ORIGINAL ARTICLE

Does Physical Activity, Eating Habit and Psychological Stress Affect Body Mass Index? A Cross-sectional Study Among University Students in Malaysia

Mehrnoosh Akhtari-Zavare[1], Sherina Mohd Sidik[2], Nurul Elyani Mohamad[3], Nurfaizah Saibul[4]

[1] Department of Public Health, Faculty of Health, Tehran Medical Sciences, Islamic Azad University (IAU), 19585-466 Tehran, Iran.
[2] Department of Psychiatry, Faculty of Medicine & Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[3] Biotechnology Research Institute, Universiti Malaysia Sabah, 88400, Kota Kinabalu, Sabah
[4] Clinical Research Unit, Hospital Sultan Abdul Aziz Shah, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

ABSTRACT

Introduction: Being overweight or underweight can take its toll on health. The trends in body mass index (BMI), especially higher BMI, has become a significant concern, not only in Malaysia but worldwide. This study seeks to investigate how far do physical activity, eating habit and psychological factors affect the BMI among university students in Malaysia. **Materials and methods:** A data of university students aged 18 years old and above were collected throughout Malaysia (n=1821) using a self-administered, dual-language survey questionnaire. BMI (kg/m2) was a dependent variable in multiple linear regression models with sociodemographic, academic, psychosocial, eating habits and physical activity characteristics as its independent variables. **Results:** The prevalence of underweight, overweight and obesity among the university students were 15.9%, 17.5% and 7.9%, respectively. There was a significant relationship found between BMI and gender, age, ethnicity, residency, parents with tertiary education, level of education, academic year, the field of study, current living arrangements, depression, anxiety, water intake, vegetable intake, snacking frequency, and recreation factors. **Conclusion:** This study confirmed the association between physical activity, eating habit and psychological stress with BMI. Implementing appropriate interventions on the importance of healthy BMI is crucial to create awareness among the students in order to lead them towards a healthy lifestyle.
Malaysian Journal of Medicine and Health Sciences (2025) 21(2): 126-135. doi:10.47836/mjmhs.21.2.17

Keywords: Malaysia, Body mass index, University students, Physical activity, Eating habit, Psychological stress

Corresponding Author:
Sherina Mohd Sidik, PhD
Email: sherina@upm.edu.my
Tel : 03-97692541

INTRODUCTION

The World Health Organization (WHO) defined body mass index (BMI) as the weight of the individual in kilograms (kg) over the square of their height in meter (1). WHO classified BMI into several classes, which are underweight (< 18.5 kg/m), average weight (18.5–24.9 kg/m), overweight (25.0–29.9 kg/m) and obesity (>30.0 kg/m). When people mention BMI, they often relate it to one's lifestyle and its association with health-related quality of life (1, 2). BMI is known to be interconnected with one's wellbeing. Nowadays, obesity has become one of the most serious public health challenges of the 21st century. Previously, obesity was often associated with high-income countries; currently, it is also found in low- and middle-income countries (3). According to the National Health and Morbidity Survey (NHMS) 2019, the prevalence of underweight, normal weight, overweight, and obesity among adults aged 18 years old and above in Malaysia was recorded at 6.5%, 43.3%, 30.4%, and 19.7%, respectively (4). Based on this report, the prevalence of obesity increased from 17.7% in 2015 to 19.7% in 2019 (4). A similar trend was observed worldwide (2). The most common talk about high BMI is its association with the prevalence of cardiovascular diseases, the leading cause of death worldwide (5). On the other hand, lower BMI has been reported to be one of the risk factors contributing to the increased risk of death in patients with chronic obstructive pulmonary diseases (COPD) (6).

University students are one of the best target populations to promote a healthier lifestyle. A study showed that there was a significant association between healthy weight and the academic performance of the students.

Eating habits, physical activities, and mental wellbeing are among the factors associated with BMI (7, 8). Psychological factors such as academic burnout have been reported to be one of the factors contributing to eating disorders among students at Monash University Malaysia (9). Those who have a healthy weight are usually energetic, lead a healthy lifestyle, and have a lower risk of getting diseases related to obesity (10). This cross-sectional study was designed to determine the correlation between physical activity, eating habits, and psychological stress and body mass index among university students in Malaysia.

MATERIALS AND METHODS

Study Design

A cross-sectional study using a self-administered questionnaire was conducted among 1814 undergraduate students at selected public and private universities in Malaysia. The study was conducted for six months (from June to December 2019). The inclusion criteria of participants included Malaysian citizens, age 18 years and older, who were pursuing higher education at the selected public or private universities in Malaysia during the data collection period.

Sampling method

The study involved selecting universities in Malaysia using a multistage cluster random sampling process. Universities were divided into public and private categories and screened based on their ranking. Public universities were listed under QS University Rankings Asia 2017/2018, while private universities were listed under SETARA and Times Higher World University Rankings 2018. Universities were sorted by state, with six geographical zones in Peninsular Malaysia and East Malaysia. Three or four universities from each selected state were selected by simple random sampling. Each university was invited and approved by the university, and student recruitment and data collection schedules were arranged by the respective authorities. A total of sixteen out of twenty-two listed universities agreed to participate in the study. The study recruited participants based on university lists. Eligible students signed a consent form upon receiving study information. Research assistants measured participants' height and weight for BMI calculation after completing the self-administered questionnaire.

Instruments

A dual-language questionnaire (English and Bahasa Malaysia) was developed and pre-tested among 80 university students, with content validity evaluated by experts from the Faculty of Medicine and Health Sciences of Universiti Putra Malaysia (UPM). The questionnaire was divided into five sections: sociodemographic characteristics, academic characteristics, psychosocial assessment, eating habits, and physical activity. The reliability of the questionnaire was determined using the Cronbach alpha reliability test.

- Socio- demographic data included age, gender, ethnicity, marital status, residency, monthly family income, household number, tertiary education background, smoking, alcohol consumption, academic characteristics and sleep quality by asking "you regularly wake up more than once per night (yes / no)".
- The psychosocial section of the study included the Patient Health Questionnaire-9 (PHQ-9) and the Generalized Anxiety Disorder (GAD-7) to determine the presence or absence of depression and anxiety, respectively. Total scores for the PHQ-9, based on the nine DSM-IV criteria for major depression, ranges from 0 to 27, with scores ranging from 0 (not at all) to 3 (nearly every day) for each of the 9 items / questions. A total score of 10 and above indicates depression. The GAD-7 has seven items ranging from 0 (not at all) to 3 (nearly every day) and total cut-off scores of 8 and above determine the presence of anxiety. Both questionnaires have been validated into the Malay language (11). The psychosocial characteristics of participants were identified through the four questions which were selected based on the findings of the pilot test including (having a good friend in university, doubts about the future, involvement in social activities, problems with other students, and lecturers).
- The eating habits section included questions on several eating characteristics such as breakfast intake, daily meal frequency, water intake, meals with friends and family, fruits, vegetables, fried food, snacks, and fast food.
- Physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ), developed by the World Health Organization (WHO), which measures intensity, duration, and frequency of physical activity. The study assessed three domains: occupational, transport-related, and leisure time. Physical activity scores were calculated using WHO's GPAQ Analysis Guide, which provides a total measure of Metabolic Equivalent (MET) minutes per week based on the amount of time spent performing moderate and vigorous physical activity for work, transport, and recreation purposes. The validated Bahasa Melayu version of the GPAQ was used (12).
- Participants were assessed for their body mass index (BMI) using the Omron HN-286 Digital Body Weight Scale and the SECA 213 portable stadiometer. BMI was calculated by dividing weight in kilograms by the square of height in meters. Based on criteria by the WHO (2000), BMI of the participants was classified as underweight (< 18.5 kg/m), normal weight (18.5 -24.9 kg/m), overweight (25.0 - 29.9 kg/m) and obesity (>30.0 kg/m) (1, 2).

Ethics Approval

Ethics approval for this study was obtained from the Ethics Committee for Research Involving Human Subject of Universiti Putra Malaysia (JKEUPM)(UPM/TNCPI/RMC/1.4.18.2).

Data Analysis

The study analyzed data using Statistical Package for Social Sciences version 25.0. Descriptive statistics (frequencies, percentage and median) and inferential analysis included chi-square and Kruskal-Wallis were used. Participants' physical activity intensity was measured using Metabolic Equivalent Tasks (MET mins/week), with moderate-intensity activities having 4 METS and vigorous-intensity activities having 8 METS. The total Moderate to Vigorous Physical Activity (MVPA) MET-min score was calculated as the sum of all MET-min/week from MVPA performed in work, commuting, and recreation (13). The Chi-square test was used to determine the association between BMI and independent variables.

RESULTS

The study analyzed 1814 participants' socio-demographic characteristics, finding that over half had normal BMI 1063(58.6%), followed by overweight 318(17.5%), underweight 289(15.9%), and obese 144(7.9%). Normal BMI was higher among females (60.8%) than males (54.9%). Overweight and obesity were more common among males, while underweight was more prevalent among females. The results showed a significant association between BMI and socio-demographic factors including gender, age group category, ethnicity, residency, and parents with no tertiary education background ($p< 0.05$) (Table I).

Table I: The association between BMI and sociodemographic characteristics of participants (n=1814)

Sociodemographic Characteristic	Total number	BMI category				Statistics
	N	UW N (%)	NW N (%)	OW N (%)	OB N (%)	
Gender						
Male	680	90(13.2%)	373(54.9%)	150(22.1%)	67(9.9%)	χ^2=25.31
Female	1134	199(17.5%)	690(60.8%)	168(14.8%)	77(6.8%)	p<0.00*
Age group category						
18-22	1526	257(16.8%)	909(59.6%)	251(16.4%)	109(7.1%)	χ^2=31.03
23-27	268	31(11.6%)	148(55.2%)	59(22.0%)	30(11.2%)	p<0.00*
>28	20	1(5.0%)	6(30.0%)	8(40.0%)	5(25.0%)	
Ethnicity						
Malay	917	140(15.3%)	506(55.2%)	173(18.9%)	98(10.7%)	
Chinese	552	101(18.3%)	344(62.3%)	88(15.9%)	19(3.4%)	χ^2=34.14
Indian	165	25(15.2%)	104(63.0%)	27(16.4%)	9(5.5%)	p<0.00*
Others	180	23(12.8%)	109(60.6%)	30(16.7%)	18(10.0%)	
Marital status						
Single	1793	286(16.0%)	1054(58.8%)	314(17.5%)	139(7.8%)	χ^2=11.25
Married	19	3(15.8%)	7(36.8%)	4(21.1%)	5(26.3%)	p=0.08
Divorced & Widow	2	0(0.0%)	2(100.0%)	0(0.0%)	0(0.0%)	
Monthly family income (RM)						
950 and below	330	57(17.3%)	198(60.0%)	51(15.5%)	24(7.3%)	
RM 951-RM3,900	717	129(18.0%)	411(57.3%)	119(16.6%)	58(8.1%)	χ^2=8.95
RM 3,901-RM8,400	503	64(12.7%)	300(59.6%)	98(19.5%)	41(8.2%)	p=0.44
RM 8,401 and above	264	39(14.8%)	154(58.3%)	50(18.9%)	21(8.0%)	
Residency						
Rural	451	79(17.5%)	235(52.1%)	91(20.2%)	46(10.2%)	χ^2=11.53
Urban	1363	210(15.4%)	828(60.7%)	227(16.7%)	98(7.2%)	p<0.009*
Current smoking						
Yes	54	9(16.7%)	24(44.4%)	14(25.9%)	7(13.0%)	χ^2=5.93
No	1760	280(15.9%)	1039(59.0%)	304(17.3%)	137(7.8%)	p=0.11
Alcohol consumption						
Yes	158	18(11.4%)	101(63.9%)	32(20.3%)	7(4.4%)	χ^2=6.49
No	1656	271(16.4%)	962(58.1%)	286(17.3%)	137(8.3%)	p=0.09
Poor sleep quality						
Yes	775	132(17.0%)	454(58.6%)	124(16.0%)	65(8.4%)	χ^2=3.18
No	1039	157(15.1%)	609(58.6%)	194(18.7%)	79(7.6%)	p=0.36
Number of people in the household						
1-5	1147	173(15.1%)	673(58.7%)	207(18.0%)	94(8.2%)	χ^2=2.64
6-10	645	113(17.5%)	376(58.3%)	108(16.7%)	48(7.4%)	p=0.85
≥11	22	3(13.6%)	14(63.6%)	3(13.6%)	2(9.1%)	
Parents with tertiary education background						
Yes	785	103(13.1%)	483(61.5%)	133(16.9%)	66(8.4%)	χ^2=9.54
No	1029	186(18.1%)	580(56.4%)	185(18.0%)	78(7.6%)	p<0.02*

*Significant at p<0.05; Under-weight (OW), Normal-weight (NW), Over-weight (OW), Obese –weight (OB)

The study found that the most participants were pursuing degree education (78.6%) and in early years of university (61.5%). Many participants were studying in engineering/ manufacturing (23.8%), medicine (19.8%), and health sciences (17.8%) related fields. Over half (62.1%) had a GCPA between 3.0 to 3.74

and received financial support for their studies (54.8%). Factors significantly associated with BMI were the level of education, academic years, field of study, and current living arrangements (Table II).

Table II: The association between BMI and academic characteristics of participants (n=1814)

Academic Characteristic	Total number	BMI category				Statistics
	N	UW N (%)	NW N (%)	OW N (%)	OB N (%)	
Level of education						
Diploma	357	75(21.0%)	211(59.1%)	51(14.3%)	20(5.6%)	
Degree	1426	212(14.9%)	839(58.8%)	257(18.0%)	118(8.3%)	χ^2=25.17
Master	23	2(8.7%)	9(39.1%)	7(30.4%)	5(21.7%)	p<0.003*
PhD	8	0(0.0%)	4(50.0%)	3(37.5%)	1(12.5%)	
Academic year						
1-2	1115	194(17.4%)	671(60.2%)	172(15.4%)	78(7.0%)	χ^2=20.18
3-4	629	84(13.4%)	347(55.2%)	137(21.8%)	61(9.7%)	p<0.003*
5 and above	70	11(15.7%)	45(64.3%)	9(12.9%)	5(7.1%)	
Field of Study						
Education	28	3(10.7%)	15(53.6%)	9(32.1%)	1(3.6%)	
Social Science, Business, Law	201	38(18.9%)	123(61.2%)	26(12.9%)	14(7.0%)	
Science, Mathematics, Computer	161	26(16.1%)	94(58.4%)	26(16.1%)	15(9.3%)	χ^2=49.51
Medicine	359	29(8.1%)	234(65.2%)	63(17.5%)	33(9.2%)	p<0.00*
Health Science	322	54(16.8%)	202(62.7%)	44(13.7%)	22(6.8%)	
Engineering /Manufacturing	431	71(16.5%)	224(52.0%)	96(22.3%)	40(9.3%)	
Others	312	68(21.8%)	171(54.8%)	54(17.3%)	19(6.1%)	
CGPA¥						
3.75-4.00	276	47(17.0%)	167(60.5%)	49(17.8%)	13(4.7%)	
3.0-3.74	1126	170(15.1%)	676(60.0%)	189(16.8%)	91(8.1%)	χ^2=11.92
2.25-2.99	373	66(17.7%)	198(53.1%)	71(19.0%)	38(10.2%)	p=0.21
2.0-2.24	39	6(15.4%)	22(56.4%)	9(23.1%)	2(5.1%)	
Financial support for the study						
Yes	994	142(14.3%)	596(60.0%)	175(17.6%)	81(8.1%)	χ^2=4.56
No	820	147(17.9%)	467(57.0%)	143(17.4%)	63(7.7%)	p=0.20
Current living arrangements						
Parent's home	438	65(14.8%)	262(59.8%)	80(18.3%)	31(7.1%)	
College Dormitory	1087	169(15.5%)	659(60.6%)	178(16.4%)	81(7.5%)	χ^2=17.55
Off Campus	281	53(18.9%)	140(49.8%)	58(20.6%)	30(10.7%)	p<0.04*
Others	8	2(25.0%)	2(25.0%)	2(25.0%)	2(25.0%)	

*Significant at p<0.05; ¥Cumulative Grade Point Average (CGPA), Under-weight (OW), Normal-weight (NW), Over-weight (OW), Obese –weight (OB)

The association between BMI and psychosocial characteristics are presented in Table 3. Most participants reported to have no depression (66.3%) and anxiety (70.8%), had a good friend in university (93.6%), were actively involved in societies (50.6%) and had no problems with other students (78.9%) or lecturers (90.9%). However, about 77% of participants doubted their future. There was a statistically significant association between depression and anxiety with BMI (p<0.05) (Table III).

Table III: The association between BMI and psychosocial characteristics of participants (n=1814)

Psychosocial characteristics	Total number	BMI category				Statistics
	N	UW N (%)	NW N (%)	OW N (%)	OB N (%)	
Depression						
Yes (PHQ-9≥10)	611	114(18.7%)	336(55.0%)	100(16.4%)	61(10.0%)	χ^2=11.91
No (PHQ-0<10)	1203	175(14.5%)	727(60.4%)	218(18.1%)	83(6.9%)	p<0.008*
Anxiety						
Yes (GAD>8)	529	104(19.7%)	294(55.6%)	82(15.5%)	49(9.3%)	χ^2=11.08
No (GAD<7)	1285	185(14.4%)	769(59.8%)	236(18.4%)	95(7.4%)	p<0.01*
Having a good friend in university						
Yes						
No	1697	266(15.7%)	993(58.5%)	299(17.6%)	139(8.2%)	χ^2=3.35
	117	23(19.7%)	70(59.8%)	19(16.2%)	5(4.3%)	p=0.34
Having doubt regarding your future						
Yes						
No	1393	222(15.9%)	807(57.9%)	255(18.3%)	109(7.8%)	χ^2=2.61
	421	67(15.9%)	256(60.8%)	63(15.0%)	35(8.3%)	p=0.45
Actively involved in societies						
Yes	918	145(15.8%)	523(57.0%)	170(18.5%)	80(8.7%)	χ^2=3.30
No	896	144(16.1%)	540(60.3%)	148(16.5%)	64(7.1%)	p=0.34

CONTINUE

Table III: The association between BMI and psychosocial characteristics of participants (n=1814). (CONT.)

Psychosocial characteristics	Total number	BMI category				Statistics
	N	UW N (%)	NW N (%)	OW N (%)	OB N (%)	
Having problems with other students						
Yes	383	72(18.8%)	216(56.4%)	68(17.8%)	27(7.0%)	χ^2=3.40
No	1431	217(15.2%)	847(59.2%)	250(17.5%)	117(8.2%)	p=0.33
Having problems with any lecturer(s)						
Yes	165	28(17.0%)	89(53.9%)	37(22.4%)	11(6.7%)	χ^2=3.64
No	1649	261(15.8%)	974(59.1%)	281(17.0%)	133(8.1%)	p=0.30

*Significant at p<0.05; Under-weight (OW), Normal-weight (NW), Over-weight (OW), Obese –weight (OB)

The eating habits of participants and its association with BMI are shown in Table IV. More than half of participants skipped breakfast (54.6%), consumed less than three times of daily meals (59.2%) as well as drank two or more litres of water per day (57.6%). Many participants had daily meals with friends and family (60.2%) and were more likely to eat fried food either several times a week (44.4%) or daily (41%). Fruits were commonly consumed for several times a week (38.2%); meanwhile, vegetable intake was reported daily (45.5%). Many participants had snacks frequently, in which 44.1% reported several times a week and 28.2% daily. About 33% of participants ate fast food several times a week. BMI was significantly associated with water intake, vegetables intake and frequency of having snacks (p<0.05) (Table IV).

Table IV: The association between BMI and eating habits of participants (n=1814)

Eating habits characteristics	Total number	BMI category				Statistics
	N	UW N (%)	NW N (%)	OW N (%)	OB N (%)	
Breakfast intake						
Daily	824	139(16.9%)	480(58.3%)	148(18.0%)	57(6.9%)	χ^2=3.00
Skip	990	150(15.2%)	583(58.9%)	170(17.2%)	87(8.8%)	p=0.39
Frequency of daily meals						
Less than three times	1074	167(15.5%)	632(58.8%)	189(17.6%)	86(8.0%)	χ^2=0.29
Three or more times	740	122(16.5%)	431(58.2%)	129(17.4%)	58(7.8%)	p=0.96
Water intake (litres/day)						
Below 2	769	152(19.8%)	475(61.8%)	94(12.2%)	48(6.2%)	χ^2=40.88
2 and above	1045	137(13.1%)	588(56.3%)	224(21.4%)	96(9.2%)	p<0.000*
Meals with friends and family						
Daily	1092	177(16.2%)	646(59.2%)	189(17.3%)	80(7.3%)	χ^2=1.65
Not daily	722	122(15.5%)	417(57.8%)	129(17.9%)	64(8.9%)	p=0.64
Fruits intake						
Daily	131	22(16.8%)	72(55.0%)	28(21.4%)	9(6.9%)	
Several times a week	693	95(13.7%)	404(58.3%)	128(18.5%)	66(9.5%)	
Once or twice in 2 weeks	435	74(17.0%)	266(61.1%)	67(15.4%)	28(6.4%)	χ^2=13.03
Several times a month	514	93(18.1%)	293(57.0%)	89(17.3%)	39(7.6%)	p=0.36
Never	41	5(12.2%)	28(68.3%)	6(14.6%)	2(4.9%)	
Vegetable intake						
Daily	825	105(12.7%)	499(60.5%)	146(17.7%)	75(9.1%)	
Several times a week	668	116(17.4%)	382(57.2%)	119(17.8%)	51(7.6%)	
Once or twice in 2 weeks	146	25(17.1%)	81(55.5%)	31(21.2%)	9(6.2%)	χ^2=28.52
Several times a month	125	32(25.6%)	76(60.8%)	14(11.2%)	3(2.4%)	p<0.005*
Never	50	11(22.0%)	25(50.0%)	8(16.0%)	6(12.0%)	
Fried food intake						
Daily	744	120(16.1%)	417(56.0%)	135(18.1%)	72(9.7%)	
Several times a week	806	119(14.8%)	490(60.8%)	136(16.9%)	61(7.6%)	
Once or twice in 2 weeks	161	28(17.4%)	100(62.1%)	26(16.1%)	7(4.3%)	χ^2=14.26
Several times a month	96	20(20.8%)	52(54.2%)	20(20.8%)	4(4.2%)	p=0.28
Never	7	2(28.6%)	4(57.1%)	1(14.3%)	0(0.0%)	
Frequency of having snacks						
Daily	511	87(17.0%)	324(63.4%)	78(15.3%)	22(4.3%)	
Several times a week	800	122(15.3%)	461(57.6%)	142(17.8%)	75(9.4%)	
Once or twice in 2 weeks	278	39(14.0%)	157(56.5%)	51(18.3%)	31(11.2%)	χ^2=28.00
Several times a month	212	41(19.3%)	114(53.8%)	42(19.8%)	15(7.1%)	p<0.006*
Never	13	0(0.0%)	7(53.8%)	5(38.5%)	1(7.7%)	
Fast food intake						
Daily	97	19(19.6%)	48(49.5%)	21(21.6%)	9(9.3%)	
Several times a week	601	106(17.6%)	351(58.4%)	100(16.6%)	44(7.3%)	
Once or twice in 2 weeks	537	69(12.8%)	327(60.9%)	105(19.6%)	36(6.7%)	χ^2=16.10,
Several times a month	556	93(16.7%)	322(57.9%)	87(15.6%)	54(9.7%)	p=0.18
Never	23	2(8.7%)	15(65.2%)	5(21.7%)	1(4.3%)	

*Significant at p<0.05; Under-weight (OW), Normal-weight (NW), Over-weight (OW), Obese –weight (OB)

Table V shows the association between BMI category based on the physical activity of participants. Based on the GPAQ analysis, more than half (51.5%) of participants had a high physical activity level. About 27% and 22% had moderate and low physical activity level, respectively (Data was not shown in the table). The median of GPAQ Total MVPA of the participants was 8400 (10890) MET-minutes/week. The median of total moderate to vigorous physical activity of the participants was 8400 (10890) MET-minutes/week. The median (IQR) of total MVPA for work components was 3660 (5640) MET-minutes/week; meanwhile, the median (IQR) of total MVPA for recreation components was 3660 (5640) MET-minutes/week. There was no vigorous travelling activity reported by participants; hence the total MVPA for travelling components was not available. The median (IQR) of sedentary behaviour of total participants was 360 (420) minutes/ day. Overweight participants reported significantly higher moderate recreation-related PA (median Met-minutes/ week: 720) than other groups (Table V).

Table V: The association between BMI category based on the physical activity of participants (n=1814)

GPAQ (MET-mins/week)	Total number	BMI category				Statistics
	Median (IQR)	UW Median (IQR)	NW Median (IQR)	OW Median (IQR)	OB Median (IQR)	
Work						
Vigorous	1440(3140)	1440(3720)	1440(3300)	1440(3200)	1920(2370)	¥p=0.90
Moderate	1440(2940)	1440(2880)	1200(2880)	1200(2460)	1320(2640)	¥p=0.82
Total Work MVPA	3660(5640)	3840(5490)	3240(5700)	3810(6300)	3960(3630)	¥p=0.86
Travel						
Moderate	840(1760)	600(1860)	600(1140)	600(1140)	600(900)	¥p=0.83
Recreation						
Vigorous	1800(2880)	1440(1680)	1440(2160)	1440(2640)	1440(1620)	¥p<0.02*
Moderate	680(1145)	480(720)	480(840)	720(1185)	600(840)	¥p<0.01*
Total Recreation MVPA	2400(3855)	2160(2400)	2160(3120)	2430(3684)	2160(2400)	¥p=0.07
GPAQ Total MVPA	8400(10890)	8100(9930)	7800(10350)	12060(19175)	12060(19175)	¥p=0.60
SB mins/day	360(420)	360(420)	360(420)	360(420)	360(420)	¥P=0.22

*Significant at p<0.05; Inter Quarter Range (IQR); ¥ Kruskal-Wallis; Sedentary Behaviour (SB); Moderate to Vigorous Physical Activity (MVPA), Under-weight (OW), Normal-weight (NW), Over-weight (OW), Obese –weight (OB)

DISCUSSION

This study found that 17.5% of university students were overweight and 7.9% were obese, with male students being more overweight and obese than female students. This trend is consistent with previous studies in Malaysia and 22 other countries, such as Russia, Singapore, Colombia, Istanbul, Thailand, and so on (8, 14). However, 15.9% of students were underweight, with female students dominating the category. This trend is similar to Abdul et al.'s (2015) study, with the percentage of underweight students being slightly lower (15). The higher prevalence of overweight and obesity in males and underweight in females is common due to females being more conscious about their weight and physical appearance, while males desire to gain more weight to build their bodies (16).

Our findings showed over half of students aged 28 and above being were overweight or obese. This could be due to low metabolism and poor diet management, which increases the risk of becoming overweight or obese (17). However, while our data revealed that the prevalence of underweight decreases as the age increases. This finding contradicts a study by Subhaluksuksakorn et al. (2016), which found that as students' age increases, the prevalence of underweight also increases (18).

Malay students had a higher percentage of overweight and obese students compared to other races, while Chinese students had a higher prevalence of underweight. Previous studies found that high BMI be due to lower diet quality, while students who are more active and concerned about their diet may have a lower BMI (19, 20). Another study found that differences in dietary behavior and sedentary lifestyle are significantly correlated with BMI, cultural and socio-economic differences between ethnicities, which may explain the observed trend (21).

The study found that rural students tend to be underweight, overweight, and obese, contrasting with global studies that show higher prevalence of these issues in urban areas (22, 23). Characteristics of the rural environment that may contribute to a higher risk of obesity include poverty, barriers to physical activity, limited access to affordable healthy food and reduced access to preventative care and nutrition education (24). Childhood exposure to the stressors associated with living in a rural environment may also lead to obesity, as well as obesity-promoting eating behaviors and poor dietary quality (25).

The study found a significant relationship between BMI and parent's education level. However, a higher prevalence of overweight was observed in students with tertiary education parents, as these parents have good socioeconomic status and may provide their children

with excess food. Parents with higher education levels may have better nutritional awareness and can assist their children in eating more healthily, and may control what their children should eat and avoid (26, 27). This is consistent with the data, as most students living with their parents had normal BMI, and only a few were underweight. Parental control has been shown to have a significant relationship with a healthier diet in children. The study found that education level, academic year, and field of study significantly influenced BMI. Undergraduate students had a higher rate of normal BMI, while postgraduate students had a higher prevalence of overweight and obesity. However, the data contradicts a study in Denmark that found lower mean BMI levels in more educated adults (28).

Students in Medicine and Health Sciences have a higher percentage of normal BMI compared to other courses, similar to another study which found that 66.7% of medical students had normal BMI (29). Another study also showed that students taking health courses have more knowledge on diet, exercise, and obesity-related factors, making them more aware of their weight (30).

The study found that anxiety and depression were statistically significant with BMI, with students who were at risk of anxiety and depression being more obese and underweight. This association has been reported in many studies with higher BMI, where emotional problems were linked to emotional eating and food addiction (31, 32). However, other study reported an insignificant relationship between anxiety and depression with BMI among university students (33). The disagreement in findings may be due to different sampling methods and geographical factors. The exact underlying pathophysiological mechanism between being overweight and poor mental health is unknown. It has been shown that immune inflammation disorder plays an essential role in mental health disorders such as depression and anxiety. Moreover, a high BMI status can lead to many pro-inflammatory factors in the peripheral circulation system crossing the blood–brain barrier, subsequently inducing depressive-like behaviors. In such cases, the risk of depression and anxiety gradually increases (34). The study highlights the need for further research to better understand the relationship between BMI and psychiatric morbidities like anxiety and depression.

Eating habits and BMI are interconnected, influenced by socioeconomic, socio-demographic, cultural, and climate factors (33). Transitioning from high school to university life may affect students' diets and eating habits. Educating students on healthy eating habits and nutrition is crucial (22). The study found that students who drink 2 litres or more of water daily have a higher BMI than average, consistent with study in Saudi Arabia (35). However, this contradicts other studies that suggest water intake is crucial for weight control, such as a Spanish study indicating an inverse relationship between BMI and water intake (36).

Regarding vegetable intake, the study found an inconsistent relationship between vegetable intake and BMI, with 28% of students who never eat vegetables having BMI above average and 12% being obese. Fruits and vegetables are recommended for maintaining healthy weight due to their high water, fiber, and antioxidant content (37). However, those who never eat vegetables are more at risk to be underweight compared to those who eat them daily, and this finding is similar to a study conducted by Heo et al., (2011) (38). The low vegetable consumption can result in the poor intake of fiber and lower macronutrient and micronutrient intakes, which may cause slow growth rates, inadequate bone mass, and impaired cognitive functioning, which is consistent with study done in in Davao City, Philippines (39). The results support dietary recommendations on the regular consumption of vegetables to maintain a healthy weight and good nutrition.

Snacking has been linked to increased energy intake and body mass index (BMI), but the health benefits depend on the type and frequency of snacks consumed (40). This study found a significant correlation between snacking and BMI, with most daily snacking students having normal BMI. Higher BMI students also ate less or never ate snacks. While there is inconsistency in data on the relationship between habitual snacking and BMI (41), there have been studies which show that no association between snack habit and obesity (3). This difference might be due to sociocultural differences and differences in what constitutes healthy behaviour. The types and portions of snack that are frequently consumed are those that are high in calories and low in fiber and sedentary behavior that might cause obesity (42). BMI was not the only factor that was influenced by snake habit; many other factors contributed to BMI. Chronic disease, which might affect an individual's physical condition and eating habits, could also influence BMI (3). Moreover, socio-economic status can influence BMI because it can affect the purchasing power required to meet a person's nutritional needs (3).

Our data revealed that physical activity significantly impacts body mass index (BMI), with vigorous and moderate recreation being linked to higher BMI. Studies have shown that decreased physical activity among youth leads to higher weight (43). Physical activity also improves psychological and emotional health (44), impacting BMI (45). However, around half of university students do not engage in physical activity, which leads to unhealthy eating habits and sedentary lifestyles, increasing the risk of overweight (46).

The study, which includes 16 universities, has strengths of a large sample size which covered students across several states in Malaysia. However, limitations include

the random sampling method, which may lead to inaccuracies in data. Additionally, there is limited literature on the relationship between BMI and university students, especially in Malaysia, making it difficult to interpret key findings. Most studies focus on the prevalence of overweight and obesity, with few reporting on underweight status. BMI, while commonly used to measure body weight, may not be totally accurate, and further assessments on waist circumference and visceral fat should be conducted to evaluate body composition.

CONCLUSION

In this study, we found a high prevalence of overweight/ obesity among university students. Although many research has been conducted to discern whether physical activity, eating habit, and psychological stress are related to BMI, the data has been found to be inconsistent. Several factors associated with BMI were identified in this study and can be utilized in health promotion programmes. Underweight and overweight / obesity warrants attention from universities and responsible bodies to examine this issue further and promote healthy lifestyles among the university students.

ACKNOWLEDGEMENT

We sincerely appreciate Puan Norsidawati Abdul Gani, the students, and staff who collaborated with us in this study. This study was supported by the Putra Matching Grant, Universiti Putra Malaysia [UPM/800– 3/3/1/ Matching- Geran Putra/2018/9300443].

REFERENCES

1. WHO : Global Database on Body Mass Index. https://apps.who.int/bmi/index.jsp?introPage=intro_3.html. Accessed May 10, 2024.
2. Shan MJ, Zou YF, Guo P, et al. Systematic estimation of BMI: A novel insight into predicting overweight/obesity in undergraduates. Medicine (Baltimore). 2019;98(21):e15810. doi:10.1097/MD.0000000000015810.
3. Lisetyaningrum I, Pujasari H, Kuntarti K. A cross-sectional analysis of snacking habits, eating habits, physical activity, and indicators of obesity among high school students in Jakarta, Indonesia. Journal of Public Health Research. 2021; 10(s1):2402. Doi:10.4081/jphr.2021.2402.
4. Institute for Public Health. National Health and Morbidity Survey (NHMS) 2019: NCDs–Non-Communicable Diseases: Risk Factors and other Health Problems. Ministry of Health Malaysia; 2020.
5. Baker JL, Olsen LW, Sшrensen TIA, Sci M. Childhood Body-Mass Index and the Risk of Coronary Heart Disease in Adulthood. N Engl J Med. 2007; 357(23):2329-2337. doi: 10.1056/NEJMoa072515.
6. Celli BR, Cote CG, Marin JM, et al. The Body-Mass Index, Airflow Obstruction, Dyspnea, and Exercise Capacity Index in Chronic Obstructive Pulmonary Disease. N Engl J Med. 2004; 350(10):1005-1012. doi:10.1056/NEJMoa021322.
7. Balluck G, Zaynab Toorabally B, Hosenally M. Association Between Body Image Dissatisfaction and Body Mass Index, Eating Habits and Weight Control Practices among Mauritian Adolescents. Mal J Nutr. 2016; 22(3): 389-401.
8. Chong CT, Lai WK, Mohd Sallehuddin S, Ganapathy SS. Prevalence of overweight and its associated factors among Malaysian adults: Findings from a nationally representative survey. PLoS ONE. 2023;18(8): e0283270. doi.org/ 10.1371/journal.pone.0283270.
9. Kristanto T, Chen WS, Thoo YY. Academic burnout and eating disorder among students in Monash University Malaysia. Eat Behav. 2016; 22:96-100. doi:10.1016/j.eatbeh.2016.03.029.
10. Raghav Gujjar K, Sharma R, Al-Jashamy K. Correlation between Body Mass Index (BMI) and Waist to Hip Ratio (WHR) among undergraduate students. Pakistan Journal of Nutrition. 2016; 15(7): 618-624. doi:10.3923/pjn.2016.618.624.
11. Sherina MS, Arroll B, Goodyear-Smith F. Criterion validity of the PHQ-9 (Malay version) in a primary care clinic in Malaysia. Med J Malaysia. 2012;67(3):309-315. PMID: 23082424.
12. Soo KL, Wan Abdul Manan WM, Wan Suriati WN. The bahasa melayu version of the global physical activity questionnaire: Reliability and validity study in Malaysia. Asia-Pacific J Public Heal. 2015; 27(2):NP184-NP193. doi:10.1177/1010539511433462.
13. Global Physical Activity Questionnaire (GPAQ) Analysis Guide [http://www. who.int/chp/steps/resources/GPAQ_Analysis_Guide.pdf]. Accessed Feb 2024.
14. Peltzer K, Pengpid S, Samuels T, et al. Prevalence of Overweight/Obesity and Its Associated Factors among University Students from 22 Countries. Int J Environ Res Public Health. 2014;11(7):7425-7441. doi:10.3390/ijerph110707425.
15. Abdul N, Kutty M, Hwang V, Chiang Q, Zhi Y. Association of Dietary Habits and Body Mass Index among University Students in Malaysia: A Cross-Sectional Study. J Nurs Heal Sci. 2015;4(5):78-85. doi:10.9790/1959-04517885.
16. Peltzer K, Pengpid S. Underestimation of weight and its associated factors in overweight and obese university students from 21 low, middle and emerging economy countries. Obes Res Clin Pract. 2015;9(3):234-242. doi:10.1016/j.orcp.2014.08.004.
17. Pojednic R, D'Arpino E, Halliday I, Bantham A. The Benefits of Physical Activity for People with Obesity, Independent of Weight Loss: A Systematic Review. Int J Environ Res Public Health. 2022;

20;19(9):4981. doi:10.3390/ijerph19094981.
18. Subhaluksuksakorn P, Sinjariyanon BNS W, Pimsaran BNS R. Gender Difference in Underweight, Overweight and Obesity among First-Year Students of Suranaree University of Technology in 2015. J Med Assoc Thai. 2016; 99(7): S24-9.
19. Lawless M, Shriver LH, Wideman L, Dollar JM, Calkins SD, Keane SP, Shanahan L. Associations between eating behaviors, diet quality and body mass index among adolescents. Eat Behav. 2020; 36: 101339.doi.org/10.1016/j.eatbeh.2019.101339.
20. Mohammadi S, Jalaludin MY, Su TT, Dahlui M, Mohamed MNA, Majid HA. Determinants of diet and physical activity in malaysian adolescents: A systematic review. Int J Environ Res Public Health. 2019;16(4):603. doi: 10.3390/ijerph16040603.
21. Abdullah NF, Teo PS, Foo LH. Ethnic differences in the food intake patterns and its associated factors of adolescents in Kelantan, Malaysia. Nutrients. 2016; 12;8(9):551.doi: 10.3390/nu8090551.
22. Niba LL, Atanga MB, Navti LK. A cross sectional analysis of eating habits and weight status of university students in urban Cameroon. BMC Nutr. 2017; 3(1):1-8. doi.org/10.1186/s40795-017-0178-7.
23. Baruwa OJ, Gbadebo BM, Adeleye OJ, et al. Decomposing the rural-urban disparities in overweight and obesity among women of reproductive age in Nigeria. BMC Women's Health. 2023; 23(1):680. doi: 10.1186/s12905-023-02813-2.
24. Seguin R, Connor L, Nelson M et al. Understanding barriers and facilitators to healthy eating and active living in rural communities. Nutr Metab. 2014; 2014:146502–8. doi: 10.1155/2014/146502.
25. Miller AL, Gearhardt AN, Retzloff L et al. Early childhood stress and child age predict longitudinal increases in obesogenic eating among low-income children. Acad Pediatr. 2018; 18:685–91. doi: 10.1016/j.acap.2018.01.007.
26. Doustmohammadian A, Abdollahi M, Bondarianzadeh D, Houshiarrad A, Abtahi M. Parental determinants of overweight and obesity in Iranian adolescents: A national study. Iran J Pediatr. 2012; 22(1):35-42. PMID: 23056857.
27. Hoque KE, Hoque KF, A/P Thanabalan R. Relationships between parents' academic backgrounds and incomes and building students' healthy eating habits. Peer J. 2018; 3; 6: e4563. doi: 10.7717/peerj.4563.
28. Johnson W, Kyvik KO, Skytthe A, Deary IJ, Sшrensen TIA. Education Modifies Genetic and Environmental Influences on BMI. PLoS One. 2011; 6(1):e16290. doi.org/10.1371/journal.pone.0016290.
29. Junger J, Niźnikowska E, Bergier B, et al. A field of study as a factor determining physical activity, BMI indicator and self-assessment of physical activity of students in the Visegrad countries. Heal Probl Civiliz. 2016;10(4):14-25.doi: 10.5114/hpc.2016.63567.
30. Alghamdi SA, Alqarni AA, Alghamdi AF, Alghamdi TK, Hasosah NM, Aga SS, et al. Knowledge, attitude, and practices regarding dietary habits among medical and non-medical university students. J Family Med Prim Care. 2021; 10(9):3436-3443. doi: 10.4103/jfmpc.jfmpc-2227-20.
31. Lee E, Kim Y. Effect of university students' sedentary behavior on stress, anxiety, and depression. Perspect Psychiatr Care. 2018;55:164-169. doi:10.1111/ppc.12296.
32. Keck MM, Vivier H, Cassisi JE, Dvorak RD, Dunn ME, Neer SM, Ross EJ. Examining the Role of Anxiety and Depression in Dietary Choices among College Students. Nutrients. 2020 Jul 11;12(7):2061. doi: 10.3390/nu12072061.
33. Haidar SA, de Vries NK, Karavetian M, El-Rassi R. Stress, Anxiety, and Weight Gain among University and College Students: A Systematic Review. J Acad Nutr Diet. 2018;118(2):261-274. doi: 10.1016/j.jand.2017.10.015.
34. Amer SAAM, Fouad AM, El-Samahy M, et al. Mental stress, anxiety and depressive symptoms and interleuken-6 level among healthcare workers during the COVID-19 pandemic. J Prim Care Community Health. 2021; 12:21501327211027430. doi: 10.1177/21501327211027432.
35. Ahmeda AF, Al-Ahmadi TF, Alotaibi AF, Alshehri MA, Almousa AM, Alshehri OM, Alanazi AZ, Anweigi LM. The awareness of water intake and its correlation with BMI among students attending national and international secondary schools inRiyadh, Saudi Arabia. Libyan J Med. 2021 Dec;16(1):1918903. doi: 10.1080/19932820.2021.1918903.
36. Milla-Tobarra M, Garcнa-Hermoso A, Lahoz-Garcнa N, et al. The association between water intake, body composition and cardiometabolic factors among children-The Cuenca study. Nutr Hosp. 2016; 33(3):19-26. doi: 10.20960/nh.312.
37. Charlton K, Kowal P, Soriano M, et al. Fruit and Vegetable Intake and Body Mass Index in a Large Sample of Middle-Aged Australian Men and Women. Nutrients. 2014; 6(6):2305-2319. doi:10.3390/nu6062305.
38. Heo M, Kim RS, Wylie-Rosett J, Allison DB, Heymsfield SB, Faith MS. Inverse Association between Fruit and Vegetable Intake and BMI even after Controlling for Demographic, Socioeconomic and Lifestyle Factors. Obes Facts. 2011; 4(6):449-455. doi:10.1159/000335279.
39. Calumba KFA, Castro MMC, Delima AGD, Loquias MP, Emma Ruth V. Bayogan, Pedro A. Alviola IV. (2023). Association between nutrient intake from vegetables and BMI category of in-school adolescents in urban and rural areas in Davao City, Philippines. Dialogues in Health, volum 2, 100116

https://doi.org/10.1016/j.dialog.2023.100116
40. Mattes RD. Snacking: A cause for concern. Physiol Behav. 2018; 193(1):279-283. doi: 10.1016/j.physbeh.2018.02.010.
41. Stephanie R. Hunter, Richard D. Mattes. The Role of Eating Frequency and Snacking on Energy Intake and BMI. In: Handbook of Eating and Drinking. Springer, Cham; 2020:659-678.
42. Spanos D, Hankey CR. The habitual meal and snacking patterns of university students in two countries and their use of vending machines. J Hum Nutr Diet. 2010; 23(1):102–107.
43. Alfawaz HA. The Relationship Between Fast Food Consumption and BMI among University Female Students. Pakistan J Nutr. 2012; 11(5): 406-410. doi: 10.3923/pjn.2012.406.410.
44. Li GSF, Lu FJH, Wang AHH. Exploring the relationships of physical activity, emotional intelligence and health in Taiwan college students. J Exerc Sci Fit. 2009; 7(1):55-63. doi:10.1016/S1728-869X (09)60008-3.
45. Haghighi ES, Jahromi MK, Daryano Osh F. Relationship between cardiorespiratory fitness, habitual physical activity, body mass index and premenstrual symptoms in collegiate students. J Sport Med Phys Fit. 2015; 55(6):663-667.
46. Shida Y, Yoshida D, Honda T, Hirakawa Y, Shibata M, Sakata S, et al. Influence of the Accumulation of Unhealthy Eating Habits on Obesity in a General Japanese Population: The Hisayama Study. Nutrients. 2020; 12(10):3160.doi: 10.3390/nu12103160.