ORIGINAL ARTICLE

# New Insights on Dietary Assessment Recommender System for Pre-University Adolescents

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## ABSTRACT

**INTRODUCTION:** An individual's health status will be influenced by their nutritional status, which is mainly based on their eating habits. Adolescence is an essential phase for growth and development that will be influenced by healthy eating habits. In view of this, a dietary recommender system to understand and improve dietary habits is crucial. In this study, the dietary recommender system, consisting of meal routines, food preferences, and dietary practices of pre-university adolescents, will be presented. **MATERIALS AND METHODS:** This study was conducted at a pre-university centre, involving a sample of 125 students. A self-administered structured questionnaire was used to collect demographic data, daily meal routines, food intake frequency, and dietary behaviour patterns. Two weeks before completing the questionnaire, the students were instructed to monitor their dietary practices. **RESULTS:** The food intake frequency survey was divided into two categories: food intake less than three times a week (< three times/week) and three times a week or more (≥ three times/week). The results showed that cereal consumption was most frequent at 87.2% for food intake < three times/ week, while meat consumption was highest for food intake ≥ three times/week (84.8%). Almost 81% of students reported snacking between meals, with the majority snacking less than twice daily (60.8%). Females showed a higher tendency to snack. In terms of dietary behaviour patterns, there were significant differences between genders in terms of overeating and unbalanced food intake. The four primary dietary behaviour patterns were found to be positively correlated with each other. The correlation study results indicated positive relationships between dietary behaviour patterns and body mass index (BMI), except for a negative relationship between high fat/high calorie diet and BMI. **CONCLUSION:** Multiple regression analysis suggested that overeating, having a high fat/ high calorie diet, unbalanced food intake, and dietary impulses collectively explains variations in BMI.

**Keywords**
Dietary practices; Food intake; Malaysia; Meal routines; Pre-university adolescents

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Received: 22nd January 2024; Accepted: 25th November 2024

Doi: https://doi.org/10.31436/imjm.v23i04.2509

## INTRODUCTION

With recent improvements in economic and sociocultural situations, modern diets have changed. It is well-known that changes in eating patterns frequently result in nutritional imbalances, sharply raising the incidence of chronic diseases.[1] According to the National Health & Morbidity Survey[2], 30.4% of adults were overweight, and 19.7% were obese, accounting for 50.1% of overweight or obese individuals in Malaysia. When compared to data from 2011 and 2015, the trends for overweight and obesity are still on the rise.[3]

Daily dietary practices have a significant impact on human health. Poor choices in food consumption can increase the likelihood of developing certain illnesses and disorders, such as diabetes, high blood pressure, and obesity[4]. As dietary habits and chronic diseases are strongly correlated, nutritional assessment is becoming increasingly crucial for disease prevention and management. This underscores the importance of examining the dietary habits of an individual.

The period of life known as adolescence falls between childhood and adulthood. It is a transitional period in which individuals experience rapid physical and psychological growth and development. This is also recognized as the transition from childhood to adulthood. Moreover, pre-university students experience living away from home for the first time and have less parental or guardian supervision over their dietary behaviours. Pre-university adolescents are thus a vulnerable group that should be the focus of this study.

Adolescence is also a period susceptible to obesity. Obesity is primarily attributed to a lack of physical activity, outdoor activities, and the consumption of fat-rich junk foods.[5] Individuals who regularly consume a diet high in sugar, saturated fat, and salt are more prone to developing obesity.[6] Some standard dietary practices among adolescents include snacking on high-energy foods, irregular meal patterns typically involving fast food, skipping meals especially breakfast, and inadequate intake of fruits and vegetables.

Previous research on measuring the overall quality of dietary habits has been limited as it does not thoroughly evaluate individual dietary behaviours, particularly among pre-university adolescents.[7-9] In light of this, this paper aims to address this gap. The study's purpose is to monitor dietary behaviours by examining each individual's dietary habits, with the goal of assessing meal routines, food preferences, and dietary practices of pre-university adolescents, which are referred to as the dietary assessment recommender system.

The paper is organized as follows: Section 2 describes the methodology, Section 3 presents the findings, Section 4 discusses the collected results and section 5 concludes the paper.

## MATERIALS AND METHODS

The present study utilized a quantitative approach using a structured questionnaire. The questionnaire consisted of three sections, with Section 1 focusing on demographics. Section 2 included information about daily meal routines and food intake frequency. Section 3 employed a dietary pattern evaluation tool to investigate dietary behaviour patterns. This evaluation tool was adapted from Do Lee, Kim, Choi, Kim, Cho and Sohn.[10] The 34-item questionnaire was designed to assess dietary habits and was categorized into unbalanced food intake pattern (5 items), dietary impulse pattern (8 items), overeating pattern (9 items), and high fat and calorie pattern (12 items). A 1–5 scale was used to rate dietary habits and behaviours, with 1 being "not at all", 2 being "no", 3 being "average", 4 being "yes", and 5 being "very much so". This tool can help identify dietary behavioural issues. The study was conducted among pre-university adolescents in a pre-university centre. A survey was administered using a self-administered structured questionnaire to 125 students. Two weeks before data collection, respondents were asked to monitor their dietary practices to ensure data reliability[11]. The questionnaire was tested for internal reliability during a pilot test with a sample of 35 students chosen by simple random sampling. Students were briefed about the study objectives, and written informed consent was obtained accordingly. Participation was voluntary and anonymous[12].

IBM SPSS Statistics Version 25 was used to input and analyse the collected quantitative data. A hypothesis t-test was used to investigate gender differences in the four major dietary behaviour patterns. The relationship between dietary behaviour pattern scores and body mass index (BMI) was examined via Pearson's correlation. A p-value less than 0.05 ($p\text{-value}<0.05$) was considered significant. Multiple regression analysis was utilized to estimate the amount of BMI variance attributed to overeating, high fat/high calorie diet, unbalanced food intake, and dietary impulse.

## RESULTS

This study included 69 female participants with an average age of 18.87 years and a body mass index (BMI) of 21.50 kg/m² and 56 male participants with an average age of 18.89 years and a BMI of 21.58 kg/m². Table 1 presents the findings from the examination of the meal routine. 79.2% of the participants had lunch every day, while the dinner routine was followed by 71.2% daily.

Regarding the breakfast routine, 64.0% occasionally consume breakfast. The snacking routine between meals among participants, as shown in Table 1, indicates that 60.8% of the participants snack less than twice daily, with females comprising 35.2%. Moreover, females showed a higher tendency towards snacking, regardless of the daily snacking frequency.

The types of food intake frequency are displayed in Table 1. There are 12 types of food with a frequency of less than three times a week (<3 times/week) or three times or more a week (≥3 times/week). Cereal intake was the most frequent < 3 times/week (87.2%), followed by roots and tubers (78.4%) and soft drinks (71.2%). Meat intake showed the highest frequency for ≥3 times/week, at 84.8%. Oils, fats, and eggs were the second and third most frequent foods at 83.2% and 78.4%, respectively.

Table 2 displays the results of the dietary behaviour pattern scores by gender. The dietary behaviour pattern is divided into four major categories: overeating pattern, high fat/high calorie pattern, unbalanced food intake pattern, and dietary impulse pattern, rated on a five-point Likert scale, where 1 represents "not at all" and 5 represents "very much so". A higher score denotes undesirable dietary habits. The scores for each dietary behaviour pattern: overeating, high fat/high calorie, unbalanced food intake, and dietary impulse ranged from 9 to 45, 12 to 60, 5 to 25, and 8 to 40, respectively. Females scored 28.68 points for the overeating pattern, higher than males at 26.39 points (p-value<0.05). Males scored 16.73 points for unbalanced food intake pattern compared to female's 15.55 points (p-value<0.05).

The relationship between dietary behaviour pattern scores and body mass index (BMI) was examined using Pearson's correlation. Figure 1 displays the correlation analysis findings. There was a positive correlation across all four dietary behaviour patterns. Dietary impulse was positively correlated with the high fat/high calorie pattern (r=0.458, p<0.01). A notable positive correlation was observed between high fat/high calorie and dietary impulse with overeating. A positive correlation (r=0.191, p<0.05) was found between dietary impulse and

**Table 1:** Meal Routines and Food Intake Frequency among the Participants

| | Male n (%) | Female n (%) | Total n (%) |
|---|---|---|---|
| Breakfast | | | |
| Everyday | 21 (16.8%) | 16 (12.8%) | 37 (29.6%) |
| Sometimes | 32 (25.6%) | 48 (38.4%) | 80 (64.0%) |
| None | 3 (2.4%) | 5 (4.0%) | 8 (6.4%) |
| Lunch | | | |
| Everyday | 46 (36.8%) | 53 (42.4%) | 99 (79.2%) |
| Sometimes | 10 (8.0%) | 15 (12.0%) | 25 (20.0%) |
| None | 0 | 1 (0.8%) | 1 (0.8%) |
| Dinner | | | |
| Everyday | 46 (36.8%) | 43 (34.4%) | 89 (71.2%) |
| Sometimes | 10 (8.0%) | 24 (19.2%) | 34 (27.2%) |
| None | 0 | 2 (1.6%) | 2 (1.6%) |
| Snacking | | | |
| Yes, < 2 times daily | 32 (25.6%) | 44 (35.2%) | 76 (60.8%) |
| Yes, ≥ 2 times daily | 11 (8.8%) | 14 (11.2%) | 25 (20.0%) |
| No | 13 (10.4%) | 11 (8.8%) | 24 (19.2%) |
| Food intake frequency | | | |
| Cereals | | | |
| < 3 times/week | 45 (36.0%) | 64 (51.2%) | 109 (87.2%) |
| ≥ 3 times/week | 11 (8.8%) | 5 (4.0%) | 16 (12.8%) |
| Roots and tubers | | | |
| < 3 times/week | 41 (32.8%) | 57 (45.6%) | 98 (78.4%) |
| ≥ 3 times/week | 15 (12.0%) | 12 (9.6%) | 27 (21.6%) |
| Vegetables | | | |
| < 3 times/week | 14 (11.2%) | 17 (13.6%) | 31 (24.8%) |
| ≥ 3 times/week | 42 (33.6%) | 52 (41.6%) | 94 (75.2%) |
| Fruits | | | |
| < 3 times/week | 20 (16.0%) | 26 (20.8%) | 46 (36.8%) |
| ≥ 3 times/week | 36 (28.8%) | 43 (34.4%) | 79 (63.2%) |
| Meat | | | |
| < 3 times/week | 8 (6.4%) | 11 (8.8%) | 19 (15.2%) |
| ≥ 3 times/week | 48 (38.4%) | 58 (46.4%) | 106 (84.8%) |
| Egg | | | |
| < 3 times/week | 12 (9.6%) | 15 (12.0%) | 27 (21.6%) |
| ≥ 3 times/week | 44 (35.2%) | 54 (43.2%) | 98 (78.4%) |
| Seafood | 32 (25.6%) | 46 (36.8%) | 78 (62.4%) |
| < 3 times/week | 24 (19.2%) | 23 (18.4%) | 47 (37.6%) |
| ≥ 3 times/week | | | |
| Legumes, nuts and seed | | | |
| < 3 times/week | 37 (29.6%) | 51 (40.8%) | 88 (70.4%) |
| ≥ 3 times/week | 19 (15.2%) | 18 (14.4%) | 37 (29.6%) |
| Milk and milk products | | | |
| < 3 times/week | 22 (17.6%) | 31 (24.8%) | 53 (42.4%) |
| ≥ 3 times/week | 34 (27.2%) | 38 (30.4%) | 72 (57.6%) |
| Oils and fats | | | |
| < 3 times/week | 8 (6.4%) | 13 (10.4%) | 21 (16.8%) |
| ≥ 3 times/week | 48 (38.4%) | 56 (44.8%) | 104 (83.2%) |
| Condiments | | | |
| < 3 times/week | 26 (20.8%) | 30 (24.0%) | 56 (44.8%) |
| ≥ 3 times/week | 30 (24.0%) | 39 (31.2%) | 69 (55.2%) |
| Soft drinks | | | |
| < 3 times/week | 38 (30.4%) | 51 (40.8%) | 89 (71.2%) |
| ≥ 3 times/week | 18 (14.4%) | 18 (14.4%) | 36 (28.8%) |

**Table 2**: Dietary Behaviour Patterns Scores by Gender and Results for every Predictor in a Regression Model that Predicts BMI

| Dietary behaviour pattern type | Male (n = 56) | Female (n = 69) | Total (n = 125) | p-value |
|---|---|---|---|---|
| Overeating | 26.39 ± 5.82 | 28.68 ± 6.38 | 27. 66 ± 6.22 | < 0.05 |
| High fat/high calorie | 37.57 ± 7.65 | 37.81 ± 7.32 | 37.70 ± 7.44 | 0.858 |
| Unbalanced food intake | 16.73 ± 3.09 | 15.55 ± 3.38 | 16.08 ± 3.29 | < 0.05 |
| Dietary impulse | 25.14 ± 7.02 | 26.54 ± 7.21 | 25.91 ± 7.13 | 0.279 |
| Regression model | B [95% CI] | β | $sr^2$ | p-value |
| Overeating | 0.280 [0.137, 0.422] | 0.368 | 0.1102 | 0.000 |
| High fat/high calorie | -0.104 [-0.228, 0.020] | -0.164 | 0.0201 | 0.099 |
| Unbalanced food intake | 0.002 [-0.246, 0.249] | 0.001 | 0.0000 | 0.988 |
| Dietary impulse | 0.016 [-0.116, 0.148] | 0.024 | 0.0004 | 0.809 |

unbalanced food intake. Additionally, overeating, high fat/ high calorie, and unbalanced food intake were positively correlated. Nevertheless, there is insufficient evidence to suggest a positive correlation between overeating and high fat/high calorie with unbalanced food intake within the population. Figure 1 indicates that overeating, dietary impulse, and unbalanced food intake have a positive correlation with BMI, while a weak negative correlation exists between high fat/high calorie and BMI.

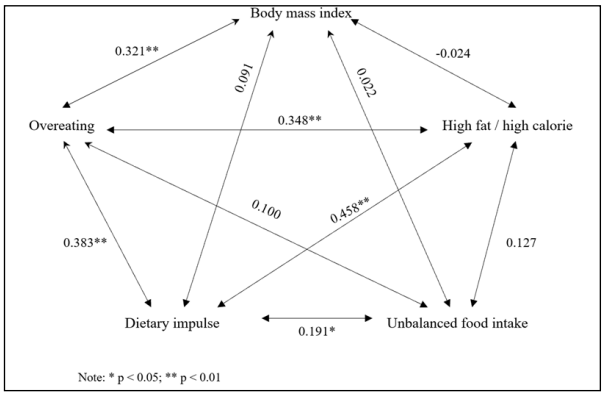


**Figure 1**: Pearson's Correlation Coefficient Model between Body Mass Index, Overeating, High Fat/High Calorie, Unbalanced Food Intake and Dietary Impulse

Overeating, high fat/high calorie, unbalanced food intake and dietary impulse were examined using a standard multiple regression analysis (MRA) to determine their influence on variation in BMI. The analysis revealed that 12.4% of BMI variability was attributable to a combination of overeating, high fat/high calorie, unbalanced food intake, and dietary impulse ($R^2$=0.124, adjusted $R^2$=0.095, F (4 , 120)=4.257, p-value<0.01). The results in Table 2 display the squared semi-partial correlations ($sr^2$), as well as the unstandardized (B) and standardized (β) regression coefficients for each predictor in the model.

## DISCUSSION

With the rise in diseases associated with poor dietary habits, it is more crucial than ever to provide healthcare through nutritional counselling based on an assessment of eating habits. The quality of one's diet has a significant impact on health through food consumption, but study on pre-university adolescents is limited.[13] Therefore, it is necessary to investigate the dietary behaviour patterns among pre-university adolescents. Our goal in this study was to establish new insights on dietary patterns and conduct a survey on 125 pre-university students. Considering the survey's findings, the main meals routine in a day, food intake frequency, snacking routine between meals, and dietary behaviour pattern scores were obtained and assessed, applying to the evaluation of dietary quality in the field of nutrition education.

Most participants consumed two or three main meals daily, which is essential for overall health. This result aligns with a study conducted among medical school students in Bede, Cumber, Nkfusai, Venyuy, Ijang, Wepngong and Kien.[14] However, many of them either snack between meals or skip breakfast. A minority of the respondents occasionally skip lunch or dinner, but most of them sometimes skip breakfast. Meal skipping is a relatively widespread habit among pre-university students. Despite the fact that breakfast is crucial for the body's health and well-being, students may find it challenging to eat because they are rushing to go for their classes.[15] Some may purposely skip breakfast because they are self-conscious about their appearance and body weight. This is more typical in females who are mindful of what they eat.[16] The majority of the respondents have snacks in-between meals, possibly to help them meet their body's energy requirements while they engage in their academic activities. This is similar to findings observed among undergraduate students in a private university located in Nigeria[17].

The majority of respondents' meal patterns indicate that they frequently consumed meat, oils, fats, and eggs for ≥ three times a week. Meanwhile, for < three times a week, the top three food consumed were cereals, roots, tubers, and soft drinks. This could have an impact on the respondents' access to nutrients, i.e., minerals present in these dietary groups. This dietary diversity indicates an indication of a greater understanding of the fundamental nutritional values of various food groups. This ensures optimal nutrition that will benefit the individual's nutritional and health status[18].

A survey on dietary habits and behaviour was conducted, consisting of 34 items in total. The questions were classified into overeating, high fat/high calorie, unbalanced food intake, and dietary impulse. From the findings, the overeating and unbalanced food intake scores showed significant difference between female and male students. Female students obtained higher overeating scores compared to male students. On the contrary, male students scored higher than female students on unbalanced food intake pattern. There is a positive correlation between the four main dietary behaviour patterns. For example, when the overeating score increases, the high fat/high calorie, unbalanced food intake, and dietary impulse scores also increase. This indicates that an unhealthy dietary pattern will lead to another problem in the dietary pattern[19]. There is a positive correlation between overeating, unbalanced food intake, and dietary impulse with body mass index (BMI). This highlights that when overeating, unbalanced food intake, and dietary impulse scores increase, the BMI will also increase. A higher BMI indicates an unhealthy body status. However, there is a weak negative relationship between high fat/high calorie and BMI. This reflects that there are good unsaturated fats (i.e., monounsaturated), which can lower the risk of getting disease.[20]

From the multiple regression analysis, 12.4% of the variation in BMI can be explained by overeating, high fat/ high calorie, unbalanced food intake, and dietary impulse. If this study were to be repeated numerous times with samples taken from the same group, overeating, high fat/ high calorie, unbalanced food intake, and dietary impulse would, on average, explain around 9.5% of the variance in BMI. Additionally, the analysis of variance (ANOVA) is significant (p-value<0.05), showing that $R^2$ deviates far from zero. In other words, the combination of overeating, high fat/high calorie, unbalanced food intake, and dietary impulse can account for a greater variation in BMI than would be predicted by chance.

From Table 2, the unstandardized regression coefficient, B, for overeating is 0.280. This suggests that a 1-unit increase in overeating will result in a predicted 0.280-unit increase in BMI, after controlling high fat/high calorie, unbalanced food intake, and dietary impulse. Meanwhile, overeating has a standardized regression coefficient, or β, of 0.368. In other words, a 1 SD increase in overeating will result in a 0.368 SD increase in BMI, after controlling high fat/high calorie, unbalanced food intake, and dietary impulse.[21]

From the analysis, overeating can account for variance in BMI. It is a significant predictor, t(120)=3.891, p-value <0.01. There is a 95% confidence level that the true population B is contained in the interval between the lower and upper bounds. For example, B=-0.104 for high fat/high calorie is within the lower bound of -0.228 and upper bound 0.020. The corresponding predictor is not significant when a confidence interval comprises zero. This is true for high fat/high calorie, unbalanced food intake, and dietary impulse. For the zero-order correlations, the Pearson's correlation for overeating and BMI is r=0.321. This is similar to the Figure 1 correlation analysis. Here, the semi-partial correlation (sr) for overeating is 0.332, suggesting that overeating is the sole cause of about 11.02% of the variation in BMI.

## CONCLUSION

Adolescence is a stage of rapid growth, impacting nutritional requirements and dietary preferences. Many pre-university adolescents experience living independently for the first time, thus becoming the primary decision-makers regarding their dietary behaviour. They may avoid certain foods due to personal preference, peer pressure or other factors. This study has shown positive correlations between overeating, unbalanced food intake, dietary impulse patterns and

Body Mass Index (BMI) thus highlighting the need for regular nutrition education programs focusing on appropriate dietary practices.


## ACKNOWLEDGEMENT

This research was supported by the Fundamental Research Grant Scheme number FRGS/1/2023/TK07/UKM/02/12, which was awarded by the Ministry of Higher Education, Malaysia.


## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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