

**Nutrition KAP and Nutritional status: A Comparison between
Malaysian Chinese and Mainland Chinese Students at USM
Health Campus**

XIA JIA

**Dissertation submitted in partial fulfilment of the requirements
for the degree of Bachelor of Health Science (Honours)
(Nutrition)**

UNIVERSITI SAINS MALAYSIA

January 2026

CERTIFICATE

This is to certify that dissertation entitled NUTRITION KAP AND NUTRITIONAL STATUS: A COMPARISON BETWEEN MALAYSIAN CHINESE AND MAINLAND CHINESE STUDENTS AT USM HEALTH CAMPUS is the project done by XIA JIA from April 2025 to January 2026 under my supervision. I have read this dissertation and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation to be submitted in partial fulfillment for the degree of Bachelor of Health Science (Honour) (Nutrition).

Main Supervisor,

.....

Dr. Dr. Soo Kah Leng

Lecturer

School of Health Sciences

Universiti Sains Malaysia

Date:

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated and duly acknowledged. I also declare that it has not been previously or concurrently submitted 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.

.....

XIA JIA

Date:

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to all those who supported me throughout the journey of completing this thesis.

I wish to extend my sincere appreciation to my supervisor, Dr. Soo Kah Leng, for her invaluable guidance, patience, and encouragement throughout this project. Her expertise and insightful feedback were crucial to the success of this research. Under her guidance, I was able to conduct a comprehensive study, enabling me to explore some key and noteworthy questions and greatly enriching my academic experience.

Additionally, I would especially like to thank Prof. Dr Foo Leng Huat, for his academic and personal support, as well as his invaluable advice that enabled me to persevere. And I am very grateful to all the participants in USM health campus who took the time to participate in this study. This research would not have been possible without their willingness to participant my questionnaires about their socioeconomic Status (SES), nutrition KAP, food frequency question nutritional status.

On top of that, special thanks to my friends, Michelle, Yi Jing, Geogina and Eileen for their moral support, and for always being there to lend a helping hand. Your presence made this journey more joyful, meaningful, and manageable. I truly appreciate the laughter we showered, the thoughtful advice you offered, and the countless moments that helped me stay grounded and motivated throughout this process.

Finally, a heartfelt gratitude to my beloved family, especially my parents and my deceased maternal grandmother Peng Guiying, for their unwavering love and support, sacrifices in terms of time and money. Your unwavering belief in my abilities has been

my greatest strength throughout my academic pursuits, and your encouragement gave me the strength to persevere and has been my anchor through the most challenging times. I am forever grateful for the sacrifices you made and the constant reassurance, and I will always love you all. Thank you.

ABSTRAK

Kajian ini menyiasat dan membandingkan pengetahuan, sikap, dan amalan (KAP) pemakanan serta status pemakanan antara pelajar Cina Malaysia dan pelajar Cina Tanah Besar di Kampus Kesihatan, Universiti Sains Malaysia (USM), Kelantan. Reka bentuk kajian hirisan lintang telah digunakan, melibatkan seramai 70 orang pelajar universiti (Cina Malaysia: $n=37$; Cina Tanah Besar: $n=33$). Pengumpulan data dijalankan menggunakan borang soal selidik sendiri yang telah disahkan untuk menilai KAP pemakanan, manakala Soal Selidik Kekerapan Pengambilan Makanan (FFQ) digunakan untuk menilai corak pemakanan. Status pemakanan dinilai melalui ukuran antropometri dan analisis komposisi badan menggunakan Analisis Impedans Bioelektrik (BIA), yang merangkumi Indeks Jisim Tubuh (BMI), peratusan lemak badan, kadar metabolisme basal (BMR), lemak visceral, jisim tulang, dan jisim otot. Analisis statistik, termasuk Ujian-t Sampel Bebas, Ujian Mann-Whitney U, Ujian Tepat Fisher, dan Ujian Khi-kuasa telah dilakukan untuk mengenal pasti perbezaan yang signifikan antara kedua-dua kumpulan tersebut. Objektif utama kajian ini adalah untuk menentukan bagaimana latar belakang budaya dan persekitaran makanan universiti mempengaruhi pilihan diet dan status pemakanan dalam kalangan pelajar daripada etnik yang sama tetapi berasal dari negara yang berbeza.

ABSTRACT

This study investigated and compared the nutrition knowledge, attitude, and practices (KAP) and nutritional status between Malaysian Chinese and Mainland Chinese students at the Universiti Sains Malaysia (USM) Health Campus in Kelantan. A cross-sectional research design was employed, involving a total of 70 university students (Malaysian Chinese: n=37, Mainland Chinese: n=33). Data collection was conducted using a validated self-administered questionnaire to assess nutrition KAP, while a Food Frequency Questionnaire (FFQ) was utilized to evaluate dietary patterns. Nutritional status was assessed through anthropometric measurements and body composition analysis using Bioelectrical Impedance Analysis (BIA), including Body Mass Index (BMI), body fat percentage, basal metabolic rate (BMR), visceral fat, bone mass and muscle mass. Statistical analyses, including Independent Samples T-test and Mann-Whitney U test, and Fisher's Exact Test and Chi-square Test were performed to identify significant differences between the two groups. The primary objective was to determine how cultural background, and the university food environment influence the dietary choices and nutritional status of students from same ethnic but different countries.

Table Of Contents

CERTIFICATE	ii
DECLARATION	iii
ACKNOWLEDGEMENTS	iv
ABSTRAK	vi
ABSTRACT	vii
List of Tables	xi
List of Figures	xii
Chapter 1: Introduction.....	1
1.1 Background of the Study	1
1.2 Problem Statement.....	2
1.3 Research Questions.....	3
1.4 Research Objectives.....	3
1.4.1 General Objective.....	3
1.4.2 Specific Objective	4
1.5 Research Hypothesis.....	4
1.5.1 Hypothesis 1	4
1.5.2 Hypothesis 2	4
1.6 Significance of Study.....	5
1.7 Conceptual framework.....	6
Chapter 2: Literature Review	8
2.1 Introduction.....	8
2.2 Nutrition Knowledge, Attitude, and Practices (KAP) and Its Impact on Nutritional Status	8
2.3 Socioeconomic Status (SES) and Its Impact on Nutritional Status	10
2.4 Food Intake Pattern and Its Impact on Nutritional Status.....	14
2.4.1 Factors that influence food intake pattern	16
2.4.2 Risks from food intake pattern	17
2.5 Nutritional status.....	19
2.5.1 Definition and classification of BMI.....	19
2.5.2 Definition and classification of Body Fat Percentage	21
2.5.3 Definition of Basal Metabolic Rate (BMR)	22
2.5.4 Definition of Body Water Percentage	23
2.5.5 Definition and classification of Visceral Fat	24
2.5.6 Definition of Bone Mass and Muscle Mass	25
2.6 Deficiencies in the existing literature	26
Chapter 3: Methodology	28
3.1 Study Design.....	28

3.2 Study Population.....	28
3.2.1 Target Population.....	28
3.2.2 Selection Criteria.....	28
3.3 Study Location.....	29
3.4 Study Participants	29
3.5 Study Period.....	30
3.6 Sample Size Calculation	30
3.7 Sampling Method.....	31
3.8 Study Instruments	31
3.8.1 Sociodemographic	31
3.8.2 Socioeconomic Status (SES).....	32
3.8.3 Nutrition Knowledge, Attitude, and Practice (KAP).....	32
3.8.4 Food Intake Pattern (based on FFQ)	33
3.8.5 Nutrition Status (Body Mass Index and Body Fat Percentage)	35
3.9 Data Collection	37
3.10 Data Analysis	39
3.11 Ethical Clearan.....	39
3.12 Study Flowchart.....	40
Chapter 4: Results.....	42
4.1 Sociodemographic	42
4.2 Socioeconomic Status (SES)	48
4.3 Nutrition Knowledge, Attitude, and Practice (KAP)	51
4.4 Food Intake Pattern (based on FFQ).....	61
4.5 Nutritional Status	68
Chapter 5: Discussion	72
5.1 Overview of the Study	72
5.2 Sociodemographic	73
5.3 Socioeconomic Status (SES)	74
5.4 Nutrition Knowledge, Attitude, and Practice (KAP)	76
5.4.1 Background of respondent	76
5.4.2 Knowledge on food and nutrition.....	77
5.4.3 Attitude on food and nutrition	78
5.4.4 Practice on food and nutrition	79
5.5 Food Intake Pattern (based on FFQ).....	81
5.5.1 Cereals and Cereal Products.....	81
5.5.2 Meat and Meat Products.....	81
5.5.3 Fish and Seafood	82
5.5.4 Legumes and Legume Products	82
5.5.5 Milk and Dairy Products	83
5.5.6 Vegetables.....	84
5.5.7 Fruits.....	84

5.5.8 Drinks	85
5.5.9 Confectionery	85
5.6 Nutritional Status	86
5.7 Strength and Limitation of Study	88
5.7.1 Strength of Study.....	88
5.7.2 Limitation of Study	89
Chapter 6: Conclusion	91
6.1 Conclusion	91
6.2 Recommendations.....	92
References	94
Appendix A.....	99
Appendix B.....	118
Appendix C	125
Appendix D	127

List of Tables

Table 4.1: The Age between students of Malaysia and China (N=70).....	42
Table 4.2: The Majors of students of Malaysia and China (N=70).....	47
Table 4.3: The Socioeconomic Status between students of Malaysia and China (N=70)	49
Table 4.4: The Parental Education Levels (Mother & Father) between students of Malaysia and China (N=70)	50
Table 4.5: The Knowledge Scores of Nutrition between students of Malaysia and China (N=70)	55
Table 4.6: Practice on Food and Nutrition between students of Malaysia and China (N=70)	58
Table 4.7: The Monthly Food Intake Frequency between students of Malaysia and China (N=70)	67
Table 4.8: The Nutrition Status between students of Malaysia and China (N=70)....	71

List of Figures

Figure 4.1: The Gender of students of Malaysia and China (N=70)	43
Figure 4.2: The Academic Degree of students of Malaysia and China (N=70)	44
Figure 4.3: The school of students of Malaysia and China (N=70)	45
Figure 4.4: The Year of Study of students of Malaysia and China (N=70)	46
Figure 4.5: Average number of cigarettes smoked by students from Malaysia and China (N = 70)	51
Figure 4.6: The Weighing (unit week) between students of Malaysia and China (N=70)	52
Figure 4.7: The Current Disease Status between students of Malaysia and China (N=70)	53

Chapter 1: Introduction

1.1 Background of the Study

Nutrition knowledge, attitude, and practices (KAP) are essential to ensure good health and are key determinants of desired behavioral changes in health and nutrition and are positively correlated with good nutritional status. Adequate nutritional intake lays the foundation for improving health literacy and preventing diet-related chronic diseases. Therefore, this behavior can be assessed through KAP and food intake pattern, and intervention plans can be implemented. (Hammouh et al., 2023)

Malaysia has formed a multicultural society due to its special geographical location, complex historical development and multi-ethnic composition. The interweaving and integration of these factors also determine the diversity of its eating habits. At the same time, Malaysia was influenced by Indian and Chinese cultures in its early historical development, especially in terms of dietary traditions, which were deeply influenced by China's local diet and culture. However, due to differences in geographical environment (Malaysia is located in the tropics, with a hot and humid climate, while mainland China is vast, with large climate differences in different regions, and eating habits are restricted by local products.) and social and cultural environment (the dietary cultures of different ethnic groups such as Malays, Chinese, and Indians influence each other), the eating habits of Malaysian Chinese and mainland Chinese have differences. However, there are currently few studies that explore the differences in such food intake preferences and nutritional status among students in health campus.

The Universiti Sains Malaysia Health Campus in health campus, Kelantan, contains a large population of Malaysian Chinese and mainland Chinese students. This provides a unique opportunity to compare the nutrition knowledge, attitude, and practices, socioeconomic status and food intake pattern of these two groups in a common academic setting, which is crucial for cross-cultural research in developing health promotion programs and narrowing health disparities.

1.2 Problem Statement

Cultural diversity in university settings often leads to differences in food intake pattern and lifestyles, especially in the multicultural university environment of Malaysia. Although the Malaysian population includes a large Chinese community, there are few studies comparing the nutritional behaviors of Malaysian Chinese (who have adapted to local food intake pattern) and mainland Chinese students (who are influenced by traditional Chinese dietary systems and institutional dietary systems). Existing studies have highlighted differences between international and local students in terms of obesity rates, food intake preferences, and health status (Sabbah et al., 2024). However, no study has specifically examined these differences in Kelantan, a state with Malay-majority culture in Malaysia. This study aimed to compare the difference of nutritional knowledge, attitude, and practices; socioeconomic status; food intake pattern; and nutritional status, as measured by BMI and body fat percentage, between

Malaysian Chinese and Mainland Chinese students at Universiti Sains Malaysia health campus.

1.3 Research Questions

- Is there any difference in socioeconomic status (SES) between Malaysian Chinese and Mainland Chinese students at USM Health Campus?
- Is there any difference in nutrition knowledge, attitude, and practice (KAP) between Malaysian Chinese and Mainland Chinese students at USM Health Campus?
- Is there any difference in food intake pattern between Malaysian Chinese and Mainland Chinese students at USM Health Campus?
- Is there any difference in nutritional status (BMI, and body fat percentage) between Malaysian Chinese and Mainland Chinese students at USM Health Campus?

1.4 Research Objectives

1.4.1 General Objective

To compare nutrition KAP, socioeconomic status, food intake pattern and nutritional status, as measured by BMI and body fat percentage, between Malaysian Chinese and Mainland Chinese students at Universiti Sains Malaysia Health Campus.

1.4.2 Specific Objective

- To compare socioeconomic status (SES) between Malaysian Chinese and Mainland Chinese students at USM Health Campus.
- To compare nutrition knowledge, attitude, and practice (KAP) between Malaysian Chinese and Mainland Chinese students at USM Health Campus.
- To compare food intake pattern between Malaysian Chinese and Mainland Chinese students at USM Health Campus.
- To compare nutritional status (BMI, and body fat percentage) between Malaysian Chinese and Mainland Chinese students at USM Health Campus.

1.5 Research Hypothesis

1.5.1 Hypothesis 1

Null hypothesis, H_0 : There is no significant difference in food intake pattern between Malaysian Chinese and Mainland Chinese students at USM Health Campus.

Alternative hypothesis, H_A : There is a significant difference in food intake pattern between Malaysian Chinese and Mainland Chinese students at USM Health Campus.

1.5.2 Hypothesis 2

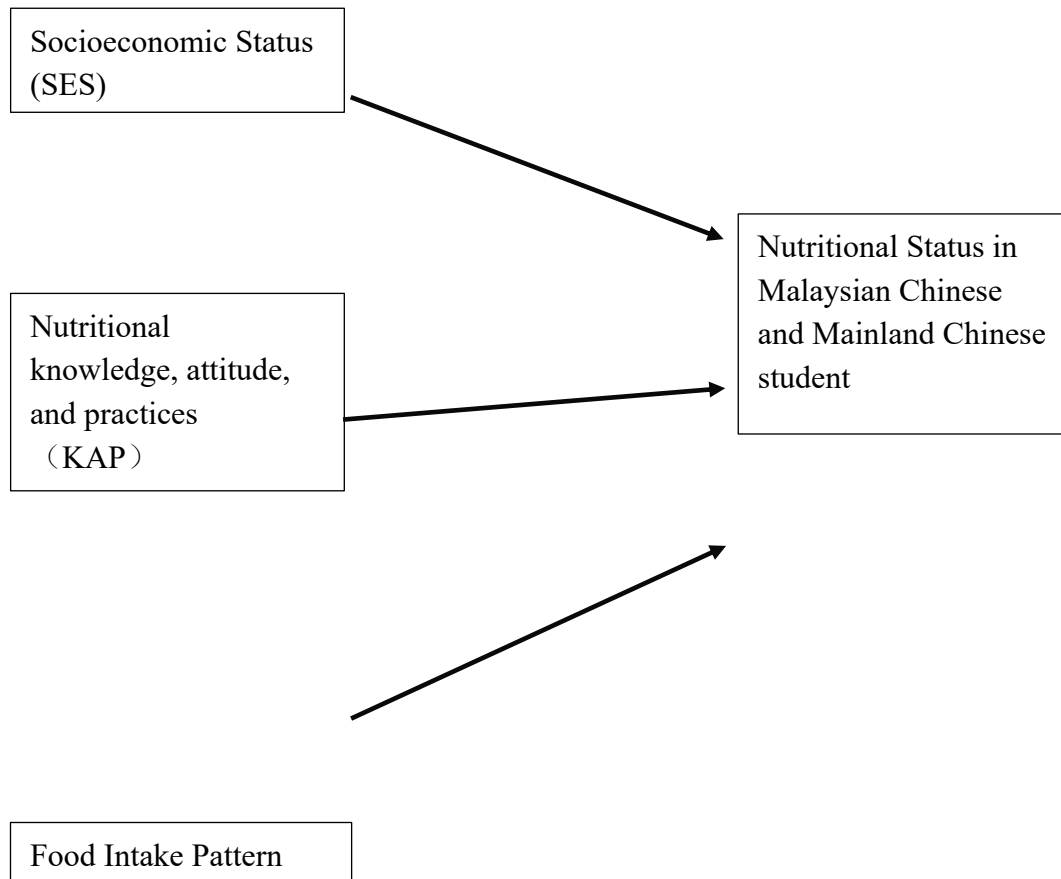
Null hypothesis, H_0 : There is no significant difference in nutritional status between Malaysian Chinese and Mainland Chinese students at USM Health Campus.

Alternative hypothesis, H_A : There is a significant difference in nutritional status between Malaysian Chinese and Mainland Chinese students at USM Health Campus.

1.6 Significance of Study

This study enriches cross-cultural health research by combining quantitative assessments (e.g., BMI, food intake pattern) with statistical analysis to compare the nutrition knowledge, attitude, and practice, socioeconomic status, and food intake pattern of Malaysian Chinese and mainland Chinese students in a health campus environment. In addition, the findings can be used to design culturally tailored nutrition education programs for campus students and provide a reference for students from different cultural groups to adapt to local and international food intake preferences. It can also help institutions create an inclusive campus environment that prioritizes students' health and well-being, ultimately improving their academic achievement and narrowing health disparities.

1.7 Conceptual framework



This conceptual framework aims to compare the nutritional status of Malaysian Chinese and mainland Chinese students at USM health campus. The framework considers that nutrition knowledge, attitude, and practice (KAP), socioeconomic status (SES) and food intake pattern (based on FFQ) as independent variables (IV) affect

students' BMI and body fat percentage as nutritional status (dependent variables). Nutrition knowledge, attitude, and practice (KAP) explore students' individual knowledge of nutrition, attitudes towards nutrition, and actual eating behaviors, and analyze how they work together to affect the final nutritional status (BMI and body fat percentage). Socioeconomic status (SES) affects students' nutritional status through methods such as food access. Food intake pattern based on food frequency questionnaires (FFQ) assess long-term food intake habits and how they affect their nutritional status by having participants recall and report the frequency and amount of each type of food intake. By studying the interrelationships between these independent variables (IV), we can compare whether there are differences in the nutritional status of the two groups of students and provide references for developing targeted interventions to improve their nutritional health.

Chapter 2: Literature Review

2.1 Introduction

Nutritional status has become a common health problem among young people, especially among college students. In China, driven by globalization, China has become one of the world's largest source countries for international students (educationfair.net, 2025). Therefore, some researchers have conducted a series of nutrition or food surveys on international students and local students. For example, in 2018, there was a comparative study on the nutritional status, knowledge, attitude and practice (KAP) and dietary intake of Chinese international students and Chinese students in Nanjing (Haq et al., 2018). The study showed that the prevalence of overweight and obesity among international students was higher than that of Chinese students, and the BMI and body fat percentage of international male and female students were significantly higher than that of Chinese male and female students. It provides data support for the nutrition education and guidance of international students, which helps to improve their nutritional status and health behaviors.

2.2 Nutrition Knowledge, Attitude, and Practices (KAP) and Its Impact on Nutritional Status

Nutrition knowledge, attitudes and practices (KAP) is a tool used to assess the target population's cognition, emotional tendencies and behavioral patterns on specific health or nutrition issues, such as knowledge of diet, attitudes towards the health

consequences of unhealthy diets, and habits of specific food intake. Through these analyses, the target population's nutrition problems and their behavioral roots can be identified, providing a scientific basis for designing targeted intervention measures and verifying their effectiveness. (*Guidelines for Assessing Nutrition-related Knowledge, Attitudes and Practices*, n.d.)

A comparative study on the nutritional status, knowledge, attitude and practice (KAP) and dietary intake of international and Chinese students in Nanjing found significant differences in nutritional knowledge, attitude and practice. In terms of nutritional knowledge, Chinese students scored higher than international students ($p < 0.0001$), and Chinese students had a more comprehensive grasp of knowledge such as dietary balance and the role of nutrients. For example, Chinese students had a 23% higher correct recognition rate of "a moderate number of fish should be consumed daily" than international students, while international students had insufficient knowledge of "high energy density of fast food", which led to their high frequency intake of fast food. Differences in nutritional attitudes also directly reflect the dietary preferences of Chinese and international students. For example, Chinese students prefer traditional healthy foods such as steamed fish and green leafy vegetables, while international students are more accepting of hamburgers and carbonated drinks (weekly consumption rate of 63.0%). Because of the differences in nutritional knowledge and attitudes, the nutritional practices of the two groups of students are also very different. For example, in terms of unhealthy diet, the weekly fast food consumption rate of

international students (63.0%) is 2.2 times that of Chinese students (28.1%), and the frequency of carbonated beverage intake is also significantly higher ($p < 0.001$). These differences are closely related to cultural background, education and lifestyle, which provides a basis for targeted nutritional intervention for students (Haq et al., 2018).

Cross-cultural comparisons further highlighted differences in knowledge, attitudes, and behaviors between Malaysian Chinese students and mainland Chinese students. This is because the dietary habits of mainland Chinese students are influenced by the traditional Chinese dietary system and institutional norms, and their food intake patterns may differ from those of Malaysian Chinese students who are influenced by the local Malay and Indian diets. These cultural adaptations highlight the need to explore how sociocultural and environmental factors influence nutrition practices, especially in university settings where students are exposed to diverse dietary environments and highlight that nutrition education and attitudes are key factors in improving nutrition practices.

2.3 Socioeconomic Status (SES) and Its Impact on Nutritional Status

Socioeconomic status is a core factor affecting dietary behavior and body mass index (BMI) and has been shown to be significantly associated with a high-energy, low-density nutritional diet in non-student groups. In an ELANS study, researchers used two 24-hour dietary recall methods to evaluate dietary quality scores (DQS), dietary diversity scores (DDS), nutrient adequacy rates (NAR) and other dietary assessment

methods to analyze 9,218 participants from eight Latin American countries including Argentina and Brazil. Studies have shown that socioeconomic status (SES) significantly affects people's dietary quality and weight status. For example, low-SES groups consume less fruits, vegetables, whole grains, fiber, and fish and seafood, and more beans. Dietary quality scores (DQS, DDS, NAR) increase with increasing SES. This reflects the direct impact of dietary quality on nutrient intake. The estimated average requirement (EAR) of vitamin C in low-SES and high-SES groups was 0.84 and 0.91, respectively. The estimated average requirement (EAR) of vitamin A was 0.83 and 0.89, respectively. The estimated average requirement (EAR) for calcium was 0.67 and 0.74, respectively, and the estimated average requirement (EAR) for magnesium was 0.75 and 0.79, respectively. However, there was no significant difference in the nutritional status of the overall participants by SES, with BMI being 26.92 and 27.30 kg/m² for low SES and high SES, respectively. However, it is worth noting that women are more likely to face the risk of weight and obesity due to low SES. The results showed that the BMI of low SES women was 27.72 kg/m², and the proportion of abdominal obesity and overweight reached 68%, which was significantly higher than the proportion of abdominal obesity and overweight in women with medium and high SES (64% for medium SES and 66% for high SES). There was no significant difference in BMI between different SES in men, and the proportion of abdominal obesity and overweight was only 53%-57%. (Gómez et al., 2021)

However, as a transitional group, the association between SES and dietary patterns and nutritional status of college students has not been fully explored. Based on an empirical study of a private university in the southeastern United States, this paper systematically analyzes the impact mechanism of SES on college students' dietary habits and nutritional status and explores the role of campus environment in alleviating SES dietary differences. The study confirmed that the impact of SES on college students' diet presents a staged characteristic. The unhealthy food intake of low-SES freshmen (family income $\leq$ 200% of the federal poverty line) is significantly higher than that of high-SES peers. The frequency of unhealthy food consumption is 4 times more on average within 3 days ($p=0.009$), while healthy food intake is less than 4 times. The results show that this phenomenon is consistent with the conclusion of the "hunger-obesity paradox" in the general population of the United States. Due to economic pressure and food access barriers, low-SES groups are more inclined to choose cheap high-energy foods. For example, the weekly fast food consumption frequency of low-SES freshmen is 1.8 times that of non-low-SES students, while the frequency of fresh fruit and vegetable intake is 37% lower. The results of nutritional status showed that the average BMI of low-SES freshmen was 1.2 kg/m² higher than that of high-SES students, and the body fat percentage was 3.5% higher, which was positively correlated with the intake of unhealthy foods ($r=0.37$, $p<0.01$). In addition, long-term follow-up studies have shown that poor diet during the freshman period may lead to the "freshman

15-pound" weight gain phenomenon, and the weight gain of low-SES students is 1.5 times that of high-SES students.

While under the equalization of resources in the campus environment, the meal plan of sophomores covers more healthy dining options on and off campus, weakening the restrictions of SES on food access. The association between their SES and diet quality is no longer significant, and there is no statistical difference in the consumption of unhealthy foods between low-SES and middle-high SES students. The results show that the three major nutrient intakes of low-SES students show "high sugar, high fat and low fiber" characteristics (daily added sugar intake exceeds the recommended amount by 42%, saturated fat intake exceeds 35%, and dietary fiber intake is only 68% of the recommended amount). This is alleviated with the improvement of dietary structure in the sophomore year, and even the healthy food intake of low-SES students is slightly higher. (Merhout & Doyle, 2019)

Although the causal relationship cannot be determined from the use of a cross-sectional design in the study, and the reliance on self-reported dietary data of participants may have recall bias. However, it provides a basis for the association between college students' SES and dietary patterns and nutritional status and provides effective health guidance for campuses that promote students' healthy lifestyles.

2.4 Food Intake Pattern and Its Impact on Nutritional Status

As a core determinant of nutritional status, food intake pattern is closely related to long-term health risks in young people. Especially in the transition of college students from home to campus environment, the change of their food intake pattern has become an important factor affecting their nutritional status, such as overeating, dieting, self-vomiting and other abnormal eating behaviors. A study by the Malaysian Allied Health Sciences Academy (MAHSA) University in Malaysia showed that 6% of students had abnormal eating behaviors, of which 57.8% of students had had overeating (eating more than normal and out of control), 13.3% used laxatives or diet pills to control their weight, and 65.3% lost weight through excessive exercise. This eating behavior directly leads to macronutrient imbalance and micronutrient deficiency in the eater. For example, in an Indian study, the daily protein intake of abnormal eaters was 15-20% lower than the recommended amount, affecting muscle synthesis and immune function. Among Malaysian students, due to excessive control of diet, the proportion of abnormal eaters with insufficient vitamin D and calcium intake was 23% higher than that of normal eaters. Global evidence also shows that eating behavior is associated with iron and folic acid deficiencies, especially increasing the risk of anemia in women. A "high-sugar, high-fat, low-fiber" diet is a common food intake pattern among abnormal eaters, often accompanied by the risk of central obesity. This also shows that the binge food intake pattern is positively correlated with BMI ($r=0.14$, $p=0.015$) and waist-to-height ratio ($r=0.14$, $p=0.017$). (Hing, 2021)

However, in the context of globalization, there are also differences in food intake pattern among student groups. A comparative study by Nanjing Medical University showed that there are significant differences in the food intake pattern, nutrient intake and nutritional status of international and Chinese students. In terms of food intake pattern, the weekly fast food intake rate and carbonated beverage intake rate of international students are both 63.0%, while the weekly egg intake rate is only 32.8%, and the weekly fish intake rate is less than 41%, showing the dietary characteristics of "high energy density and low dietary fiber". In contrast, the daily egg intake rate of Chinese students is 53.4%, the weekly fish intake rate is significantly higher than that of international students, and the daily intake rate of green leafy vegetables is 27% higher than that of international students. However, in terms of the overall intake of fruits and vegetables, both groups of students are below the recommended standard. Under the influence of food intake patterns, the overweight or obesity rate of international students (25.1%) is 2.5 times that of Chinese students (9.9%). The body fat rates of male international and Chinese students are 21.1% and 18.0%, respectively, and the body fat rates of female international and Chinese students are 33.1% and 27.9%, respectively. The risk of abdominal obesity in international students is positively correlated with fast food consumption ($r=0.23$, $p<0.01$). Although the BMI distribution of Chinese students is more reasonable, the underweight rate (16.5%) is higher than that of international students (10.9%), which may be related to excessive dietary control. (Haq et al., 2018c)

2.4.1 Factors that influence food intake pattern

The campus environment is one of the factors that affect students' food intake patterns. Campus pressures such as academic and social pressures drive students to change their eating patterns. In the study, 67.7% of the respondents were aged 20-30 years old. When faced with the pressure of course load and future planning, 28.6% of students would choose high-sugar and high-fat foods to relieve this pressure. The popularity of convenient foods (such as campus fast food restaurants) has also promoted low-SES students to give priority to high-energy, low-density foods.

Emotional factors can also affect changes in students' food intake patterns. Among Malaysian students, 68.9% of students with EAT-26 scores >20 have poor sleep quality, less than 6 hours a day, and lack of sleep increases appetite by reducing leptin secretion (down 15-20%), forming positive feedback of "emotional eating-metabolic disorder". Studies on American adolescents have confirmed that this emotion-driven eating disorder behavior causes the annual BMI growth rate to reach 2.1 times that of the normal group. Stress-induced emotional eating is more common in women. A US study showed that the correlation coefficient between depressive symptoms and binge eating behavior was 0.37 ($p < 0.01$).

Students' food intake patterns are also affected by the society's aesthetic preference for "thin body shape". Among Malaysian college students, 64.3% of female respondents showed higher EAT-26 scores, which were 9.31 ± 7.79 , compared with 7.23 ± 5.95 for men ($p = 0.01$). The results showed that this kind of oppression by social

body shape standards prompted 57.8% of students to binge eat, and 13.3% of students used laxatives or diet pills to control their weight, forming a vicious cycle of "body image dissatisfaction-extreme diet control". Cross-cultural studies in South Korea and India confirmed that women's cognitive bias towards ideal body shape was 2.3 times more correlated with abnormal eating behavior than men, and 79.3% of the samples of Malaysian medical students came from health-related disciplines, and the implicit requirements of their professional environment for body shape further amplified this trend.

Lack of nutritional knowledge and cognitive bias also lead to differences in students' food intake patterns. Among those with abnormal eaters, only 12.7% can accurately identify daily protein needs, and 34.5% mistakenly believe that "dieting is the best way to lose weight quickly." As a result, abnormal eaters have insufficient protein intake, accompanied by increased rates of vitamin D and calcium deficiency. (Hing, 2021b)

2.4.2 Risks from food intake pattern

Studies have shown that obesity and other health problems among Malaysian students are often due to their unhealthy eating habits, with 17.6% of students being obese and 23.0% being overweight. These unhealthy habits increase their mental health, quality of life, and risk of developing non-communicable diseases such as type 2 diabetes and cardiovascular disease. (Azhar et al., 2023)

In addition, students' BMI and mental health were also affected by unhealthy eating habits, as levels of anxiety and depression were highly correlated with a diet high in saturated fat and refined carbohydrates. (Firth et al., 2020) This is because students who are under long-term stress and who overeat or have other bad eating habits often have difficulty controlling their emotions, which in turn exacerbates mental health problems. (Shafiq et al., 2024) And compared to people of a healthy weight, those with a higher BMI are more prone to experience depression and have a lower sense of well-being. (Segal & Gunturu, 2024) Therefore, the link between eating habits and mental health emphasizes the significance of encouraging a balanced diet, but they also have a significant impact on students' BMI.

The negative effects of unhealthy food intake pattern also extend to academic performance. Due to performance such as skipping meals or relying on high-calorie fast food, energy levels drop, and cognitive impairment occur and even affect students' attention in class or learning. Therefore, the results show that skipping breakfast and frequently eating fast food are associated with poor academic performance. (Caso et al., 2020) Not only that, but drinks high in sugar and saturated fat can also impair cognitive function, while behaviors like eating breakfast and consistently consuming nutrient-dense foods (fruits and vegetables) are often associated with higher academic performance.

2.5 Nutritional status

Nutritional status is a core indicator for measuring human health. It reflects the balance between the supply and demand of nutrients (such as protein, energy, vitamins, minerals, etc.) in the human body, such as malnutrition caused by insufficient nutrient intake or overnutrition caused by excessive intake. The assessment of nutritional status is usually carried out using anthropometric measurements (height, weight, body fat percentage), laboratory tests (biochemical indicators such as serum albumin and prealbumin), and dietary review analysis. Early nutritional status assessment and timely targeted measures can effectively reduce disease risks and medical costs. However, some indicators for evaluating nutritional status may produce errors because they may be affected by factors such as dehydration, edema, and disease. Therefore, a comprehensive assessment of nutritional status requires consideration of multiple factors, such as physiological factors (age, disease status, and drug side effects) and social factors (economic status, dietary preferences, and level of nutritional knowledge). (Kubrak & Jensen, 2006)

2.5.1 Definition and classification of BMI

The body mass index (BMI) is the metric currently used to define anthropometric height/weight characteristics in adults and to classify (categorize) them into groups. (Professional, 2025) It is commonly interpreted as an indicator of a person's index of body fat. It is also frequently used as a risk factor for the emergence or occurrence of several health problems. It is also frequently used to decide on public health policies.

The BMI's broad acceptance in defining body mass categories as a health concern has made it helpful in population-based research.

However, BMI is not a good indicator of body fat percentage. Sometimes it misclassifies total body fat content and fails to assess the quality of fat in different parts of the body. For example, athletes with well-developed muscles have higher BMIs because muscle is heavier than fat, so even if they are not obese, their BMI is in the overweight range. People with normal BMI but high body fat are underestimated for their health risks. Secondly, Asians have a higher body fat percentage at the same BMI. A study in Singapore showed that the BF% of Chinese people at BMI 25 kg/m² was 5-8% higher than that of white people in Europe and America, and visceral fat accumulation was more significant. Age and gender can also lead to insufficient sensitivity of BMI. For example, the elderly may have a normal BMI but excessive body fat due to muscle loss, while women naturally have a higher body fat percentage at the same BMI (Chen et al., 2021). Despite some flaws of BMI, all studies still recommend it as an indicator of obesity in adults. (Goshen Health, 2025)

Classification	BMI (kg/m²)	Risk of co-morbidities
Underweight	<18.5	Low (but increased risk of other clinical problems)
Normal weight	18.5-22.9	Average
Overweight	23-24.9	Increased

Obese I	25-29.9	Moderate
Obese II	≥ 30	Severe

Table 2.5.1 Proposed classification of weight by BMI in adult Asians

2.5.2 Definition and classification of Body Fat Percentage

Body fat percentage (BF%) refers to the proportion of adipose tissue in the body's total body weight, which directly reflects the relative composition of fat and lean body mass (muscle, bone, water, etc.) in the body composition, which helps to assess overall health status, compared with BMI. For example, if a 70 kg adult has a body fat percentage of 25%, then his body fat weight is 17.5 kg, and the remaining 52.5 kg is lean body mass. Commonly used clinical measurement methods include dual-energy X-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA) and skinfold thickness measurement, among which DXA is regarded as the "gold standard" due to its high accuracy and can simultaneously assess fat distribution and bone density.

The normal range of body fat percentage (BF%) has obvious gender and age differences. The normal body fat percentage for adult males aged 10-30 is 12-18%, and the normal body fat percentage for females aged 10-19 is 18-25%, and 20-26% for those aged 20-30. Body fat below or above this range is considered abnormal and may be associated with metabolic syndrome and cardiovascular disease. For example, for every 5% increase in body fat percentage, the risk of diabetes increases by 12%. (Chen et al., 2021)

	Male		Female	
Age	Low %	High %	Low %	High %
1-4	16	20	15	19
5-9	12	15	15	19
10-19	12	18	18	25
20-30	12	18	20	26
31-40	13	19	21	27
41-50	14	20	22	28
51-60	16	20	22	30
>61	17	21	22	31

Table 2.5.2 From User's Guide for Bodystat 1500

2.5.3 Definition of Basal Metabolic Rate (BMR)

Basal metabolic rate (BMR) refers to the minimum amount of energy required by the human body to maintain basic life functions (cell renewal, respiration, blood circulation, body temperature, etc.) under conditions of complete rest, wakefulness, fasting, and constant body temperature. For most people, BMR accounts for approximately 60–70% of total daily energy expenditure, with about 10% used for food digestion and absorption, and the remainder used for various physical activities. Factors affecting BMR include genetics, age, sex, height, body composition (muscle/fat ratio), race/ethnicity, and certain endocrine and disease conditions. Temporary factors such as

fever, serious illness, certain medications or stimulants, pregnancy, and breastfeeding can also alter BMR. (Professional, 2025)

Fat-free mass (FFM) is the biggest determinant of changes in basal metabolic rate (BMR), followed by age. This is because muscle tissue has higher metabolic activity than adipose tissue (Johnstone et al., 2005). For measuring the nutritional status of college students, basal metabolic rate (BMR) is a key indicator of metabolic health. A higher BMR is usually associated with higher muscle mass, while restrictive diets, sedentary lifestyles, hormones, or diseases can all lead to a lower BMR/metabolic rate. Furthermore, BMR can roughly determine the minimum number of calories needed to sustain life each day, and by using daily activity levels to estimate total energy requirements, it can aid in weight loss or weight maintenance plans.

2.5.4 Definition of Body Water Percentage

Body water percentage is the percentage of total body weight that is water. The human body is approximately 60% water, and the water content varies among different organs (approximately 73% for the brain and heart, 83% for the lungs, and 31% for bones). For healthy adults, the average range for body fluid percentage is approximately 45%–60% for women and 50%–65% for men. Nutritional and clinical recommendations suggest that to maintain healthy body water levels, women should drink approximately 11 cups of water daily, and men approximately 16 cups. Sugary drinks should be avoided to prevent increased risks of obesity and cardiovascular

disease. This is because water plays a crucial role in regulating body temperature, lubricating joints, maintaining blood pressure, transporting oxygen and nutrients, and removing metabolic waste. Total body water (TBW) can be estimated using the Watson formula, which has good accuracy in adults (Body Water Percentage: Normal Levels, Total Body Water, and Risks of Low Hydration, n.d.). Studies have shown that low levels of body water (especially intracellular water) can lead to decreased muscle strength, limited function, and frailty in older adults, even after adjusting for factors such as muscle mass, age, and sex. (Serra-Prat et al., 2018)

2.5.5 Definition and classification of Visceral Fat

Visceral fat, also known as "active fat," is a layer of fat located deep in the abdominal cavity, surrounding and cushioning internal organs such as the liver, pancreas, and intestines, hence the name "visceral." Although it is part of abdominal fat, it differs from subcutaneous fat because visceral fat secretes various hormones (such as insulin and cortisol) and signaling molecules involved in energy metabolism and hormonal responses. Metabolic syndrome or diabetes can alter the way these hormones function, further worsening fat metabolism and cardiovascular risk. The causes of visceral fat include genetic factors, lifestyle, and certain endocrine disorders. Genetic factors typically influence a person's tendency to store fat in the abdomen. Lifestyle factors such as high-fat, high-sugar diets, lack of physical activity, and chronic stress leading to elevated cortisol levels promote visceral fat accumulation. Therefore,