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Research Article

Self-Esteem, Body Mass Index Status and Risk of Eating Disorders among Health Sciences Students

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ABSTRACT

This study aimed to ascertain the association between eating disorder risk, Body Mass Index (BMI), and self-esteem level among Universiti Sains Malaysia (USM) undergraduate health sciences students at Health Campus, Kubang Kerian, Kelantan, Malaysia. The self-esteem level and eating disorder risk of 166 USM health sciences students were evaluated in this cross-sectional study using the Rosenberg's Self Esteem Score and the Eating Attitude Test 26 (EAT-26) questionnaire, respectively. Based on their self-reported height and weight, the BMI was computed. The Fisher Exact Test and Chi-Square were used to determine the associations between the self-esteem level and BMI and the risk of eating disorders, respectively. Out of the 166 students, the majority (65.1%) had self-esteem levels within the normal range, while 57.8% had normal BMI. In the meantime, it was found that 19.9% had a high chance of getting an eating disorder. This study demonstrated a substantial association (p=0.012) between self-esteem and BMI status as well as between eating disorder risk and self-esteem (p=0.002). Self-esteem has a major impact on the psychological factors influencing BMI and contributing to the development of eating disorders. Additionally, future research should consider incorporating factors like body perception and body dissatisfaction. Additional research was required to validate the existing findings.

INTRODUCTION

Examining the association between self-esteem among undergraduate health sciences students and their susceptibility to eating disorders is relatively new, but it is gaining recognition as a significant field of research. According to Minev *et al.* (2018), an individual's attitude toward themselves, whether positive or negative, and their overall judgment of their own thoughts and feelings make up their self-esteem. Positive self-assertion is associated with acceptance, cherishing, and confidence in one's appearance and talents. Positive self-assertion also involves focussing on one's advantages (Ümmet 2015). On the other hand, low self-esteem exacerbates problems with body image and unfavourable assessments can result in bulimia and depression (Gilbert & Meyer 2005). Research has shown a substantial association between eating disorders and low self-esteem and elevated Body Mass Index (BMI) among undergraduate university students, with a high prevalence of eating disorders (Naeimi *et al.* 2016; Chaudhari *et al.* 2017).

It makes sense that university students may undergo shifts in their sense of self-esteem due to the transitional period from high school to university and from adolescence to adulthood. Research has demonstrated that self-esteem experiences a substantial decrease during the initial year of university, suggesting that

the transition to university can challenge the individuals' perceptions and self-conceptions (Luciano & Orth 2017). Conversely, though, certain studies argue that self-esteem can form and potentially rise during adolescence, a crucial period for the development of one's personality (Moksne & Espnes 2012).

In terms of BMI status, Suhaimi *et al.* (2020) discovered that the rate of obesity among undergraduate students were 6.3% and 12.9% were underweight at Universiti Putra Malaysia (UPM), while 61.3% of people had normal weight, and 19.6% were overweight. Ren *et al.* (2015) hypothesized that low nutrient intake as a result of improper eating habits may be the cause of university students' increased occurrence of underweight (Ren *et al.* 2015).

A research conducted in Malaysia based on a university in Kuala Lumpur found that an eating disorder was highly likely to affect 13.9% of university students (Chan *et al.* 2020). There aren't many research on the association between undergraduate students' BMI and self-esteem in Malaysia. Studies conducted in Malaysia have demonstrated that undergraduate student's academic performance is significantly influenced by their self-esteem (Zainal *et al.* 2021). Furthermore, Lee *et al.* (2012) have noted that self-esteem is influenced by their BMI. Worldwide, eating disorders are a problem that affects many university students (Pengpid & Peltzer 2018; Abdalla *et al.* 2020).

This study was necessary as a result of previous study, which examined the concerns with one's bodily image and self-esteem. It was suggested that the susceptibility to develop eating disorders may be potentially contributed by their high feelings of body dissatisfaction and low self-esteem (Teixeira *et al.* 2016). This study was conducted among health sciences students due to the potential impact on their careers. It was demonstrated that these students are poised to become future healthcare practitioners and will play a vital role in educating others about lifestyle modification and health promotion. Therefore, it is essential to conduct thorough research among these students (Alotaibi *et al.* 2021). Thus, the purpose of this study was to investigate the association between eating disorder risk, BMI, and self-esteem among health science students at Universiti Sains Malaysia's Health Campus in Kelantan, Malaysia.

METHODS

Design, location, and time

The study was carried out from September 2021 to January 2022, which employed a cross-sectional study design. The study was carried out at the local university in Kelantan, in the northeast of Malaysia, called Universiti Sains Malaysia. The Human Research Ethics Committee (JEPeM) USM granted ethical permission for the project (Reference number: USM/JEPeM/21060447). Conducting research on health sciences students is crucial because these individuals will be working in the healthcare industry. It is essential for them to prioritise leading a healthy lifestyle and maintaining a healthy diet in order to effectively promote health among their patients (Sajwani *et al.* 2009). Investigating whether health sciences students are more vulnerable to an increased risk of eating disorders and low self-esteem is therefore crucial.

Sampling

Convenience non-probability sampling was used in this investigation, and Naing's formula was utilised to determine the sample size (Naing 2009), $n=[Z/\Delta]^2 p (1-p)$ (n=sample size, z=value representing the desired confidence level, p=anticipated population proportion and Δ=precision (0.05). For this study, the level of confidence was set to be 95%. The Z-score value for 95% confidence level was 1.96. Among obese university students, low self-esteem was prevalent (9.8%), as per ALAhmari *et al.* (2019). Based on a research study conducted at King Saud University (KSU), the prevalence of obesity is represented by a p-value of 0.10. In the interim, the precision rate has been established at 5%. The research was predicated on a 20% dropout rate (Bujang 2021). Consequently, this research necessitates the participation of 166 students studying health sciences as undergraduates. The study's inclusion criteria, meanwhile, included anyone who was at least 18 years old, a citizen of Malaysia, and undergraduate students enrolled in Year 1–4 of the School of Health Sciences at Universiti Sains Malaysia who could accurately report their height, current body weight, and body weight from the previous six months. There were instructions on how to precisely self-measure height and body weight for those who were unsure of their self-reported measurements. The study did not include any participants who had long-

term health issues like diabetes, cardiovascular disease, cancer, or chronic kidney disease.

Data collection

After ethical approval was granted, the data collection process commenced. Students received the recruitment link via WhatsApp and email. The class representative distributed the survey invitation to the WhatsApp group of School of Health Sciences students from year 1 to year 4, which included a simple poster and QR code to facilitate the participants' to access the questionnaire. Each participant was guaranteed the confidentiality of their responses. According to the previous study, Google Form has been recognised as an intuitive web interface for the creation and implementation of web-based survey questionnaires for academic research (Vasantha Raju & Harinarayana 2016). Participants who fulfilled the eligibility criteria may participate by submitting the online questionnaire and permission form. Up until the researchers obtained 166 legitimate responses in total, the advertisement study link was submitted repeatedly.

The four-part questionnaire was completed by the participants in approximately 20 minutes. There are four sections for each set of online questionnaires which were: Section A (socio-demographic data), Section B (Anthropometric status), Section C (Self-esteem level) and Section D (Risk of eating disorder).

Section A (socio-demographic data). Section A focuses on students' personal information, such as their age, year of study, programmes, gender, ethnicity, living arrangements, and study sponsorship.

Section B (anthropometric data). In this study, participants self-reported their body weight and height. Following that, it was the researcher's responsibility to use the gathered data to compute BMI. According to the World Health Organisation (WHO), BMI was defined using cut-off points of 18.5 kg/m2 (underweight), 18.5 to 24.9 kg/m^2 (normal), 25.0 to 29.9 kg/m^2 (overweight), and 30.0 kg/m^2 (obesity) (WHO 2000).

Section C (self-esteem level). In order to assess their degree of self-esteem, students were required to complete a questionnaire. The English version of the validated Rosenberg Self-Esteem Scale (RSES) (Rosenberg 1989) was used to measure self-esteem. The 10-item survey had good validity and strong internal reliability (α=0.96). A four-point rating system, ranging from 0 (strongly disagree) to 3 (strongly agree), is used to score responses. The sum of the 10 answers was used to determine the overall self-esteem score. The possible scores are 0 through 30. Higher scores correspond to higher levels of self-worth. A score of 15 to 25 is regarded as normal; a number below 15 denotes poor self-esteem, and a score above 25 denotes good self-esteem. According to García *et al.* (2019), self-esteem levels yield greater accuracy than global ratings.

Section D (risk of eating disorder). The risk of having an eating disorder was evaluated using the validated Eating Attitude Test (EAT-26). The 26 items on the self-administered questionnaire had six components that were graded from 0 to 3 (0 being "Never," "Rarely," and "Sometimes," 1 being "Often," 2 being "Very often," and 3 being "Always"). The enquiries focus on attitudes, convictions, and actions related to food, weight, and body type. Three subscales are produced by this questionnaire: dieting, bulimia, and oral control. A total score is also generated. According to Garner (2004), the total score varied from 0 to 78, where scores less than 20 indicated a low risk of developing an eating disorder and scores more or equal than 20 indicated a higher chance of developing disordered eating attitudes or behaviours.

Data analysis

Version 26.0 of the Statistical Package for Social Sciences (SPSS) was used to analyse the data in this study. The normalcy distribution represents numerical data as mean (Standard Deviation (SD)), whereas frequency (percentage) represents categorical data. To calculate the variables' means, percentages, standard deviations, and frequencies, descriptive statistics were used. Weight (kg)/height (m^2) was used to calculate the Body Mass Index (BMI). The individuals' BMI levels were classified into groups based on the WHO BMI cut-off point. Categorical data was used to present each variable. Using Pearson's Chi-Square if the predicted count is less than 20% of the cells or Fisher's Exact if the expected count is more than 20% of the cells, the associations between self-esteem level and BMI status and the likelihood of eating disorders are evaluated. Statistical significance was defined as a p-value of less than 0.05 (two-tailed) at a 95% confidence level.

RESULTS AND DISCUSSION

Demographic characteristics

This investigation comprised 166 undergraduate health science students. There were 166 students, with 120 females (72.3%) and 46 males (27.7%). The students' mean age was 21.39±1.94 years. Majority of the students were at the age group of 18 to 21 years old (48.8%), Year 4 (45.8%), dietetics programme (23.0%), Malay (80.7%), living with parents (60.2%) and received scholarship as their sponsorship during study (44.0%). The demographic details of the study's health sciences students are displayed in Table 1.

Female students outnumbered male students in this study may be due to a gender imbalance in higher education. A supporting study conducted by Tienxhi (2017), found a gender disparity between male and female students enrolled in Malaysian public universities. This disparity is primarily due to the fact that female enrolment is higher than male enrolment. Since the COVID-19 outbreak, most educational systems have switched from in-person instruction in classrooms to an online learning environment (Azman *et al.* 2021). This explains why the vast majority of students (60.2%) live with their parents. Students were not required to be on campus because the education was delivered virtually to prevent the spread of COVID-19. Approximately 35.0% of students live in hostels, which were typically associated with clinical or practical learning activities. This required them to be on campus to meet specific credit hour requirements. On the other hand, a smaller portion (4.8%) of participants choose to live off-campus or independently. This could be because final-year students were doing internships away from their usual residences or campuses.

In terms of anthropometric data, the study's findings indicated that nutritional problems among the health sciences students included issues related to being underweight in addition to overweight or obese. The average BMI for 166 students was 24.50 kg/m^2. The majority of them, 96 students (57.8%), have a normal BMI, followed by 33 students (20.0%), who are underweight, and 19 (11.4%) and 18 (10.8%) of them are overweight and obese.

Level of self-esteem and eating disorder risk

Table 2 shows the level of self-esteem and the risk of eating disorders among health

Table 1. Demographic characteristics and body mass index status of health sciences students

Characteristics	n (%) (N=166)	Mean±SD
Gender		
Male	46 (27.7)	
Female	120 (72.3)	
Age, years		21.39±1.94
18–21	81 (48.8)	
22–25	78 (47.0)	
>25	7 (4.2)	
Ethnicity		
Malay	134 (80.7)	
Chinese	14 (8.5)	
Indian	10 (6.0)	
Others	8 (4.8)	
Year of study		
Year 1	51 (30.7)	
Year 2	15 (9.0)	
Year 3	24 (14.5)	
Year 4	76 (45.8)	
Programmes		
Audiology	7 (4.2)	
Biomedicine	16 (9.6)	
Dietetics	38 (23.0)	
Environmental and Occupational Health	30 (18.1)	
Forensic Science	9 (5.4)	
Medical Radiation	21 (12.7)	
Nursing	9 (5.4)	
Nutrition	16 (9.6)	
Speech Pathology	2 (1.2)	
Exercises and Sport Science	18 (10.8)	
Living arrangement		
With parents	100 (60.2)	
Hostel	58 (35.0)	
Living outside/ Alone	8 (4.8)	

Continue from Table 1

Characteristics	n (%) (N=166)	Mean±SD
Sponsorship		
Parents	25 (15.0)	
Scholarship	73 (44.0)	
Loan	63 (38.0)	
Others	5 (3.0)	
Anthropometric data		
BMI kg/m^2		24.50±23.05
Underweight (<18.5 kg/m^2)	33 (20.0)	
Normal (18.5–24.9 kg/m^2)	96 (57.8)	
Overweight (25.0–29.9 kg/m^2)	19 (11.4)	
Obese (≥30.0 kg/m^2)	18 (10.8)	

BMI: Body Mass Index; SD: Standard Deviation

science students. The students' self-esteem scores averaged 16.64. Among the 166 students, 108 (65.1%) had normal self-esteem, 50 (30.1%) had low levels, and 8 (4.8%) had high levels. The students had a mean EAT-26 score of 13.01. The majority of the students, n=133, or 80.1%, had a minimal chance of acquiring an eating disorder, while the remaining 33 students, or 19.9%, had a higher risk.

When comparing this study to other studies among Malaysian undergraduate university students, the prevalence of obesity was nearly identical (10.8% and 10.1%) (Pitil & Ghazali 2022). Furthermore, Tan *et al.* (2021) discovered that the proportions of overweight or obese Malaysian students remained stable during the epidemic, despite the fact that the majority of them walked. The fact that self-reported body weight and height were employed in both research accounts for the findings' similarity. The results of this study showed that most of the students had normal self-esteem. The findings of this study were close to those of a previous study conducted among Malaysian undergraduate students, where the mean self-esteem was normal at 17.44 (Fakaruddin & Tharbe 2018). A study by Keshk *et al.* (2019) among university students in Egypt revealed that only 34 out of 366 (8.5%) of students at Cairo University have poor self-esteem, however this study's sample of low self-esteem is substantially more frequent than average (Keshk *et al.* 2019). These disparities in the prevalence of low self-esteem could be attributed to environmental and psychosocial factors. Online learning, stress from a heavy workload, a lack of adequate technological infrastructure, or an unfavourable learning environment were the stressors that were most frequently mentioned as having an impact on participants' psychological aspects. Additionally, it's probable that a significant risk factor for the long- or short-term development of mental health problems may be low self-esteem (Keane & Loades 2017). The majority of the research in a systematic review conducted among university students and based on 115 studies published from 1970 to 2017 found an association between higher self-esteem and healthier behaviour (Arsandaux *et al.* 2020).

The current study's findings indicated that most students have a minimal chance of acquiring eating disorders. The prevalence of eating disorders is quite low (19.9%), with students having a mean risk of 13.01±11.38. However, this study's high-risk eating disorder prevalence is much higher than that of a study by Abdalla *et al.* (2020) that involved college students at a private university (Abdalla *et al.* 2020). In that study, only 18 out of 300 students (6.0%) were found to have high risk eating disorders. Meanwhile, a worrying discovery from research conducted in Indonesia revealed that 23% of teenage girls are susceptible to eating disorders (Sari *et al.* 2021). Pengpid and Peltzer's (2018) study indicated that Malaysia has the second-highest prevalence of eating disorder risk among university students among ASEAN nations, at 13.8% (Pengpid &

Table 2. Self-esteem level and risk of eating disorders among health sciences students

Variables	n (%) (N=166)	Mean±SD
Self-esteem level		16.64±4.68
Low self-esteem	50 (30.1)	
Normal self-esteem	108 (65.1)	
High self-esteem	8 (4.8)	
Risk of eating disorders		13.01±11.38
Low risk	133 (80.1)	
High risk	33 (19.9)	

SD: Standard Deviation

Peltzer 2018). Furthermore, the current study, conducted between 2021 and 2022, may have been influenced by the COVID-19 outbreak. Individuals at risk of eating disorders could have experienced psychosocial stress factors related to disrupted daily routines, social distancing measures, and restricted access to certain foods (McLean *et al.* 2022).

Association between self-esteem and BMI status

Table 3 showed the association between self-esteem and BMI status. Using Fisher's Exact Test, the study discovered a substantial correlation ($p=0.012$, $p<0.05$) between undergraduate health sciences students' BMI status and self-esteem. The results of the current study indicated a pattern in which obese undergraduate students were reported to have low self-esteem on a regular basis. As per the results, 9 (27.3%) of the 33 underweight students have low self-esteem, 23 (69.7%) have normal self-esteem, and 1 (3.0%) have high self-esteem. The majority of participants with a normal BMI, 70 (72.9%), have normal self-esteem, while 21 (21.9%) have low self-esteem and 5 (5.2%) have high self-esteem. Eight (42.1%) overweight participants have low self-esteem, while the other nine (47.4%) have normal self-esteem and the remaining two (10.5%) have high self-esteem. Of the 18 obese participants, 12 (66.7%) have low self-esteem, while the remaining six (33.3%) have normal self-esteem. The current study revealed that obese undergraduate students have a higher prevalence of low self-esteem.

The results of the current study show a statistically significant association between the BMI status and self-esteem of undergraduate health sciences students at USM's Health Campus. According to Kiviruusu *et al.* (2016), there is a stronger association between BMI and self-esteem between the ages of 22 and 32. This illustrates how self-esteem and BMI status can be greatly impacted by the start of young adulthood, which is probably connected to a new environment and new obstacles in life. People with high BMI may also experience stigma connected to their body weight, which could be linked to low self-esteem. Body weight stigma, also known as weight-based discrimination, is the stereotyping of a person's body type according to societal perceptions of body shape and weight (Tomiyama *et al.* 2018). This is because the potential for weight stigmatisation to have an impact on young people is high, as they are overly preoccupied with adhering to social standards of appearance, which could potentially adversely affect their health.

Association between self-esteem and risk of eating disorder

Table 4 indicates a strong link between undergraduate health sciences students' self-esteem and their likelihood of eating disorders, as determined by the Pearson Chi Square Test [χ^2 (2)=12.576, p=0.002]. Of the participants, 15 (13.9%) had a higher chance of developing an eating disorder, compared to the majority (86.1%) who have normal self-esteem. A high risk for an eating disorder, as shown by an individual's score on the EAT-26, which usually indicated a significant level of concern over disordered eating attitudes and practices. An elevated score on the EAT-26 denoted a stronger endorsement of attitudes and behaviours linked to eating disorders, such as binge eating disorder, bulimia nervosa, and anorexia nervosa. There is a low probability of having an eating disorder for 32

Table 3. Association between self-esteem level with body mass index among health sciences students

Body mass index status	Self-esteem, n (%) (N=166)			*p*
	Low	Normal	High	
Underweight	9 (27.3)	23 (69.7)	1 (3.0)	0.012*
Normal	21 (21.9)	70 (72.9)	5 (5.2)	
Overweight	8 (42.1)	9 (47.4)	2 (10.5)	
Obese	12 (66.7)	6 (33.3)	0 (0.0)	

*Fisher Exact Test significant at $p<0.05$

Table 4. Association between self-esteem level and risk of eating disorders among health sciences students

Self-esteem	Risk of eating disorder, n (%) (N=166)		X^2 (df)	*p*
	Low risk	High risk		
Low	32 (64.0)	18 (36.0)	12.576 (2)	0.002*
Normal	93 (86.1)	15 (13.9)		
High	8 (100.0)	0 (0.0)		

*Pearson's Chi Square significant at p<0.05

students (64.0%) who have low self-esteem, and a high risk for 18 students (36.0%). Despite having strong self-esteem, 8 (100%) of the participants had little chance of getting an eating issue.

The results of this study showed a strong association between the likelihood of developing an eating disorder and one's level of self-esteem. This result is in line with earlier studies that discovered a strong link between a high risk of eating disorders and a low self-esteem score (Yusoff & Shukri 2020) maybe due to distorted and negative body view as a result of low self-esteem, and thus raises the risk of disordered eating. Self-esteem is also thought to be a key factor in determining how one feels about their body (Stavrou 2018). It is important to follow the guidelines to avoid the emergence of poor self-esteem, which may eventually result in eating disorders. It is important to have personalized treatment plans that cater to the unique needs of each patient, as well as a multidisciplinary approach that combined psychological, medical, and nutritional interventions. This comprehensive approach is crucial for effectively addressing eating disorders (Wilson *et al.* 2007). The findings of this study can be employed to conduct future intervention studies that aim to mitigate the risk of developing an eating disorder among health sciences students. This investigation, nevertheless, was subjected to numerous constraints. Above all, convenience sampling was used, which may have introduced bias, and participant self-reported body weight and height were the only sources of information used for data assessment. In addition, the study was carried out in the midst of the COVID-19 outbreak. During the COVID-19 quarantine, the effect of psychological factors on students' likelihood of acquiring eating disorders is yet unknown. A limitation of this research was that it only examined the association between BMI, eating disorder risk, and self-esteem. It did not take into account other important factors like body dissatisfaction and media influences. Future studies should incorporate these measures for a more comprehensive analysis.

CONCLUSION

In summary, university students are thought to be a particularly sensitive population that could become afflicted with an eating disorder. Undergraduate health science university students from USM Health Campus exhibited a significantly high prevalence of risk of eating disorder (19.9%) despite the high prevalence of normal self-esteem and normal BMI status. Additionally, the results of this investigation show a connection between BMI and eating disorder risk as well as self-esteem. Still, more investigation is required to pinpoint the precise variables that raise the risk of eating disorders and low self-esteem. This will make it easier to create methods for prevention. Further research on the incidence of eating disorders among university students in Malaysia may also include non-health sciences students and students from other universities in the country.

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DECLARATION OF CONFLICT OF INTERESTS

The study's authors affirm that they have no competing interests, either financial or non-financial.

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Systematic Review Article

The Correlation between Probiotic Consumption and Sleep Quality among Adults : A Systematic Review and Meta-Analysis

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ABSTRACT

This study aims to determine the relationship between probiotic consumption and an individual's sleep quality. A systematic search for relevant articles was conducted in Scopus, PubMed, Cochrane Library, and ScienceDirect databases for publication between 2013 and 2023. The article selection process is presented using a PRISMA diagram. Data analysis was performed using Review Manager Version 5.4 and publication bias was assessed using Comprehensive Meta-Analysis Software (CMA) V4. This systematic review and meta-analysis included 10 studies examining the effect of probiotic consumption on sleep quality measured by Pittsburgh Sleep Quality Index (PSQI) and 3 studies assessing the effect measured by Electroencephalogram (EEG). Based on the PSQI results, the findings indicate that probiotics considerably enhance sleep quality, with the pooled odds ratio of -0.32 (95% CI:-0.64–0.01; p=0.04). However, probiotic consumption shows no significant effect on sleep quality measured by EEG. Further studies exploring the relationship between probiotic consumption and sleep quality using objective methods and larger samples are necessary to confirm the impact of probiotic supplementation on sleep quality. While these findings suggest that probiotic supplementation could be a potential strategy for improving sleep quality, additional research is required to strengthen these conclusions and investigate the underlying mechanisms.

INTRODUCTION

Sleep plays various important roles in humans, reflecting both physical and psychological conditions. As a result, good sleep is essential for maintaining physical health, mental well-being, and quality of life. Sleep quality refers to an individual's satisfaction with all aspects of their sleep experience. It encompasses key attributes: sleep efficiency, sleep latency, total sleep time, and wake time after sleep onset. The quality of sleep can be evaluated using both objective and subjective methods. Subjective methods involve self-assessment of sleep quality using sleep diaries . The most frequently used tool is the Pittsburgh Sleep Quality Index (PSQI) questionnaire. In contrast, objective methods involve measuring sleep quality using tools such as traditional Polysomnography (PSG) macrostructural sleep measures and techniques that further analyze the microstructures of PSG-measured sleep, including Electroencephalography (EEG). Factors influencing sleep quality are diverse and can vary, including sociodemographic variables, way of life propensities, wellbeing status, stress, cortisol levels, and natural variables.

Recent research has demonstrated that probiotics can improve sleep quality (Lee *et al.* 2022). Previous studies on the relationship between probiotic consumption and sleep quality have yielded various conclusions. For example, Putriningtyas and Astuti (2019) find that yogurt containing *L. bulgaricus* and *S. thermophilus* significantly enhances both the elderly's immune system and quality of sleep. A study by Sawada

et al. (2017) implies that taking probiotics will reduce stress biomarkers such as salivary cortisol and chromogranin A, leading to improved sleep quality. However, Marotta *et al.* (2019) found no significant difference between the control and experimental groups, likely due to their study's small sample size and the use of multiple probiotics over different time periods. Similarly, Shafie *et al.* (2022) reports that probiotic yogurt does not affect depression or sleep quality, but reduces lower anxiety, tension, and improves the quality of life in postmenopausal women.

Previous research by Haarhuis *et al.* (2022) has examined the relationship between traditional prebiotics, postbiotics, and probiotics such as *Lactobacilli* and *Bifidobacteria* in improving sleep quality and stress. However, the studies have been limited to systematic reviews and have not utilized a meta-analysis approach. Chu *et al.* (2023) conducted a meta-analytical research on the daily consumption of *Lactobacillus gasseri CP2305* for improving sleep quality in adults. However, this study only focuses on a single type of probiotic using a smaller sample size. While numerous studies have investigated the effects of various probiotics on sleep quality, the findings remain inconsistent, often limited by small sample sizes or a focus on single probiotic strains. Moreover, there is a lack of comprehensive meta-analyses that encompass a broader range of probiotic strains and larger sample sizes to provide more conclusive evidence. This meta-analysis research aims to address these gaps by including a larger number of subjects and a variety of probiotic strains. The additional number of subjects and broader scope provided in this study will generate stronger evidence and identify methodological gaps in understanding the relationship between probiotic consumption and sleep quality.

METHODS

Design, location, and time

This study followed The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines as outlined by (Koutsos *et al.* 2019). The design criteria were based on the following basic framework step: 1) Scoping; 2) Planning; 3) Searching; 4) Screening; 5) Eligibility and; 6) Interpretation.

The selection of studies was based on the following inclusion criteria: 1) research investigates the connection between probiotic intake and the quality of sleep; 2) studies conducted on adults with sample size greater than 10; 3) use of a randomized controlled trial design; 4) availability of a sufficient data for analysis and publishing in English. The exclusion criteria were as follows: 1) studies that do not primarily investigate the relationship between probiotic intake and sleep quality; 2) literature with a "low" quality rating (a Joanna Briggs Institute (JBI) score of less than four Indicating low quality). The data search was conducted for publications from 2013–2023, focusing on data from the last decade to ensure the validity, reliability, and relevance of research findings.

Data collection

The research data were obtained through literature searches using databases such as Scopus, Pubmed, Cochrane Library, and ScienceDirect. The search strategy involved using the keywords: "probiotics" or "bacteria" or "microbiome" or "*lactobacillus*" or "*streptococcus*" or "*saccharomyces*" or "*bifidobacteria*" and "tired" or "sleep" separately or combined in the title, abstract, and keywords.

Quality assessment

The Joanna Briggs Institute (JBI) Tool was used to assess the quality of the studies. JBI critical appraisal tool for RCTs (Randomized Controlled Trials) presents 13 questions. These questions aim to identify whether certain safeguards have been implemented to minimize the risk of bias and address other aspects related to the validity or quality of the study. Each question can be scored as met (yes), unmet (no), unclear, or not applicable. According to JBI scoring systems, a score of less than four is considered low quality, a score between four and six is considered medium quality, and a score of seven or even higher is considered high quality. In the current Systematic Review and Meta Analysis only studies with scores of four or higher were included.

Data analysis

The meta-analysis was conducted using Revman 5.4.1 with a random effect model. Statistical significance was determined when a p-value is less than 0.05, the Confidence Interval (CI) was set at 95%. Publication bias testing was conducted using Comprehensive Meta-Analysis Software (CMA) V4. The I^2 statistic values of

25%, 50%, and 75% were considered indicative of mild, moderate, and high heterogeneity, respectively (Higgins 2023). Egger's test was conducted to detect publication bias. The test indicated statistical significance ($p<0.05$), suggesting the publication bias (Egger *et al.* 1997). Additionally, the Fail safe N-Method was used for bias analysis. This method is defined as, "the number of new, unpublished, or un-retrieved non-significant or "null result" studies that would be required to exist to lower the significance of a meta-analysis to some specified level".

RESULTS AND DISCUSSION

The total of 1,520 articles were identified: 501 from Scopus, 97 from PubMed, 422 from Cochrane Library, and 560 from ScienceDirect. After removing 15 duplicates using Mendeley Reference Manager, 1,505 articles remained. Title screening based on the study's scope narrowed this down to 188 papers. Ultimately, 10 studies of the effect of probiotic consumption on sleep quality measured by PSQI and 3 studies of the effect of probiotic consumption on sleep quality measured by EEG were included. Using the PRISMA flowchart as a guide, the study selection process is illustrated in Figure 1 (Page *et al.* 2021). The detailed characteristics of the included studies (PICOS) are summarized in Table 1 and Table 2.

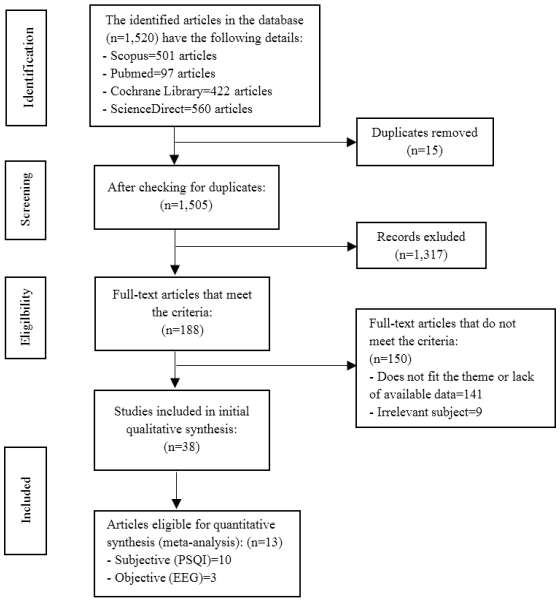


Figure 1. Flow chart of study selection results

Publication bias relationship between probiotic consumption and sleep quality measured by PSQI and EEG

According to Egger regression test, the p-value for the effect of probiotic consumption and sleep quality measured by PSQI is 0.455. Meanwhile for the effect of p-value of probiotic consumption and sleep quality measured by EEG is 0.144 for sleep latency, 0.210 for total sleep time, and 0.202 for wake time after sleep. Since these p-values are above 0.05 statistical significance was not attained, indicating no evidence of publication bias. However, the result of fail-safe N method suggest that the observed significant effect in our meta analysis is highly sensitive to presence of unpublished or unretrieved studies with null results.

Probiotic consumption on sleep quality measured by PSQI

Figure 2. shows the forest plot illustrating the relationship between probiotic consumption and sleep quality measured by PSQI. It indicates high heterogeneity among the studies ($p<0.00001$, $I^2=83\%$). The high heterogeneity may be attributed to variations in population characteristics (demographic differences), differences in intervention protocols, and sample size. The data analysis indicates a significant correlation between the subjective sleep quality measured with PSQI and probiotics, with a pooled odds ratio of -0.32 (95% CI:-0.64–0.01; $p=0.04$). This suggests that the intervention group has a significant effect of 0.32 better than the control. These results align with a meta-analysis conducted by Chu *et al.* (2023), which found that the administration of *Lactobacillus gasseri CP2305* improved adult's sleep quality.

Several mechanisms can link probiotic effects to sleep quality. Higher stress level is associated with lower perceived sleep quality (Horvath *et al.* 2023). Following a 12-week intervention, *L. plantarum P8* (2×10^{10} CFU/day) can enhance the gut's synthesis of neurotransmitters or neuroactive substances, which can improve mood, reduce stress and anxiety, and positively impact neural and psychological function (Ma *et al.* 2021). Randomized controlled placebo trials with stressed-out students have shown that three weeks of *L. plantarum JYLP-326* administration resulted in a reduction in the symptoms of anxiety, depression, and sleeplessness (Zhu *et al.*

Table 1. Characteristic of included studies by Pittsburgh Sleep Quality Index (PSQI)

Study	Study country (Study design)	Population (Duration)	Sample size (Age)/ Intervenation	Type and amount of probiotics	PSQI score
(Shafie *et al.* 2022)	Iran (Randomized, Triple-Blind, Placebo-Controlled Trial)	Postmenopausal women who have medical records at the health center (6 weeks)	66 (45–55)/ 100 mL yogurt daily	$1x10^8$ C CFU *Bifidobacterium lactis* & *L. acidophilus*	PRO: 3.46±1.81 PLA: 3.77±1.32
(Davoodabadi *et al.* 2021)	Iran (Randomized, Double-Blind, Placebo-Controlled Trial)	Women suffering from cyclical mastalgia that associated with a diagnosis of breast FCC (12 weeks)	45 (18–40)/ 1 capsule daily	$2x10^9$ CFU *Lactobacillus Acidophilus, Lactobacillus Fermentum, Lactobacillus Reuteri, & Bifidiobacterium Bifidum*	PRO: 7.4±2.2 PLA: 8.5±2.6
(Fei *et al.* 2023)	China (Randomized, Double-Blind, Placebo-Controlled Trial)	Meets Peterson MCI diagnostic criteria; no serious problems with the heart, lungs, liver or kidneys; do not have chronic disease exacerbations or seizures; have no visual or hearing impairment. (12 weeks)	40 (>60)/ 2 g probiotics daily	$>2x10^{10}$ CFU *Bifidobacterium lactis HNO19, Lactococcus lactis LY-66, Lactobacillus rhamnosus HNO01, Bifidobacterium animalis BB-115, Lactobacillus paracasei GL-156, Lactobacillus fermentum TSF331, Lactobacillus casei CS-773, Bifidobacterium infantis BLI-02, Lactobacillus reuteri TSR332, Lactobacillus rhamnosus Bv-77, Lactobacillus plantarum CN2018, Lactobacillus plantarum BioF-228, Lactococcus lactis BioF224, Bifidobacterium lactis CP-9, Lactobacillus acidophilus TYCA06, Lactobacillus johnsonii MH-68, Lactobacillus paracasei MP137, Lactobacillus salivarius AP-32*	PRO: 5.35±2.78 PLA: 8.40±1.76
(Kinoshita *et al.* 2021)	Japan (Randomized, Double-Blind, Placebo-Controlled Trial)	Women who work as medical professionals or related to welfare in the medical field (16 weeks)	961 (20–71)/ 112 mL yogurt daily	$\geq 1.12x10^9$ CFU *L. bulgaricus* & *S. Thermophilus*	PRO: 5.03±2.68 PLA: 5.22±2.68
Matsuura *et al.* 2022)	Japan (Double-Blind and Placebo-Controlled Clinical Trial)	Healthy young male (8 weeks)	27 (>23.5)/ 1 capsule daily	(-) *Lactococcus lactis subsp. cremoris (YRC3780)*	PRO: 3.3±1.6 PLA: 3.8±2.0
(Önning *et al.* 2023)	Ireland (Randomized, Double-Blinded, Placebo-Controlled, and Parallel-Designed Study)	Healthy adult men and women (12 weeks)	132 (21–52)/ 1 capsule daily	$1x10^{10}$ CFU (10B CFU) *Lactiplantibacillus plantarum HEAL9* (*LPHEAL9, HEAL9™, DSM 15312*)	PRO: 4.94±0.32 PLA: 5.36±0.36

Continue from Table 1

Study	Study country (Study design)	Population (Duration)	Sample size (Age)/ Intervenation	Type and amount of probiotics	PSQI score
(Lee *et al.* 2021)	South Korea (Randomized, Double-Blind, Placebo-Controlled Trial)	Healthy adults with subclinical symptoms of depression, anxiety, and insomnia (8 weeks)	156 (19–65)/ 2 capsules daily	Each 500 mg contains $2.5x10^9$ CFU (2.0x109 CFU *Lactobacillus reuteri NK33* & $0.5x10^9$ CFU *Bifidobacterium adolescentis NK98*)	PRO: 6.83±2.79 PLA: 6.80±2.36
Nishida *et al.* 2019)	Japan (Double-blind, Placebo-Controlled, Parallel-Group Clinical Trial)	Japanese medical students preparing for national exams (24 weeks)	60 (23–25)/ 1 tablet daily	Per 2 tablets contains $1x10^{10}$ *Lactobacillus gasseri CP2305*	PRO: 3.9±0.4 PLA: 4.1±0.5
(Boehme *et al.* 2023)	Switzerland (Double-blind, Placebo-Controlled, Parallel-Group Clinical Trial)	Healthy adults with mild stress (6 weeks)	45 (25–65)/ 1 sachet daily	$1x10^{10}$ CFU *Bifidobacterium longum NCC3001*	PRO: 5.2±1.8 PLA: 4.3±1.7
Sawada *et al*. 2019)	Japan (Double-Blind, Randomized, and Placebo-Controlled Clinical trial)	Male students who do not suffer from psychological or physical disorders, or have a history of serious illness (12 weeks)	49 (18–22)/ 200 mL daily	$1x10^{10}$ CFU *Lactobacillus gasseri CP2305*	PRO: 5.0±1.9 PLA: 4.8±2.3

-: Not provided; CFU: Colony-Forming Unit ; PRO: Probiotic ; PLA: Placebo

2023). The relationship between stress and sleep is well documented (Önning *et al.* 2023). One of the reasons for this relationship is that stress response can elevate blood pressure, heart rate, cortisol levels, and adrenaline response, all of which negatively impact sleep quality (Martire *et al.* 2020).

Administration of red bean yogurt containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus* has been shown to improve sleep quality (Putriningtyas & Astuti 2019). The fermentation process of red bean yogurt produces bioactive peptides and minerals, such as zinc, which can directly impact sleep and nervous system function. Bioactive peptides may be linked to GABAergic or serotonergic neurons, such as melatonin, which help regulate the body's circadian cycle (Codoñer-Franch *et al.* 2023).

Another mechanism that may occur is that various types of microbiomes can generate the neurotransmitters and precursors that are important in controlling sleep (Haarhuis *et al.* 2022). Through the synthesis of SCFA, the microbiome can affect neurotransmitter release by enterochromaffin cells in addition to directly generating neurotransmitters. Gastrointestinal neurons in the vagus nerve, have receptors that can be activated by neurotransmitters. These activated neurotransmitters send signals from the central terminals of the vagus nerve, to the brain (Breit *et al.* 2018). By acting on the vagus nerve, these neurotransmitters play a role in regulating sleep.

Probiotic consumption with sleep quality measured by EEG

Figure 3 (A) presents funnel plot and forest plot of the relationship between probiotic consumption in sleep latency. The analysis indicates low heterogeneity among the studies ($p=0.31$, $I^2=14\%$). The pooled odds ratio is 0.36 (95% CI:-0.04–0.77; p=0.08). Sleep latency, which measures the time it takes to fall asleep, can indicate sleep quality. Very short sleep latency may suggests excessive daytime

Table 2. Characteristic of included studies by Electroencephalogram (EEG)

Study	Study country (Study design)	Population (Duration)	Sample size (Age)/ Intervenation	Type and amount of probiotics	ECG score
(Nakagawa *et al*. 2018)	Japan (Randomized, Double-Blind, Placebo-Controlled Trial	Adults who face sleeping difficulty every day (4 weeks)	38 (20–64)/ 8 tablets daily	(-) *Lactobacillus helveticus MIKI-020* (LBH MIKI-020)	- Sleep latency PRO: 18.14±15.98 PLA: 15.86±12.30 -Total sleep time PRO: 323.93±81.44 PLA: 317.67±77.26 -Wake time after sleep PRO: 3.64±4.24 PLA: 4.57±4.85
(Monoi *et al.* 2016)	Japan (Randomized, Double-Blind, Placebo-Controlled Trial)	Healthy man suffering sleep disorders (4 weeks)	68 (Average 38)/ 4 sake yeast tablets (125 mg each tablet)	(-) *Saccharomyces cerevisiae*	- Sleep latency PRO: 17.1±10.9 PLA: 18.6±10.7 - Total sleep time PRO: 334±67 PLA: 341±78 - Wake time after sleep PRO: 6.32±3.65 PLA: 6.21±3.36
Nakakita *et al.* 2016)	Japan (Randomized, Double-Blind, Placebo-Controlled Trial)	Full-time employees who have good sleep quality (10 days)	14 (40–69)/ 25 mg daily	(-) *Lactobacillus brevis SBC8803* (SBL88™)	- Sleep latency PRO: 11±1 PLA:10±2 -Total sleep time PRO: 340±7 PLA: 334±7 - Wake time after sleep PRO : 16±1 PLA : 17±1

-: Not provided; CFU: Colony-Forming Unit ; PRO: Probiotic ; PLA: Placebo

sleepiness or pathological sleep conditions such as narcolepsy. The meta-analysis results on sleep quality measured using the EEG are inversely proportional to the meta-analysis results on sleep quality measured using the PSQI method and the study reported by Nishida *et al.* (2019) which measured sleep quality using EEG before (0) and after 6 or 12 weeks of consuming *Lactobacillus gasseri CP2305*. *Lactobacillus gasseri CP2305* significantly reduced sleep latency. Takada *et al.* (2017) also reported that prolonged sleep latency was lowered by taking *Lactobacillus casei* daily.

Figure 3 (B) shows funnel plot and forest plot of the relationship between probiotic consumption and total sleep time. The analysis indicates moderate heterogeneity among the studies (p=0.09, I^2=58%). The pooled odds ratio is 0.37 (95% CI:-0.25–0.98; p=0.24). Total sleep time refers to the total amount of time spent sleeping over the whole recording period, encompassing the interval between the start and the end of sleep. The meta-analysis results are consistent with the study by Takada *et al.* (2017), which found that *Lactobacillus casei* strain Shirota did not affect total sleep time measured by EEG, but had a significant effect on total sleep time as measured subjectively using the Oguri-Shirakawa-Azumi (OSA) score.

Figure 3 (C) shows the funnel plot and forest plot of the relationship between probiotic consumption and wake time after sleep. The analysis indicates moderate heterogeneity among the studies (p=0.08, I^2=61%). The pooled odds ratio is -0.48 (95% CI:-1.12–0.17; p=0.15). The data analysis reveals no significant relationship between probiotic consumption and sleep quality

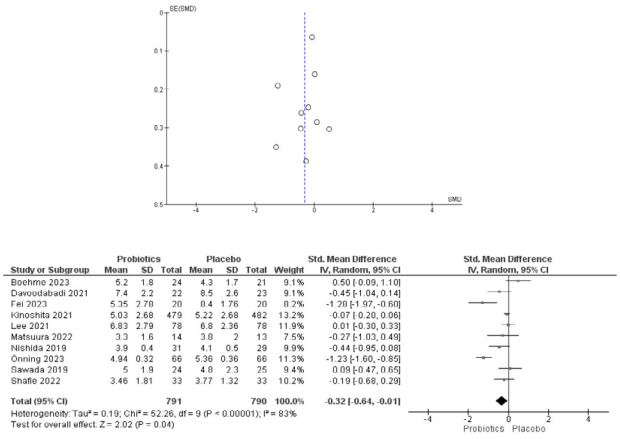


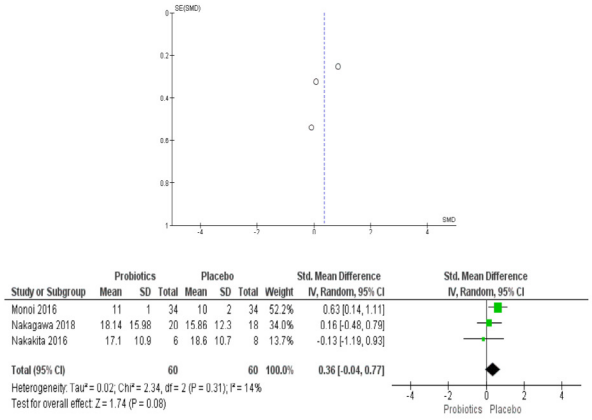
Figure 2. Funnel plot and Forest plot of the meta-analysis on the effect between probiotic consumption and sleep quality measured by pittsburgh sleep quality index

measured by EEG. Wake time after sleep refers to the period of wakefulness occuring after the beginning of sleep cycle. A high percentage of total sleep time is generally associated with a low percentage of wake time after sleep, and vice versa. This measures describes the amount of time spent awake following the start of a particular sleep cycle (Shrivastava *et al.* 2014).

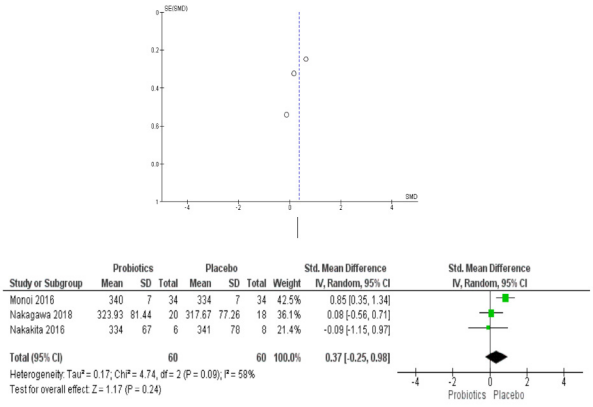
There is a difference between the results of the meta-analysis of subjective (PSQI) and objective (EEG) sleep quality measurements. The meta-analysis results found that probiotic administration had no significant effect on objective sleep quality (sleep latency, total sleep time, and wake time after sleep). In contrast, people assess their sleep quality using the PSQI questionnaire, which evaluates sleep over the past month (Pilz *et al.* 2018). In comparison, objective measurements are gathered in advance and only collected for three (Nakagawa *et al.* 2018) or four (Monoi *et al.* 2016) consecutive nights of the entire experimental trial. However, participants often report advantages from taking probiotics for improved sleep quality. Consequently, the limited duration of objective measurements may restrict the ability to detect subtle changes in sleep characteristics following probiotic ingestion. Another contributing factor could be the smaller sample sizes and fewer studies using the objective methods. The impact sizes reported in the meta-analysis represent the weighted averages of the effect sizes from each study. The weights are assigned based on how well each study predicts the impact size. In meta-analysis, larger studies typically receive more weight and contribute significantly to the overall effect size, primarily based on their sample size (Schober & Vetter 2020). Other factors such as dietary influences and emotional factors may affect sleep quality and contribute to the inconsistencies. These factors might be more controlled or reported in subjective assessments like the PSQI compared to objective measurements.

Strength and limitations of the review

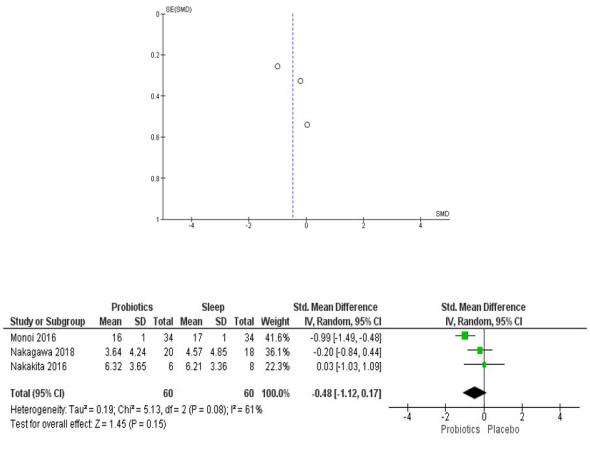
The key strength of this study is its comprehensive approach, incorporating both subjective (PSQI) and objective (EEG) measures to assess the relationship between probiotic consumption and human's sleep quality. This dual approach provides a more nuanced understanding of how probiotics may influence sleep quality. However, this systematic review and meta-analysis had several limitations. First, this systematic review and meta-analysis remain general and do not categorize results based on other factors such as gender or age, due to the limited number of available studies. Additionally, potential confounding factors were not considered, which could have influenced the results. More studies of the relationship between probiotic consumption and sleep quality measured by objective method with large samples are required to verify the impact of probiotic use on the quality of sleep. This study did not include probiotic-containing foods such as kimchi and kombucha, which could have provided additional insights. Moreover, some studies exhibited heterogeneity in their results, to mitigate this, future research should focus on standardizing methodologies and consider potential confounding variables.



(A) Funnel plot and Forest plot of sleep latency



(B) Funnel plot and Forest plot of total sleep time



(C) Forest plot of wake time after sleep

Figure 3. Funnel plot and forest plot of the meta-analysis on the effect between probiotic consumption and sleep quality measured by electroencephalogram

CONCLUSION

Based on the results of the meta-analysis, probiotics have a significant impact on sleep quality measured by subjective methods (PSQI). The research indicates that probiotics are effective in improving sleep quality. However, the current evidence suggests that probiotics intake does not significantly influence responses measured by objective methods (EEG). There is currently a scarcity of well-designed research studies in this area. Further research is warranted to gain a deeper understanding of the effects of probiotics on objective sleep characteristics.

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DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflict of interest.

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Research Article

Practitioner's Perspective on Activities and Outcomes of the Weight Management Program: A Qualitative Study

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ABSTRACT

This study aims to explore the activities and outcomes of weight management programs from the practitioner's perspective. A qualitative approach was employed in this study, which included in-depth interview and document analysis. Ten practitioners with experience and diverse backgrounds were interviewed using a semi-structured questionnaire. Concurrently, document analsis was utilised by examining the printed and online documents provided by the practitioners. The verbatim transcripts and documents were analysed thematically by using Nvivo 12 software. Thematic analysis revealed four themes that represent the key activities generally executed in weight management programs: 1) nutrition and physical activities; 2) screening and monitoring; 3) motivation and spirituality, and 4) task and challenge. This study found two uncommon activities rarely mentioned in previous programs: spirituality and challenge. Practitioners also highlighted activities in the program had positive effects on participants, including: 1) demonstrating positive self-change; 2) influencing their surroundings, and 3) cost savings. Notably, combining these activities could lead to improved outcomes, particularly when participants are fully committed to the program. In conclusion, this study identified four primary activities and three positive outcomes from the weight management programs. From the practitioner's perspective, integrating these activities was seen as a good strategy to achieve an optimal result. Hence, it is recommended that future practitioners to incorporate and diversify the activities to enhance their effectiveness.

INTRODUCTION

The worldwide rate of overweight and obesity among adults remains a cause for concern. A significant increase has been observed in the prevalence of adults categorised as overweight and obese from 1990 to 2022, with approximately 43.0% and 16.0%, respectively (WHO 2024). In Malaysia, the rate of adult obesity appears to be growing, with the latest statistics from the National Health and Morbidity Survey (NHMS) indicating that 54.4% belong to this category (IPH 2024). Being overweight and obese has been associated with a higher risk of several non-communicable diseases, such as various types of cancer (Meshram *et al.* 2022), hypertension (Diana *et al.* 2018; Meshram *et al.* 2022), metabolic syndrome and fertility abnormalities (De Lorenzo *et al.* 2020), psychological disorders and mental health conditions such as anxiety and depression (Rajan & Menon 2017). Moreover, a notable increase in the expenses associated with managing and treating obesity (Wulansari *et al.* 2016). Due to medical cost treatment, this situation will impact individuals and the economy.

Diverse strategies, including weight management programs, have significantly shown effectiveness in reducing the prevalence of obesity, which improves health and quality of life for committed participants (Ongan *et al.* 2019). Previous studies found that interventions that combine activities, emphasising healthy eating and physical activity, will increase the intervention success rate (O'Connor *et al.* 2020)

and decrease the possibility of developing cardiovascular disease (Nitschke *et al.* 2022).

Nutrition and physical activity are vital components in weight management programs, but integrating components such as behaviour modification, motivation and education has significantly improved participant's weight reduction (Buhari *et al.* 2022). A qualitative study demonstrated that weight management programs improve behaviour change and indirectly benefit participant's partners, showing a wider impact beside physical appearance (Albright *et al.* 2020). However, limited studies explore non-anthropometric measurement especially based on practitioner's perspectives and observations.

Practitioners from various disciplines, such as nutritionists, dietitians, fitness instructors and physical therapists, provide holistic care in the program, especially for adults with overweight or obese who seek consultations (Claridge *et al.* 2014; Nitschke *et al.* 2020). Previous practitioners revealed that support and motivation lead to positive lifestyle changes and achieving weight loss targets (Claridge *et al.* 2014). These practitioners showed the ability to change the participant's behaviour through strategic interventions and tailored it according to participant's needs. It is crucial to recognise their perspective regarding this issue. Participants struggled to maintain weight after the program due to social influence and relapse which required them to manage their health independently. Nevertheless, practitioner's expertise and support do initiate participant's weight loss target (Jessen-Winge *et al.* 2020). Exploring practitioner's perspectives on important activities could aid in developing a more structured program that meets participant's target. Hence, the main objective of this research is to elucidate the activities and their outcomes in the context of weight management intervention from the practitioner's perspective.

METHODS

Design, location, and time

This study utilised a qualitative research methodology to gather information and insights from the perspective of practitioners such as activities and outcomes of the weight management program. A one-to-one-in-depth interviews guided by semi-structured questions were conducted among practitioners in Klang Valley, Malaysia from November 2020 until December 2021. Several printed and online documents, such as program modules and guidance books, were used as supplementary material for document analysis to provide a greater understanding of the activities in the programs. However, the study duration was extended due to the initial anticipation of achieving data saturation after interviewing six to seven participants, as suggested by a previous study (Guest *et al.* 2020). The research committee decided to include more participants after thoroughly analysing the data. Hence, data saturation was reached after interviewing ten participants from various organisations such government agencies, private companies and non-government organisations. It is imperative to prioritize data comprehensiveness rather than just focusing on the number of participants (Knott *et al.* 2022).

The research received ethical approval from the Secretariat of Research and Innovation at Universiti Kebangsaan Malaysia, with reference number UKM PPI/111/8/JEP-2020-516. Additionally, ethical approval was also obtained from the National Medical Research Register (NMRR), Ministry of Health Malaysia, with the approval number NMRR-20-2450-57008 (IIR). Before beginning the data collection, practitioners were provided with information sheets and signed a formal consent form.

Sampling

The initial selections of six practitioners involved purposive sampling and snowball sampling from the practitioner's professional networks. Nevertheless, qualitative studies do not necessitate statistical sample calculation or achieving a large sample size (DeJonckheere & Vaughn 2019). This research used a maximum variation strategy to involve diverse participant's background, including year of experience, type of employment and organisation. The data collection continued until data saturation was reached, signifying that no new themes or codes emerged from the interviews (Creswell & Creswell 2018; Braun & Clarke 2021).

The inclusion criteria for practitioners consisted of two main requirements: previous experience in managing weight management interventions and a minimum of one year experience in respective disciplines. Thus, ten professionals, including nutritionists, dietitians, and fitness instructors, were involved.

Data collection

The selected practitioners were contacted by phone or email. Some interviews were held at the practitioners' office or studio, while others were performed through Google Meet due to COVID-19 restrictions. The practice of online interviews began before the pandemic (Brown *et al.* 2021), and this adaptable approach has proven advantageous for researchers exploring diverse environments (Keen *et al.* 2022). Additionally, several practitioners provided the program's related documents.

The interview session comprises semi-structured questions that enable practitioners to share their experience in conducting the interventions. The semi-structured questions were developed based on the components found in the Theory of Change, such as Input, Activity, Output, Outcome, and Impact. Theory of Change was selected due to its suitability to use as a strategy and program planning to identify the current and desired situation as a component needed to ensure the program has promising progress (Rogers 2014). However, this study reported to main components which are activities and the outcome of the activity. The language spoken throughout the interview was Malay, and partially mixed with English. Thus, translation into English were done for the purpose of presenting this research. The questions were grouped into two mains topics as follow: 1) What are the key activities that you have been conducting that influence a weight management intervention?; 2) What are the outcomes that you observe in a weight management intervention that you have been conducting?

Each session ranged from 40 to 60 minutes, audio recorded and transcribed verbatim. A probing technique was also used to gather additional information. Thematic analysis was then applied to analyse the verbatim transcripts and documents for deeper understanding.

Data analysis

Reflexive approaches were employed to conduct thematic analysis, which conceptualises shared meaning patterns with a central organising concept (Braun & Clarke 2021). This process involved six phases: becoming familiar with the data, coding the data, generating initial themes, reviewing and developing the themes, refining, describing, and naming the themes, and finally, documenting the findings (Braun & Clarke 2021). Next, NVivo 12 software was used to organise the identified codes, initial themes, and themes.

Data validity was ensured through an audit trail, member checking and peer review. An audit trail was established to record research activities and ensure reliability of both data collection and analysis (Nowell *et al.* 2017). The audit trails track research activities, including instrument development information and data reconstruction, enabling researchers to refine the initial coding and sub-themes before continuing to member checking.

Member checking is a method for verifying interpretations and obtaining feedback from the informants (Creswell & Creswell 2018). Therefore, practitioners were contacted by phone or WhatsApp messenger to set up another discussion. In this session, practitioners reviewed a verbatim transcript labelled with initial coding and sub-themes to verify the interpretation. Prior to peer examination, research teams revised the coding, sub-themes and themes to ensure their relevance to research questions. Lastly, findings were validated through a peer examination by expert as recommended (Creswell & Creswell 2018).

RESULTS AND DISCUSSION

Ten practitioners were involved in this study, with an equal gender distribution and a mean age of 35.7 (SD=7.7). Forty percent of the practitioners had more than ten years of experience in handling weight management. Practitioners were recruited from various organisations such as government (n=4, 40.0%), freelance (n=1, 10%), non-government organisations (n=1, 10%) and health-related organisations (n=4, 40%).

This study discovered four significant themes for activities and three themes for outcomes (Figure 1). Four significant themes for weight management intervention activities were identified: (i) nutrition and physical activities, (ii) screening and monitoring, (iii) motivation and spirituality, and (iv) task and challenge. Meanwhile, based on the practitioner's observation and experience, three significant themes emerged as common outcomes identified by the participants. The themes of these activities, which are (i) demonstrating positive self-change, (ii) being able to influence their surroundings, and (iii) being able to save costs, particularly on food and healthcare.

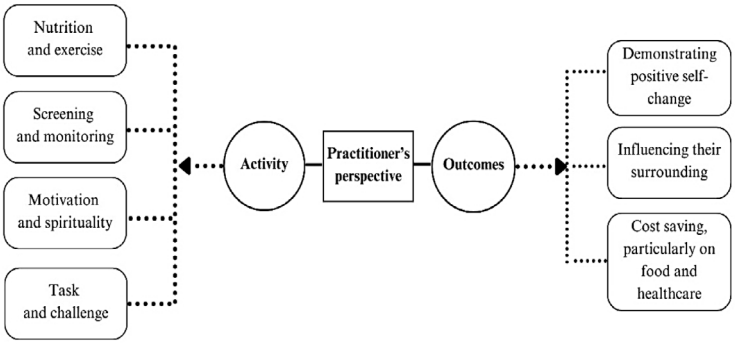

Figure 1. Overview of the theme for activity and outcomes of the weight management program

Themes for activities of weight management intervention

Activity is a fundamental component in weight management programs, notably nutrition and physical activity. According to the practitioner's experience and perspective, this study discovered several activities that provide beneficial outcomes for the participant. The themes and sub-themes for activities are outlined in Table 1.

Theme 1: Nutrition and physical activities. Most practitioners generally agree that a weight management intervention should include both nutrition and physical activities, as these components are fundamental requirements for this type of program.

"*There is an element of nutrition and exercise. These are two basic things. If one is missing, it's not a weight management program, right?*" (Practitioner 2, Male, 40)

"*Same with our program. It's not just talk about nutrition. It's also focusing more on exercise.*" (Practitioner 8, Male, 44).

Several studies indicated that combining nutrition or dietary activity with physical activity proved effective in weight loss (Buhari *et al.* 2022). Typically, practitioners will begin by disseminating knowledge and information about food, teaching techniques to control portion sizes, and strategies for establishing healthy habits. It is essential to provide an effective dietary intervention to promote long-term positive sustainability and help participants have a nourishing dietary intake that leads to decreased body fat while increasing lean mass (Buhari *et al.* 2022). Previous research indicated participants are more likely to engage if allowed to choose their preferred physical activity intensity (Williams *et al.* 2015), which is similarly observed in this study.

Theme 2: Screening and monitoring. Practitioners emphasised the importance of screening participants before the program. A screening process was used to determine the participant's situation, which was crucial for assessing their preparedness. There are a variety of tools used by the practitioners to screen the participant's readiness such as survey form, a rapport and interview session with the potential clients. Thus, certain practitioners used strict screening processes to ensure participants were fully prepared.

"*So before becoming a client, we will assess your readiness to change. Ok, so readiness to change, if he/she is not ready, we tell them. This is not the best time for you. Ok. Come back when you are ready. That's why we have a high success rate here. Because all the clients have come here and are ready.*" (Practitioner 6, Female, 27).

A scoping review revealed that the Transtheoretical Model was the most common theory or model used in program or interventions to assess participants for behaviour change

Table 1. Themes and sub-themes of activities in the weight management program

No	Activity (themes)	Sub-themes
1	Nutrition and exercise	Controlling diet intake
		Physical activity
2	Screening and monitoring	Observe and follow-up
		Evaluate the readiness to change
3	Motivation and spirituality	Encouragement talk
		Spiritual talk
4	Task and challenge	Positive competition
		Daily assignment

(Suhaimi *et al.* 2022). Including a screening process helps practitioners to choose a suitable strategy that aligns with each participant's requirements. The program module shared by practitioners illustrates how to assess a client's readiness for change using the Transtheoretical Model, which assist the practitioners in taking a proper approach for the participants. Meanwhile, practitioners monitor participant's progress during the intervention. Monitoring is a process that is performed during the intervention, such as weighing the participants before and after the intervention and evaluating their progress. Consistent monitoring increases the possibility of success, particularly in an exercise program (Petridou *et al.* 2019). Some practitioners monitored participant's food intake with apps or food diary, while others conducted weekly anthropometry measurement to track the progress. Both methods are common monitoring mechanisms used in weight management programs.

"*There is a record. We called it food diary. We record in food diary. We monitor their food diary. Aaa yes, food diary. We have two ways. One, we used the Apps. Another one, we write in the book. We also have a diary.*" (Practitioner 1, Female, 37).

"*Okay, on certain days we measure their body weight. Once a week we will take their body fat measurement and other details.*" (Practitioner 9, Male, 36).

Meanwhile, some practitioners use different approaches to assess participants, like conducting a quiz.

"*We will have close monitoring. So, during close monitoring, we will make a zoom call. So, during zoom call we will make a quiz. We will ask, we will teach them interactively, because by the end of the day, after they finish with our program, we will assess, whether they are ready for us to let them go. If they are not ready, meaning that they don't understand anything, we will ask them to renew again until you are ready."* (Practitioner 6, Female, 27).

Theme 3: Motivation and spirituality. Practitioners typically motivate current participants through sharing session with past successful participants to boost self-efficacy and attain their objectives. Self-efficacy facilitates behavioural changes that result in positive outcomes (Bandura 1998). Furthermore, to increase participant motivation, practitioners commonly invited knowledgeable or professional individuals.

"*For the motivation perspective, we invited ustad, psychologist, icon or even celebrity, or anyone with connection.*" (Practitioner 2, Male, 40).

"*For motivation, certain nutritionist they called a motivational specialist who is specialises in losing weight to motive. Aa to motivate. Because if we only do nutrition and physical activity only with no motivations, meaning it will not work, right? So, there are certain time we call for motivation talk*." (Practitioner 1, Female, 37).

Beside motivation, a new theme emerged: spirituality. It was found that practitioners also integrated spiritual activities such as religious elements that involve inviting speakers or ustad to discuss nutrition from an Islamic perspective.

"*Nutrition, then disease prevention, is the doctor's job. Then, for the spiritual soul, it's the counsellor's job. Now, we also include a religious part. Meaning that we are not only focused on a single talk. We have many things.*" (Practitioner 4, Female, 46).

One practitioner uses a spiritual approach to encourage participants to manage their time and routine by waking early and performing a voluntary Sunnah Prayer, which strengthens their discipline to lose weight.

"*Actually, what I want to convey is to wake up and ask Him. 'Oh Almighty, I want to be healthy'. That is the reason. If you asked God, God will take care of your life, your time. All of sudden, they can exercise. Suddenly trying to fasting. What I want to teach is, what I want to show them, you have to ask the God first. I'm just a medium.*" (Practitioner 10, Female, 36).

Spirituality is commonly perceived as having deeper meaning and experience in life beyond scientific explanation, yet vital in a religious context (Steinhauser *et al.* 2017). Although it is not common in the intervention, including a religious component can enhance participant's health awareness that complies with spiritual teachings. A study found that the majority of Malay Muslim respondents did not follow Prophet (SAW) healthcare practices, which raising concerns about the uncontrolled eating habits that are linked to obesity risk (Burhanundin *et al.* 2017). Another study reported that Muslims usually experience weight changes during the month of fasting (Sadeghirad *et al.* 2014), which lasts 29 or 39 days and refrains them

from consuming food and drinking from sunrise to sunset (Moghadam *et al.* 2021). This fasting generally contributes to weight loss depending on individual dietary intake. As the majority of Malaysians are Muslim, some practitioners emphasise the importance of incorporating spiritual activities such as fasting to increase the chance of losing weight.

"*We focus more on calorie deficits and fasting. Ha, we got three styles of fasting. One, once a week. Second, of course on Tuesday and Thursday. Thirdly, Nabi Daud's fasting. Or if can't at all, we will try to push it. Try at least three days in a month*." (Practitioner 10, Female, 36).

Theme 4: Task and challenge. Various tasks and challenges were employed due to the intervention's lengthy duration and increasing participant's engagement. Task refers to the activity participants are required to fulfil, such as sharing their daily food intake and steps. Practitioner 10 mentioned using WhatsApp messenger or email to assign daily or weekly tasks to the participants:

"*But for example, I gave them through email. Email. Then we WhatsApp daily. Then they have homework again every week. Their homework is like focusing more on getting the steps every day*." (Practitioner 10, Female, 36).

"*I said, there are days when you are busy, for example, Monday. Based on research, at least try to reach 4,700 steps less or more. So on Monday, try to complete 5,000 steps, is enough. Aa so we focus get the 10,000 steps on Saturday and Sunday. Because we know everybody is busy, it is not possible to get 10,000 steps on Monday."* (Practitioner 10, Female, 36).

A practitioner stated that responses usually based on the participant's input.

"*But I, I usually encourage those who have just joined to show us what they eat. And from there, we can help to guide them. It means, they upload the foods photo, chicken rice. And I said, okay good. Very good. Okay, no problem. How about the food got coconut milk? No problem, coconut milk is good.*" (Practitioner 10, Female, 36).

Meanwhile, challenge activities create competitiveness, such as counting the highest weekly steps among participants.

"*And we also do a challenge, a physical challenge. We have a virtual run, and we have a medal. And we have a challenge like a squat. In those six weeks, they must complete squats, plank and burpees."* (Practitioner 9, Male, 36).

A task-based weight management program was discovered as a practical approach. Task-based activities include weekly goals like walking 10,000 steps daily, using a food diary and avoiding unhealthy food (McRobbie *et al.* 2019). These activities are not only effective but also cost effective particularly for low socioeconomic communities. In contrast, middle-class-and upper-class communities tend to engage in voluntary online platform activities like viewing multimedia information submitting dietary activities through platform (Leahey *et al.* 2018). Participation in these activities is typically voluntary and optional.

Nevertheless, these task and challenge activity indirectly help initiate participants' self-efficacy in engaging in healthy behaviour. Self-efficacy, derived from the Social Cognitive Theory constructs, describes individual's belief in achieving goals based on task-specific challenges (Bandura 1998; Johari 2019). Hence, increasing self-efficacy may contribute to participants' capability to sustain a healthy lifestyle.

Themes for outcomes of weight management intervention

The practitioners pointed out three primary outcomes that commonly occur following the completion of the intervention, as listed in Table 2. According to practitioners, these outcomes usually become apparent after a minimum duration of eight weeks of the program.

Table 2. Themes and sub-themes of out comes in the weight management program

No	Outcome (themes)	Sub-themes
1	Demonstrating positive self-change	Confident and motivated
		Changing lifestyle
		Body weight loss
		Healthier dietary intake
2	Influencing their surrounding	Inspiration to other people
3	Cost saving, particularly on food and healthcare	Less money being spent

Theme 1: Demonstrating positive self-change. Participants demonstrated a positive self-change in two categories: physical and mental improvement. Depending on their personal goals, participants will either lose or maintain their physical weight. Practitioner 1 noticed that participants display positive behavioural changes towards healthy eating and lifestyle, which aligns with previous research on the health benefits of weight management programs (Nitschke *et al.* 2022).

"*Actually, weight management can be a cure. It means that it can be a treatment for fertility. And the positive impact that we can see the changes in their lifestyle, which has been able to change towards a healthy lifestyle*." (Practitioner 1, Female, 37).

From a mental perspective, practitioners observed that participants developed greater self-confidence along with weight loss. This finding is consistent with a review of the program focusing on behavioural change (Jones *et al.* 2021), which will improve the participant's mental well-being and quality of life.

"*They seem to gain more confidence. People who are losing weight seem happy, more healthy and have higher levels of self-confidence.*" (Practitioner 4, Female, 46)

"*Definitely those who managed to lose weight look more confident. Yes definitely, and aaa how do you say? They are braver too*." (Practitioner 2, Male, 40)

Theme 2: Influencing their surrounding. Practitioners posited that participants positively impact themselves and the people surrounding them.

"*But I think the positive impact is also that he/she actually influences his/her friends who did not join the program.*" (Practitioner 1, Female, 37).

"S*o, we've got participant who was very shy at first. Later, become successful. We bring that participant to be an icon for the next program, which can give presentation and give motivation to others*." (Practitioner 2, Male, 40).

The weight management interventions enable participants to positively influence their families and communities (Solmon 2015), which influences the social environment. Engaging as a team encourages the likelihood of success due to positive support (Johari 2019). Based on this finding, participants can influence fellow program participants, as well as their peers who are not enrolled in the weight management program.

Theme 3: Cost saving, particularly on food and healthcare. Practitioners noticed economic savings among participants, especially in food and health-related treatment.

"*We want to promote that when they become healthy, their cost for medical treatment will decrease*." (Practitioners 1, Female, 37).

According to some practitioners, participants often choose pricier food while starting a weight loss journey.

"*I noticed one more thing. When people are aware of changing their diet and lifestyle, they think they need to eat expensive food. Usually, they choose Western food. They don't realise that our food is actually healthy.*" (Practitioner 5, Male, 26).

Thus, practitioners guided participants towards healthier choice but affordable.

"*When we do personalisation with him, it's really helpful from the economic point of view. It's like, there are people who think they have to eat salmon to be healthy, right? We just give him eggs; he'll be like, 'Can we eat eggs to lose weight?' People are always afraid of cholesterol and all, things like that*." (Practitioner 7, Female, 28).

A weight management intervention was found to assist a family in improving their finance by decreasing health treatment (Albright *et al.* 2020). A possible explanation was that reducing sugar or fat intake allows them to purchase healthier food like fruits and vegetables (Kaur *et al.* 2020). Indirectly, intervention promotes nutritious food purchased and minimises illness risk while reducing spending on health treatment.

In general, four significant themes for activities and three themes for outcomes were identified from this study. Most practitioners agreed that nutrition and exercise; screening and monitoring activity are essential components in the intervention, as emphasised by Practitioner 1 and Practitioner 9. By the program's end, participants that committed to nutrition and exercise activity can manage their weight, aligning with previous studies showing that these activities assist in weight loss effectively (Buhari *et al.* 2022). Not all programs include spiritual and challenge activities, as highlighted by several practitioners. The implementation of spiritual activities depends on several factors, such as the speaker's topic and participant's willingness to engage.

Therefore, not all favourable results may be achieved. Practitioners observed that some low

success rates were caused by participant's lack of commitment, time constraints, limited resources, and mental and physical preparation or readiness. A similar study found that a lack of dedication prevents participants from progressing in weight loss (Johari 2019). Participants acknowledge the importance of commitment, yet deficiencies in action and mental preparedness, dedication to change, and managing time compromise the program's effectiveness.

Practitioner's perspectives are crucial as they are responsible for planning and implementing interventions. This present study also identified novel themes, such as spirituality and challenge activities, that are rarely report in previous research. While most programs include motivational activities, limited studies have considered spiritual activities. Spirituality is diverse and subjective, which depends on human belief (Michopoulou & Jauniškis 2020). Although often overlooked, some studies demonstrated its significance in strengthening health promotion intervention and health outcomes (Steinhauser *et al.* 2017) and improving dietary intake and Body Mass Index (BMI) among overweight and obese individuals (Patel *et al.* 2017). Hence, in this study, practitioners believe adding spiritual activities can be beneficial to the participants.

Conversely, a challenge activity can appear as a physical task, such as achieving physical goals, which significantly improved weight loss among participants (Bojd *et al.* 2022). Thus, some practitioners integrated into the program in the hope of increasing the effectiveness of the outcome. However, limited studies have explored the effectiveness of this activity. Our findings grouped challenges and task activities, while spirituality and motivation were combined into another theme. It is recommended that they be classified as separate and independent themes. Spirituality and challenges activity are valuable sharing from practitioners, although they only emerged briefly during the interview. Incorporating these two activities may improve future interventions, especially in the Malaysian context.

CONCLUSION

In conclusion, practitioners believe that combining various activities will strengthen the program's effectiveness, including nutrition and physical activity, screening and monitoring, motivation and spirituality, and task and challenge. The present study also discovered two types of potential activities, namely spirituality and challenge activity. Including activities like spiritual talks by certified speakers and creating positive competition among participants is recommended. Hence, future intervention practitioners may incorporate relevant activities to boost the intervention's impact.

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DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflict of interest.

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Research Article

Obstetrical Characteristics and Glucose Profile of Singleton Primigravid Women with Gestational Diabetes Mellitus in Meru Mother and Child Health Clinic, Malaysia

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ABSTRACT

This study aims to explore the baseline obstetric characteristics of singleton, primigravid women with Gestational Diabetes Mellitus (GDM) from an experimental study. A total of 58 subjects with GDM, who were solely on diet control, were recruited from Meru Health Clinic in Selangor. The majority of the subjects (97%) were Malay. The mean age of the subjects was 27.6±3.2 years, with a pre-pregnancy weight of 68.9±17.8 kg, a height of 1.6±0.1 m, and Body Mass Index (BMI) of 28.1±6.7 kg/m^2. Most subjects in this study (93%) were diagnosed with GDM at their first Oral Glucose Tolerance Test (OGTT), conducted at a mean gestational age of 18.9±2.8 weeks. The OGTT readings at diagnosis were 5.1±0.6 mmol/L for Fasting Blood Glucose (FBG) and 7.9±1.5 mmol/L for 2-Hour Postprandial (2HPP). The Blood Sugar Profile (BSP) levels were recorded as follows: fasting at 4.8±0.4 mmol/L, pre-lunch at 5.1±0.5 mmol/L, post-lunch at 5.3±0.5 mmol/L, and post-dinner at 5.3±1.5 mmol/L. Macronutrient intake was within the recommended guidelines. The subjects delivered at a mean gestational age of 38.8±1.1 weeks, with a mean birth weight of 2.9±0.4 kg. No incidences of macrosomia were recorded in this study. In conclusion, the subjects underwent early GDM screening, had well-controlled antenatal blood glucose levels, and experienced no adverse pregnancy outcomes.

INTRODUCTION

Women at high risk of developing Gestational Diabetes Mellitus (GDM) are required to be screened as soon as possible upon registering for antenatal check-ups in the Malaysian clinical setting. According to the Malaysian Clinical Practice Guideline, women at risk of developing GDM include those with a pre-pregnancy Body Mass Index (BMI) of ≥27 kg/m^2, a previous history of GDM, a first-degree relative to diabetes, a history of macrosomia, a poor obstetric history, the occurrence of glycosuria ≥2 on two occasions, and current obstetric problems such as essential hypertension, pregnancy-induced hypertension, and polyhydramnios (MaHTAS 2017). However, high-risk women not diagnosed with GDM during their initial Oral Glucose Tolerance Test (OGTT) undergo an additional OGTT screening between gestational weeks 24 and 28, along with those aged 25 and above who do not exhibit other risk factors.

Recent data reveals a 10% increase in the prevalence of GDM in Malaysia over the past six years. According to the National Health and Morbidity Survey on maternal and child health, there has been a nationwide rise in GDM prevalence, increasing from 13.5% in 2016 to 27.1% in 2022 (IPH 2023). Furthermore, a study conducted by Logakodie *et al.* (2017) across 72 public health clinics in Selangor observed that 27.9% of 745 women were diagnosed with GDM. This significant rise in prevalence is concerning, as it highlights the escalating burden of GDM in Malaysia and the potential risks it poses to maternal and child health.

Primigravid women, those experiencing their first pregnancy, represent a particularly vulnerable group with unique obstetric challenges and an increased risk of adverse outcomes associated with GDM (Kampmann *et al.* 2015). These outcomes include hypertensive disorders, preterm birth, cesarean delivery, and macrosomia (Le *et al.* 2023). Recent studies highlight the importance of early detection and individualized management of GDM to improve pregnancy outcomes (Raets *et al.* 2021). Understanding the obstetrical characteristics and glucose profiles of primigravid women with GDM is essential for developing targeted interventions and improving maternal and fetal outcomes. Hence, this study aims to explore the baseline obstetrical characteristics and glucose profile among singleton primigravid women with GDM in an experimental study.

METHODS

Design, location, and time

This study presents the baseline obstetric data from an experimental study design involving first-time mothers diagnosed with GDM. The experimental group received a series of breastfeeding modules during the antenatal period, with breastfeeding being explored as a potential preventive strategy to lower the risk of postnatal diabetes. Meanwhile, the control group continued with the standard antenatal care provided by the health clinic. Every participant was followed up until six months postpartum, resulting in a total duration of 10 months. This study was conducted from March 2022 to August 2023 at Meru Health Clinic, Selangor. It was registered with the National Medical Research Register (NMMR) (ID: NMMR-19-4204-52471(IIR)) and received ethics approval from the Research Ethics Committee (REC) of Universiti Teknologi MARA (ID: REC/08/2021(MR/678)). All subjects provided written consent before enrolment in this study.

Sampling

The sample size was determined using a formula developed by Ogston *et al.* (1991). This formula was used to calculate the sample size for two groups to compare the effects of the experimental and control interventions, based on the mean difference in HOMA-IR between the high-intensity and non-high-intensity breastfeeding groups, which was approximately 0.64 at 12 to 14 months after delivery. Group allocation was conducted using unrestricted randomization. A previous study reported a pooled standard deviation of 0.68 (Yasuhi *et al.* 2017). The necessary sample size to achieve 80% statistical power at a significance level of 5% was calculated. Therefore, a total of 58 subjects were recruited for both groups, with an additional 20% to account for potential dropouts. This study involved primigravid, singleton pregnant mothers with GDM, aged 18 to 45 years, at 20 weeks of gestation or later, who were on diet control alone and were Malaysians. Mothers with severe illness or infection, multiple pregnancies, or a prior diagnosis of Type 1 Diabetes Mellitus (T1DM) or Type 2 Diabetes Mellitus (T2DM) were excluded from this study.

Data collection

The obstetric data, maternal glucose parameters, nutrient intake, and pregnancy outcomes were retrieved from the subjects' medical records and face-to-face interviews. In Malaysia, mothers at high risk of developing GDM are diagnosed as early as possible. The diagnostic criteria for the subjects were based on the Malaysian Clinical Practice Guidelines (CPG), which specify that blood glucose levels must be either Fasting Blood Glucose (FBG) ≥5.1 mmol/L or 2-Hour Postprandial Blood Glucose (2HPP) ≥7.8 mmol/L (MaHTAS 2017). However, if mothers pass the first Oral Glucose Tolerance Test (OGTT), they undergo a second OGTT at weeks 24 to 28 of gestation. They are excluded from a GDM diagnosis if they pass the second OGTT.

Mothers with GDM are required to perform BSP at the clinic during fasting, pre-lunch, post-lunch, and post-dinner. The target blood glucose levels are as follows: FBG ≤5.3 mmol/L, 1-hour postprandial ≤7.8 mmol/L, and 2-hour postprandial ≤6.7 mmol/L. The BSP was conducted once or twice a month in this clinical setting, depending on the subjects' blood glucose control. Therefore, BSP readings during pregnancy reflect blood glucose levels during this period, as they represent the average BSP taken during antenatal care.

Subjects' nutrient intake was assessed using the Food Frequency Questionnaire (FFQ), adopted from Norimah *et al.* (2008), as soon as they were recruited in this study. This FFQ

includes 137 food items categorized into 14 food groups. Subjects were interviewed by a dietitian to report the frequency of their consumption of these food items over the previous month, specifying whether items were consumed daily, weekly, or never. Nutrient analysis was conducted using Dietary Plus Software, developed by Ng (2010). Most local foods consumed by the subjects were available in the database. In cases where specific foods were not present, they were deconstructed into individual ingredients, which were then analyzed alongside estimated amounts of added oil and salt, as previously done by Farhanah *et al.* (2017).

Data analysis

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software, version 26 (SPSS Inc., Chicago, USA). Descriptive statistics, including mean±SD, were used to provide an overview of the socio-demographic data, maternal baseline characteristics, and nutrient intake. Pearson correlation was used to observe the relationship between the level of 2HPP and birthweight. Numerical data were presented as mean and standard deviation.

RESULTS AND DISCUSSION

The majority of the subjects in this study (97%) were Malay, while the other 3% were Indian. More than half (55%) of the subjects had a tertiary education level. Regarding occupation, 18 subjects were unemployed (31%), while the majority (57%) worked in the private sector. Four subjects (7%) were self-employed, and three subjects (5%) were government servants. The household income categories were based on the Department of Statistics Malaysia (2023). Most subjects' household income was categorized under the B40 household group, with only one subject (1%) in the T20 household group.

Table 1 presents the obstetric characteristics of the subjects in this study. The majority (93%) were diagnosed during their first OGTT, while a minority (7%) were diagnosed during their second OGTT. The subjects' age was 27.6±3.2 years, their pre-pregnancy weight was 68.9±17.8 kg, their height was 1.6±0.1 m, and their pre-pregnancy BMI was 28.1±6.7 kg/m². According to Asian categories, the pre-pregnancy BMI classifications showed that 46.0% were classified as overweight, 27.0% as Obese Class I, 17.0% as Obese Class II, and 9% as Obese Class III. Compared to previous studies conducted in Asian countries among women with GDM, the subjects in this study had a higher mean pre-pregnancy BMI of 28.1 kg/m². This contrasts with studies conducted in China (You *et al.* 2020) and Japan (Yasuhi *et al.* 2019), where the average pre-pregnancy BMI of subjects was 25.91 kg/m^2 and 23.9 kg/m^2, respectively. According to the National Health and Morbidity Survey 2019, the prevalence of overweight Malaysians was 50.1% in 2019, showing an increasing trend from 44.5% in 2011 to 47.7% in 2015 (Chong *et al.* 2023). Surprisingly, in 2023, the prevalence of overweight and obesity continued to rise, reaching a rate of 54.5% (IPH 2023). It was found that the female gender was significantly associated with a higher risk of being overweight (Chong *et al.* 2023). In Southeast Asia, overweight and obesity are recognized as significant risk factors for non-communicable and chronic diseases (Dans *et al.* 2011). The rising prevalence of overweight and obesity has been associated with adverse maternal outcomes, including an increased risk of macrosomia, GDM, eclampsia, and higher cesarean delivery rates among pregnant women in Southeast Asia. Consequently, it is anticipated that as obesity rates continue to rise, the incidence of diabetes in pregnancy will also increase (Bashir *et al.* 2024). A similar trend has been observed in Malaysia, where both the prevalence of GDM and obesity have seen a notable rise (IPH 2023).

It has been outlined that women at high risk of developing GDM should undergo screening for GDM promptly (MaHTAS 2017). This study recorded that the subjects underwent screening at an average gestational age of 18.9±2.8 weeks. This has been categorized as early GDM screening, as it is conducted within 13 to 20 weeks of gestation, according to Deitch *et al.* (2024). Furthermore, the majority (93%) of the subjects were diagnosed with GDM at their first OGTT. When compared to other studies, the gestational age at which women were diagnosed with GDM varied significantly. In Poland, Oleszczuk-Modzelewska *et al.* (2022) found that women were diagnosed at 25.4 weeks of gestation. In Northern California, the diagnosis was made at 24 weeks of gestation (Gunderson *et al.* 2015). In Japan, women with GDM were diagnosed at 28.1 weeks of gestation (Yasuhi *et al.* 2019). Meanwhile, a study in Indonesia found that among 35 subjects with GDM, only

Table 1. Obstetrical characteristics of the subjects

Characteristics	Mean±SD (N=58)	Range (Minimum–Maximum)	n (%)
Age (year)	27.6±3.2	28.8–28.4	
Pre-pregnancy weight (kg)	68.9±17.8	64.2–73.5	
Height (m)	1.6±0.1	1.5–1.6	
Pre-pregnancy BMI (kg/m^2)	28.1±6.7	26.3–29.8	
Week of OGTT measurements	18.9±2.8	18.2–19.7	
Birth weight (kg)	2.9±0.4	2.8–3.1	
Delivery week	38.8±1.1	38.4–39.0	
Pre-pregnancy BMI (kg/m^2)			
Overweight (23.0–27.4)			27 (46.0)
Obese class I (27.5–32.4)			16 (28.0)
Obese class II (32.5–37.4)			10 (17.0)
Obese class III (≥37.5)			5 (9.0)
Family history of Diabetes			
Yes			31 (53.0)
No			27 (47.0)
Mode of treatment			
Diet control			29 (100.0)
Metformin			-
Insulin			-
Number of OGTT			
First			54 (93.0)
Second			4 (7.0)
Mode of delivery			
Normal			38 (66.0)
SVD			32 (84.0)
Vac Ext			1 (3.0)
LFD			5 (13.0)
Caesarean			20 (35.0)
Incidence of Macromia			0 (0.0)

BMI: Body Mass Index; OGTT: Oral Glucose Tolerance Test; SVD: Spontaneous Vaginal Delivery; LFD: Low Forceps Delivery; Vac Ext: Vacuum Extraction Delivery; SD: Standard Deviation

4 (11.4%) were diagnosed during the second trimester, whereas the remaining 31 (88.6%) were diagnosed in the third trimester (Kwan & Susanto 2022). These findings indicate that the subjects in this study, who were overweight and obese, had a first-degree relative with diabetes, were classified as being at significant risk of GDM, and were diagnosed with GDM at an early stage. More than half (53%) had a family history of diabetes. Delivery occurred at a gestational age of 38.8±1.1 weeks, with 66.0% having delivered their babies normally. Among them, the majority (84.0%) had a Spontaneous Vaginal Delivery (SVD), one subject (3.0%) had a vacuum extraction delivery, and five subjects (13.0%) had a Low Forceps Delivery (LFD).

Table 2 shows the antenatal glucose parameters of the subjects. FBG level during the OGTT for GDM diagnosis was 5.1±0.6 mmol/L, and the 2HPP level was 7.9±1.5 mmol/L. In comparison to the Malaysian Clinical Practice Guidelines (CPG), 31% had an FBG level ≥5.1 mmol/L, 45% had a 2HPP level ≥7.8 mmol/L, and 24% had both FBG and 2HPP levels ≥5.1 and ≥7.8 mmol/L, respectively (Figure 1).

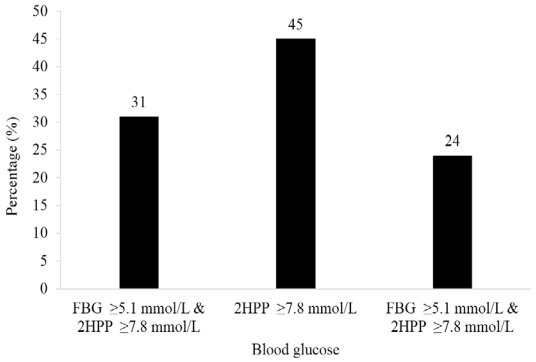
According to (Ryan *et al.* 2020), having elevated antenatal FBG levels was associated with a higher risk of Large-For-Gestational Age (LGA) and Hypertensive Disorders of Pregnancy (HDP) compared to elevated postprandial blood glucose levels among women with GDM. This association remained regardless of whether the mother received pharmacological intervention, predominantly insulin therapy. This finding was supported by a study in China involving 14,741 women, which found an approximately two-fold higher incidence of LGA, macrosomia, and cesarean section among women with elevated FBG compared to those with elevated postprandial blood glucose (Feng *et al.* 2017).

Contradicting the findings of this study, although 31% of the subjects had exceeded the cut-off point of FBG during diagnosis and 24% had exceeded both FBG and 2HPP, no incidence of macrosomia was observed. This outcome may be attributed to the fact that this study only included subjects who were on diet control alone. This is supported by previous research indicating that women with GDM on diet control alone tend to exhibit better blood glucose profiles compared to those requiring insulin therapy (Mecacci *et al.* 2021). Furthermore, women with GDM on insulin therapy are more likely to experience adverse pregnancy outcomes, such as preterm delivery and the need for cesarean section (Ye *et al.* 2022). However, the sample size of this study

Table 2. Antenatal glucose parameters of the subjects

Parameters	Mean±SD (N=58)	Range (Minimum–Maximum)
OGTT		
Fasting (mmol/L)	5.1±0.6	4.9–5.2
2HPP (mmol/L)	7.9±1.5	7.5–8.2
BSP		
Fasting (mmol/L)	4.8±0.4	4.7–4.9
Pre-lunch (mmol/L)	5.1±0.5	4.9–5.1
Post-lunch (mmol/L)	5.3±0.5	5.2–5.4
Post-dinner (mmol/L)	5.3±1.5	4.9–5.7
Blood pressure (mm/hg)		
Systolic	116±10.3	113.6–119.1
Diastolic	73±9.3	69.7–74.6

OGTT: Oral Glucose Tolerance Test; 2HPP: Two-Hour Postprandial Blood Glucose, BSP: Blood Sugar Pofile; SD: Standard Deviation



FBG: Fasting Blood Glucose; 2HPP: 2 Hour Post-Prandial

Figure 1. Oral glucose tolerance test during diagnosis compared to the Malaysian clinical practice guidelines

is insufficient to establish a definitive correlation between blood glucose levels and pregnancy outcomes. This limitation aligns with the main objective of this study, which is to observe the baseline obstetrical characteristics of the subjects.

The BSP levels during pregnancy were monitored four times daily, showing readings of 4.8±0.4 mmol/L (fasting), 5.1±0.5 mmol/L (pre-lunch), 5.3±0.5 mmol/L (post-lunch), and 5.3±1.5 mmol/L (post-dinner). The Mean±SD of the antenatal blood pressure was 116/73 mmol/L. Figure 2 shows the antenatal BSP readings of the subjects in comparison to the Malaysian Clinical Practice Guidelines. The blood glucose levels for BSP indicate that the FBG must be ≤5.3 mmol/L, 1-hour postprandial should be ≤7.8 mmol/L, and 2-hour postprandial must

FBG: Fasting Blood Glucose

Figure 2. Antenatal blood sugar profile compared to the Malaysian clinical practice guidelines

be ≤6.7 mmol/L. The overall mean shows that the Mean±SD of BSP readings was within the specified guidelines (Table 2). However, further analysis has been conducted to categorize the levels of BSP. The findings indicate that a small proportion (9%) of the subjects exceeded the cut-off points during fasting, while 2% and 3% of the subjects exceeded the recommended guidelines during post-lunch and post-dinner, respectively.

Based on a report of systematic review and analysis, it has been documented that blood glucose monitoring has been associated with favorable pregnancy outcomes. These outcomes include a lower incidence of macrosomia, a lower mean birth weight, and a lower rate of shoulder dystocia (Yeh *et al.* 2023). Consistent with the findings of this study, most of the BSP readings were within the recommended range, with a mean birth weight recorded at 2.9±0.4 kg and no incidences of macrosomia observed. To further support this outcome, a small positive correlation was observed between the level of 2HPP levels after lunch and birthweight (r=0.2, p=0.2), suggesting that the lower level of 2HPP levels corresponded to lower birthweight. However, it is important to note that this relationship did not reach statistical significance. The management guidelines for diabetes in pregnancy state that women with GDM who are on diet control alone must deliver before 40 weeks of gestation (Nurain *et al.* 2019). Subjects in this study adhered to the recommended guidelines, with a recorded delivery at week 38.8±1.1 of gestation.

The nutrient intake of the subjects was meticulously analyzed, with the Mean±SD values for energy, carbohydrate, protein, and fat recorded as 1,591±563 kcal/day, 198.7±78.9 g, 74.3±29.3 g, and 54.8±24.5 g, respectively. In terms of macronutrient distribution, carbohydrates accounted for 50% of Total Energy Intake (TEI), protein made up 19% of TEI, and fat contributed 31% of TEI (as shown in Table 3). According to the Malaysian guidelines for the management of diabetes in pregnancy, particularly for women with GDM, maintaining optimal glucose control and achieving appropriate GWG is crucial. The guidelines advise women with GDM to consume a minimum of 175 g of carbohydrates per day, with carbohydrates contributing 50% to 55% of TEI. Additionally, protein intake should be at least 71 g daily, accounting for 15% to 20% of TEI, while fat intake should range between 25% and 35% of TEI (MaHTAS 2017; ADA 2022). The results of this

Table 3. Nutrient intake of the subjects during pregnancy

Nutrient	Mean±SD (N=58)	RNI
Energy (kcal)	1,591±563	-
Protein (g)	74.3±29.3	Minimum of 71 g
TEI protein (%)	19	15%–20%
Fat (g)	54.8±24.5	-
TEI fat (%)	31	30%
Carbohydrate (g)	198.7±78.9	Minimum of 175 g/day
TEI Carbohydrate (%)	50	50%–55%
Sugar(g)	64.5±35.9	-
Dietary Fiber (g)	15.5±8.2	25 g
Calcium (mg)	662.6±291.6	1,000 mg/day
Sodium (mg)	1,500.0±852.7	1,500 mg/day
Ferum (mg)	94.1±62.0	e
Potassium (g)	1,766.6±674.1	4,700 mg/day
Cholesterol (mg)	267.5±139.4	-
Dietary glycemic index	57.4±5.8	-
Dietary glycemic load	115.1±50.5	-

TEI: Total Energy Intake; RNI: Recommended Nutrient Intake; e: Iron supplementation; Sources: Ministry of Health Malaysia (2017) and ADA (2022); SD: Standard Deviation

study indicate that the macronutrient intake of the subjects was consistent with these recommended guidelines. The study found that the dietary fiber intake of the subjects averaged 15.5±8.2 g/day, which falls short of the Recommended Nutrient Intake (RNI) for Malaysians, set as 25 g per day (Ministry of Health Malaysia 2017). A diet containing more than 25 g of dietary fiber is associated with numerous health benefits, including a reduced risk of Type 2 Diabetes Mellitus (T2DM), Cardiovascular Diseases (CVD), and support in maintaining a healthy weight (Ministry of Health Malaysia 2017).

The National Institute for Health and Care Excellence (NICE) guidelines recommend that women with GDM substitute high glycemic index foods with those that have a lower Glycemic Index (GI) (NICE 2015). A study by Farhanah *et al.* (2017) observed that women adhering to a low GI diet (50±9 units), rich in dietary fiber and calcium, had favorable outcomes. In this study, the dietary GI and Glycemic Load (GL) were found to be 57.4±5.8 and 115.1±50.5, respectively. Although the dietary fiber was below the recommended levels, the dietary GI was moderate (57.4±5.8). This moderate dietary GI, despite low fiber intake, could be attributed to the high fat intake recorded during pregnancy (54.8±24.5, accounting for 31% of total energy intake). It was reported that the presence of fats can prolong the transit time of food through the intestine, thereby slowing carbohydrate digestion and consequently lowering the dietary GI (Eleazu 2016).

The strength of this study is that it provides information on the obstetrical characteristics of first-time mothers with GDM at the Meru Mother and Child Health Clinic in Malaysia. This study will serve as preliminary data, including demographics, medical history, and

other relevant clinical parameters. The data will be used for future research on women with GDM, particularly in Malaysia. However, this study had a small sample size and was limited to primigravid women with GDM who were treated with diet alone.

CONCLUSION

This study provides valuable insights into the baseline obstetrical characteristics of primigravid women with GDM who were managed solely through diet control. The findings emphasize the critical role of early GDM screening, which enables timely and effective management to maintain optimal blood glucose levels during pregnancy. This, in turn, supports favorable maternal and neonatal outcomes in pregnancies complicated by GDM.

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DECLARATION OF CONFLICT OF INTEREST

The authors have no conflicts of interest.

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Research Article

The Complexities of Social Dining: Investigating Role of Impression Management, External Eating, and Known Companion Towards Food Portion

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ABSTRACT

This study aims to investigate how dining with acquaintances or friends, the desire to manage others' impressions, external eating, and influence food portion sizes. The research employed a quasi-experimental design, involving 236 participants who were active students at Semarang State University, all of whom were not on a diet, did not have allergies, and non-vegetarians. A General Linear Model Univariate analysis reveals that individuals who ate alone had a bigger portion compared to when eating with a known companion ($F(1,228)=4.059$, $p=0.045$, partial $\eta 2=0.17$). Furthermore, the impression management or external cues influenced the individuals to take bigger portions when eating alone ($F(1,228)=5.290$, $p=0.022$, partial $\eta 2=0.023$; $F(1,228)=4110$, $p=0.044$). However, those with high impression management and external eating tendencies took larger portions when eating with a known companion ($F(1,228)=4.652$, $p=0.032$, partial $\eta 2=0.020$). Thus, the presence of a known companion had a less significant influence on overall portion sizes ($F(1,228)=4.059$, $p=0.045$, partial $\eta 2=0.17$). These findings suggest that known companions exert a complex effect on eating behaviors. Future research should provide clearer guidelines for the appropriate portion sizes companions should take, while emphasizing healthy food choices in social dining setting.

INTRODUCTION

Obesity and overweight have become increasingly significant issues in Indonesia, with excess fat accumulation in overweight and obese individuals leading to chronic diseases, as well as emotional, social, and economic challenges (Masrul 2018; Khotimah & Nainggolan 2019; Sumarni & Bangkele 2023). The prevalence of overweight and obesity among children and adolescents aged 5 to 19 years has increased drastically, from 4% in 1975 to over 18% ini 2016 (Dianah *et al.* 2022). Furthermore, The National Basic Health Research data (MoH RI 2018) indicates among individuals aged 20−24 years, 8.4% are overweight, and 12.1% are obese. As of 2023, the prevalence of overweight in Indonesia has risen to 8.6% and obesity at 13.4%. Among 19 years old, obesity prevalence stands at 8.5%, and overweight 6.2% (IHDPA 2023).The continued increase highlights the need for prevention strategies addressing the underlying causes.

Unhealthy eating habits, often associated with overweight and obesity, often rooted from a lack of nutritional knowledge (Khoirunnisa & Kurniasari 2022). Factors such as macronutrients intake, fiber consumption, breakfast habits, and individual eating patterns influence obesity level (Mulyani *et al.* 2020). Another significant factor is the increasing consumption of calorie and fat-dense fast food (Dianah *et al.* 2022). Food portion size are closely linked to the risk of weight gain (Livingstone & Pourshahidi 2014). Food portions that are not balanced with energy expenditure lead to excess body weight (Stroebe 2023). This demonstrates that consuming portions larger than needed contributes to weight gain. In addition, food choices are influenced by external factors, such as the presence of friends, and internal factors (Higgs & Thomas 2016).

Known companions, such as acquaintances or friend, can influence eating behavior. Previous research shows that people tend to eat similar amount with acquaintances and eat more while with close friend (Higgs *et al.* 2022). Friend's food choices and portions strongly influence others (Higgs 2015; van den Broek *et al.* 2022). This influence stems from social norms shaped by societal expectations or beliefs regarding consumption. For instance, women are often viewed more favorably when eating smaller portions (Higgs 2015; Robinson *et al.* 2014).

Beyond social norms, friends can encourage individuals to align their behavior with their companions, acting as role models in eating habits (Cruwys *et al.* 2015). Studies also show that the presence of friends at meals increases food intake as individuals tend to prepare more pre-meals, leading to larger portions being available. Additionaly, eating with friends also extend meal duration, which can prompt increased consumption (Ruddock *et al.* 2021). There is conflicting evidence regarding the influence of known companions on eating behaviour. Previous studies involving students in Semarang found that social factors, such as the influence of friends or family, did not directly affect food choices. Social factors can have an impact if other factors, such as personal conditions or consumer behavior, are involved in the process (Ramadhani *et al.* 2024). However, other research has found no significant influence of peers on individual eating habits (Jauziyah *et al.* 2021; Lindawati 2019; Muna & Mardiana 2019). These inconsistencies suggest that additional factors, such as individual impression management, may also play a role in eating behavior.

Impression management is one of the factor that influences changes in food portions. In social interactions, individuals often adjust their behavior to shape other's perceptions and present themselves favorably (Bolino *et al.* 2016; Huang *et al.* 2014; Otterbring *et al.* 2023). This conscious modification of actions to desired impression, is known as impression management (Goffman 2023). Moreover, impression management becomes active under two conditions: when individuals regularly monitor their impact on others, and are motivated to measure and control other people's perceptions (Leary & Kowalski 1990). Eating behavior, including adjusting portion sizes, is one way individuals practice impression management (Folwarczny *et al.* 2023). Self-presentation serves three functions: interpersonal influence, identity construction and self-esteem maintenance, and the enhancement of positive emotions (Leary 2019). Conforming to others' food preferences fulfils one of these functions, as it is often considered as emotionally positive (Higgs & Thomas 2016).

In addition to impression management, external eating also affects meal portions. External eating refers to eating behavior triggered by environmental stimuli, such as the smell, appearance, or taste of food, which can increase food intake and lead to larger portion size (Polivy and Herman 2015; Zarychta *et al.* 2019). These external cues often stimulate the urge to eat, overriding satiety. External eaters are more influenced by environmental conditions than by internal signals of hunger or fullness (Hendrikse *et al.* 2015). Visual and olfactory stimuli, such as the sight or smell of food, can trigger eating behavior (Boswell and Kober 2016). Food cues may increase cravings and motivate individuals to seek specific foods (Maxwell *et al.* 2017). External influences can diminish the role of satiety, leading to excessive food consumptions (Boswell & Kober 2016; Schneider-Worthington *et al.* 2022). Additionally, a study indicates that external eating is closely related to obesity, as overweight individuals are particularly vulnerable to environmental cues, such as the availability, variety, and palatability (Benbaibeche *et al.* 2023).

A review of previous research reveals inconsistencies in the influence of known companions on eating behavior and highlights other factors affecting meal portions. Previous studies relied on questionnaires to assess behavior, which can introduce bias, as individuals tend to choose answers that reflect ideal conditions rather than their actual behavior. This study uses a fake food buffet to measure behavior more accurately, as participants' food choices are likely to reflect their genuine preferences. There is also limited research on the influence of friends on food choices and meal portions among students at universities in Semarang.

Therefore, this study aim to determine the influence of known companions on meal portions using different methods such as behavioral measurement. This study provides novelty by examining the interaction between known companions, impression management, and external eating behavior in relation to

individual meal portions. Furthermore, this study employed behavioural measurement through a fake food buffet during data collection process. The research results are expected to enhance knowledge and inform strategies for promoting healthier eating behaviors. However, this study is limited to active students at Semarang State University.

METHODS

Design, location, and time

This study utilized a quasi-experimental design, incorporating both self-reported and behavioral measurements. The research was conducted with students at Semarang State University in December 2023. This study received ethical clearance from the Health Ethics Committee of Semarang State University (approval number 444/KEPK/EC/2023).

The study procedure involved dividing participants into two groups: the experimental group and the control group. The experimental group consisted of participants who made their food choices in the presence of a known companion, while the control group made their food choices without being accompanied. Known companion is determined from random active students in Semarang State University, who introduced themselves to the participants to ensure familiarity. The research was conducted for approximately 8 days, with 3 days for the control group and 5 days for the experimental group. The study was conducted in a laboratory setting, divided into two sessions. Participants in the first session were assigned to the control group, while those in the second session were placed in the experimental group.

The laboratory was divided into three rooms. In the first room, participants completed informed consent forms and questionnaires. In the second room, they selected food, and in the third room, they received debriefs. Participants began in the first room by signing the informed consent form, ensuring mutual agreements on the research terms. Next, participants completed demographic forms, a hunger scale, and questionnaires (Impression management scale and DEBQ 33). The hunger scale assessed variations in the participants hunger levels. In the experimental group, the companion was instructed to establish familiarity with the participant to ensure they knew each other before proceeding to the next phase. Both groups then proceeded to the second room to select food from the fake food buffet. A fake food buffet was arrange on a large table alongside with smaller table with cutlery (trays, spoons, forks, plates and glasses). Before taking the food, the researcher explained the process of taking the food. Participants then selected food according to the menu and their current appetite, taking as much as they desired and placing it on their plate. For drinks, participants selected from the available options and decided whether they would use sugar or not. There were no limits on the quantity of food taken. Control group participants chose their food alone, while the experimental group made their choices alongside with a companion, with whom they were allowed to converse. After completing the procedure, participants received debriefing about the experiment. Upon completing the study, participants were given a reward.

Sampling

The study population consisted of active students from Semarang State University. Voluntary quota sampling was employed with specific inclusion criteria: partcipants had to be an active student, and are not vegetarian, do not have food allergies, or be on a diet program. Sample size analysis was conducted using G*Power 3.1.9.4 with t-test, assuming an effect size of d 0.5, alpha=0.5, and power of 0.90, resulting in a minimum sample size of 231 participants with a medium a priori effect size. The study ultimately recruited 236 participants, comprising 116 in the control group (eating alone) and 120 in the experimental group (eating with known companion).

Recruitment involved distributing pamphlets online, through platforms such as WhatsApp and Instagram, as well as direct brochures distribution. Participants received souvenirs as a token of appreciation. Companion in this study is an active student who is well known and involved in students union (e.g. BEM). Prior to the experiment, companions greeted and conversed with the participants to build rapport.

Data collection

The study hypothesized that known companions, impression management, and external eating would influence meal portions. The hypothesis also included interaction effects between known companions and impression

management or external eating, impression management and external eating, as well as the combined effect of all three factors. To measure individual food portions, this study utilized a fake food buffet, developed by Tamara Butcher in 2011. The fake food buffet consist of a buffet of food replica for participants to choose from. Butcher's research indicates that the overall reliability of the menu was high (M=4.81, SD=0.83). The results from using fake food buffet showed a strong correlation with the results from real food buffets (r=0.76) (Bucher *et al.* 2012). The fake food buffet was selected from its hygienic advantages, practicality, and efficiency compared to using real food. The menu consisted of 24 items, including grilled chicken, meatballs, white rice, boiled potatoes, boiled carrots, boiled cauliflower, apples, bananas, fried chicken, fried beef sausages, fried rice, chips, fried carrots, fried cauliflower, cakes, and fries. Beverages offered included mineral water, juice, soda, Sprite, sweet tea, plain tea, sweet coffee, and plain coffee. The buffet setup included utensils such as plates, spoons, and trays. The fake food dishes was served individually on each plate. For example, fried chicken and fried cabbage were placed on separate plates. Meanwhile, beverage such as Coca-Cola, Sprite, coffee, tea and bottled mineral water were placed directly on the table. The layout arranged drinks and dessert placed next to each other with the main course positioned in front.

Participants completed a hunger scale using a 1−5 likert scale with 1 indicating not hungry and 5 indicating very hungry. Impression management was measured using Bolio and Turnley's 1999 impression management scale, which assesses self-promotion, ingratiation, exemplification, intimidation and supplication. This scale also employed a Likert scale from 1 (strongly disagree) to 5 (strongly agree) (Karam *et al.* 2016). External eating behavior was measured using the DEBQ-33 questionnaire (Van Strien *et al.* 1986), which covers restrained eating, emotional eating, and external eating. For this study, only the external eating data from the 10-item DEBQ-33 questionnaire was used. This contain question on how external cues impact food portion (e.g. If foods smells and looks good, do you eat more than usual?). It uses Likert scale from 1 to 5, where 1 indicates for never and 5 indicates very often. At the end of the section, to assess the familiarity with companion, participantes were responded to a scale from 1 (do not know the companion) to 5 (familiar with the companion).

Data analysis

Questionnaire data were scored according to each specific measures used in the study. Hunger scale data were analyzed using frequency analysis in SPSS, with each hunger level (range between 1: extremily not hungry and 5: extremily hungry) calculated as a percentage of the total number of participants. Similarly, the level of acquaintance with companions in the experimental group was also analyzed to determine the percentage distribution accross each category of level of acquaintance. Portion data from the fake food buffet were manually counted by summing the total number of items selected by each participant. For instance, if a participant chose one serving of plain rice, two serving of fried chicken and one mineral water, so the total item would be four items.

The data from fake food buffet, DEBQ for External Eating, and IM Questionnaire were analyzed using the General Linear Model (GLM) Univariate analysis in BMI SPSS 25.0, with a significance threshold of $p<0.05$. The GLM Univariate approach examined the relationship between the dependent variable and one or more independent variables (portion size, or the total number of food items selected). The independent variables: impression management, known companion, and external eating. Statistical significance was determined with $p<0.05$.

RESULTS AND DISCUSSION

Participants' characteristics including gender, age, Body Mass Index (BMI), and hunger scale. presented at Table 1. Female comprised 60.0% of the sample, and males made up 40.0%. In term of age, 46.2% of participants were between 17 to 19 years old, while 53.8% were aged 20 to 25 years. Regarding BMI, the majority (49.6%) had an ideal body weight, while 22.4% were underweight. The percentages of overweight was 13.6%. Followed by obese I around 10.6% and obese II around 3.8% among the participants. Hunger scale results varied; with 51.3% of participants reported low hunger, 30.1% reported medium hunger, and 18.7% reported very hungry. The companion was a well-known, active students in university union (e.g. BEM).

Table 1. Participant characteristics

Characteristics	n	%
Gender		
Female	141	60.0%
Male	95	40.0%
Age (years)		
17−19	109	46.2%
20−25	127	53.8%
Body mass index (kg/m^2)		
Underweight (<18.5)	53	22.4%
Ideal (18.5–22.9)	117	49.6%
Overweight (23–24.9)	32	13.6%
Obese I (25–29.9)	25	10.6%
Obese II (30 or more)	9	3.8%
Hunger level		
Low hunger/Not hungry	121	51.3%
Medium hunger	71	30.1%
Hungry/Very hungry	44	18.7%
Familiarity to the acquaintance scale		
Had known	75	62.5%
Quite familiar	29	24.2%
Familiar	16	13.3%
Total	120	100.0%

Analysis of Table 1 shows that 62.5% of the 120 experimental group participants reported that they had known the companion (acquaintance) in one way or another, while 24.2% reported quite familiar with the companion, and 13.3% felt familiar with the companion. This data indicates that all participants were at least somewhat acquainted with the companion. The portion size represented by the number of items taken by participants. The average around 10.08 or approximately 10 items. The minimum number of items taken was 2, while the maximum was 36, with mode of 7. The measurement of external eating was conducted using the scores from 10 questions in the DEBQ-33 questionnaire, with participants' minimum score being 14 and maximum score 47. The average score obtained was 31, with the following distribution: 3% of the total participants had the average score, while 25.4% scored between 14−31, and 71% scored between 32–47. Meanwhile, the measurement of impression management used Bolio and Turnley's 1999 scale. The minimum score recorded among participants was 22, while the maximum score reached 105. The average score fell within the range of 59−60, with the distribution as follows: 5.1% of the total participants had the average score, 44.9% scored between 22–58 and 50% scored between 61–105.

Table 2 shows that individuals who ate alone (M=11.40, SD=4.18) consumed larger portion compare to those who accompanied by a known companion (M=8.72, SD=3.42), this suggests that eating with a known companion reduces portion size. The average External Eating score was 31.14 with a standard deviation of 5.64 indicating that most data points close to the average score. Meanwhile, Impression Management (M=59.73, SD=12.74) is evenly distributed. This suggest that some food preferences among participants vary, which are influenced by their impression management and other less affected.

Table 3 presents the results of the univariate GLM analysis indicating that individual who eat alone showed positive association with the portion of food taken, $F(1,228)=4.059$, $p=0.045$, $\partial\eta 2=0.017$. Individuals who eat alone tend to eat bigger portion compared to those who eat in the presence of known peers. While External eating and Impression management alone as moderators did not show significant influence toward portion taken (IM ($F(1,228)=0.791$, $p=0.375$, $\partial\eta 2=0.003$) and external behavior ($F(1,228)=0.403$, $p=0.526$, $\partial\eta 2=0.002$)). However, the interaction between the presence of Known Companion (KC) and Impression Management (IM) is significant in influencing meal portions, $F(1,228=5.290$,

Table 2. Descriptive statistic of portion

Variables	Mean±SD	n
Group		
Alone	11.40±4.18	120
Known companion	8.72±3.42	116
Total	10.08±4.04	236
External eating	31.14±5.64	236
Impression management	59.73±12.74	236

SD: Standard Deviation

Table 3. General linear model univariate details

Effect	Variable	F	Sig	Partial eta square
Main				
	Group	4.059	0.045*	0.017
	EXT	0.791	0.405	0.003
	IM	0.403	0.220	0.007
Interaction				
	Group*EXT	4.110	0.044*	0.018
	Group*IM	5.290	0.022*	0.023
	EXT*IM	0.172	0.206	0.007
	Group*EXT*IM	4.652	0.032*	0.020

*: General linear model univariate analysis test significantly at $p<0.05$; Group: Participants who eat alone vs with a known companion; IM: Impression Management; EXT:External Eating

p=0.022, ∂η2=0.023. Additionally, the interaction effect between KC and External Eating (EXT) behavior is also significant in influencing meal portions, F(1,228)=4.110, p=0.044, ∂η2=0.018. Subsequently, the total effect of interaction between KC, IM, and EXT showed significant influences on meal portions, F(1,228)=4.652, p=0.032, ∂η2=0.020. As predicted, the interaction effect between impression management and external eating behaviour is not significant on meal portions F(1,228)=0.172, p=0.678, ∂η2=0.001).

However, the effect size of the model is relatively small by looking the partial eta square of the independence variables (i.e., Group: 0.017; Group*Impression management: 0.023; Group*External eating: 0.018; Group*Impression management*External eating: 0.020) were between small to medium (0.01−0.06) (ASC 2024). These indicate that all independence variables have significant influence on the food portion even though others variables might have stronger impact.

These results support the hypothesis that the interaction of known companions, impression management, and external eating influences individual food portions. Specifically, while the interaction effect of eating with a known companion, impression management, and external eating can lead to an increase in individual food portions. Participants who eat alone tend to take larger portions than when with a known companion. Individuals who eat alone tend to take bigger portions of food when having impression management or when having external eating behaviors compared to when accompanied. Another hypothesis, which states that impression management and external eating, as well as their interaction, affect food portions, is rejected. This may be because both variables cannot exert their influence without the presence of other individuals in the process. Despite the statistical significance of known companions and their interactions with other variables, the effect size suggests a weak influence on the outcome. This could be attributed to the impact of other factors.

Although participants have a desire to manage their image in front of others, they tend to take a larger portion when eating alone compared to eating with a known companion. Overall, individuals are motivated to present themselves favourable, as the image they project impacts how others perceive and treat them, as well as their own self-perception. In social interactions, self-monitoring often leads to impression management (Wang *et al.* 2020). Impression management becomes active when individuals are conscious of an audience whose impressions they want to control, this could explain participants' behavior that eating large portions when alone compared when with a known companion. The presence of an identity threat can reduce individual food portions. For instance, a good impression of femininity in women is often associated with taking smaller portions of food. The influence of impression management in a social context is less about the eating behavior of what companions eat and more about adhering to the norms of smaller portion sizes, as demonstrated in Vartanian's research (Vartanian *et al.* 2017). This explanation aligns with the tendency to mimic the behaviors or

thoughts of others to gain acceptance in a desired social group (Li *et al.* 2023). Such evidence supports the idea that impression management can be strategically employed to influence and alter eating behavior (Folwarczny *et al.* 2023).

Another aspect that drives individuals to consume larger portions is their tendency toward external eating. External eaters are influenced by environmental cues like taste and aroma in their food selection process (Nurdiani *et al.* 2023). This behavior is often associated with unhealthy eating habits, as it stimulates cravings for sweet, high-fat, or high-carbohydrate foods (Boswell & Kober 2016; Dakin *et al.* 2023). External eaters also tend to disregard feelings of fullness, leading to the consumption of larger (Schneider-Worthington *et al.* 2022). Compared to eating with a known companion, a lack of self control encourages participants to eat more when dining alone. The presence of a known companion introduces a new factor that impacts portion size, such as social modelling. Social modelling requires individuals to observe and imitate the behavior of others regarding food choices and portion sizes (Liu & Higgs 2019). For instance, when eating with individuals who takes small portions, they tend to take smaller portions as well, and vice versa (Vartanian 2015). The presence of known peers during food selection influences individuals to align their portions with what they observe.

Portion size increases when known companions, impression management, and external eating behavior interact, potentially due to distractions during the food selection process. In the experiment, the companion was instructed to engage participants in conversation or encourage them to get to know each other. The pressure to create a friendly impression via impression management may cause individuals to become more socially engaged while selecting food. This interaction between individuals and confederates as peers create distractions in taking food process. Any distraction results in reduced self-monitoring while eating, therefore they tend to take larger portions of food (van Meer *et al.* 2022). These distractions, caused by the communication process between participants and companions, highlight the impact of known companions during food selection.

The overall results of this study show that the presence of known companion can influence eating behavior through the roles of social norms and modelling. Peers involved in the process create conditions that align with appropriate behavioral norms, encouraging individuals take smaller portions of food to maintain a favorable impression (Higgs 2015; Vartanian 2015). This triggers the emergence of role modeling for other individuals present at that time. Individuals tend to follow the eating behaviours of other people who are present at the same time. For instance, if peers take smaller portions, the individual will likely do the same (Cruwys *et al.* 2015; Liu & Higgs 2019). Another finding from this study shows that, as moderators, impression management and external eating, as well as the interaction between the two, are not significant in influencing individual food portions since both factors require the presence of other people to have an effect.

This study reveals the complexity of the influence of known companions on food portions, which vary depending on internal and environmental conditions at the time of food selection. The findings of this study have practical applications for daily life. To prevent overeating, individuals can be encouraged to eat with known companions; such as family or friends. In addition, people can prevent taking excessive portions by limiting distractions, such as engaging in conversation while eating. Furthermore, the results of this study provide new insights into how adjusting social conditions, such as eating with known peers, can help reduce portion sizes and address issues like obesity in Indonesia. The presence of known companions can effectively reduce food intake, especially when individuals have external eating or motivated to impress others. A notable strength of this study is its use of behavioral measurement techniques, which ensures that the results reflect actual behaviors. However, a limitation of this study is the lack of an ideal standard for the portion sizes taken by confederates and the hunger scale was only used to ensure variation among participants. Future research should establish standardized portions size for confederates. Another limitation is the limited exploration of the hunger scale's influence on food portions. Researcher also could examine the hunger scale as an independent variable, including analyzing its interactions with other relevant factors. Additionally, future studies could focus more specifically on healthy food choices, rather than solely on portion sizes. This would help expand the scope of research in this area.

CONCLUSION

The interaction between known companions, impression management, and external eating behavior can lead to increased food portions. Participants with a tendency for external eating behavior or those who desire to manage their self impression in front of others tend to consume a larger portion when eating alone compared to when accompanied by a known companion. The desire to create a positive impression encourages people to eat less only active when there is other people around them. While individuals with external eating habits often model their behavior based on social cues from their peers. However, when all three factors—known companions, impression management, and external eating—interact simultaneously, distractions may arise, leading to larger food portions being consumed. This study provides valuable insights for developing communication strategies aimed at behavior change, which can be utilizd to reduce or prevent obesity.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Research Article

The Relationship Between Authoritative Parenting Style, Oral Sensory Processing, and Eating Behaviour Related to Picky Eaters among Toddlers in Klang Valley, Malaysia

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ABSTRACT

This study aimed to examine the relationship between authoritative parenting style, oral sensory processing, and eating behaviour related to picky eaters among children aged 3 to 5 years. A cross-sectional study was conducted with 99 mother/father-child dyads from several Klang Valley nurseries and kindergartens. Online survey data collection, including the Child Eating Behaviour Questionnaire (CEBQ), the Child Sensory Profile 2 Questionnaire (CSP-2) (Oral Domain), the Parental Style Dimension Questionnaire (PSDQ), and a demographic questionnaire. Appointment-based collection of anthropometric measurements (weight and height) was conducted. Pearson correlation was used to determine the relationship between eating behaviour (picky eaters), oral sensory processing, and authoritative parenting scores, independent t-test to determine nutrition status and eating behaviour, and chi-square test to examine picky eater status and oral sensory processing classification. Results show that the prevalence of picky eaters is 45.5%. Picky eaters scored low in food responsiveness and food enjoyment but high in satiety response and slowness in eating. There was only an association between picky eating behaviour and oral sensory processing ($r=0.22$, $p=0.003$), but no correlation between these indicators and authoritative parenting styles ($p>0.05$). No significant difference was found in nutrition status between non-picky eaters and picky eaters ($p>0.05$). According to this study, nearly one out of two children is a picky eater, which is defined by less enjoyment of food, less responsiveness to food, eating slowly, and feeling full quickly. This research is likely to aid in the development of more targeted intervention programmes for picky eaters.

INTRODUCTION

Picky eating is one typical nutritional issue among children under five (Taylor *et al.* 2019). Although there is variance in the description of picky eaters, most researchers identify the following elements: lack of variety in food consumption, fear of trying new foods (neophobia), and refusal to eat commonly consumed foods, which all interfere with the child's daily routine (taking a long time to eat) (Taylor *et al.* 2015). Consequently, this poses a challenge for parents in providing food, which eventually impacts the nutritional status of children (Antoniou *et al.* 2016; Xue *et al.* 2015). Children who are picky eaters are more likely to be underweight and stunted than those who aren't (Taylor *et al.* 2019; de Barse *et al.* 2015; Tharner

et al. 2014). Grulichova *et al.* (2022) showed in a long-term study that children who are picky eaters at a young age are slightly lighter and shorter than those who are not by age 15.

The prevalence of picky eaters among children varies by age and geographical region between 23.8 and 49.6 % (Goh & Jacob 2012; Li *et al.* 2017; Machado *et al.* 2016). In Malaysia, between 31 and 54 % of children five to ten years old are reported as picky eaters (Hanapi & Teng 2022; Joseph-Louise & Tan 2020). Chilman *et al.* (2021) found cognitive factors features as intrinsic traits of picky eater children. Sensory sensitivity to taste, smell, and texture was discovered to have a strong connection with picky eaters and food neophobia (Kutbi *et al.* 2019). According to previous studies, children reject certain foods because they dislike their flavour or texture (Pellegrino & Luckett 2020). In their research, Farrow and Coulthard (2012) discovered an association between picky eaters and taste sensitivity, tactile sensitivity, and total sensory sensitivity. It was also shown that taste sensitivity could predict the behaviour of picky eaters, and one study suggested that sensitive children at the age of four are more likely to become picky eaters by the age of six (Steinsbekk *et al.* 2017a).

In addition, picky eaters are affected by social environmental factors, which include prenatal experience, peer impact, weaning practise, and parenting styles (Lafraire *et al.* 2016). The majority of intervention studies focused on children using parents as mediators, as they play a crucial role in controlling food availability within the home environment (Garcia *et al.* 2020; Kaur *et al.* 2020; Sandvik *et al.* 2019). Parenting style looks at the interaction between parents and child throughout all domains. According to Chilman *et al.* (2021), parenting style and feeding practices can either raise or decrease the likelihood that a child would be a picky eater.

Prior research also shown that there ia a strong negative association between picky eaters and authoritative parenting style (Macinnes 2012; Leuba *et al.* 2022; Podlesak *et al.* 2017). Additionally, it has been demonstrated that those who are picky eaters have poorer nutritional status than their peers (Antoniou *et al.* 2016; Taylor *et al.* 2019). Similar to the relationship between oral sensory and picky eaters, the majority of studies demonstrated a good association between the two (Farrow & Coulthard 2012; Nederkoorn *et al.* 2015; Johnson *et al.* 2015). Giving a clearer understanding of the interplay between sensory processing and authoritative parenting style will aid in creating strategies to address the problem of picky eaters. Therefore, this study aims to determine the association between oral sensory processing, eating behaviour, and authoritative parenting style in children aged 3 to 5 years. In addition, differences in nutritional status and eating behaviour between non-picky and picky eaters children were examined.

METHODS

Design, location, and time

This cross-sectional study was carried out in the Klang Valley. This study was approved by the Research and Ethics Committee of The National University of Malaysia (UKM) with the ethical code UKM PPI/111/8/JEP-2021-746. Prior to choosing the subjects, an information sheet with a detailed methodology of the study and a consent form was provided to all via the online Google form. To ensure that the privacy of each subject is protected, a code is assigned to each subject, and personal information is not disclosed during the data analysis process. The collected information is also used exclusively for this study.

Sampling

This study included a group of healthy children between the ages of 3 and 5 years. The participants in this study consist of children, whereas the respondents are their mothers or fathers. The proportionate cluster sampling method was used to select nurseries and kindergartens. Four federal agencies provided the lists of nurseries and kindergartens. These nurseries and kindergartens were then categorised as Government Nurseries (GN), Private Nurseries (PN), Government Kindergartens (GK), and Private Kindergartens (PK). Using a random number generator, 22 nurseries and kindergartens were chosen (7 GN, 8 PN, 3 GK, and 4 PK). Four to five children are chosen at each nursery and kindergartens based on the promptest parental answer to the offered questionnaire link. A total of 99 mother/father-child dyads participated in this study, based on the sample calculation (Sharma *et al.* 2020) and taking into consideration 10% dropout factors. Acceptance requires the child's parents to live with them and aware their

nutrition and behaviour. Children with autism, down syndrome, delayed global development, dyslexia, or eating disorders were excluded. This information was self-reported by parents and screened by the research team.

Data collection

The collection of data was performed both physically and online. While anthropometric data was collected physically, demographic information and questionnaires were collected online using gogle form platform. The online survey links were distributed to the parents by the teachers or administrators of nurseries and kindergartens. The parents of the selected children completed all the demographic information and questionnaires.

Anthropometry measurement. Children's weight and height were measured using standard scales and stadiometers. WHO Antro software was used to calculate growth z-scores based on WHO guidelines (WHO 2011; WHO 2006).

Eating behaviour measurement. Child Eating Behavior Questionnaire (CEBQ) from Wardle *et al.* (2001), which has been translated and validated by Ong (2015), was used to identify the eating behaviour of children. The CEBQ consists of 35 questions with eight primary constructs that can be separated into two categories: food approach, which refers to good reactions, and food avoidance, which refers to negative emotions during eating. The behaviour that promotes food intake is food responsiveness (7 questions), enjoyment of food (3 questions), emotional overeating (3 questions), and the desire to drink (3 questions). In contrast, the activity that prevents food intake is the satiety responsiveness (5 questions), slowness in eating (4 questions), emotional undereating (4 questions), and food fussiness (6 questions). Each question requires a response on a 5-point Likert scale: never (1), rarely (2), sometimes (3), often (4), and always (5). A high mean score for each dimension suggests that the behaviour is intense. The construct utilised in the CEBQ to evaluate the behaviour of picky eaters is food fussiness, which consists of six questions. Children are considered picky eaters if their mean value is three or higher (Steinsbekk *et al.* 2017b).

Parenting style measurement. Parenting style is evaluated using the Parenting Style Demention Questionnaire (PSDQ). Robinson *et al.* (2001) created the PSDQ, which initially comprised 62 items and was later reduced to 32 items. The purpose of the PSDQ is to assess Baumrind's original three parenting styles: authoritative (15 questions), authoritarian (12 questions), and permissive (5 questions). Each item is rated on a 5-point Likert scale, with one representing never and five representing always. A high score on the style domain reflects the most prominent parenting style. A Malay-English bilingual speaker translated the PSDQ into Malay and back into English before giving it to parents. These results were evaluated by experts to ensure each question's meaning had not changed. The three dimensions' Cronbach's alpha values after the reliability test were 0.90 for authoritative, 0.77 for authoritarian, and 0.48 for permissive. The authoritative and authoritarian domains had high Cronbach's alpha values, while the permissive domain had a low value (below 0.75). The permissive domain value obtained from other studies was equally low, ranging between 0.64 and 0.67 (Rahmawati *et al.* 2022; Yaffe 2018; Oliveira *et al.* 2018; Robinson *et al.* 2001).

Oral sensory processing measurement. The Child Sensory Profile 2 (CSP-2) is a tool for assessing children's sensory processing based on Dunn's Model (Dunn 2014). The CSP-2 evaluates children in six sensory domains (oral, touch, visual, auditory, movement, and body position) and three sensory-related behaviours (conduct, social emotional and attentional). Based on the assessment, children were divided into four sensory pattern categories (seeking, avoiding, sensitivity and registration). The evaluation was conducted using a 5-point Likert scale, where one represents almost never, and five represents almost usually. This study applied primarily the oral sensory processing aspect, which consisted of only ten questions because most picky eater children reject food due to its taste or texture (Farrow & Coulthard 2012; Kutbi *et al.* 2019). Zulkifli (2023) has translated this questionnaire into Malay, and Cronbach's alpha value is satisfactory (0.85). Dunn's Model categorises a zero score of up to seven as less than others, eight to 24 as just as the majority of others, and 25 to 50 as more than others (Dunn 2014).

Data analysis

IBM SPSS Statistics 20.0 (IBM Corp. Armonk, NY, USA) was used for statistical testing. For descriptive evaluation, frequency, mean, standard deviation, and percentage were

measured for socio-demographic data, nutritional status, picky eaters' prevalence, oral sensory processing, and parenting style. A Pearson correlation test determined the association between eating behaviour (picky eaters), oral sensory processing, and authoritative parenting scores. Regarding nutritional status and children's eating behaviour, an independent t-test was performed to determine the differences between picky and non-picky eaters. The Chi-square test examined the association between non-picky and picky eaters and the classification of oral sensory processing.

RESULTS AND DISCUSSION

Socio-demographic data

Most subjects were female (56.6%) with an average age of 4.02±0.70 years, and all were of Malay ethnicity (100%). The prevalence of picky eaters was 45.5% overall, with a mean score of 2.94±0.36. The proportion was greater than the 31.8% revealed in a research conducted in Kuala Selangor for children aged 5–6 years, and lower than the 53.4% observed in children aged 5–10 years in Kuala Lumpur. As for the parents' background, the average age for fathers was 33.37±7.91 years; 98.2% were employed, and 58.6% had tertiary education. While the average age for mothers was 33.07±4.81 years, 86.9% were employed, and 69% hold a university degree. Half of the respondents (49.5%) have a monthly household income below USD 1,013.87 (RM4,850). Regarding parenting style, all parents employed an authoritative approach. The socio-demographic characteristics of the subjects are detailed in Table 1.

Children's nutritional status, eating behavior and oral sensory processing

Weight, height and Body Mass Index (BMI) measures did not differ significantly between non-picky and picky eaters (Table 2). Nutritional status (weight-to-height, weight-for-age, height-for-age and BMI-for-age) between non-picky and picky eaters' children also did not demonstrate any significant difference ($p>0.05$). Prior research also produced inconclusive findings regarding nutritional status (growth charts) in children with and without picky eating habits (Ali & Ahmed 2022; Joseph-Louise & Tan 2020; Maranhão *et al.* 2017; Mascola *et al.* 2010; Rohde *et al.* 2017). In a study conducted by Mascola *et al.* (2010),

Table 1. Subject socio-demographic's characteristices

Variables	n (%) (N=99)	Mean±SD
Age		
3 year old	23 (23.2)	4.02±0.70
4 year old	51 (51.5)	
5 year old	25 (25.3)	
Gender		
Boy	43 (43.4)	
Girl	56 (56.6)	
Picky Eaters Status		
Picky eaters	45 (45.5)	3.13±0.32
Non-picky eaters	54 (54.5)	2.78±0.32
Numbers of Sibling		
Only child	11 (11.1)	
>1 child	88 (88.9)	
Father's Age[a]		
≤30 years old	17 (17.2)	24.06±11.52
>30 years old	81 (81.8)	35.88±3.67
Father's education level		
Primary school	2 (2.0)	
Secondary school	39 (39.4)	
College/ University	58 (58.6)	
Father's working status[a]		
Working	97 (98.0)	
Not working	1 (2.0)	
Mother's age[a]		
≤30 years old	20 (20.2)	28.3±2.23
>30 years old	78 (78.8)	34.68±2.81
Mother's education level		
Primary school	1 (1.0)	
Secondary school	29 (29.3)	
College/ University	69 (69.7)	
Mother's working status[a]		
Working	86 (86.9)	
Not working	12 (12.1)	
Total income		
Low-income (<USD1,013.87)	49 (49.5)	5336.4±3266.9
High-income (>USD1,013.87)	50 (50.5)	
Parenting style		
Authoritative	99 (100)	3.77±0.64

[a]Missing data; SD: Standard Deviation; USD: US Dollar

Table 2. Mean of anthropometric measures and nutritional status for non-picky eaters and picky eaters

Indexes	Non-picky eaters (n=54) Mean±SD	Picky eaters (n=45) Mean±SD	*p*
Weight (kg)	15.36±3.11	15.03±2.72	0.58
Height (cm)	99.84±6.43	98.97±5.62	0.48
BMI (kgm^{-2})	15.32±1.98	15.25±1.75	0.88
Weight-for-height[a]	0.14±1.31	-0.45±1.23	0.76
Weight-for-age	-0.35±1.19	-0.65±1.17	0.71
Height-for-age	-0.65±0.86	-0.65±0.89	0.46
BMI-for-age	0.77±1.37[a]	-0.38±1.26	0.10

[a]Missing data (There are 13 children between the ages of five years and one month, and five years and eleven months); T-test; BMI: Body Mass Index; SD: Standard Deviation

it was observed that children who were picky eaters had a limited range of food options, but their food consumption was nearly equivalent to that of non-picky eaters. As a result, there was no significant difference in their nutritional status. However, another study found that picky eaters had lower z-score values for the BMI-for-age indication compared to non-picky eaters (Chao 2018).

Table 3 shows the difference in each domain of eating behaviour for non-picky eaters and picky eaters. There were significant differences in the two domains of the food approach group between non-picky eaters and picky eaters, i.e. food responsiveness (t(2.973)=97, p=0.004 and enjoyment of food (t(4.167)=97,p=0.000). Picky eaters have a low mean score for both domains. This was consistent with the findings of previous research (Joseph-Louise & Tan 2020; Hanapi & Teng 2022). According to Tharner *et al.* (2014), children who are picky eaters are less receptive to eating, do not enjoy food, and eat slowly. This could be attributed to the association between picky eaters and parents who practice unresponsive feeding practices or exert excessive control over their children, diminishing the likelihood of food enjoyment (Finnane *et al.* 2017; van der Horst 2012). For the food avoidance group, there was a significant difference ($p<0.05$) in the satiety responsiveness domain (t(-2.6)=97, p=0.011), slowness in eating (t(-3.098)=97, p=0.003) and food fussiness domain (t(-11.479)=97, p=0.000). In these domains, picky eaters have a higher mean score than non-picky eaters. This finding aligns with previous research since it has been observed that children who exhibit picky eating habits tend to engage in food-inhibiting behaviour (Boquin *et al.* 2014). A positive link between the satiety responsiveness subscale and picky eating behaviour was also discovered in a study by Caton *et al.* (2014). Research has revealed that children who are picky eaters experience rapid satiety, resulting in reduced food consumption and potential failure to meet their daily nutritional

Table 3. Child eating behaviour mean differences of non-picky eaters and picky eaters children

Domains	Non-picky eaters (n=54) Mean±SD	Picky eaters (n=45) Mean±SD	*p*
Food approach			
Food responsiveness	3.26±0.93	2.74±0.78	0.01*
Enjoyment of food	3.90±0.83	3.25±0.70	0.01*
Emotional overeating	2.31±0.79	2.13±0.59	0.22
Desire to drink	2.64±0.67	2.56±0.64	0.56
Food avoidance			
Satiety responsiveness	2.63±0.69	2.98±0.67	0.01*
Slowness in eating	2.60±0.70	3.01±0.60	0.01*
Emotional undereating	2.80±0.62	2.91±0.61	0.35
Food fussiness	2.34±0.45	3.33±0.40	0.00*

*T-test significant for $p<0.05$; SD: Standard Deviation

requirements. The slowness in the eating of picky eaters indicates a lack of interest in food and a tendency to consume meals at a slower pace. Hanapi and Teng (2022) and Tharner *et al.* (2014) conducted similar findings, indicating that a notable attribute of picky eaters in children is the tendency to consume food at a slower pace.

Pearson's correlation was used to determine the association between eating behaviour- picky eaters and scores for oral sensory processing and authoritative parenting style. A positive correlation was discovered between oral sensory processing and eating behaviour- picky eaters (food fussiness domain), r=0.22, p=0.003 (Table 4). This finding is corroborated by prior research that has similarly identified a positive correlation between picky eating behaviour and oral sensory processing (Farrow & Coulthard 2012). The oral sensory processing score is thereafter categorised based on the standard categorisation of the form, which are . "Just Like the Majority of Others" and "more than others". "Just Like the Majority of Others" indicates that the child has a typical level of sensory processing, however "more than others" suggests that the child will exhibit heightened reactions to sensory stimuli. From the result, 58.1% of non-picky and 58.9% of picky eaters had a level of oral sensitivity 'more than others'. This ratio was practically almost the same between both groups (Table 5), and no significant relationship was found between these two indicators, X^2(1, n=99), p=0.50. Based on these findings, it is possible that oral sensitivity is not the primary determinant of picky eating behaviour in the population under study. Children who exhibit picky eating habits may have a predilection for specific tastes and textures of certain foods, which may not always be associated with oral sensitivity. Repeated exposure (and social influence (peers, parents, and family members) also play a role in the choice of this food (Chilman *et al.* 2021). This assertion is substantiated by the findings of Johnson *et al.* (2015), who observed no correlation between oral sensitivity and the consumption of several food groups except sugary beverages. A weak correlation was seen between the consumption of sweetened beverages and oral sensitivity.

In addition, there was no correlation between the eating behaviour of picky eaters and authoritative parenting style. Although the authoritative parenting style has been shown to have an inverted association with picky eaters (Podlesak *et al.* 2017), the prevalence of picky eaters in this study was more than half (56%), and all the parents were classified as authoritative parents. Previous research found a negative correlation between authoritative parenting and the behaviour of picky eaters, while authoritarian and permissive parenting have a positive relationship with the behaviour of picky eaters (Macinnes 2012). Podlesak *et al.* (2017) also obtained a comparable finding, where the positive link between picky eaters' behaviour was

Table 4. Association between eating behaviour-picky eaters, oral sensory processing, and authoritative parenting style

Variables	Eating behaviour-picky eaters r (*p*)	Oral sendory processing r (*p*)	Authoritative parenting style r (*p*)
Eating behaviour- picky eaters	-	-	-
Oral sensory processing	0.22 (0.003)*	-	-
Authoritative parenting style	-0.17 (0.09)	0.09 (0.36)	-

*Pearson correlation significant for p<0.05 (2-way pearson correlation)

Table 5. Classification of oral sensory processing according to picky eater status

Classification	Non-picky eaters (SD) (n=54)	Pikcy eaters (SD) (n=45)	X^2	*p*
Oral sensory processing			0.45	0.50
Just like the majority of others	24 (44.4%)	17 (37.8%)		
More than others	30 (55.6%)	28 (62.2%)		

*Chi-square test; SD: Standard Deviation

more frequent in permissive and authoritarian parenting than in authoritative parenting.

The authoritative parenting style is frequently related to food parenting strategies such as food consumption monitoring, absence of pressure to eat, or restriction, which is the greatest combination in minimising picky eater behaviour (Collins *et al.* 2014). However, according to a study, there is another parenting style that is similar to authoritative parenting which is known as the overprotective parenting style (van der Horst & Sleddens 2017). The overprotective parenting style exhibits the same high values in nurturing, structure, and behaviour control as authoritative parenting but also exhibits high values in eating pressure and restriction (access using food parenting practice). Since food parenting practice was not evaluated in this study, some of the parents in this study likely employed this parenting style, which may impact the picky eaters' status. Besides lack of variability in parenting styles in this study might have also contributed to the lack of association.

According to Lafraire *et al.* (2016), picky eaters are in a complex situation where the relationship between the many factors remains unclear. A study conducted by Chilman *et al.* (2021) categorised the components that contribute to picky eating into intrinsic (taste, smell, and texture; personality; gender) and extrinsic (parenting style and social environment). The reason for picky eaters could be a single issue or a combination of factors. This study identified only a correlation between the behaviour of picky eaters and the oral processing of sensory. No statistically significant association was observed between the picky eaters and the authoritative parenting style. This does not imply that parenting variables are irrelevant in assisting children with picky eating habits. It is crucial to highlight that the study on this topic is ongoing and that other factors, such as genetics and emotional or behavioural difficulties, may contribute to picky eating (Lafraire *et al.* 2016). A review by Kamarudin *et al.* (2023) determined that each situation of picky eaters is unique and proposed a multidisciplinary intervention approach (nutrition, sensory, parenting, and social and environmental) as the most effective way to assist children with picky eating habits.

This study has several limitations. Only one region, the Klang Valley, was surveyed for information, and only Malay respondents participated. Therefore, the findings of this study cannot be generalized to all Malaysian populations. All data collection was also conducted online, with parents providing their responses independently. Therefore, over-reporting and under-reporting of CEBQ and CSP2 may occur during the procedure. However, this is one of the earliest Malaysian studies to examine the association between picky eating, authoritative parenting, and oral sensory processing.

CONCLUSION

In the Malaysian perspective, the prevalence of picky eaters is at substantial 45.5%, despite the fact that the parents applies authoritative approach in parenting their child. A low food responsiveness score, less food enjoyment, rapid satiety and slow eating also characterised picky eaters. There was an association between the behaviour of picky eaters and oral sensory processing, but there was no association between these two indicators and authoritarian parenting style. There is no significant difference in the nutritional status between picky and non-picky eaters. However, the complex interactions between these elements were less studied. It is advised that future research focuses on food parenting practice, given that parents' eating behaviour significantly impacts children's eating behaviour. This study may aid in developing an intervention plan for picky-eater children. Suggestions for future research to assess food intake in order to better understand the correlation between nutritional status and picky eating behaviour.

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DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflict of interest.

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Research Article

Anthropometric Measures of Adiposity and Their Associations with Blood Pressure among Malay Adolescents Aged 18 to 19 Years Old in Terengganu

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ABSTRACT

This study aims to explore association of anthropometric adiposity measures with blood pressure among Malays aged 18 to 19 years. Participants comprised 309 university students of Malay ethnicity residing in Kuala Nerus, Terengganu. This cross-sectional research study was done in April 2021 to August 2023. A total of 40.7% of participants were overweight/obese, 42.1% normal weight, and 17.5% underweight based on World Health Organisation (WHO)-Asian Body Mass Index (BMI) classification. Among this population, 15.5% of the students was considered as Hypertension (HPT) and 21.4% had Elevated Blood Pressure (EBP). Proportions of male students with HPT (35.7%) and EBP (29.8%) were significantly higher compared to female students (18% and 18.2%, respectively). Linear regression analysis indicated that BMI was a significant factor that influenced Systolic Blood Pressure (SBP), especially among female participants. Obese adolescents had 7.0 times higher odds of developing EBP/HPT compared to those in other BMI categories (aOR=6.97; 95% CI:2.92–16.6; p<0.05). The high prevalence of HPT and EBP raises concern, as the study also confirmed an association between obesity and blood pressure. In conclusion, anthropometric measures of adiposity were associated with increased odds of HPT. Thus, early identification of individuals with high-risk anthropometric adiposity is crucial to facilitate timely intervention and mitigate associated risks.

INTRODUCTION

The increasing prevalence of Hypertension (HPT) among older adolescents can persist and progress into HPT in adulthood (Kurnianto *et al.* 2020). EBP often leads to organ damage and cardiovascular complications, including early endothelial dysfunction, arterial stiffness, and left ventricular hypertrophy in later life, which gives grave concern in healthcare (Wang *et al.* 2019). For adolescents aged 13 years and above, EBP is defined as Systolic Blood Pressure (SBP) of 120 to 129 mmHg and Diastolic Blood Pressure (DBP) of less than 80 mmHg, while blood pressure reading at ≥130/80 mmHg is considered as HPT According to the Clinical Practice Guidelines (CPG), for the diagnosis, evaluating, and treating children and adolescents from the American Academy of Paediatrics (AAP) in 2017, those aged ≥3 years with HPT are recommended to undergo annual screening for blood pressure abnormalities during preventative visits (Flynn *et al.* 2017).

Several countries have reported a high prevalence of HPT among late adolescents and adults that can be even more severe among those who are obese. Data from a meta-analysis of Chinese children and adolescents indicate a pooled prevalence of 9.8%, with variation based on weight status (Wang *et al.* 2019). Findings

from a cohort study, also revealed that HPT during adulthood correlates with the high blood pressure monitored during their adolescence (Azegami *et al.* 2021). During adolescence, it is challenging to distinguish between natural growth and increased adiposity due to rapid changes in body composition and sex hormones. Studies suggest that to assess adiposity and its relation to vascular diseases, more detailed phenotyping methods, such as DEXA, should be used to break down the weight components (Dangardt *et al.* 2019; Bennett 2023; Fedewa *et al.* 2019).

In addition, although various studies have shown strong association between body composition and increased blood pressure among children and adolescents, no studies have focused specifically on the adolescent population in Malaysia. The only study involving Malay adolescents was conducted in Sarawak, and examined only anthropometric measurements but not body adiposity in relation to blood pressure (Cheah *et al.* 2018). The present study focused on Malays aged 18−19 years old, as research has shown that late adolescents have a higher prevalence of HPT compared to early adolescents (Daniel *et al.* 2020; Mohan *et al.* 2019; Chandrashekarappa *et al.* 2022).

Therefore, this study was conducted to investigate the relationship of various anthropometric adiposity, including BMI, Waist Circumference (WC), Waist-Height Ratio (WHtR), Waist-Hip Ratio (WHR), Fat Mass Index (FMI), Fat-Free Mass Index (FFMI), Fat-to-Fat Free Mass Ratio (FFFMR), and Body Fat (BF) percentage with blood pressure, focusing specifically on Malays aged 18 to 19 years old. This research focused on this age group as it is a crucial transition period from childhood to adulthood. During this time, many adolescents begin entering higher education institutions and living away from the family, which impacts their independence and lifestyle adaptation, further influencing health outcome.

METHODS

Design, location, and time

This study was conducted between April 2021 to August 2023 using cross-sectional study design. Participants were students aged between 18 to 19 years old from a public university in Terengganu who were enrolled in foundation and diploma programmes. Students who were of non-Malay ethnicity, those with medical history of chronic diseases, on medication, pregnant or breastfeeding, elite athletes involved in competitive sports, or COVID-19 positive patients, were exlucded. Ethical approval for this study was obtained by UniSZA Human Research Ethics Committee (UHREC) (RACER/1/2019/SKK06/UniSZA/3).

Sampling

This study employed probability sampling. Based on the student list from the academic section of the university, the total number of undergraduate students in both diploma and foundation programs in the university was 2,357. Subjects were choosen at random. Single proportion formula of Krejcie and Morgan (1970) was used to determined the sample size (Morgan 1970) :

$$s = \frac{X^2 NP(1-p)}{d^2(N-1)} + X^2 P(1-p)$$

where the X-score for a 95% confidence interval is 1.96, population size for this research is 2,357 students (N), for the population proportion (p) (0.17, as the prevalence of HPT among those 18 years and older in Malaysia is 17.3% (Omar *et al.* 2016)), and margin of error (d) is 0.05. Considering a 20% drop-out rate, the final sample size was calculated to be 266 participants.

Data collection

Based on the student list, 419 students (17.8%) were precluded for being ≥20 years old or non-Malay. Given the challenging circumstances of COVID-19 during the data collection period, participants recruitment was conducted through social media. For each student who met all the inclusion criteria, an appointment was scheduled and data collection was done at the agreed-upon date and time. The timeline between an interview and data collection averaged within 3 months due to movement restrictions imposed during COVID-19. Consent forms were also distributed to participants using online questionnaires, which were shared via social media to minimise contact.

Anthropometric measurements. Height was measured using SECA Model 217 stadiometer (SECA, Germany) to the nearest 0.1 cm, and weight was measured using Electronic Weighing Scale SECA 880 (SECA, Germany) to the nearest 0.1 kg. Measurements were taken twice, and the average of both weight and height

were calculated and taken as the final value. If the difference between the 2 readings is more than 10%, a third measurement will be taken. Weight (kg) is divided by height meters squared (m²) to get BMI. BMI of adolescents were categorised according to the WHO-Asian guidelines: low normal (<18.5 kg/m²), normal (18.5−22.9 kg/m²), overweight (23−24.9 kg/m²) and obese (≥25 kg/m²) (Saha *et al.* 2021).

Waist and hip circumferences were measured using Rosscraft Anthrotape (USA). The measurements were taken while the participant stood erect with bared waist, after exhaling, with both feet together and both arms relaxed and hanging freely at their sides. Waist circumference was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, according to WHO Regional Office for the Western Pacific (2008). The fullest part of the buttocks were measured for hip circumference. The measurements were taken twice and were recorded in centimetres (cm) to the closest 0.1 cm. The average reading is then calculated. WHR was calculated using WC (cm) divided by hip measurement (cm), whereas WHtR was calculated using WC (cm) divided by height (cm).

The cut-off values for waist circumference used in this study, based on the International Diabetes Federation (2007) guidelines for Asian individuals aged ≥18 years old, are ≥80 cm and ≥90 cm for women and man respectively (Xi *et al.* 2019). The cut-off values were WHR 0.891 (Widjaja *et al.* 2023) and WHtR 0.49 (Eslami *et al.* 2023) for both males and females.

Body composition measurement. Body composition was measured using Bioelectrical Impedance Analysis (BIA) technique with the Bodystat Quadscan 4000 (Bodystat Ltd, Isle of Man, British Isles). For this measurement, two electrodes were placed on the right hand and 2 electrodes on the right foot (Froon-Torenstra *et al.* 2024) . Students needed to fast overnight and avoid exercise a day prior to data collection date. During the measurement, the participant must be in a supine position, with arms abducted at least 30°C and legs abducted at approximately 45°C (Fowler 2019). Based on the BIA measurement, Fat Free Mass (FFM) (kg) and Fat Mass (FM) (kg) data were extracted.

Fat Mass Index (FMI), Fat-Free Mass Index (FFMI) and Fat-to-Fat Free Mass Ratio (FFFMR) were then calculated (Xiao *et al.* 2018) :

$$FMI = \frac{Fat\ mass\ (kg)}{Height(m)^2}$$

$$FFMI = \frac{Fat\ free\ mass\ (kg)}{Height(m)^2}$$

$$FFFMR = \frac{Fat\ mass\ (kg)}{Fat\ free\ mass\ (kg)}$$

Blood pressure measurement. Blood pressure was measured using Omron Digital Blood Pressure Monitor HEM 7203 (Omron, Japan). Measurement was taken in the morning, with participant asked to sit comfortably and remain silent during the measurement process. Blood pressure was recorded twice and mean blood pressure was calculated (Kallioinen *et al.* 2017). The HPT cut-offs employed was based on the American Academy of Paediatrics (AAP 2017), among adolescents aged ≥13 years old EBP is defined as having blood pressure 120−129/<80 mmHg, while HPT is defined as ≥130/≥80 mmHg (Flynn *et al.* 2017).

Data analysis

IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, New York, USA) was used to analyse the data. For descriptive statistics analysis, data are written as mean and Standard Deviation (SD). For this research, multiple linear regression between blood pressure and other anthropometric adiposity indicators was done, with $p<0.05$ set as a significant level. Analysis for associations between the anthropometric adiposity measures with blood pressure employed linear regression analysis. Selected anthropometric variables were then analysed to estimate the adjusted odds ratio and 95% confidence interval for their association with blood pressure using multiple logistic regression.

RESULTS AND DISCUSSION

In this study, 309 students aged between 18 and 19 years old participated, with 27.2% (84) males and 72.8% (225) females. The mean and Standard Deviation (SD) of anthropometric adiposity parameters and blood pressure are presented in Table 1. There were significant differences ($p<0.05$) between male and female students in all measurements, except for WHtR and BMI. Male students had significantly heavier, taller, high BMI, WC, HC, WHR, WHtR, FFM, FFMI, SBP and DBP. Females had higher fat mass and body fat percentage than male students.

The frequency of obese adolescents (23.1%) was triple the prevalence announced in the

National Health and Morbidity Survey (NHMS) in 2019 (8%) (Ganapathy *et al.* 2019).This data was similar to findings among adolescents in the United States (22.2%) (Ganapathy *et al.* 2020). The dissimilarity in results may be ascribed to the different classification BMI systems used to categorize participants' body weight status, this study employed the WHO-Asian BMI classification which has lower cut-off values for obese (BMI ≥25 kg/m²) and overweight (BMI ≥23 kg/m²) compared to the WHO criteria for White, Hispanic and Black populations (WHO Regional Office for the Western Pacific 2000). This classification for the Asian population has been shown to have better sensitivity in predicting comorbid dysmetabolic conditions, particularly HPT, among North Indian populations (Verma *et al.* 2019).

Studies have comprehensively demonstrated that gender plays an important role in blood pressure, where females are likely to have lower SBP than males (Alhawari *et al.* 2018; Tebar *et al.* 2018). This trend was observed in this study as males have significantly higher blood pressure than females. This difference is seen not only in adolescents but also in adult populations (Soo *et al.* 2020). The primary contributors to blood pressure differences between genders include the sympathetic nervous activity, immune system, endothelin-1, renin-angiotensin system, and also sex hormones (Song *et al.* 2020). Males and females also differ in vascular function, hence, effecting their renal sodium handling capacity, which contributes to differences in blood pressure (Drury *et al.* 2024).

The data suggests that females have a tendency to have lower WC compared to males. This result aligns with existing evidence that males generally have larger waist circumference due to sexual development (Taxová Braunerová

Table 1. Mean differences in anthropometric adiposity and blood pressure by gender

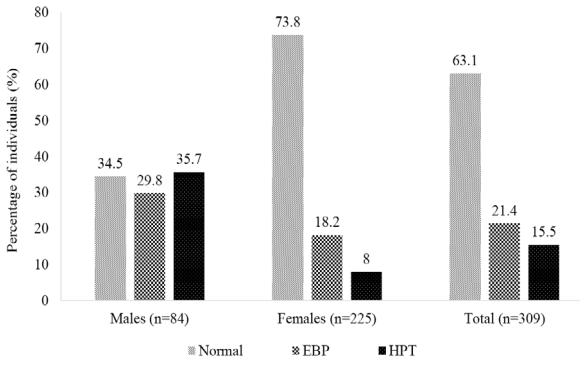
Anthropometric/ Body composition parameters	Males (n=84) Mean±SD	n (%)	Females (n=225) Mean±SD	n (%)	p^*	Total (N=309) Mean±SD	n (%)
Weight (kg)	66.59±18.15		55.40±13.54		<0.001	58.44±15.72	
Height (cm)	1.69±0.06		1.56±0.05		<0.001	1.59±0.08	
BMI (kg/m²)	23.44±6.35		22.81±5.21		0.376	22.98±5.54	
Underweight (<18.5 kg/m²)		17 (20.2)		35 (15.6)			52 (16.8)
Normal (18.5−22.9 kg/ m²)		31 (36.9)		100 (44.4)			131 (42.4)
Overweight (23−24.9 kg/m²)		14 (16.7)		38 (16.9)			52 (16.8)
Obese (≥25 kg/m²)		22 (26.2)		52 (23.1)			74 (23.9)
WC (cm)	78.33±14.07		71.74±11.21		<0.001	73.53±12.39	
HC (cm)	95.06±11.84		95.01±9.58		<0.001	95.02±12.39	
WHR	0.82±0.06		0.75±0.07		<0.001	0.77±0.07	
WHtR	0.46±0.08		0.46±0.07		0.693	0.46±0.07	
FM (kg)	11.59±9.43		16.85±8.10		<0.001	15.42±8.79	
FFM (kg)	55.32±10.16		38.62±6.42		<0.001	43.16±10.64	
BF (%)	15.9±6.9		29.2±6.20		<0.001	25.6±8.7	
FMI (kg/m²)	4.08±3.30		6.95±3.28		<0.001	6.17±3.51	
FFMI (kg/m²)	19.46±3.40		15.90±2.20		<0.001	16.86±3.03	
FFFMR	0.20±0.12		0.42±0.14		<0.001	0.36±0.17	
SBP (mmHg)	124±12		112±11		<0.001	116±12	
DBP (mmHg)	76±8		74±8		0.032	75±8	

*An Independent t-test test significantly at p<0.05; Mean and SD were reported or n (%): SD: Standard Deviation; BMI: Body Mass Index; WC: Waist Circumference; HC: Hip Circumference; WHR: Waist-Hip Ratio; WHtR: Waist-Height Ratio; FFM: Fat Free Mass; FM; Fat Mass; BF: Body Fat Percentage; FMI: Fat Mass Index; FFMI: Fat Free Mass Index; FFFMR: Fat-to-Fat Free Mass Ratio; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure

et al. 2021). A cross-sectional study conducted among Korean adolescents similarly found that WC among males was significantly higher with noticeable differences between genders (Kim *et al.* 2018). These differences serve as indicators, as studies have revealed that higher WC is linked with abdominal fat, which is a crucial factor in the development of vascular and cardiac impairment (Trandafir *et al.* 2020).

Although females tend to have smaller WC, data showed that females have higher BF percentages due to notable differences in body fat composition and distribution between the genders, which are influenced by changes in sex hormone level (Yao *et al.* 2023). Supporting this finding, a cross-sectional study in Terengganu also shared a similar perspective that males have lower body fat percentage than females at the same pubertal status (Khair & Wee 2021). Studies have shown that factors, such as motor skills, environment, eating habits, health knowledge, lifestyle and socioeconomic status, play a significant role in adolescent body fat percentage (Ab Rahman *et al.* 2020; Martha Sari *et al.* 2021; Egg *et al.* 2020).

As shown in Figure 1, most of the participants (63.1%) had normal blood pressure, followed by EBP (21.4%) and HPT (15.5%). The prevalence of EBP and HPT among males (65.5%) was much higher compared to females (26.2%). The prevalence of HPT among this population (15.5%) is higher than that found in a study conducted among adolescents in Putrajaya (11.6%) and is significantly higher than recent studies conducted in Kuala Lumpur (4.7%) (Poh *et al.* 2022; Rampal *et al.* 2011). This disparity in results could be attributed to differences in data distribution related to body weight status, as blood pressure varied based on weight status (Wang *et al.* 2019). This population had a higher percentage of obese and overweight students, which likely contributed to the high numbers of HPT.



EBP: Elevated Blood Pressure; HPT: Hypertension

Figure 1. Proportion of participants by blood pressure categories

Overall, the prevalence of HPT and EBP was very high in this community (36.9%), signalling a major concern that requires focused attention from primary care providers. In Malaysia, research linking anthropometric indices with blood pressure among adolescents remains limited. As obesity continue to rise and increasing affects not only among adult populations but also children and adolescents, it is crucial to monitor blood pressure regularly to prevent future health disease.

On regressing anthropometric adiposity parameters on blood pressure (Table 2 and Table 3), among all participants, BMI revealed a significant association with SBP, while WHR was significantly related with DBP. WC was the only anthropometric indicator revealed to possess a significant association with both blood pressure readings among all participants.

The result from logistic regression analysis of the risk of HPT across different factors is shown in Table 4. In these analyses, after adjusting for gender, weight status was identified as a significant predictor for the risk of HPT among adolescents particularly among obese participants (OR=6.97; 95% CI:2.92–16.60; $p<0.05$). However, a large WC was not a significant predictive for the risk of HPT with aOR of 1.07 (95% CI:1.04–1.09). Based on the result, obese adolescents had a 7.0 times higher risk of developing EBP/HPT compared to other BMI categories. Also, adolescents who had abdominal obesity had a 1.0 times higher risk for developing EBP/HPT.

Overall, this study shows that obesity, as measured by BMI, is linked with increased odds of HPT and EBP compared to other anthropometric adiposity parameters, making it the best predictor of HPT among Malay late adolescents in Terengganu. Logistic regression revealed that obese adolescents had 7.0 times the odds of developing EBP/HPT compared to other BMI ranges (aOR=6.97; 95% CI:2.92–16.60; $p<0.05$). This finding is in line with a previous study that emphasised obesity as a contributor to the increased odds (aOR=8.97; 95% CI:3.16–25.48; $p<0.05$) of EBP/HPT and served as the strong predictor blood pressure (Poh *et al.* 2022). Similarly, data from Chinese adolescents

Table 2. Linear regression of anthropometric adiposity parameters on systolic blood pressure

Model	Coefficients (Dependent variable: Systolic blood pressure in all participants) (N=309)				*p*
	Unstandardized coefficients		95% CI for *B*		
	B	SE	Lower bound	Upper bound	
(Constant)	71.42	8.82	54.07	88.77	<0.001
BMI	1.05	0.42	0.22	1.89	<0.05
WC	0.56	0.10	0.36	0.75	<0.001
HC	-0.15	0.12	-0.38	0.09	0.215
WHR	20.57	13.05	-5.11	46.25	0.116
WHtR	-8.35	18.88	-45.49	28.80	0.659
FMI	-0.44	1.17	-2.74	1.86	0.708
FFMI	1.02	0.63	-0.22	2.25	0.106
FFFMR	-16.88	19.25	-54.76	21.00	0.381

CI: Confidence Interval; BMI: Body Mass Index; WC: Waist Circumference; HC: Hip Circumference; WHR: Waist-Hip Ratio; WHtR: Waist-Height Ratio; FMI: Fat Mass Index; FFMI: Fat-Free Mass Index; FFFMR: Fat-To-Fat Free Mass Ratio; SE; Standarad error

Table 3. Linear regression of anthropometric adiposity parameters on diastolic blood pressure

Model	Coefficients (Dependent variable: Diastolic blood Pressure in all participants) (N=309)				*p*
	Unstandardized coefficients		95% CI for *B*		
	B	SE	Lower bound	Upper bound	
(Constant)	53.65	7.07	39.73	67.58	<0.001
BMI	0.63	0.34	-0.04	1.30	0.065
WC	0.21	0.07	0.07	0.35	<0.05
HC	0.03	0.09	-0.14	0.20	0.726
WHR	22.84	10.47	2.23	43.45	0.97
WHtR	-18.22	15.15	-48.03	11.59	0.230
FMI	0.24	0.94	-1.60	2.09	0.796
FFMI	-0.19	0.50	-1.18	0.81	0.712
FFFMR	-2.33	15.45	-32.73	28.06	0.880

CI: Confidence Interval; BMI: Body Mass Index; WC: Waist Circumference; HC: Hip Circumference; WHR: Waist-Hip Ratio; WHtR: Waist-Height Ratio; FMI: Fat Mass Index; FFMI: Fat-Free Mass Index; FFFMR: Fat-To-Fat Free Mass Ratio; SE; Standarad error

have shown a pooled prevalence of HPT at 9.8%, which rise to 34.1% among obese and 15.5% among overweight adolescents (Wang *et al.* 2019). Additionally, a study in Central Java found an increased risk of metabolic syndromes among obese adolescents, with over half already having HPT (53%) (Sukmasari *et al.* 2019).

The results suggest no significant association between HPT and WC. Logistic regression showed that adolescents with high WC had only a slightly increased odds of developing HPT, with an aOR of 1.07 (95% CI:1.04–1.09). However, global findings suggest that high WC is associated with 2 to 3 times greater risk of HPT compared to a normal WC (Mohammed Nawi *et al.* 2021). Larger WC was related with elevated visceral fat, which is associated with arterial stiffness potentially leading to higher SBP (Guimarães Filho *et al.* 2022). A large-scale observational study among Brazilian adolescents

Table 4. Odds ratio between selected anthropometric adiposity variables and high blood pressure

Variable	Normal BP n (%)	HPT n (%)	Multiple logistic regression	
			aOR (95 % CI)	*p*
BMI status				
Obese (≥25 kg/m)	51 (68.9)	23 (31.1)	6.97 (2.92−16.60)	<0.001
Overweight (23−24.9 kg/m²)	42 (80.8)	10 (19.2)	1.97 (0.78−4.99)	0.152
Normal (18.5−22.9 kg/ m²)	120 (91.6)	11 (8.4)	1.00	
WC category				
Abdominal obesity	4 (36.4)	7 (63.6)	1.07 (1.04−1.09)	<0.001
≥90 cm for males				
≥80 cm for females				
Normal WC	257 (86.2)	41(13.8)	1.00	

BMI: Body Mass Index; Obese is 25 kg/m² or higher; Overweight is between (23−24.9 kg/m²); Normal weight is between (18.5−22.9 kg/ m²); Underweight is below 18.5 kg/m²; Abdominal Obesity criteria is ≥90 cm for males and ≥80 cm for females; CI: Confidence Interval; aOR: Gender-adjusted Odds Ratios; *Multiple logistic regression significantly p<0.05; WC: Waist Circumference; BP: Blood Pressure; HPT: Hypertension

showed that larger WC, even with normal BMI, increased the risk of EBP (Pazin *et al.* 2020).

Notably, this study did not find a strong association between WHtR, FMI and BF percentage and risk of HPT. These findings support a study on Chinese children and adolescents, which indicates that BMI and WC are more accurate predictors of HPT compared to the other anthropometric indices (Li *et al.* 2020). Nevertheless, a cohort study of children and adolescents aged 9 to 17 found that high FM during adolescence, period was linked with a higher risk for arterial stiffness, which is related to advanced SBP (Dangardt *et al.* 2019). Also, research in Beijing involving children and adolescents suggests that a higher body fat percentage might negatively affect blood pressure among children (Chen *et al.* 2021).

This research only focused on one population in the same area which reduced the results' usage to a wider range of the adolescent population. A nationwide study that includes all ethnic groups in Malaysia, focusing on individuals aged 18 to 19 years old population to provide an overview of HPT in the country. Additionally, as this study focused on late adolescents the data may not fully represent the whole adolescent age group. However, the findings offer an overview of adolescents' current blood pressure trends. Importantly, this study highlights a more accessible approach to identifying adolescents in danger of EBP and HPT, which could serve as a routine measurement for all adolescents.

CONCLUSIONS

In conclusion, approximately one-third of 18−19 years old were found to have HPT or EBP, with males disproportionately affected – two-thirds of male participants had HPT and EBP. BMI demonstrated the strongest association with HPT, reinforcing the significant correlation between obesity and blood pressure. The findings underscore the critical need for routine blood pressure monitoring and early screening in late adolescents to identify and mitigate high blood pressure risks. Targeted intervention programs aimed at raising awareness and promoting healthy lifestyles are essential to prevent obesity and reduce the burden of HPT in this age group.

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DECLARATION OF CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interest in conducting or publishing this study.

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