

EFFECT OF BODY WEIGHT ON MEMORY FUNCTION AMONG
UNDERGRADUATE STUDENTS IN HEALTH CAMPUS UNIVERSITI
SAINS MALAYSIA

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by

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LIST OF ABBREVIATIONS

AVLT	– Auditory Verbal Learning Test
BMI	– Body Mass Index
LTM	– Long-Term Memory
MVAULT	– Malay Version Auditory Verbal Learning Test
RAVLT	– Rey’s Auditory Verbal Learning Test
STM	– Short-Term Memory
USM	– Universiti Sains Malaysia
WHO	– World Health Organization

**Kesan Berat Badan Terhadap Fungsi Ingatan di Kalangan Pelajar Sarjana Muda
di Kampus Kesihatan Universiti Sains Malaysia (USM)**

ABSTRAK

Kesedaran dan pengendalian berat badan yang sihat adalah penting kerana berat badan mempunyai kesan yang menyeluruh terhadap kesihatan seseorang. Fungsi ingatan yang baik berdasarkan berat badan yang sihat adalah mustahak untuk meningkatkan kualiti hidup seseorang. Oleh itu, kajian keratan rentas telah dilakukan untuk mengenalpasti perhubungan antara berat badan terhadap fungsi ingatan di kalangan pelajar di USM. Data telah dikumpulkan menggunakan borang "Google". Seramai 151 pelajar dari Kampus Kesihatan, USM yang memenuhi kriteria kemasukan telah terlibat. Mereka dipilih melalui kaedah persampelan berstrata rawak. Data yang dikumpulkan dianalisis secara statistik menggunakan perisian Statistical Package Social Sciences (SPSS) versi 27. Kajian menunjukkan bahawa 43.8% pelajar yang berlebihan berat badan menunjukkan fungsi ingatan yang lambat. Perhubungan antara berat badan terhadap fungsi ingatan adalah signifikan secara statistik ($p < 0.05$).

**Effect of Body Weight on Memory Function among undergraduate students in
Health Campus Universiti Sains Malaysia (USM)**

ABSTRACT

Acknowledging and maintaining a healthy body weight is essential among students as it has a diverse effect on overall health. A good memory function according to a healthy body weight is crucial to enhance the quality of life. Thus, a cross-sectional study was carried out to detect the association between body weight on memory function among undergraduate students in USM. Data was collected through Google form. A total of 151 students from the Health Campus, USM who fulfilled the inclusion criteria were involved. They were chosen through a stratified random sampling method. Data was analysed using the Statistical Package for Social Science (SPSS) version 27. This study showed that 43.8% of overweight students showed delayed memory recall. There is a statistical association between body weight on memory function ($p < 0.05$).

Chapter 1 : INTRODUCTION

1.1 Background of the Study

A healthy body weight within an ideal range is essential to reduce the susceptibility of the body in preventing any diseases. Healthy eating, physical activity, getting enough sleep and stress management are some of the factors that have an impact on the body weight (Centers for Disease Control (CDC), 2021).

Underweight, also known as malnutrition is referred to deficiency or imbalance nutrients intake or impaired nutrients utilization. Therefore, being underweight is defined as low weight-for-age/height (Fox, 2011). Poor nutrition or underlying health conditions can affect adults of being underweight. According to National Health and Nutrition Examination Survey (NHANES) from 2017 to 2018, using measured heights and weights, showed that approximately 1.6% of American adults aged 20 and over are underweight (Fryar *et al.*, 2020).

It is known that obesity is now a global health crisis. According to World Health Organization (WHO), more than 1 billion people worldwide are obese comprise of 650 million adults, 340 million adolescents and 39 million children. It is believed that these numbers are increasing. It is a disease that affects our body systems which leads to a range of non-communicable diseases (NCDs) (Mundial de la Salud, 2022). Previous study reported that the prevalence of obesity ($BMI \geq 30 \text{ kg/m}^2$) among adults in Selangor, Malaysia was 18.6% (Mohd-Sidik *et al.*, 2021). The prevalence of obesity in Malaysia was increased drastically compared to other Asian countries due to the Malaysians' eating habits (Lim *et al.*, 2020).

Moreover, an elevated BMI was significantly correlated ($p < 0.01$) with a decreasing in a neuronal fiber bundle length (FBL), which is known to contribute to

brain atrophy (Fotuhi & Lubinski, 2013). The parts of brain that are vulnerable to obesity-related-atrophy are hippocampus, cingulate gyrus, and frontal lobes (Fotuhi & Lubinski, 2013). It is also noted that overweight and obese individuals with extensive cerebral atrophy are cognitively impaired (Fotuhi & Lubinski, 2013). Therefore, excessive gain in the body weight is definitely associated with the changes of functions and structures of the brain which leads to the cognitive impairment (Fotuhi & Lubinski, 2013).

1.2 Problem Statement

It is crucial that body weight of an individual should be controlled since early childhood because weight related behaviors such as food preferences and routines of physical activities are formed as habits. Previous study showed that unhealthy eating habits raised the levels of Low Density Lipoprotein (LDL) known as ‘bad’ cholesterol which led to the higher chances of being overweight and obese (Bucholz *et al.*, 2018). Furthermore, study in the older children and adults that practice higher intake of a “Western style diet” showed a high level of saturated fat and refined sugars which led to the cognitive impairment and low academic performance (Tandon *et al.*, 2016).

Moreover, obesity is a potential factor that deficits the cognitive function. The data was in line with a study reported by Prickett *et al.* (2015), the unhealthy body weight associated with a negative psychological growth and neurocognitive function. Working memory also known as a short-term memory, is an indicator of academic performance. Previous study proved that working memory in executive function and neurocognition is essential to determine its possible role in children with obesity (Lessard & Juvonen, 2019). In that study, obese children showed a poor track record of academic achievement compared to the non-obese children (Lessard & Juvonen, 2019).

1.3 Research Question

- i. What is the body weight of the undergraduate students according to the Body Mass Index (BMI) ranges in Health Campus, Universiti Sains Malaysia?
- ii. What is the level of memory function among undergraduate students in Health Campus, Universiti Sains Malaysia?
- iii. Is there any association between the body weight and memory function among undergraduate students in Health Campus, Universiti Sains Malaysia?

1.4 Research Objective

1.4.1 General Objective

The general objective of this study is to determine the effect of body weight on memory function among undergraduate students in Health Campus, Universiti Sains Malaysia.

1.4.2 Specific Objectives

- i. To identify the Body Mass Index (BMI) of undergraduate students in Health Campus, Universiti Sains Malaysia.
- ii. To identify the level of memory function among undergraduate students in Health Campus, Universiti Sains Malaysia.
- iii. To determine the association between body weight and memory function among undergraduate students in Health Campus, Universiti Sains Malaysia.

1.5 Hypothesis

Hypothesis H₀: There is no significant association between body weight and the level of memory function among undergraduate students in Health Campus, Universiti Sains Malaysia.

Hypothesis H₁: There is a significant association between body weight and the level of memory function among undergraduate students in Health Campus, Universiti Sains Malaysia.

1.6 Conceptual and operational definitions

Table 1.1: Definition for operational terms used in this study

Terms	Conceptual	Operational
Body weight	Body is defined as a whole physical structure of a human or entity while weight is defined as the body's relative mass that is measured against the earth's gravity (Prescribe Synonyms Collins English Thesaurus, 2022).	In this study, body weight is referred to the whole mass of a student which also then categorized according to Body Mass Index (BMI) which is the weight-for-height index.
Memory	The ability of the mind to store and recall past sensations, thoughts, and knowledge (Prescribe Synonyms Collins English Thesaurus, 2022).	In this study, memory function of undergraduate students are assessed using the Auditory Verbal Learning Test (AVTL). This is also known as the test for short-term memory.

Undergraduate	A student who is pursuing study for the first degree at a college or university (Prescribe Synonyms Collins English Thesaurus, 2022).	An individual who takes a degree or diploma course in Health Campus, Universiti Sains Malaysia such as degree in medical sciences, degree in dental sciences and degree in health sciences. Researcher chose those students because they were all currently in their learning process and it will be more suitable to carry out the memory test among undergraduates.
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1.7 Significance of the study

This study is conducted among undergraduate students in University Sains Malaysia because university students tend to neglect the importance of balancing optimum body weight (Hui Tee et al., 2018). The university students are mostly aged 17 years old and above (Study Malaysia, 2015). A study has shown that largest growth of population that are obese or overweight comes from people aged group of 18 to 29 years old (Yan & Harrington, 2020). This is also the time when students make their decisions on choices of food, poor time management and academic stress. This will eventually lead students to being obese or overweight. Undergraduate students also spend a lot of time studying and learning throughout their university days. Therefore, a good memory function is crucial for the wellbeing and longevity of students. Memory function also acts as a

support for simultaneous learning capabilities such as time management as it also helps in learning and enhancement in career (Hui Tee et al., 2018). By assessing students' cognitive capabilities, this study will crave an idea of the effect of body weight on memory function.

Therefore, as a researcher, I expect undergraduate students in Health Campus USM has a good quality of life which parallels to the outcome of this study.

Nowadays due to rapid evolution of new era, implementation of progressively more sedentary lifestyle that are instilled in human affected the prevalence of obesity worldwide. To build a healthy nation and fuel economic growth, as the future pillars of the country, healthy young adults with good cognitive function is important for the development of intervention programs to reduce the association of body weight on memory function. Hence, this issue should be addressed to provide the guidance and resources needed to create a meaningful difference for future health.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter presented a review of the literature related to body weight and short-term memory retention. This chapter formulated into covering issues that answers to this study's research questions, meeting its objectives and supporting or disagreeing its hypotheses.

2.2 Body Weight

An individual's body weight status plays an essential role as a parameter on the psychological growth and health-related quality of life as well as cognitive function. According to the World Health Organization (WHO,2023), body mass index (BMI) is a directly understandable weight-for-height index that is used to categorized normal weight, overweight and obese among individuals. A person's BMI can be measured by dividing weight in kilograms with height in meters (kg/m^2). Therefore, BMI is used as a defining parameter as well as an associative factor in this study to measure the memory function of an individual (Table 2.1). Body mass index (BMI) can be a screening tool for weight category and moderately correlated with more direct body fat measures (Davies & Lucas, 1989).

Uncontrollable body weight measures will eventually lead to individuals being obese, overweight or underweight. In Malaysia, the prevalence of obesity and overweight showed a rapid rise as it also contributes to the accumulating numbers of non-communicable diseases such as hyperlipidemia, diabetes and hypertension which might cause increased morbidities among Malaysian population in the future (Wan Abdul Hamed & Abd Aziz, 2020).

Table 2.1: BMI categories in adults

Body Weight Status	BMI (kg/m²)
Underweight	Below 18.5
Normal weight	18.5 – 24.9
Overweight / Pre-obesity	25.0 – 29.9
Obesity class I	30.0 – 34.9
Obesity class II	35.0 – 39.9
Obesity class III	Above 40.0

Source: (World Health Organization, 2010).

2.3 Memory

Memory represents the ability to contain information of knowledge and past experiences based on mental processes that requires encoding, retention and retrieval (Roger et al., 2022). There are some of major variables that influence the memory retention, for example, the duration of retention which indicates the maintaining of memory through short-term and long-term (Roger et al., 2022). Other variables is the condition of learning and receiving information, which involves learning strategies such as degree of attention and lifestyle of an individual (Roger et al., 2022). Memory can be defined using the Atkinson-Shiffrin Memory Model known as Multi-store Model of Memory (McLeod, 2021). This model proposed that memory consist of three storage systems which are sensory register, short-term memory (STM) and long-term memory (LTM). It describes that information is processed through sensory and travels to the STM store. Then, information from the STM will be progressed into LTM store. However, for

STM to transferred into LTM, STM information must be rehearsed (repeated) and strengthened (Chang et al., 2012).

As relation to the human memory function, working memory is resulted in the wellbeing of adolescents and longevity. Working memory also acts as a support for simultaneous learning capabilities such as time management (Hui Tee et al., 2018). Not only that, it also promotes future learning and a sole support for career success. Therefore, a decline in memory function are attributed to negative health conditions too in which includes psychosocial problems such as aggression (Hui Tee et al., 2018).

2.3.1 Short-term Memory

Short-term memory is also referred as a working memory that stores information or experiences temporarily (Norah Hadi Alsaeed, 2017). As explained based on the Atkinson-Shiffrin Memory Model, the information is transported by senses into STM storage and then into the LTM. Short-term memory has a very limited space to store information and unrepeated memory is forgotten within 15 to 30 seconds (Norah Hadi Alsaeed, 2017).

2.3.2 Long-term Memory

A continuous retention of memory is known as Long-term memory (LTM). LTM is a vast storage of knowledge and captures a record of prior events (Cowan, 2008). LTM is also referred to preconscious and unconscious memory. When the information is relatively easy to recall, it is called pre-consciousness in a span time of few minutes to a couple of hours and this is related to long-term memory. Unconscious memory refers to any data that is unavailable during normal consciousness (Norah Hadi Alsaeed, 2017).

2.4 Body Weight Affecting Memory Function

The factors that this study focuses is on the abnormality in body weight which is influenced by imbalanced nutrition intake too and somehow affects the psychological behavior (Light, 1996). According to a research study (Yang *et al.*, 2019), data analysis showed that obese women showed worse working memory ($M = 3.88$) ($SE = 0.05$) than overweight women ($M = 4.23$) ($SE = 0.06$) and normal weight women ($M = 4.35$) ($SE = 0.05$). It is expected to find that lower neurocognitive performance scores on the domains of memory, attention and executive function for obese than normal-weight women (Lentoor, 2022).

Obesity is proved to have an association in neurodevelopmental such as impaired grey and white matter of the brain and degeneration of prefrontal cortex (PFC) which has contributed to poor memory function (Hui Tee *et al.*, 2018). Previous studies have shown that there is a consistent relationship between the increase of BMI and poor inhibition among individuals. However, the relationship between obesity and the working memory have remained inconclusive (Hui Tee *et al.*, 2018).

Overall, as obesity is a modifiable risk factor for memory impairment, dementia and Alzheimer's disease, early detection and management are more likely to minimize the chance of getting these diseases (Lentoor, 2022).

2.5 Conceptual and Theoretical Framework of the Study

2.5.1 Conceptual Framework of the Study

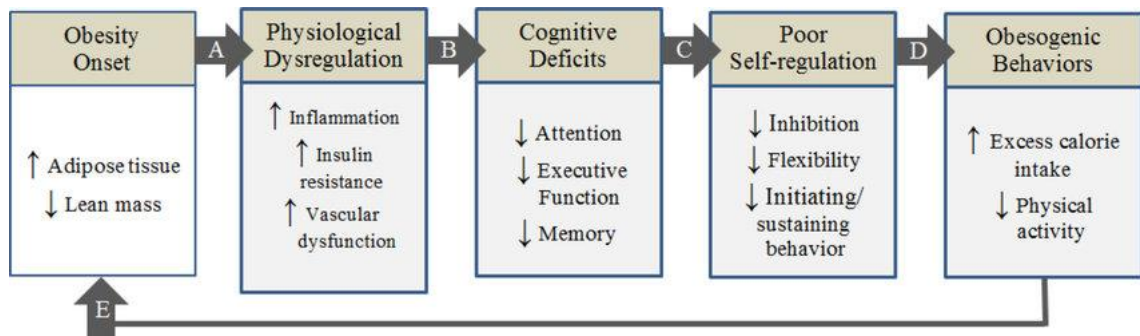


Figure 2.0 The cyclical model of obesity and cognitive function (Adopted from Hawkins et al., 2018)

According to the cyclical model, obesity is a disease in which adipose tissue are high in the body (Part A) (Hawkins *et al.*, 2018). This will cause physiological dysregulation (Part B) that impairs the cognitive function (Part C) and resulting in unhealthy behaviors and habits (Part D) and that which leads to obesity (Hawkins *et al.*, 2018).

White adipose tissue can be categorized through healthy expansion or unhealthy expansion. Healthy expansion adipose tissue which contribute to excessive body weight protects against metabolic complication of obesity while unhealthy expansion promotes obesity-related metabolic complication (Longo *et al.*, 2019).

2.5.2 Theoretical Framework of the Study

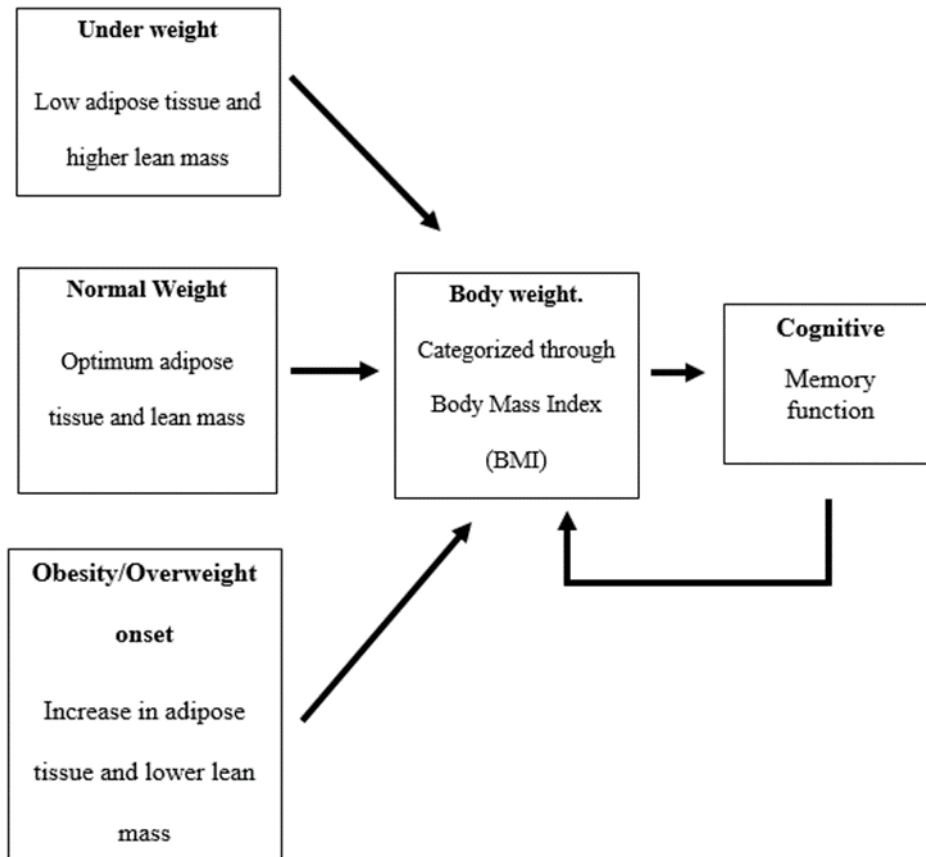


Figure 2.1 The cyclical model of obesity affecting cognitive function.

Based on theoretical cyclical model, the researcher found that the current investigation studies that memory function of undergraduate students depends on the body weight according to the classification BMI as it gives an idea on the level of adipose tissue in the body. In order to get a clear result from this study, all BMI categories are to be obtained tested on students' memory function. The negative effect of obesity on memory function is also proved to happen due to sedentary lifestyle and poor eating habits. Socio-demographic characteristics are included but will not be studied in detailed in this model. Moreover, it is shown that obesity is a cyclic disease which high adipose tissue and low lean mass causes physiological changes such as reduced insulin resistance that leads to cognitive deficits (Hawkins et al., 2018).

CHAPTER 3 : METHODOLOGY AND METHODS

3.1 Research Design

A cross sectional study design was used in the current study. This method was chosen as it enables researcher to conduct the data collection in a quick amount of time and requires only one time interaction among the participants.

3.2 Research Location

This study was conducted at the School of Medical Sciences, School of Dental Sciences and School of Health Sciences in Universiti Sains Malaysia which is located in Kubang Kerian, Kelantan. Participants were selected randomly throughout the campus.

3.3 Research Duration

This study was conducted from October 2022 until August 2023.

3.4 Research Population

The current study targeted respondents were among undergraduate students in Health Campus, USM which includes medical, dental and health sciences schools.

3.5 Subject Criteria

3.5.1 Inclusion Criteria

- i. Undergraduate students from School of Medical Sciences, School of Dental Sciences and School of Health Sciences.

3.5.2 Exclusion Criteria

- i. Students who have diagnosed with psychiatric disease.
- ii. Students who had previous brain or head injury.

Students who have diagnosed with psychiatric disease were excluded from this study. Psychiatric diseases such as depression, bipolar disorder, schizophrenia, anxiety disorders and mood disorders. This is because mental disorders are linked to memory function which leads to confusions, forgetfulness, disrupts emotion condition and mental state (Shelton & Kirwan, 2013). It can impair the attention and memory of students as the hippocampus will be affected in size and reduce its effectiveness (Wetsman Nicole, 2019). Next, students who have had a previous brain or head injury were also excluded from this study. Individuals who have undergone brain or head injury remain confused and they are unable to store memories after the injury and this condition is called post-traumatic amnesia, the loss of memory after Traumatic Brain Injury (TBI) (Hart & Sander, 2017). Students were asked if they are prone to these criteria and researcher excluded them before the survey was conducted.

3.6 Sampling Plan

3.6.1 Sample Size Estimation

The sample size calculated for objective 1 and objective 2. An appropriate sample size was considered as a study sample. For objective 1 and objective 2, single proportion formula was used.

$$n = \left[\frac{z}{\Delta} \right]^2 p (1 - p)$$

n = required sample size

z = value of the standard normal distribution curve cutting off probability Alpha (α) in one tail for one-sided alternative or $\frac{\alpha}{2}$ in each tail for a two-sided alternative (z0.05 = 1.96)

Δ = desired level of precision

p = estimated proportion of an attribute that is present in the population

For objective 1 (to identify the Body Mass Index (BMI) of undergraduate students in Health Campus, Universiti Sains Malaysia), based on previous study, p value was retrieved from the article cited.

$z = 1.96, \Delta = 0.05, p = 0.099 \%$ (Vidyanti et al., 2020)

$$n = \left[\frac{z}{\Delta} \right]^2 p (1 - p)$$

$$= 137$$

Dropout factor = 137 x 10%

$$= 151 \text{ participants}$$

For objective 2 (to determine the level of memory function among undergraduate students in Health Campus, Universiti Sains Malaysia) based on previous study, it has shown that

$z = 1.96, \Delta = 0.05, p = 0.031$ (Tian et al., 2021)

$$n = \left[\frac{z}{\Delta} \right]^2 p (1 - p)$$

$$= 46 \text{ participants}$$

For objective 3, two proportion formula was used as there are two parameters involved in calculation:

$$n = \frac{[P_1(1-P_1) + P_2(1-P_2)] (Z\alpha + Z\beta)^2}{(P_1 - P_2)^2}$$

n = required sample size

$z\alpha$ = value of standard normal distribution curve cutting off probability Alpha (α) in one tail for one-sided alternative or $\frac{\alpha}{2}$ in each tail for a two-sided alternative ($z_{0.05} = 1.96$)

$z\beta$ = power of study, 80% ($z\beta = 0.84$)

p = estimated proportion of an attribute that is present in the population

For objective 3 (to determine the association between body weight and memory function among undergraduate students in Health Campus, Universiti Sains Malaysia)

$P_1 = 0.425$, cognitive impairment among underweight (Ren *et al.*, 2021).

$P_2 = 0.212$, cognitive impairment among overweight/obese (Ren *et al.*, 2021).

$$\begin{aligned} n &= \frac{[P_1(1-P_1) + P_2(1-P_2)] (Z\alpha + Z\beta)^2}{(P_1 - P_2)^2} \\ &= \frac{[0.425(1-0.425) + 0.212(1-0.212)] (1.96 + 0.84)^2}{(0.425 - 0.212)^2} \\ &= 71.1 \text{ participants} \\ &= 71 \text{ participants} \end{aligned}$$

The minimal sample size is 71 and after considering the dropout rate 20%, the sample size is calculated is:

$$n = 71 + 20\%$$

= 71 + 14

= 85 participants.

The greatest sample size was taken for this study to ensure all of the objectives can be achieved, which was 151 participants.

3.6.2 Sampling Method

In this study, the participants were selected through a stratified random sampling method. This type of sampling method enabled the researcher to obtain sample population that represents each strata or subpopulations which has be done by schools.

Equal proportion of students from each school were chosen to answer the survey.

3.7 Research Instrument

In this study, data was collected from the participants by using a questionnaire scanned through a Quick Response (QR) code which was printed by the researcher before hand and participants were assessed using the Rey Auditory Verbal Learning Test (RAVLT) which was based on the Malay Version Auditory Verbal Learning Test (MVAULT). This survey was conducted physically with the researcher as the assessor. In order to reduce the usage of paper material, the questions were answered online with the presence of the researcher.

3.7.1 Instrument

The questionnaire was developed in a Google form. It was focused on obtaining students' body weight status and their memory function through a test (Cardoso Teruya et al., 2009). (APPENDIX C).

The questionnaire was structured into 3 sections: Section A, B and C.

Section A: Socio-demographic data

In this section, socio-demographic data includes age, gender, ethnicity and the year of study were asked.

Section B: Body Weight

This section had three self-administered questions that involve participants' body weight (kg), height (m) and BMI (kg/m²). Categorical data was used to categorize the BMI.

Section C: RAVLT Assessing Short-Term Memory Function.

In this section, two lists of words were given. The researcher held the lists and participants had to read them aloud. Each List A and List B consist of 15 nouns respectively. Participants were asked to read the words from List A five times (A1, A2, A3, A4, A5) with one item per second (using smartphone assistance a timer). After each trial, participants did a verbal recall. Scores were given by the researcher. Participants read the words from List B (interference list) and recalled them immediately (A6). After the trial of List B, participants recalled the words from List A (A7) (Moradi *et al.*, 2017).

3.7.2 Translation of Instrument

The questionnaire was held in English as the participants were undergraduates' students. They were able to comprehend English well.

3.7.3 Validity and Reliability

Validity and reliability are the important parts to consider in developing a research instrument in ensuring the quality and measurement of the data collected for the study. The index was considered good value if more than 0.80. The RAVLT is a valid and

reliable scale with 0.84 and the standardized Alpha was 0.88. The test condition coefficients varied from 0.78 to 0.82 (Magalhães *et al.*, 2012).

3.8 Variables

Table 3.1 : Study Variables

Independent variable	<ul style="list-style-type: none"> • Body Mass Index (BMI) • Socio-demographic characteristics (age, ethnicity, gender, programme of study, year of study,
Dependent variable	<ul style="list-style-type: none"> • Memory function

3.8.2 Variables Measurement and Variables Scoring

The normal scoring of the MVAVLT was based on the original AVLT (Munjir *et al.*, 2015). The test portrayed the memory function of participants instantly. A1 was known as the first trial and A2, A3, A4, A5, A6 and A7 indicated the number of trials respectively.

- A1 to A5 indicated immediate memory.
- A6 indicated intermediate memory after interference.
- A7 indicated delayed memory.

Table 3.2 : The scoring of MVAULT

Score	Normal score	
	Powell and friends (1991)	Guilmette and Rasile
A5	>12	>9
A6	-	8
A7	-	>7
Total Learning (A1 – A5)	>50	>52

Table 3.3 : The mean score and standard deviation for RAVLT scoring

Memory	Mean	SD	Category
Immediate memory	86.3	14.0	Low average
Total memory	85.6	18.2	Low average
Delayed memory	92.6	19.0	Average

Source : Scores 90 to 110 were generally considered ‘average’ (Denhart, 2018).

3.9 Data Collection Plan

A questionnaire form.

The data collection was conducted from January 2023 to March 2023. Figure 3.0 shows the flowchart of the data collection.

After the questionnaire was structured into a Google form. Participants scanned a QR code in order to access the Google form as it saved an amount of time and cost while conducting the survey.

3.9.1 Flowchart of Data Collection

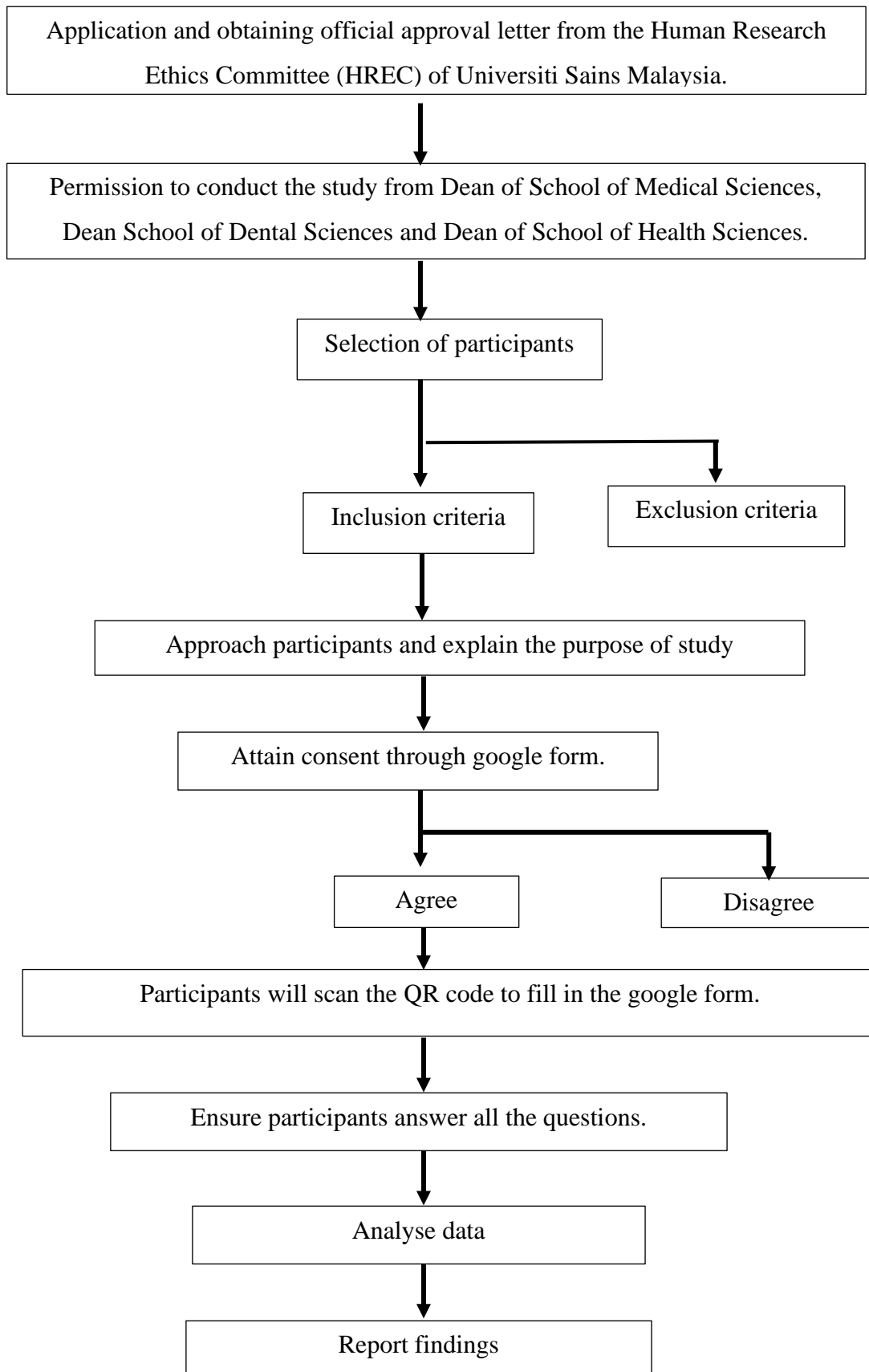


Figure 3.0 Flowchart of Data Collection.

3.12 Ethical Consideration

This research study was conducted after the ethical approval of Human Research Ethics Committee, Universiti Sains Malaysia. The participants were briefed and advised on the risks, their right to voluntary participants and the right to withdraw from the study at any time without any loss of benefits to which was otherwise entitled (Appendix C). The informed consent was directed to the participants at the first page of the Google form questionnaire. Participants were asked about their willingness to join this study or not.

The ethical approval was requested and granted from the Ethical Committee Universiti Sains Malaysia. Permission was requested from the Dean of School of Medical Sciences, Dean of School of Dental Sciences and Dean of School of Health Sciences in Health Campus, Universiti Sains Malaysia.

In this study, participants were voluntary for all subjects. They had the rights to discontinue the survey at any time without any penalty imposed. For the participants that are unsure about the study, the researcher explained thoroughly with simple words to make sure they comprehended well. Moreover, any physical or biological harm or threats to the participants were not involved in this study. There was no conflict of interest as this study is part of a final year research project.

Information obtained from this study were kept confidentially. The privacy and confidentiality of the subject data of the study were maintained throughout the process of this research and were used for the academic purposes. Information and data were only accessible to the researcher and supervisor. The individual identity were strictly kept away from being accessed by any third party to protect the right of the participants.

The benefits of this study were obtained as the researcher gave a brief health education related to achieving normal body mass index and importance of keeping it maintained on

memory function to the participants after they completed the questionnaires. Researcher also spread awareness on maintaining the ideal body weight status as one of the prevention acts towards non-communicable diseases.

No honorarium or incentives were given to the participants in this study.

3.10 Data Analysis

Data was analysed using Statistical Package for Social Science (SPSS) version 27 for Windows. All data was presented using descriptive analysis.

Table 3.4 : Measurement of Data Analysis

	Research Objectives	Test
1.	To identify the Body Mass Index (BMI) of undergraduate students in Health Campus, Universiti Sains Malaysia.	Descriptive statistic
2.	To determine the level of memory function among undergraduate students in Health Campus, Universiti Sains Malaysia.	Descriptive statistics
3.	To determine the association between body weight and memory function among undergraduate students in Health Campus, Universiti Sains Malaysia.	Chi-square test

CHAPTER 4 : RESULTS

4.1 Introduction

This chapter represents the findings of this study among undergraduate students in USM. The results portray the BMI of undergraduate students, the level of memory function among undergraduate students in USM, the association between body weight and memory function among undergraduate students in USM.

4.2 Results of the study

4.2.1 Body Weight according to Body Mass Index (BMI)

Moreover, the participation rate was 100%. According to the BMI, majority of the respondents were in normal weight range (60.9%). Respondents who were overweight (35.8%). Moreover, the least percentage of respondents are with underweight (3.3). Table 4.1 summarized the BMI among undergraduate students in USM (n=151).

Table 4.1 : The statistics of BMI among undergraduate students in USM (n=151)

Variables	n	(%)
Underweight < 18.5	5	3.3
Normal weight 18.5 – 24.9	92	60.9
Overweight 25.0 – 29.9	54	35.8
Obese class I 30.0 – 34.9	0	0
Obese class II 35.0– 39.9	0	0
Obese class III >40.0	0	0