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Influences of Night Eating Syndrome and Physical Activity Level towards Students' Body Mass Index

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Abstract

It is critical to identify the factors that influence body mass index (BMI) to properly design targeted health interventions. This study aims to investigate the relationship between physical activity level (PAL) and night eating syndrome (NES) with BMI among university students. This cross-sectional study focused on 141 students at UiTM in Selangor and used a self-administered questionnaire consisting of socio-demographic data, the IPAQ-SF, and the NEQ. A negative, weak correlation was reported between PAL and BMI, while a positive correlation was found between NES and BMI. This study concluded that improving NES and PAL are crucial to enhance BMI status.

Keywords: Body mass index; Night eating syndrome; Physical activity level, University students

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1.0 Introduction

The prevalence of overweight and obese among university students in Malaysia increased exponentially, however, factors associated with increased body mass index (BMI) are still limited (Pitil & Ghazali, 2021). A study among Malaysian university students found that a higher rate of obesity and overweight was associated with unhealthy dietary patterns (Wan Mohamed Radzi et al., 2019). Recently, night eating syndrome (NES) among university students has gained attention as a previous study reported that there was a significant association between BMI and NES among students (Kwan et al., 2021). Another study also noted that almost 15% of students in colleges located in Malaysia were presented with indications of NES (Gan et al., 2019). NES is characterized by consuming at least 25% of food after dinner or at least two episodes of eating late at night in a week, being aware of late eating, tending to avoid breakfast, feeling hungry before bed, and needing to take food to sleep, experience insomnia, practicing late eating for at least three months and not taking medication, having a psychiatric disorder or drug abuse (Allison et al., 2010).

Apart from dietary patterns, physical activity level (PAL) can also influence BMI as a study revealed that there was an inverse correlation between BMI and time spent on physical activity among university students in Malaysia (Tan et al., 2021). Additionally, a previous study also found that almost half of the university students presented with moderate and low PAL, and this trend increased

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exponentially due to increased screen time and academic-related activities (Ferreira Silva et al., 2022; You et al., 2020). As the prevalence of high BMI among university students in Malaysia is alarming and it has been associated with NES and PAL, therefore a study focused on BMI and the influence of NES and PAL is warranted. However, most of the studies in Malaysia focused on the general adult population, while most of the studies focusing on university students were mostly conducted overseas, limited study was found to highlight the relationship between BMI, NES, and PAL among university students in Malaysia. Hence, this study aims to investigate the prevalence of students with different BMI, an indication of NES and PAL among university students. Specifically, the objective of this study was to investigate the relationship between NES and PAL with BMI status among university students.

2.0 Literature Review

BMI is a useful tool to estimate the risk of non-communicable diseases (NCDs) in which a higher BMI was associated with a higher risk for diabetes, hypertension, and hypercholesterolemia. Recently, a study conducted among Malaysians revealed that more than 50% of Malaysians were overweight and increased risks for diabetes by 1.47 fold and 2.6 fold higher risks for hypertension (Chong et al., 2023). Therefore, the Malaysia Ministry of Health (MOH) introduced a new BMI cutoff for Malaysians in which normal BMI had been re-adjusted from 18.5 to 24.9 kg/m² in the World Health Organization (WHO) guideline to 18.5 to 22.9 kg/m² as reported in the Clinical Practice Guideline (Management of Obesity 2nd Edition (2023)) considering different body proportion and risk for NCDs among Asians compared to other countries. Even though numerous studies have been done on the general adult population in Malaysia, the BMI status among university students also should be highlighted as the university study stage is a crucial period to preserve health to reduce the risk of diseases later in life. A systematic study reported that obesity during a young age is significantly associated with high blood pressure (BP), total cholesterol, low-density lipoprotein (LDL) cholesterol, and triglyceride during adulthood (Umer et al., 2017). A study among university students in ASEAN countries also reported that more than 50% of them were overweight and obese (Peltzer & Pengpid, 2018). In Malaysia, a few studies among university students in Malaysia have been conducted and found that almost half of the students were reported as overweight and obese (Pitil & Ghazali, 2021; Shahadan et al., 2022).

There are several factors associated with BMI status among university students. A study reported a high prevalence of NES among university students in Malaysia especially among students with high stress levels and non-science backgrounds (Gan et al., 2019). Additionally, it was also demonstrated in a study that there was a significant correlation between NES and BMI status among private university students, however, this correlation is weak as students with NES usually consumed excessive calories from nocturnal eating leading to weight gain (Kwan et al., 2021). The findings of this study were in line with a recent study among students in Malaysia that highlighted energy balance as individuals with nocturnal eating have lower energy expenditure, hence excess calories from food will be developed into higher adiposity (Rosli et al., 2022).

Additionally, physical activity can also influence BMI status. A study among students in a public university in Malaysia revealed that the prevalence of students minimally active achieved half of them and only 30% of them were physically active while there was a negative correlation between BMI status and PAL among students (You et al., 2020). Additionally, it was reported from another study among university students that there was a significant association between PAL and BMI status in which active students have a 0.4 times lower risk for overweight or obesity (Tapera et al., 2017). Physical activity is usually associated with energy expenditure, in which lower PAL induces low energy expenditure compared to energy intake, therefore promoting positive energy balance and weight gain.

3.0 Methodology

This study was conducted as a cross-sectional study and the participants were recruited among students who studied at the Universiti Teknologi MARA, Puncak Alam campus, Selangor, Malaysia using convenience sampling. Based on previous studies, 334 students were targeted throughout the study (Dzulkafli et al., 2020; Pitil & Ghazali, 2021; Shahadan et al., 2022). This study focused on students aged 21 years old and above and able to communicate in English or Malay. However, students who were pregnant or breastfeeding during the research period were excluded from the study. During the data collection process, the students were instructed to complete two different assessments to achieve the study's objectives which consisted of anthropometric measurements and self-administered questionnaires.

3.1 Anthropometric measurements

Weight and height were measured to obtain BMI status among the students. Weight was measured in kilograms (kg) using a digital weighing scale (Seca Electronic Mobile Flat Scale, Model 813) while a stadiometer (Seca Stable Stadiometer, Model 217) was used to measure height in centimeters (cm). During height measurement, the participants were asked to remove the shoe and stand straight, the head was positioned in the Frankfort horizontal plane with feet together and heels, buttocks, and shoulder must be in contact with the backboard. For weight measurement, the participants were asked to remove all the items attached to the clothes and remove the shoes to ensure precise readings. All the measurements were done to the nearest 0.1 cm and the readings were recorded in duplicate to minimize random error. Measured height and weight were used to obtain body mass index (BMI) using the formula: weight (kg)/height (m²). The BMI status for Malaysians was categorized based on Clinical Practice Guidelines (Management of Obesity 2nd Edition, 2023).

Table 3.1. The BMI classification for Malaysian

Classification	BMI (kg/m ²)
Underweight	Less than 18.5
Normal	18.5 – 22.9
Overweight	23.0 – 27.4
Obese class I	27.5 – 32.4
Obese class II	32.5 – 37.4
Obese class III	More than 37.5

3.2 Self-administered questionnaires

A set of questionnaires was distributed to each participant. The printed questionnaire which consists of three sections including demographic data, PAL, and NES was distributed to the recruited participants. For demographic data, the questionnaire consists of participants' personal information such as age, gender, ethnicity, household income, medication and supplement intake, health history, and family health history as well as smoking status. Furthermore, the International Physical Activity (IPAQ)-short form was used to assess the PAL among the participants. The PAL was scored using the formula: MET-min/week = minutes of activity/day x event per week x MET level. IPAQ scoring suggested there are three categories to categorize PA level as below:

Table 3.2. The category of PAL

Scoring (MET-minutes/ week)	PA level
Below 600	Low
600 to 3000	Moderate
More than 3000	Vigorous

Additionally, this study also used the Night Eating Questionnaire (NEQ) to determine NES among the participants (Allison et al., 2008). All the items within this questionnaire were summed up and a score of more than 25 indicates NES while the participants were categorized as having a strong indication of NES if they obtained a score of more than 30.

4.0 Findings

The students' sociodemographic data is shown in Table 1. As this study was conducted in one center only and limited students volunteered in this study, therefore only 150 students were enrolled. After checking for normality and removing the outliers, 141 students were included for further statistical analysis. The mean (SD) age of students was 22.3 (1.2) years old, and the majority of students were female, Malay, household income lower than RM 4,850, and non-smokers. For health-related history, more than 90% of them have no chronic disease and 64.5% have a family history of chronic disease. 91.5% of them reported no usage of prescribed medicine, however for supplement intake, 74.5% of them took daily supplements.

Table 4.1. Sociodemographic data among students in UiTM Puncak Alam (n=141)

Variables	Frequency (%)	Mean (SD)
Age (years old)		22.3 (1.2)
Gender		
• Male	35 (24.8)	
• Female	106 (75.2)	
Race		
• Malay	135 (95.7)	
• Others	6 (4.3)	
Household income		
• Less than RM 4,850	84 (59.6)	
• RM 4,851 to RM 10,970	36 (25.5)	
• Above RM 10,971	21 (14.9)	
Smoking status		
• Non-smoker	133 (94.3)	
• Current smoker	6 (4.3)	
• Ex-smoker	2 (1.4)	
Diagnosed with chronic disease		
• None	137 (97.2)	
• Yes	4 (2.8)	
Family history of chronic disease		
• None	50 (35.5)	
• Yes	91 (64.5)	
Usage of prescribed medicine		
• None	129 (91.5)	
• Yes	12 (8.5)	
Supplement consumption		
• None	105 (74.5)	
• Yes	36 (25.5)	

Table 4.2 shows BMI status among students. The mean (SD) BMI of students is 22.8 kg/m² (4.6). More than half (56.7%) of them have a normal BMI while 29.1% were overweight and 14.2% were underweight.

Table 4.2. Body mass index (BMI) status among students in UiTM Puncak Alam (n=141)

Variables	Frequency (%)	Mean (SD)
BMI (kg/m ²)		22.8 (4.6)
Category		
Underweight	20 (14.2)	
Normal	80 (56.7)	
Overweight	41 (29.1)	

The indication of NES and PAL among students is shown in Table 4.3. It was found that 89.4% of students have no indication of NES. However, it was noted that only 6.4% of students had an indication of NES while 4.3% of them had a strong indication of NES. Additionally, moderate PAL was presented with the highest percentage (39%) followed by low PAL (32.6%) and high PAL (28.4%).

Table 4.3. The indication of NES and PAL among students in UiTM Puncak Alam (n=141)

Variables	Frequency (%)	Mean (SD)
Night eating syndrome (NES)		
NES score		15.8 (6.6)
No indication	126 (89.4)	
Indicate NES	9 (6.4)	
Strong indication	6 (4.3)	
Physical activity level (PAL)		
PAL score (METS-minutes/week)		2177.2 (2455.1)
High	40 (28.4)	
Moderate	55 (39.0)	
Low	46 (32.6)	

Table 4.4 showed that there was a positive correlation between NES score and BMI ($r(141) = 0.091, p=0.285$), suggesting that students with an indication of NES tend to have higher BMI. However, this correlation was not significant. For PAL, a negative correlation but not significant with BMI was reported ($r(141) = -0.011, p=0.899$), indicating that students who spend more time being physically active tend to have lower BMI. However, the relationship between NES and PAL with BMI was weak.

Table 4.4. Correlation between NES and PAL with BMI

Variables	BMI (kg/m ²)	p-value
NES score	0.091	0.285
PAL (MET-minutes/week)	-0.011	0.899

5.0 Discussion

This study provides insight into the correlation between BMI, NES, and PAL among university students. This study found that more than a quarter of participants were overweight while more than 50% had normal BMI using the Malaysian BMI cutoff adopted from the Asian cutoff scale. The finding of this study was in line with a recent study among undergraduate students from a health campus in Malaysia in which almost 15% of students were obese and overweight using the same BMI cutoff for the Asian population (Azhar et al., 2023). However, it was found that the prevalence of overweight and obesity was lower than 5% among students from another recent study in Malaysia as this study implemented the BMI cutoff as suggested by WHO (Cheah & Chua, 2023). Additionally, a study by Pital and Ghazali (2021) noted that the prevalence of students with excessive BMI was lower using the WHO cutoff approximately 25% compared to the Asian cutoff (approximately 40%). The WHO cutoff for BMI is slightly higher as it was intended for Caucasians as Asians have a higher body fat percentage compared to Caucasians within the same BMI classification. Furthermore, it was reported that Asians presented with a higher risk for insulin resistance and visceral fat, therefore, susceptible to chronic diseases including diabetes, cardiovascular disease, hypertension, and other NCDs compared to the Caucasians population (Hood et al., 2019). Hence, it can be concluded that the Asian cutoff is more suitable to determine the BMI status among students or any population in Asia.

This study also investigated the relationship between NES and BMI, and it was found that there was a positive correlation between NES and BMI among the recruited students. A study among university students in Malaysia also reported a significant correlation between BMI and NES in which almost 50% of overweight and obese students presented with indications for NES (Kwan et al., 2021). Late-night eating was associated with higher BMI as nocturnal eating can lead to circadian misalignment, reducing leptin levels and consistently stimulating hunger sensation. Besides, energy expenditure during night is lower compared to daytime, hence excessive energy intake during night can lead to fat accumulation as glucose is not converted into glycogen and stored within adipose tissue (Yoshida et al., 2018). However, a study conducted by Dzulkafli et al. (2020) revealed that there was no correlation between NES and BMI among students in a public university in Malaysia as more than 95% of the students had no indication for NES. This study noted that gender might be the factor as this study only focused on females as females usually have a higher awareness of food intake (Dzulkafli et al., 2020). The result of this study was supported by another study as it was revealed that male students have a three times

higher tendency to have NES as they were less concerned about body weight and shape from excessive eating during the night (Gan et al., 2019).

Moreover, this study also revealed that there was a negative correlation between PAL and BMI among students, and moderate PAL was presented with the highest percentage compared to low and vigorous PAL. This finding is similar to a study among pre-university students in Malaysia in which 50% of students were minimally active and there was a negative correlation between PAL and BMI, however, the relationship was very weak (You et al., 2020). A systematic study reported that a few factors have been associated with low PAL among university students including lack of suitable facilities, longer time on screen time, and academic-related activities (Ferreira Silva et al., 2022). Additionally, another study among students in Saudi Arabia also demonstrated the same results as students have limited time to spend more time on physical activity as they need to focus on academic performance rather than their health (Alkhateeb et al., 2019). Furthermore, the digital transitions from physical to virtual lectures, online examinations, or assignments lead to higher screen time and reduced time spent on exercises or other physical activities (Tan et al., 2020).

6.0 Conclusion and Recommendation

In conclusion, the findings of this study indicated that BMI status among university students should be improved as only half of them have normal BMI. As discussed earlier, BMI status can be the predictor for chronic disease, therefore enhancing BMI status should be considered by tackling the factors influencing BMI status including NES and PAL.

Few limitations have been identified throughout the study. As this study only focused on a single center during participant recruitment, the results of this study cannot represent the whole population of university students in Malaysia. Besides, as this was conducted as a cross-sectional study, this study was unable to determine the long-term effect of NES and PAL on BMI status among students.

Despite the limitations, this study is one of the current studies that implemented the BMI cutoff for the Asian population to determine the BMI status, which is more appropriate than the WHO cutoff score and specifically focused on NES and PAL as the NES and PAL among students are quite concerning. Therefore, this study can be an indicator to highlight the importance of NES and PAL in planning interventions to improve the BMI status among students in the university. Even though this study has assessed the BMI status, it is recommended for this study to measure the waist circumference as well as BMI to provide a prediction for the risk of chronic diseases.

As this study highlights the relationship between NES and BMI, future studies should focus on the types of food consumed among the students during nocturnal eating to determine the precise macronutrient intakes including energy, carbohydrate, fat, and protein. Moreover, for PAL, specific types of exercise spent among students should be highlighted in the future to plan for suitable interventions targeting university students or young adults in improving BMI status.

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Paper Contribution to Related Field of Study

This study provides information on BMI status using the latest BMI cutoff for Malaysians and the prevalence of NES as well as PAL among university students. This study perhaps could help the healthcare sectors including nutrition to plan for comprehensive strategies or interventions to reduce the prevalence of chronic diseases as early as young age.

References

- Alkhateeb, S. A., Alkhameesi, N. F., Lamfon, G. N., Khawandah, S. Z., Kurdi, L. K., Faran, M. Y., . . . Safdar, O. Y. (2019). Pattern of physical exercise practice among university students in the Kingdom of Saudi Arabia (before beginning and during college): a cross-sectional study. *BMC Public Health*, 19(1), 1716. <https://doi.org/10.1186/s12889-019-8093-2>
- Allison, K. C., Lundgren, J. D., O'Reardon, J. P., Geliebter, A., Gluck, M. E., Vinai, P., . . . Stunkard, A. J. (2010). Proposed diagnostic criteria for night eating syndrome. *Int J Eat Disord*, 43(3), 241-247. <https://doi.org/10.1002/eat.20693>
- Allison, K. C., Lundgren, J. D., O'Reardon, J. P., Martino, N. S., Sarwer, D. B., Wadden, T. A., . . . Stunkard, A. J. (2008). The Night Eating Questionnaire (NEQ): psychometric properties of a measure of severity of the Night Eating Syndrome. *Eat Behav*, 9(1), 62-72. <https://doi.org/10.1016/j.eatbeh.2007.03.007>
- Azhar, S. B. M., Vanoh, D., & Ganggaya, K. S. (2023). Food Choice Motives, Physical Activity Level and Body Mass Index Status Among Undergraduates Students: A Cross-sectional Study [Article]. *Malaysian Journal of Medicine and Health Sciences*, 19(6), 151-156. <https://doi.org/10.47836/mjms.19.6.20>
- Cheah, K. J., & Chua, P. L. (2023). Knowledge, Attitude, and Practice of Sugar-Sweetened Beverage (SSB) Among University Students in Klang Valley, Malaysia [Article]. *Malaysian Journal of Medicine and Health Sciences*, 19(6), 186-192. <https://doi.org/10.47836/mjms.19.6.25>
- Chong, C. T., Lai, W. K., Mohd Sallehuddin, S., & Ganapathy, S. S. (2023). Prevalence of overweight and its associated factors among Malaysian adults: Findings from

- a nationally representative survey. *PLOS ONE*, 18(8), e0283270. <https://doi.org/10.1371/journal.pone.0283270>
- Dzulkaflī, N. H., Hamirudin, A. H., & Sidek, S. (2020). Night Eating Syndrome And Its Association With Body Mass Index Among Female University Students. *INTERNATIONAL JOURNAL OF ALLIED HEALTH SCIENCES*, 4(4), 1626-1634. <https://journals.iium.edu.my/ijahs/index.php/IJAHs/article/view/462>
- Ferreira Silva, R. M., Mendonça, C. R., Azevedo, V. D., Raoof Memon, A., Noll, P. R. E. S., & Noll, M. (2022). Barriers to high school and university students' physical activity: A systematic review. *PLOS ONE*, 17(4), e0265913. <https://doi.org/10.1371/journal.pone.0265913>
- Gan, W. Y., Chin, P. Q., & Law, L. S. (2019). Determination of risk factors for night eating syndrome among public university students in Malaysia. *Malaysian J Med Heal Sci*, 15.
- Hood, K., Ashcraft, J., Watts, K., Hong, S., Choi, W., Heymsfield, S. B., . . . Thomas, D. (2019). Allometric scaling of weight to height and resulting body mass index thresholds in two Asian populations. *Nutrition & Diabetes*, 9(1), 2. <https://doi.org/10.1038/s41387-018-0068-3>
- Kwan, Y., Lee, S. S., & Cheng, S. H. (2021). Night Eating Syndrome and Its Association with Sleep Quality and Body Mass Index Among University Students During the Covid-19. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, 6, 371-383. <https://doi.org/10.47405/mjssh.v6i8.944>
- Peltzer, K., & Pengpid, S. (2018). Prevalence, risk awareness and health beliefs of behavioural risk factors for cardiovascular disease among university students in nine ASEAN countries [Article]. *BMC Public Health*, 18(1), Article 237. <https://doi.org/10.1186/s12889-018-5142-1>
- Pitil, P. P., & Ghazali, S. R. (2021). Overweight and obesity: a study among university students in Sarawak, Malaysia. *International Journal of Health Promotion and Education*, 1-13. <https://doi.org/10.1080/14635240.2022.2040380>
- Rosli, H., Fitri Mat Ludin, A., Priscilla Lim, A., Vallavan, V., Sze Yuen, L., Yusop, H., . . . Sham Othman, M. (2022). Investigating the Links Between Body Composition and Female University Students' Night Eating Habits and Sleep Quality.
- Shahadan, S. Z., Bolhan, N. S., & Ismail, M. F. M. (2022). The Association between Physical Activity Status and Mental Wellbeing among Overweight and Obese Female University Students. *Malaysian Journal of Medicine and Health Sciences*, 18(19), 80-86.
- Tan, S. L., Jetzke, M., Vergeld, V., & Müller, C. (2020). Independent and Combined Associations of Physical Activity, Sedentary Time, and Activity Intensities With Perceived Stress Among University Students: Internet-Based Cross-Sectional Study [Original Paper]. *JMIR Public Health Surveill*, 6(4), e20119. <https://doi.org/10.2196/20119>
- Tan, S. T., Tan, C. X., & Tan, S. S. (2021). Physical Activity, Sedentary Behavior, and Weight Status of University Students during the COVID-19 Lockdown: A Cross-National Comparative Study. *Int J Environ Res Public Health*, 18(13). <https://doi.org/10.3390/ijerph18137125>
- Tapera, R., Merapelo, M. T., Tumoyagae, T., Maswabi, T. M., Erick, P., Letsholo, B., & Mbongwe, B. (2017). The prevalence and factors associated with overweight and obesity among University of Botswana students. *Cogent Medicine*, 4(1), 1357249. <https://doi.org/10.1080/2331205X.2017.1357249>
- Umer, A., Kelley, G. A., Cottrell, L. E., Giacobbi, P., Innes, K. E., & Lilly, C. L. (2017). Childhood obesity and adult cardiovascular disease risk factors: a systematic review with meta-analysis. *BMC Public Health*, 17(1), 683. <https://doi.org/10.1186/s12889-017-4691-z>
- Wan Mohamed Radzi, C. W. J., Salarzadeh Jenatabadi, H., Alanzi, A. R. A., Mokhtar, M. I., Mamat, M. Z., & Abdullah, N. A. (2019). Analysis of Obesity among Malaysian University Students: A Combination Study with the Application of Bayesian Structural Equation Modelling and Pearson Correlation. *Int J Environ Res Public Health*, 16(3). <https://doi.org/10.3390/ijerph16030492>
- Yaribeygi, H., Maleki, M., Sathyapalan, T., Jamialahmadi, T., & Sahebkar, A. (2021). Pathophysiology of Physical Inactivity-Dependent Insulin Resistance: A Theoretical Mechanistic Review Emphasizing Clinical Evidence. *Journal of Diabetes Research*, 2021, 7796727. <https://doi.org/10.1155/2021/7796727>
- Yoshida, J., Eguchi, E., Nagaoka, K., Ito, T., & Ogino, K. (2018). Association of night eating habits with metabolic syndrome and its components: a longitudinal study. *BMC Public Health*, 18(1), 1366. <https://doi.org/10.1186/s12889-018-6262-3>
- You, H., Tan, P., & Mat Ludin, A. (2020). The Relationship between Physical Activity, Body Mass Index and Body Composition among Students at a Pre-University Centre in Malaysia. *IJUM Medical Journal Malaysia*, 19(2). <https://doi.org/10.31436/imjm.v19i2.1567>