)	3 (12.5)
Obese	3 (30)	0 (0)	7 (70)

Table 9 depicts the association between BMI and risk of sleep apnea. From the data, the result shows that BMI is a significant positive predictor of sleep apnea risk. This study suggests that an increase in BMI (expressed in kg/m^2) was associated with an increase in the odds of having a chance of sleep apnea with an odds ratio of 0.6 (95% CI, 0.375-0.825), Wald $\chi^2(1) = 27.317$, $p < 0.001$.

Table 9: Association between BMI and risk of sleep apnea (N=143)

Variables		Odds Ratio	Wald	*P*-value	95% CI
Threshold	Risk Sleep Apnea=1	16.946	30.271	0.001	10.910- 22.983
	Risk Sleep Apnea=2	18.191	31.910	0.001	11.879- 24.502
Location	BMI	0.600	27.317	0.001	0.375- 0.825

*Statistical test: Ordinal Logistic Regression

Association between BMI Status and the Presence of Daytime Sleepiness

Table 10 shows the classes of daytime sleepiness according to BMI. For the underweight group, most of them have higher normal daytime sleepiness (37.9%), followed by moderate excessive daytime sleepiness (24.1%) and lower normal daytime sleepiness (20.7%). The same goes for the normal weight group, which shows the highest percentage of higher normal daytime sleepiness (36.3%), followed by moderate excessive (26.3%) and lower normal (15.0%). As compared to the overweight group, most of them stated lower normal daytime sleepiness (37.5%) followed by higher normal (33.3%) and severe excessive (12.5%). The obesity group also has the same pattern where they recorded the highest percentage in lower normal daytime sleepiness (40.0%), followed by higher normal (30.0%) and severe excessive (20.0%). Importantly, the findings indicated that obesity has the highest percentage (20%) compared to other BMI categories for having a severe EDS.

Table 10: Daytime sleepiness category according to BMI category among adults in IIUM Kuantan (N= 143)

Variables		Daytime sleepiness category n (%)				
		Lower normal	Higher normal	Mild excessive	Moderate excessive	Severe excessive
BMI	Underweight	6 (20.7)	11 (37.9)	2 (6.9)	7 (24.1)	3 (10.3)
	Normal	12 (15.0)	29 (36.3)	9 (11.3)	21 (26.3)	9 (11.3)
	Overweight	9 (37.5)	8 (33.3)	2 (8.3)	2 (8.3)	3 (12.5)
	Obesity	4 (40.0)	3 (30.0)	0 (0.0)	1 (10.0)	2 (20.0)

Table 11 describes the correlation between BMI values and Daytime Sleepiness Score. Based on the data, the correlation coefficient is r = -0.066, meaning there is a weak and inverse linear correlation between these variables. The *p*-value is insignificant as it is more than 0.05 (p=0.434). Therefore, the findings could not confirm the association between BMI and daytime sleepiness among adults in IIUM Kuantan.

Table 11: Association between BMI values and Daytime Sleepiness Score (N=143)

Variables		Daytime Sleepiness Score
BMI	r	-0.066
	Sig (2-tailed)	0.434

*Pearson Correlation, Significant value < 0.05

DISCUSSION

Sleep apnea and excessive daytime sleepiness (EDS) are prevalent sleep disorders that significantly impact individuals' quality of life and overall well-being. Obesity has emerged as a significant factor that may contribute to the development of these sleep disorders. This study implies that within the same environment, sleep apnea was shown to be more prevalent among staff compared to students, female gender, aged forty years and above and married. Traditionally, sleep apnea has been considered more prevalent among men (23,24). However, this study suggests that female is more prevalent to be at high risk of sleep apnea. Several factors might be considered in the effect of hormonal changes in females. According to Ayub and Won, hormonal imbalances may be associated with breathing instability and airway patency (25). Other than that, the fact that women are more likely to be obese than male may also contribute to the increased muscle mass in the tongue and increase the risk of sleep apnea (24).

This study also aims to determine the association between BMI and EDS. Nonetheless, the findings could not confirm the association between these two variables. Worth to mention that the findings inclined to suggest that the adults in IIUM Kuantan have higher-than-normal daytime sleepiness. According to Perez-Carbonell et al., EDS results from sleep deprivation, poor night-time sleep, and other sleep disorders, including sleep apnea (13). The data collection of this study was carried out during the Covid-19 pandemic, which might affect the sleep quality of the respondent. In accordance with Marelli et al., the lockdown period during Covid 19 pandemic has cause an effect on the sleep quality of the university community, including the workers and the student, due to the changes in the working and daily activities (26).

Besides that, this study shows a significant association between BMI and the risk of sleep apnea with a p-value of 0.001. All respondents (100%) with underweight and normal BMI have a low risk of developing sleep apnea. On the other hand, half of the overweight group generate a slightly high risk (33.3%) and high risk (12.5%) of developing sleep apnea. In comparison, most obese respondents have an increased risk of developing sleep apnea (70%). This finding clearly shows how the level of BMI may influence the risk of developing sleep apnea towards an individual. This study's findings align with those of another study by Ibrahim et al. in which their research suggests that increased fat in the neck circumference of adults with high BMI can narrow the airway's patency and increase the likelihood of airway collapse during sleep, leading to the development of sleep apnea (27). Hence, addressing BMI as a modifiable risk factor is crucial in managing and preventing sleep apnea.

Furthermore, some studies found that EDS is related to high BMI. For instance, a study by King-Chao and Sarte, claimed that the chance of having EDS is double for obese people compared to non-obese (19). Another study in India by Krupp et al. showed that abnormal daytime sleepiness among obese women was quadruple times that of non-obese women (28). However, we failed to confirm the association between EDS and BMI in this study. Maugeri et al., in their research, also could not establish the relationship between EDS and obesity (20). EDS can generally be associated with obesity due to obstructive sleep apnea, which leads to sleepless nights or frequent awakenings throughout the night (29,30). Nonetheless, there are other factors that may lead to EDS, such as stress, anxiety, excessive workload, and much else requiring comprehensive study.

CONCLUSION

In summary, this study of adults at IIUM Kuantan discovered that, while the respondents' mean BMI was within the normal range, the frequency of daytime sleepiness was higher than expected. Most participants had a low risk of sleep apnea, although a small number had a slightly higher risk, and a significant proportion had a high risk. The study found a link between BMI and the risk of sleep apnea, with higher BMI values indicating a higher risk of developing sleep apnea. However, no statistically significant relationship between BMI and daytime sleepiness was found, implying a weak and inverse relationship between these factors. To conclude, the findings emphasize the importance of addressing obesity and its possible implications for sleep-related disorders, notably sleep apnea, which, if left untreated, can have serious ramifications for work performance, safety, and general health. For future studies, it is recommended to focus on overweight and obese groups to get a variety of BMI and a larger scale similar study

is required to generalize the findings. Additionally, the risk of sleep apnea is associated with high BMI among adults in IIUM Kuantan; therefore, interventions can be planned to lower the prevalence of obesity, which may reduce the incidence of sleep apnea.

LIMITATION

There are a few limitations of this study which. Firstly, the sample size is relatively small due to the extent of the Movement Control Order (MCO) related to the Covid-19 pandemic. Secondly, the researcher was unable to obtain the objective measure, including the weight and height of the respondents, due to the same reason; thus, all data is self-reported, which might be subjected to bias.

CONFLICT OF INTEREST

The authors declare no conflict of interest regarding this study.

FUNDINGS

The study receives no funding.

ACKNOWLEDGEMENT

We would like to thank our respondent who has voluntarily been part of this study.

AUTHOR CONTRIBUTION

SZS: involved in drafting the manuscript, data collection, analysed the data, support with literature content and finalizing and editing the manuscript.
NNM: involved in drafting the manuscript, data collection and analysed the data.
MFMI: support with literature content and finalizing and editing the manuscript.

REFERENCES

1. MyHEALTH. Body Mass Index (BMI) - PORTAL MyHEALTH. 2012.
2. Khanna D, Peltzer C, Kahar P, Parmar MS. Body Mass Index (BMI): A Screening Tool Analysis. Cureus. 2022 Feb 11;
3. WHO | Obesity. Who. 2015.
4. Ministry of Health Malaysia. Clinical Practice Guidelines: Management of Obesity 2nd Edition [Internet]. Malaysia; 2023. Available from: http://www.fms-malaysia.org
5. An Economist Intelligence Unit report commissioned by the Asia Roundtable on Food Innovation for Improved Nutrition Tackling obesity in ASEAN Prevalence, impact, and guidance on interventions Commissioned by. 2017.
6. National Health and Morbidity Survey 2019. Institute for Public Health, National Institutes of Health, Ministry of Health Malaysia. 2019.
7. Hwang D. Is it Snoring or Sleep Apnea? American Sleep Apnea Association.
8. Matthew LH, Steven DB. Obstructive sleep apnea. Neurol Int. 2011;3(3).
9. Dong Z, Xu X, Wang C, Cartledge S, Maddison R, Shariful Islam SM. Association of overweight and obesity with obstructive sleep apnoea: A systematic review and meta-analysis. Obes Med. 2020 Mar 1;17.
10. Mitra AK, Bhuiyan AR, Jones EA. Association and Risk Factors for Obstructive Sleep Apnea and Cardiovascular Diseases: A Systematic Review. Diseases. 2021 Dec 2;9(4):88.
11. Mohamad WHW, Ismail T. Obstructive sleep apnoea hypopnea syndrome - An overview. Malaysian Family Physician. 2011;6(1):2.
12. Usmani ZA, Chai-Coetzer CL, Antic NA, Mcevoy RD. Obstructive sleep apnoea in adults. Postgrad Med J. 2013;89(1049):148–56.
13. Pérez-Carbonell L, Mignot E, Leschziner G, Dauvilliers Y. Understanding and approaching excessive daytime sleepiness. Vol. 400, The Lancet. Elsevier B.V.; 2022. p. 1033–46.
14. Li J, Covassin N, Bock JM, Mohamed EA, Pappoppula LP, Shafi C, et al. Excessive daytime sleepiness and cardiovascular mortality in US adults: A NHANES 2005–2008 follow-up study. Nat Sci Sleep. 2021;13:1049–59.
15. Wang L, Liu Q, Heizhati M, Yao X, Luo Q, Li N. Association between Excessive Daytime Sleepiness and Risk of Cardiovascular Disease and All-Cause Mortality: A Systematic Review and Meta-Analysis of Longitudinal Cohort Studies. J Am Med Dir Assoc. 2020 Dec 1;21(12):1979–85.
16. Gandhi KD, Mansukhani MP, Silber MH, Kolla BP. Excessive Daytime Sleepiness: A Clinical Review. Vol. 96,

Mayo Clinic Proceedings. Elsevier Ltd; 2021. p. 1288–301.
17. Ribeiro JP, Araújo A, Vieira C, Vasconcelos F, Pinto PM, Seixas B, et al. Undiagnosed risk of obstructive sleep apnea in obese individuals in a primary health care context. Acta Med Port. 2020;33(3):161–5.
18. Gray EL, McKenzie DK, Eckert DJ. Obstructive sleep apnea without obesity is common and difficult to treat: Evidence for a distinct pathophysiological phenotype. Journal of Clinical Sleep Medicine. 2017;13(1):81–8.
19. King-Chao NLY, Sarte MA. Association of Excessive Daytime Sleepiness and Obesity with Apnea-Hypopnea Index in Adult Patients Suspected of Obstructive Sleep Apnea Syndrome. Philippine Journal of Otolaryngology-Head and Neck Surgery. 2015;30(1):17–23.
20. Maugeri A, Medina-Inojosa JR, Kunzova S, Agodi A, Barchitta M, Sochor O, et al. Sleep duration and excessive daytime sleepiness are associated with obesity independent of diet and physical activity. Nutrients. 2018;10(9):1–14.
21. Khaledi-Paveh B, Khazaie H, Nasouri M, Ghadami MR, Tahmasian M. Evaluation of Berlin questionnaire validity for sleep apnea risk in sleep clinic populations. Basic Clin Neurosci. 2016;7(1):43–8.
22. Johns M. About the ESS – Epworth Sleepiness Scale. The Epworth Sleepiness Scale.
23. Yassin A, Al-Mistarehi AH, Beni Yonis O, Aleshawi AJ, Momany SM, Khassawneh BY. Prevalence of sleep disorders among medical students and their association with poor academic performance: A cross-sectional study. Annals of Medicine and Surgery. 2020 Oct 1;58:124–9.
24. Veasey SC, Rosen IM. Obstructive Sleep Apnea in Adults. New England Journal of Medicine. 2019 Apr 11;380(15):1442–9.
25. Ayub S, Won CH. Obstructive Sleep Apnea in Women. Journal of Sleep Medicine. 2019 Dec 31;16(2):75–80.
26. Marelli S, Castelnuovo A, Somma A, Castronovo V, Mombelli S, Bottoni D, et al. Impact of COVID-19 lockdown on sleep quality in university students and administration staff. J Neurol. 2021 Jan 1;268(1):8–15.
27. Ibrahim MIS, Mohamad H, Mohamad A, Mohamad I. Polish Annals of Medicine. Pol Ann Med. 2020;27(1):1–6.
28. Krupp K, Wilcox M, Srinivas A, Srinivas V, Madhivanan P, Bastida E. Snoring is associated with obesity among middle aged Slum–dwelling women in Mysore, India. Lung India. 2020;37(9):210.
29. Lal C, Weaver TE, Bae CJ, Strohl KP. Excessive daytime sleepiness in obstructive sleep apnea mechanisms and clinical management. Vol. 18, Annals of the American Thoracic Society. American Thoracic Society; 2021. p. 757–68.
30. Ulander M, Hedner J, Stillberg G, Sunnergren O, Grote L. Correlates of excessive daytime sleepiness in obstructive sleep apnea: Results from the nationwide SESAR cohort including 34,684 patients. J Sleep Res. 2022 Dec 1;31(6).