

THE ASSOCIATION OF BODY MASS INDEX (BMI) AND WAIST-
TO-HEIGHT RATIO (WHTR) WITH RISK OF EATING DISORDER
AMONG UNDERGRADUATE STUDENTS IN USM HEALTH
CAMPUS

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CAMPUS

by

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Dissertation submitted in partial fulfilment
of the requirements for the degree of
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DECLARATION

I hereby declare that this dissertation is the result of my investigations, except where otherwise stated and duly acknowledged. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Universiti Sains Malaysia or other institutions. I grant Universiti Sains Malaysia the right to use the dissertation for teaching, research, and promotional purposes.



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Siti Athirah Binti Ma'arof

Date: 30th June 2025

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TABLE OF CONTENTS

CERTIFICATE.....	i
DECLARATION.....	ii
ACKNOWLEDGEMENT.....	iii
LIST OF TABLES.....	vi
LIST OF FIGURES.....	vii
LIST OF APPENDICES.....	viii
LIST OF SYMBOLS AND ABBREVIATIONS.....	ix
ABSTRAK.....	x
ABSTRACT.....	xii
CHAPTER 1: INTRODUCTION.....	1
1.1 Background of the study.....	1
1.2 Problem statements.....	3
1.3 Research Objective.....	3
1.3.1 General Objective.....	3
1.3.2 Specific Objective.....	4
1.4 Research questions.....	4
1.5 Research Hypothesis.....	4
1.5.1 Null Hypothesis (H^0).....	4
1.5.2 Alternative Hypothesis (H^a).....	4
1.6 Justification of Study.....	5
CHAPTER 2: LITERATURE REVIEW.....	7
2.2 Risk Factors of Eating Disorders.....	8
2.3 Prevalence of BMI Status Among Undergraduate Students.....	9
2.4 The Association Between BMI And Risk Eating Disorder.....	10
2.5 Association between Waist to Height Ratio with Risk Eating Disorder.....	11
2.6 Conceptual Framework.....	11
CHAPTER 3: METHODOLOGY.....	13
3.1 Research Design.....	13
3.2 Study Location.....	13
3.3 Study Population.....	13
3.4 Research Subjects.....	13
3.5 Sample Size Calculation.....	14
3.6 Sampling Method.....	17
3.7 Research Tools.....	18

3.8 Operational Definition	20
3.9 Data Collection Methods.....	21
3.10 Flow Chart.....	23
3.11 Data Analysis	24
CHAPTER 4: RESULTS.....	25
4.1 Sociodemographic Characteristics of Undergraduate Students	25
4.2 Anthropometric Data of Undergraduate Students.....	27
4.3 Risk of Eating Disorder Among Undergraduate Students	27
4.4 The Association Between BMI With Risk of Eating Disorder	28
4.5 The Association Between Waist-To-Height Ratio (WHtR) With Risk of Eating Disorder.....	28
CHAPTER 5: DISCUSSION	30
5.1 Sociodemographic Characteristics	30
5.2 Anthropometric Data of Undergraduate Students.....	31
5.3 Risk of Eating Disorder Among Undergraduate Students	31
5.4 The Association Between BMI With Risk of Eating Disorder Among Undergraduate's Students in USM Health Campus.....	32
5.5 The Association Between Waist-To-Height Ratio (WHtR) With Risk of Eating Disorder Score.....	33
5.6 Strength and Limitation.....	34
CHAPTER 6: CONCLUSION	36
6.1 Summary	36
REFERENCES	37
LIST OF APPENDIXES	43
Appendix A: JEPeM Approval	43
Appendix B: Permission From Author To Use Study Instruments.....	44
Appendix C: Questionnaires	45
Appendix D: Google Form Online Questionnaire	63
Appendix E: Participant Information Sheet And Consent Form	65
Appendix F : Consent Form.....	70
Appendix G: Advertisement For Requiring Participant (Whatsapps)	75
Appendix H: Letter Of Approval	76
School of Health Campus (PPSK).....	76
School of Medical Science (PPSP).....	80
School of Dental Science (PPSG)	83

LIST OF TABLES

Table 4.1 : Sociodemographic Characteristics of Undergraduate Students	25
Table 4.2: Anthropometric Data Of Undergraduate Students.....	27
Table 4.3: Risk Of Eating Disorder Among Undergraduate Students	28
Table 4.4: The Association Between BMI With Risk Of Eating Disorder Among Undergraduates Students	29
Table 4.5: The Association Between Waist-To-Height Ratio (WHtR) With Risk Of Eating Disorder Score Among Undergraduate Students	29

LIST OF FIGURES

Figure 1: Conceptual Framework	12
Figure 2: Flow Of The Research	23

LIST OF APPENDICES

Appendix A: JEPeM Approval	43
Appendix B: Permission From Author To Use Study Instruments.....	44
Appendix C: Questionnaires	45
Appendix D: Google Form Online Questionnaire	63
Appendix E: Participant Information Sheet And Consent Form	65
Appendix F : Consent Form.....	70
Appendix G: Advertisement For Requiring Participant (Whatsapps)	75
Appendix H: Letter Of Approval	76
School of Health Campus (PPSK).....	76
School of Medical Science (PPSP).....	80
School of Dental Science (PPSG)	83
Appendix I: Correlation Results	86

LIST OF SYMBOLS AND ABBREVIATIONS

BMI = Body Mass Index

WHtR = Waist to Height Ratio

MAHSA= Malaysian Allied Health Science Academy

ASEAN = Association of South East Asian Nations

EAT-26 = Eating Attitude Test -26

BN = Bulimia Nervosa

AN = Anorexia Nervosa

GPI = Gender Parity Index

**HUBUNGKAIT ANTARA INDEKS JISIM TUBUH IJT DAN
NISBAH PINGGANG KEPADA TINGGI (WHtR) KEPADA
RISIKO GANGGUAN PEMAKANAN DALAM KALANGAN
PELAJAR SARJANA MUDA DI KAMPUS KESIHATAN USM.**

ABSTRAK

Tahap peningkatan bilangan gangguan pemakanan dalam kalangan pelajar universiti menunjukkan perkembangan yang membimbangkan sejak akhir ini. Kajian ini bertujuan untuk mengkaji hubungkait antara Indeks Jisim Tubuh IJT dan nisbah pinggang kepada tinggi (WHtR) dengan risiko gangguan pemakanan dalam kalangan pelajar sarjana muda di Kampus Kesihatan, USM. Seramai 154 pelajar mengambil bahagian dan data dikumpul menggunakan Ujian Gangguan Pemakanan-26 (EAT-26) yang dikendalikan sendiri bersama-sama dengan pengukuran antropometri dan WHtR. Berdasarkan ukuran berat dan ketinggian, IJT akan di kira menggunakan berat dan tinggi manakala WHtR dikira berdasarkan nisbah data ukuran lilitan pinggang dan ketinggian. *Fisher Exact Test* dan *Pearson's Chi-Square* digunakan untuk menentukan perkaitan antara IJT dan WHtR dengan risiko gangguan makan masing-masing. Keputusan menunjukkan bahawa majoriti responden adalah berumur 21 hingga 22 tahun (53.9%), Melayu (87.7%) seramai 68.2% adalah perempuan, majoriti dari tahun tiga pengajian (37.7%) dan dari PPSK serta PPSP (40.3%) yang terlibat dalam kajian ini. Tambahan pula, 18.2% pelajar mempunyai peluang yang lebih tinggi untuk mengalami risiko gangguan pemakanan, 48.1% pelajar IJT normal dan 72.7 % berisiko rendah dalam WHtR (< 0.5). Sementara itu, kajian melaporkan hubungan yang ketara antara IJT dan risiko gangguan pemakanan ($p < 0.001$) serta WHtR dengan risiko gangguan makan ($p < 0.001$). Oleh itu, terdapat hubungan yang

signifikan antara IJT dan WHtR dengan risiko gangguan pemakanan. Pelajar dengan IJT dan WHtR yang tinggi berkemungkinan mempunyai risiko gangguan makan yang lebih tinggi. Ini menunjukkan bahawa status antropometri boleh menjadi petunjuk awal kepada risiko gangguan pemakanan

dalam kalangan pelajar universiti.

**THE ASSOCIATION OF BODY MASS INDEX (BMI) AND WAIST-
TO-HEIGHT RATIO (WHtR) WITH RISK OF EATING
DISORDER AMONG UNDERGRADUATE STUDENTS IN USM
HEALTH CAMPUS**

ABSTRACT

Recent years have witnessed the uprising trends in the prevalence of eating disorders among university students. This cross-sectional study aimed to examine the association between Body Mass Index (BMI) and Waist-to-Height Ratio (WHtR) with the risk of eating disorder among undergraduate students in the USM health campus. A total of 154 students participated, and data were collected using a self-administered Eating Attitude Test-26 (EAT-26) along with anthropometric measurement of BMI and WHtR. Based on weight and height measurement, the BMI was calculated, while WHtR was computed using waist circumference and height measurements. The Fisher Exact Test and Pearson's Chi-Square were used to determine the association between BMI and WHtR with the risk of eating disorder, respectively. Results revealed that the majority of participants were aged between 21 to 22 years old (53.9%). Most participants were Malay (87.7%) and 68.2% were female, third year students (37.7%) and from PPSP and PPSK (40.3%). In addition, 18.2% of the students were at a higher chance on risk of developing an eating disorder, 48.1% students had a normal BMI, and 72.7% were at low risk of WHtR (< 0.5). In the meantime, the study reported a significant association between BMI and risk of eating disorder ($p < 0.001$) and as well as WHtR with risk of eating disorder ($p < 0.001$). Therefore, there is a significant association between body mass index and waist-to-height

ratio with the risk of eating disorders. Students with higher BMI and WHtR values are more likely to be at risk of eating disorders. It highlights that both measurements can be used as a potential anthropometric measure in early risk identification.

CHAPTER 1: INTRODUCTION

1.1 Background of the study

Recent years have witnessed the uprising trends in the prevalence of eating disorders among university students. Eating disorders are determined as a serious mental illness due to abnormal eating behaviours and intense obsession with weight, shape, and food intake (Eguren-Gracia et al., 2024). These disorders can be classified primarily into anorexia nervosa (AN), bulimia nervosa (BN) and binge eating disorder (BED). However, AN and BN are two of the most well-known eating disorders, which are potentially life-threatening psychiatric disorders that involve abnormal eating habits and excessive concern about body image. Eating disorders may also develop as a result of extreme dietary restriction, binge eating or an excessive amount of body image concerns.

In a recent year, a study conducted among universities in Kuala Lumpur, Malaysia, revealed that 13.9% of university students are at high risk of eating disorders (Chan et al., 2020). Also, according to a 2019 by Muley et al., (2024), the global prevalence of eating disorders rose from 3.4% to 7.8% worldwide between 2000 and 2018. Furthermore, there was a study conducted among 300 students from Malaysian Allied Health Science Academy (MAHSA) university who completed the EAT-26 questionnaire with 6% scoring more than 20, which indicated a high risk of eating disorder (Abdalla et al., 2020).

Eating disorders are prevalent among university students who are uniquely susceptible to the consequences of academic achievement, societal pressures, and the transition to adulthood (Levidi et al., 2024). Psychological distress, societal body image standards and unhealthy dietary habits are some of the factors related to eating disorder

development (Bulik et al., 2022). Thus, screening for the risk of eating disorder is one way for early identification of abnormal eating behavior among the young population.

Body Mass Index (BMI) and Waist-to-Height Ratio (WHtR) are simple anthropometric measures frequently used to assess obesity and associated health risks. BMI is a prevalent indicator, and it has been an accurate measure of anthropometric fat distribution which is considered a risk factor for developing EDs (Ashwell et al., 2016). A study among undergraduate students in University Sains Malaysia (USM) Health Campus conducted by Azhar et al.,(2023) found that the prevalence of underweight participants was 16.0%, overweight was 19.2% and obese was 11.2%. A study among university students in Sarawak by Pital & Ghazali (2022), found that 14.31% and 10.13% were overweight and obese based on WHO cut-off points, respectively. On the other hand, waist-to-height ratio (WHtR) is obtained by dividing the waist circumference by height, and it has been proposed as a more reliable measure of abdominal fat and a better predictor of metabolic diseases (On et al., 2020).

Higher BMI may be linked to a higher risk of engaging in eating disorder behaviors such as binge eating or restricting food intake, according to several studies that have looked at the relationship between BMI and eating disorder (Ramaswamy & Ramaswamy, 2023). According to Abdalla et al., (2020) points out that the higher the BMI status and WHtR are related with elevated incidence of chance of developing ED. However, the role of WHtR in predicting eating disorder risk is less understood and particularly among university students who are usually confronted with body image concerns, social media comparisons, and academic pressures (S.y & W.y, 2018).

The present study therefore seeks the association of BMI and WHtR with risk of eating disorder among undergraduate students in USM Health Campus. Since the incidence of eating disorders is on the rise in this group of people, it is important to know

these relationships so that proper measures can be taken to prevent the occurrence of such problems.

1.2 Problem statements

Factors contribute to the emergence of psychological stress, distorted body images induced by society, and improper food habits. BMI has been widely used as an indicator of body weight status. However, its limitations in reflecting body fat distribution have raised concerns about its effectiveness in predicting eating disorder risk (Ashwell et al., 2016). While the waist-to-height ratio has recently been considered a more valid indicator of central obesity, related to several health risks, its relationship with eating disorders has been scarcely investigated within university settings.

Since eating disorders are prevalent among university students, particularly among those who are exposed to academic and social pressures, understanding the relationship between BMI and WHtR and the risk of eating disorders becomes particularly relevant. While some studies have been conducted on the association between BMI and eating disorders, less is known about the contribution of WHtR specifically among students at the USM Health Campus. This present study will attempt to fill this gap by analysing the association of both BMI and WHtR with the risk for eating disorders among undergraduate students and yielding important clues to early detection and intervention strategies for the prevention of eating disorders in this vulnerable population.

1.3 Research Objective

1.3.1 General Objective

To determine the association between BMI and WHtR with the risk of eating disorder among undergraduate students in the USM Health Campus

1.3.2 Specific Objective

1. To determine the association between risk of eating disorder and BMI among undergraduate students in USM Health Campus
2. To determine the association between risk of eating disorder and WHtR among undergraduate students in USM Health Campus

1.4 Research questions

1. Is there any association between the risk of eating disorders and BMI among undergraduate students in the USM Health Campus?
2. Is there any association between risk eating disorder and WHtR among undergraduate students in USM Health Campus?

1.5 Research Hypothesis

1.5.1 Null Hypothesis (H^0)

- There is no significant association between the risk of eating disorders and BMI among undergraduate students at the USM Health Campus.
- There is no significant association between the risk of eating disorders and WHtR among undergraduate students at the USM Health Campus.

1.5.2 Alternative Hypothesis (H^a)

- There is a significant association between the risk of eating disorders and BMI among undergraduate students at the USM Health Campus.
- There is a significant association between the risk of eating disorders and WHtR among undergraduate students at the USM Health Campus.

1.6 Justification of Study

The increasing prevalence of risk of eating disorders among university students particularly in health-related fields will highlight the understanding factors that contribute to these conditions. This study is essential because it aims to address the growing concern surrounding disordered eating behaviours which are linked to various psychological and physical health issues, including depression, anxiety, and malnutrition (Gupta, 2018). University students are at an elevated risk for developing eating disorders due to factors such as academic pressure, social comparison, and body image concerns, yet there is limited research specifically exploring how body composition measures like BMI and WHtR correlate with these disorders in this population (Bulik et al., 2022).

While BMI is widely used to assess general obesity and health risks, but it has been criticized for its inability to account for fat distribution which is a crucial determinant of health outcomes. In contrast, central obesity can be measured more effectively by WHtR compared to BMI in estimating the cardiometabolic (Tewari et al., 2023). However, its potential role in the identification of students at risk for eating disorders has not been widely investigated. Research has shown that WHtR could provide a more precise measure of abdominal fat which may act as a predictor for disordered eating behaviours, especially among individuals at risk for conditions such as anorexia nervosa or bulimia nervosa (On et al., 2020).

Understanding the relationship between BMI, WHtR, and risk of eating disorder is important for identifying those students who might struggle with disordered eating, thus providing early intervention. This will add to the literature by providing an insight into how anthropometric measures of body shape are associated with eating disorder risk, especially at university settings where the students may be particularly prone to obtain and maintain a socially desirable body image and adopt unhealthy patterns of eating.

These study results can be used to formulate prevention programs aimed at targeted modifications in body image perception and eating behaviours to reduce the burden of eating disorders among these high-risk populations.

CHAPTER 2: LITERATURE REVIEW

2.1 The Incidence of Risk of Eating Disorder in Undergraduate Students

Eating disorders are becoming one of the most critical health issues faced in Malaysia. These range from serious conditions that have a significant impact on a person's physical and psychological well-being including anorexia nervosa, bulimia nervosa and binge-eating disorder. Chua et al., (2022) reported, among 18 - 73 years population in Malaysia, 1.4% of were screened positive for bulimia nervosa and 0.8% for has anorexia nervosa. Additionally, the growing concern of the prevalence of eating disorders among university students in Malaysia carries a significant implication nowadays. Based on a study in a university based in Kuala Lumpur, 13.9% of the students were at high risk of eating disorders based on the EAT-26 score (Chan et al., 2020). Meanwhile, a study by Azman et al. (2022) revealed that there are 38.1% of students at the University of Cyberjaya were at risk of developing eating disorders and the prevalence was higher in female students, where 39.4% were at risk, compared to 34.4% which is a well-documented gender disparity. These findings highlight the high prevalence of such conditions among university students in Malaysia, particularly among females.

Next, eating disorders are closely related to body image concerns, which tend to significantly impair physical, psychological, and social functioning (Mallaram et al., 2023). Anorexia nervosa, bulimia nervosa, and binge-eating disorder are some of the most common types of eating disorders. Anorexia nervosa is defined as an intense fear of gaining weight, disturbed body image, self-starvation, and excessive weight loss or failure to gain weight, according to the National Institute of Mental Health (NIMH, 2023). There are two subtypes of anorexia nervosa which are the restricting type, and the other form is defined by episodes of binge-eating or purging (NIMH, 2023).

Individuals who are bulimic will engage in a cyclical cavalcade of later binge eating followed by some form of compensatory response such as vomiting, showering, or taking pills or exerting themselves vigorously (NIMH, 2023). While binge-eating disorder is another type of disordered eating with uncontrollable eating for a short period and not mainly specified to any category of BMI (Alagha et al., 2025).

2.2 Risk Factors of Eating Disorders

University students frequently face various difficulties as they enter adulthood, such as stress related to their studies, concerns about their physical appearances and lifestyle modifications. In addition, restricted access to healthy food and insufficient knowledge of nutritional values will make it even harder to maintain a balanced diet which in turn increases the likelihood of developing eating disorders in students.

Eating behaviours are also greatly affected by stress. University students with high stress originating from academic or financial sources are less likely to adhere to regular eating habits due to many engaging practices with restrictive dieting or binge or emotional eating. Stress-related eating can trigger unhealthy behaviours while increasing the likelihood of developing clinical eating disorders.

Along with the pressure to excel academically, the stress of having a “perfect” body is tremendously high and leads to aggressive behaviours towards weight loss which is significant to eating disorders among university students (Chan et al., 2020). Obese and overweight individuals are also more likely to be driven towards control of weight and are reported to have symptoms related to eating disorders. A study among female students revealed that overweight or obese women had higher levels of weight shape concern and perceived as becoming thinner than those with normal weight (Balantekin et al., 2021). These patterns reflect broader sociocultural and environmental pressures that affect the eating culture in the university milieu.

Therefore, eating disorders among university students in Malaysia reflect a significant public health issue with a significant gender difference and higher prevalence among female students. The psychological stress, body dissatisfaction and cultural pressure are also associated with the high prevalence of eating disorders that may impact on one's physical and emotional well-being.

2.3 Prevalence of BMI Status Among Undergraduate Students

Research shows that among university students in worldwide, abnormal BMI status, such as being underweight, obese and overweight, is one of significant issue. The different prevalence of students' BMI has been studied by several studies. A study among undergraduate students at Kubang Kerian, Kelantan reported that 20.0% of the students were underweight, 57.8% normal, 11.4% overweight and 10.8% was obese (Nasrin et al., 2024). This study revealed that the majority of the students were categorized in normal category. Meanwhile, the Ministry of Health Malaysia (2021) did a survey that reported the high prevalence in obesity among young adults, especially students. Many university students suffer from excess weight and obesity which lead to an increased prevalence of hypertension, diabetes mellitus, and other noncommunicable diseases (Wan Mohamed Radzi et al., 2019).

A recent study shown that the higher prevalence of 22.0% of the MAHSA university students were underweight compared to overweight (12.7%) and obese (3.3%) (Abdalla et al., 2020). This finding revealed that underweight is another alarming issue among university populations. This was also observed in more recent work by Azhar et al.,(2023) which highlighted the fact that the presence of underweight students is more common in academic contexts where intermittent eating patterns, academic pressures, and inadequate nutrition can be observed.

2.4 The Association Between BMI And Risk Eating Disorder

Food diversity and Body Mass Index (BMI) are widely adopted to classify individuals into various weight categories from underweight to obesity, yet it has been established that there is a significant positive correlation between BMI and eating disorders (Abdalla et al., 2020). First, underweight is deeply correlated with eating disorders for the members of anorexia nervosa commonly defined with a BMI below the normal range ($<18.0 \text{ kg/m}^2$). An eating disorder that involves young women and regularly underweight students makes them more susceptible to suffering from anorexia nervosa (Azman et al., 2022). The studies show that a low BMI in such cases is related to serious malnutrition and death risk caused by complications like cardiac failure and balance of electrolytes (WHO, 2023).

On the other hand, in patients with binge eating disorder, obesity is primarily due to excessive energy intake over a short period, resulting in a high body mass index (BMI ≥ 25 or 30). Recurrent binge-eating episodes that do not include purging or compensatory behaviour are the diagnostic criterion for a binge-eating disorder (Giel et al., 2022). Moreover, high BMI is also associated with risk factors for physical health problems, such as diabetes mellitus and cardiovascular diseases, and psychological comorbidity such as depression (Safaei et al., 2021)

Bulimia nervosa is described by a period of binge eating followed by behavioural responses such as self-induced vomiting, abusing laxatives or engaging in excessive exercise (Udo & Grilo, 2018). According to studies by Barakat et al.,(2023), bulimia nervosa occurs in people with higher BMI and this trigger their levels of body dissatisfaction and a strong desire to be thin. Both of these characters, support the eating disorder cycles that related to eating pathology (Nagata el al., 2018).

2.5 Association between Waist to Height Ratio with Risk of Eating Disorder

The WHtR is a great indicator of abdominal obesity and more precise in forecasting the health effects of visceral fat compare to BMI (Baioumi, 2019). Research indicates that higher WHtR is a better predictor of metabolic well-being than BMI, especially for the identification of individuals in accounts of potential abdominal adiposity despite normal overall weight (Tewari et al., 2023). A study at MAHSA university stated that WHtR is positively correlated to the eating disorders (Abdalla et al., 2020).

In addition, WHtR has been associated with eating disorder symptoms, specifically with body image and the drive for thinness. People with higher WHtR are likely to feel worse about their bodies, worsening tendencies to engage in disordered eating behaviours, such as binge eating, over dieting, or compensatory behaviour's (Liew et al., 2022). This indicates that as the previous research means that WHtR could be use as psychological tool to address eating problems other than its ability to measure metabolic health. According to Yoo.,(2016), WHtR helps avoid psychological alterations that result in eating disorder and abdominal obesity. Furthermore, WHtR is easily measurable and made it as a better predictor of changes related to obesity in clinical and research setter that related to risk factor even when the absence of waist circumference measurements (Ashwell & Hsieh, 2005).

2.6 Conceptual Framework

As shown in Figure 1, the conceptual framework of this study examines the associations of risk of eating disorders with two indicators of physical health which are BMI and WHtR among undergraduate students in the USM Health Campus. The outcome of interest is eating disorder risk as determined by the EAT-26 questionnaire such that a score of 20 or above indicates risk.

Meanwhile, the independent variable which are BMI and WHtR indicates as predictors of nutritional and physical health status. The BMI serves as a predictor of overall nutritional status that can be categorized into underweight, normal weight, overweight, and obese. While, $WHtR \geq 0.5$ indicates health risk and may be linked to eating disorder risk (Gibson & Ashwell, 2020).

The solid arrow represent the variables investigated in this study while the dashed arrow represent other possible factors yet no assessment will be conducted in this study such as age, gender, faculty, academic year, ethnicity, study sponsorship, residential setup and socioeconomic status. Previous study done by Peltzer & Pengpid (2017) reported that the WHtR among students was found to be 28.7% as WHtR is >5 which indicates high risk.

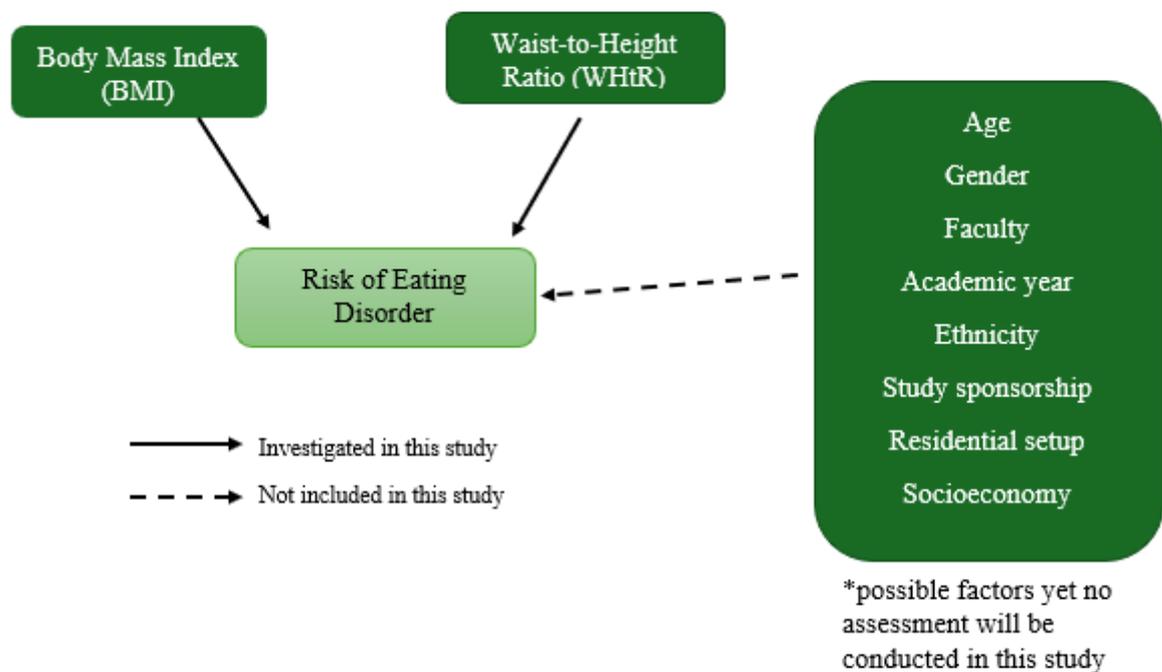


Figure 1: Conceptual Framework of association of BMI and WHtR with risk of eating disorder among undergraduate students in USM Health Campus, Kelantan

CHAPTER 3: METHODOLOGY

3.1 Research Design

This research was a cross-sectional study which designed to investigate the association of BMI and WHtR with risk of eating disorder among undergraduate students in USM Health Campus, Kelantan. It included a survey with standardized questions and questionnaires for data collection. This design was relatively quick and inexpensive to conduct and allow the data collection at a single point in time and offering a clear view of the relationships among these variables within the target population. Risk of eating disorders was measured using EAT-26 Questionnaire along with the measurements of BMI and WHtR. Data analysis focused on the prevalence of eating disorder risks and its association with BMI and WHtR.

3.2 Study Location

The study was conducted at the USM Health Campus, Kubang Kerian which located at centre of Kelantan state. The campus encompassed three schools such as School of Medical Science (PPSP), School of Dental Science (PPSG) and School of Health Science (PPSK) which collectively offer undergraduate and postgraduate programmes.

3.3 Study Population

The population included all undergraduate students currently enrolled at the USM Health Campus.

3.4 Research Subjects

The research subjects consisted of a representative sample of undergraduate students from PPSK, PPSG and PPSP at the USM Health Campus who met the study's inclusion and exclusion criteria.

Inclusion Criteria:

- Registered as undergraduate students either School of Medical Science, School of Dentistry or School of Health Science at the USM Health Campus.
- Malaysian citizen
- Aged between 19-25 years old

Exclusion Criteria:

- Clinically diagnosed with eating disorders, disordered eating behaviours or any eating-related disorders.
- Have any acute or chronic condition that would limit the ability to participate in the study (example: chronic diseases, cognitive impair, musculoskeletal impair and neurological disorder)
- Pregnant

3.5 Sample Size Calculation

3.5.1 Sample Size for first objective:

According to the first objective, the relationship between risk of eating disorder and body mass index (BMI) among undergraduate students in USM Health Campus was used as the anticipated population proportion. Using the confidence level of 95% for the study, the Z-score was 1.96 and act as a Z_{α} value. While Z_{β} was Z-score for the power of 80% power with value of 0.84. The p_1 indicated the proportion of one group which was eating disorders prevalence = 0.06 while the p_2 indicated the proportion of the second group which was BMI prevalence among obese group ($>30\text{kg/m}^2$) = 0.22. All the data was substituted into the two-proportion formula to calculate the sample size (Wang & Chow, 2005).

- Z_{α} : Z-score for the confidence level (1.96 for 95%)

- $Z\beta$: Z-score for the power (0.84 for 80% power)
- $p1$: Proportion of one group (eating disorders prevalence = 0.06)
- $p2$: Proportion of the second group (BMI prevalence = 0.22)

$$n = \left(\frac{(Z_{\alpha} + Z_{\beta})^2 \times [p1(1 - p1) + p2(1 - p2)]}{(p1 - p2)^2} \right)$$

$$n = \left(\frac{(1.96 + 0.84)^2 \times [0.06(1 - 0.06) + (0.22)(1 - 0.22)]}{(0.06 - 0.22)^2} \right)$$

$$n = 69.83 \sim 70 \text{ subjects}$$

To account for potential dropouts, extra respondents were required to be enrolled in the study. A lower dropout rate was chosen because the study population has a stronger comprehensive engagement due to the availability of the respondents at the research location. Therefore, 10% dropout rate is predicted to the sample size population (Zhang & Hartmann, 2023):

$$\text{Dropout} = \frac{10}{100} \times 69.83 \text{ subjects} = 6.98 \sim 7 \text{ subjects}$$

$$n = (70 + 7) \text{ subjects}$$

$$n = 77 \text{ subjects} \times 2$$

$$\mathbf{n = 154 \text{ subjects}}$$

3.5.2 Sample Size for second objective:

According to the last objective, the relationship between risk of eating disorder and waist to height ratio (WHtR) among undergraduate students in USM Health Campus was used as the anticipated population proportion. Using the confidence level of 95% for the study, the Z-score was 1.96 as a $Z\alpha$ value. While $Z\beta$ was Z-score for the power of 80% power with value of 0.84. The $p1$ indicated the proportion of one group which was eating

disorders prevalence = 0.06 while the p2 indicated the proportion of the second group which was WHtR prevalence = 0.287. All the data were substituted into the two-proportion formula to calculate the sample size (Wang & Chow, 2005).

- Z_{α} : Z-score for the confidence level (1.96 for 95%)
- Z_{β} : Z-score for the power (0.84 for 80% power)
- p1: Proportion of one group (eating disorders prevalence = 0.06)
- p2: Proportion of the second group (WHtR prevalence = 0.287)

$$n = \left(\frac{(Z_{\alpha} + Z_{\beta})^2 \times [p1(1 - p1) + p2(1 - p2)]}{(p1 - p2)^2} \right)$$

$$n = \left(\frac{(1.96 + 0.84)^2 \times [0.06(1 - 0.06) + (0.287)(1 - 0.287)]}{(0.06 - 0.287)^2} \right)$$

$$n = 39.71 \sim 40 \text{ subjects}$$

To account for potential dropouts, extra respondents were required to be enrolled in the study. A lower dropout rate was chosen because the study population has a stronger comprehensive engagement due to the availability of the respondents at the research location. Therefore, 10% dropout rate is predicted to the sample size population (Zhang & Hartmann, 2023):

$$\text{Dropout} = \frac{10}{100} \times 40 \text{ subjects} = 4 \text{ subjects}$$

$$n = (40 + 4) \text{ subjects}$$

$$n = 44 \text{ subjects} \times 2$$

$$\mathbf{n = 88 \text{ subjects}}$$

Therefore, based on calculation of sample size range between 88 to 154 subjects , the sample size of 154 subjects were chosen because it was among the highest value.

3.6 Sampling Method

A convenient non-probability sampling method was employed in this study to ensure that the sample obtained represents the population of undergraduate's students at USM Health Campus. Convenience sampling is a widely used non-probability sampling technique where the participants are selected based on their accessibility and willingness to participate in the research (Golzar et al., 2022). This method was particularly easy and faster to implement as it used the participants that were readily available. This study involved both male and female who were selected to examine the association between risk of eating disorder, BMI and WHtR. Then, sample size was calculated based on the desired confidence level, margin of error, power value and absolute precision to provide sufficient statistical power to determine the association between the variables.

Convenience sampling methods involved several steps to effectively enrol the participants in this study and the target population of this study is undergraduate students at USM Health Campus. A quota-based convenience sampling method was used where an equal number of participants from PPSK (n=62), PPSP (N=62) and PPSG (n=30) were recruited from each of the three selected schools to ensure balanced representation.

The class representative from each school in USM Health Campus which compromised PPSK, PPSG and PPSP accordingly to each year distributed the enrolment link to their WhatsApp group which included a simple poster and short brief about the research along with the invitation link. The accessible participants were approached from specific locations where they were readily available such as cafeterias, lecture halls or student common areas. They were informed about the study, and the interested individuals will be screened to ensure that they full-filled the inclusion and exclusion

criteria. From both approached, which by online and face to face, the eligible participants who fulfilled the criteria were recruited and invited to the WhatsApp group of the research participant until the potential participants reached. The sampling method was run until the desired sample size achieved at a total of 154 subjects including the dropouts.

3.7 Research Tools

EAT-26 Questionnaire

EAT-26 is a questionnaire that is designed for self-reporting that primarily assesses disordered eating attitudes and behaviors. The self-administered questionnaire contained 26 items that graded from 0 to 3 in six components which are 0 meaning “Never”, “Rarely”, “Sometimes”, 1 means “Often”, 2 is “Very often” and 3 as “Always”). The questions were regarding attitudes, beliefs and behaviour regarding food, weight and body shape. The total score calculated, and the range will be 0 to 78. The score below 20 were associated with low risk of developing an eating disorder, while 20 or greater were associated with higher like hood of developing eating disorder (Garner, 1991). Three subscales are produced by this questionnaire which are dieting, bulimia, and oral control. The EAT-26 has strong internal consistency with Cronbach’s alpha value 0.88 and test-retest reliability. Moreover, it is widely used in clinical and research settings as a standard screening tool for eating disorders and whoever is higher than the cutoff point which is at 20 or greater is categorized as high risk of ED (Garner, 1991). The EAT-26 has been cross-culturally validated among several populations and is useful in differentiating those at risk in clinical and nonclinical groups (Mintz & O'Halloran, 2000). Therefore, the EAT-26 questionnaire is one of the valuable research tools for early screening to detect the risk of ED among university students.

BMI

BMI is a standardized measurement to estimate body fats based on body weight and height. Stadiometer and SECA 813 digital calibrated scale were used to measure height (in meters) and weight (in kilograms), respectively. The measurement of weight and height taken twice and the average taken as the final measurement. Then, the BMI was calculated by weight (kg) over height squared (m^2). Participants were classified as underweight, normal weight, overweight and obese according to their BMI value. It also has a substantial test-retest reliability at 0.95 and acceptable validity at 0.84 (Leatherdale & Laxer, 2013). According to World Health Organization (2023), BMI values below $18.5 \text{ kg}/m^2$ is categorized as underweight, $18.5\text{-}24.9 \text{ kg}/m^2$ is classified as normal weight, $25.0\text{-}29.9 \text{ kg}/m^2$ will indicate as overweight and lastly greater than $30.0 \text{ kg}/m^2$ is classified as obese.

WHtR

WHtR is a better variable than others to detect certain metabolic and psychological health risks. It is calculated by rationing waist circumference with participant's height (Tewari et al., 2023). Waist circumference was measured at the narrowest point between the lower ribs and iliac crest using measuring tape. It was also measured twice, and the average was calculated and taken as a final measurement. Therefore, it has been shown that WHtR is the best prognostic factor in the assessment of the distribution of abdominal fat and the associated risk (On et al., 2020) . A WHtR cut off greater than 0.5 will serve as an internationally accepted cutoff for central obesity in both children aged ≥ 6 years and adults (Yoo, 2016). According to the research among ASEAN university students' population, the prevalence of WHtR of greater than 0.5 among Malaysian students is used to measure as risk of central obesity in university setting (Peltzer & Pengpid, 2017)

3.8 Operational Definition

Risk of Eating Disorder

Risk of eating disorder is a condition where an individual's potentially getting the disordered eating behaviour that can be clinically diagnosed as eating disorder. A comprehensive article by Muros et al., (2020) defined that eating disorder composed of anorexia nervosa, bulimia nervosa and atypical eating disorder as serious mental illness. Moreover, eating disorders are also derived as a condition where the individual behavioural condition is severe and experience the eating disturbance that is associated with the thoughts and emotions (National Institute of Mental Health ,2024). Therefore, from both definitions of eating disorder, the risk of eating disorder could be understood as the likelihood or potential rate of the individuals being diagnosed as a chronic psychological disorder and experiencing eating disturbance that is associated with mental health. The associated factors such as education level, body perception-related factors and beauty-centric social media also contribute to high risk of eating disorder symptoms (Barakat et al., 2023).

Body Mass Index (BMI):

Body Mass Index is the one of assessment tools that can be used to assess one's health condition based on weight and height. BMI also can be used to estimate the body fats based on the individual's height and weight (Khanna et al., 2022). It is calculated by dividing an individual weight and square of height in metres. An individual whose BMI score is below than 18.5kg/m^2 is considered as underweight and those between 18.5 and 24.9 kg/m^2 are classified as overweight. Also, those with BMI between 25.0 until 29.9 kg/m^2 are indicated as overweight and BMI above 30.0 kg/m^2 are classified as obese (WHO, 2023).

Waist-to-Height Ratio (WHtR)

WHtR is defined as waist circumference is divided with height which both data are in centimeter unit (Yoo, 2016). A cut off value at greater than 0.5 is indicated the high risk related to abdominal obesity and as a potential marker for health problems such as metabolic disorders (Peltzer & Pengpid, 2017) .

3.9 Data Collection Methods

The data collection for this study began once the ethical approval was received from the Human Research Ethics Committee at University Sains Malaysia (USM/JEPeM/KK/25010142). This was to ensure that all research practices aligned with ethical standards. The class representative from each school in USM Health Campus which compromised PPSK, PPSG and PPSP accordingly to each year distributed the enrolment link to their WhatsApp group, including a simple poster and short brief about the research and along with the invitation link. Additionally, the accessible participants were approached from specific locations where they were readily available such as cafeterias, lecture halls or student common areas. From both approaches, the participants recruited according to convenience sampling method and those who fulfilled the exclusion and inclusion criteria were invited in the WhatsApp group.

Before the participation of the study, all the eligible participants were thoroughly informed in the WhatsApp group about the study's objectives, processes, summary, objectives, informed consent, privacy, and confidentiality before the data collection begins to ensure they understood their autonomy in choosing to participate. Data collection venue within the campus area specifically in indoor student common area such as Murni Hall and Nurani Hall. Participants were given an option to choose the selected venue and date according to their accessibility preferences. The anthropometric measurements such as weight, height and waist circumference also collected during face-

to-face interview session by the researcher. This face-to-face interview session were held at chosen specific place that had a private space for measurement waist circumference, weight and height to ensure their privacy. All the participants were required to take their measurement before scanning the QR code for the Google Form online questionnaire. According to the study, Google form has been acknowledged as an easy-to-use web interface for the development and deployment of web-based survey questionnaire in academic research (Vasantha Raju & Harinayana, 2016). Both Malay and English version of questionnaire were available, and they could choose either one based on their preferences. Also, this questionnaire consisted of Section A which was sociodemographic data, Section B was anthropometric data and Section C was EAT-26 questionnaire. Only those who gave consent were taken to the next page to proceed to answer the questionnaire. The data collection session took around 15-20 minutes.

Section A: Sosio-demographic data

Section A consisted of personal information such as age, gender, faculty, academic year, ethnicity, study sponsorship and residential setup.

Section B: Anthropometric data

In this study, the researcher measured the participants' body weight, height and waist circumference. The waist circumference was measured to be inserted into Waist-to-Height ratio formula which was waist circumference divided by height. While the weight and height were measured to compute the BMI.

Section C: Risk of Eating Disorder

Risk of eating disorder is validate using Eating Attitude Test-26 (EAT-26) Questionnaire. The self-administered questionnaire contained 26 items that regarding attitudes, beliefs and behaviour regarding food, weight and body shape. The score below 20 were

associated with low risk of developing an eating disorder, while 20 or greater were associated with higher like hood of developing eating disorder. (Garner, 1991).

3.10 Flow Chart

As shown in Figure 2 is flow chart of the research pathway begins with received ethical approval from Human Research Ethics Committee USM and followed by the data collection among undergraduate students in Health Campus. The data are then analyzed using SPSS version 29. Next, the results are reported and compiled into a report for the assessment and proceed to the thesis writing. Lastly is the presentation of the findings to the experts.

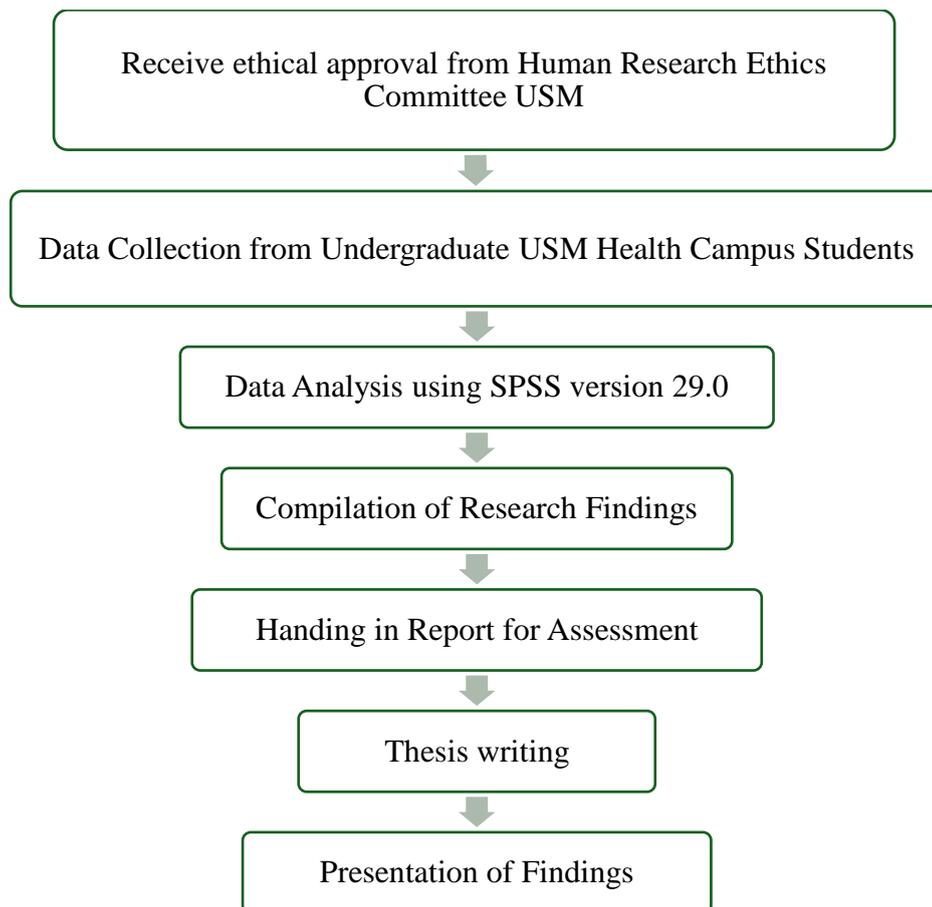


Figure 2: Flow of the Research

3.11 Data Analysis

In this study, several steps of data analysis were performed to determine the association of the risk of eating disorders with BMI, and WHtR of undergraduate students at USM Health Campus. SPSS Statistic version 29 was used to analyse the data. Descriptive statistics were employed to summarize the socio-demographic characteristics of the participants which comprised age, gender, faculty, academic year, ethnicity, study sponsorship and residential set up. Numerical data was presented as mean (SD) for normally distributed data or median (IQR) for non-probability distributed data. $\text{Weight(kg)} / (\text{Height} \times \text{Height})(\text{m}^2)$ formula was calculated to measure BMI according to WHO cut off point and WHtR will be calculated by waist circumference (cm) / Height (cm) . While categorical data was summarized and presented as frequencies and percentages.

Associations between categorical variables were analyzed using Pearson's Chi-Square or Fisher Exact test. Pearson's Chi-Square is used if the expected count <5 is less than 20% of the cells or Fisher's Exact is used if the expected count <5 is more than 20% of the cells (Nowacki, 2017). The associations between risk of eating disorder with BMI and WHtR assessed either by Pearson's Chi Square and Fisher Exact Test according to the results of data collected. The statistical significance will be considered at p-value <0.05.