

## **Relationships between food environment, general nutrition knowledge, and food preferences among international students in a public university in Malaysia**

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### **ABSTRACT**

**Introduction:** The growing population of international students in Malaysia has underscored the need to better understand their food preferences. Despite this, local studies addressing this topic have remained scarce. This study aimed to determine relationships between nutrition knowledge and food environment and their respective contributions to food preferences among international students at a Malaysian public university. **Methods:** This cross-sectional study included 619 international students. A structured questionnaire was used to assess general nutrition knowledge and food environment. Students were asked to rate their preferences for 77 food items using a five-point Likert scale, ranging from “dislike a lot” (1) to “like a lot” (5). The food items were categorised into six groups, namely animal foods (14 items), starches (12 items), dairy products (8 items), fruits (15 items), vegetables (20 items), and snacks (8 items). **Results:** A significant negative relationship was observed between dairy preference and affordability ( $r=-0.115$ ,  $p=0.005$ ). Students who lived off campus reported significantly greater preference for vegetables ( $M=75.49$ ) than those who lived on campus ( $M=72.84$ ). Nutrition knowledge related to diet, disease, and weight management emerged as the strongest predictor of fruit preference ( $\beta=0.257$ ,  $p<0.001$ ). **Conclusion:** General nutrition knowledge and food accessibility emerged as significant predictors of food preferences. Nutrition intervention programmes and efforts to improve access to fresh food options on campus may help encourage healthier food preferences among international students.

**Keywords:** food environment, food preferences, general nutrition knowledge, international students, Malaysian universities

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## INTRODUCTION

Food preference was first conceptualised in the 1950s as the liking or disliking of a specific food (Peryam & Pilgrim, 1957). Food preferences begin forming in early childhood and continue to develop across the lifespan, shaped by repeated exposure and personal experiences with food (Birch, 1999). This lifelong evolution has underscored the important role of various factors influencing food preferences, including the food environment and general nutrition knowledge.

Key elements of the food environment, including availability, accessibility, housing arrangements, and affordability, play critical roles in determining food preferences. A recent study reported that a supportive food environment could foster healthier food preferences by improving access to nutritious foods (Frank *et al.*, 2022). However, access to healthy food outlets can be constrained by transportation and geographic factors (Donkin *et al.*, 2000; Losada-Rojas *et al.*, 2021).

In addition to availability and accessibility, housing arrangements have been reported to significantly influence food preferences, particularly among university students. On-campus living environments are often characterised by a heavy reliance on ultra-processed foods, which are commonly high in sodium, sugar, and saturated fat. Li *et al.* (2022) reported that mandatory campus meal plans often limit students' autonomy, restricting their access to more diverse or culturally preferred meals. Similarly, Martinez-Perez *et al.* (2022) reported that the majority of on-campus foods were ultra-processed, with students reporting dissatisfaction with the affordability and nutritional quality of these food options.

Nutrition knowledge plays a vital role in shaping food preferences. Several studies have reported associations between higher levels of nutrition

knowledge and increased fruit and vegetable consumption and reduced intake of energy-dense foods, such as soft drinks and ice cream (Nawaz *et al.*, 2016; Rodrigues *et al.*, 2019; Wardle *et al.*, 2000). In contrast, individuals with limited nutrition knowledge were observed to have lower consumption of essential food groups, including fruits, vegetables, carbohydrates, and dairy products (Noronha *et al.*, 2020). Therefore, further investigations are needed to identify food-related challenges faced by international students in order to understand the factors influencing their food preferences in the host context.

Within Asia, international student numbers are expected to reach 1.5 million by 2025, and Malaysia aims to host around 250,000 of these students (Munusamy & Hashim, 2019). Despite the recognised role of the food environment for food preferences, limited research has examined the food-related challenges faced by international students. Several challenges, such as the impact of the food environment in the host country, the health consequences of dietary changes, and limited access to culturally appropriate foods, are underexplored (Alakaam *et al.*, 2015). Consequently, the extent to which these students are affected by their food environments, the nature of their dietary changes, and the primary drivers of their food preferences in a new cultural setting are not well understood.

A healthy diet plays a vital role in weight management, reducing the risks for hypertension and hyperglycaemia, and improving mental health outcomes. As international students study abroad, they often face impactful life transitions, particularly due to cultural differences. A change in living environment may also influence their eating behaviours. In Malaysia, research on international students has largely focused on topics unrelated to food preferences, dietary

habits, or nutrition, with limited evidence available on food-related challenges and preference patterns. Therefore, this study aimed to examine the associations between food environment, general nutrition knowledge, and food preferences among international students in Malaysia. By conducting this study, new insights from a fresh, non-Western perspective could be provided. Identifying the factors associated with international students' food preferences may help inform strategies to promote healthy eating among this population through targeted interventions at the university and national levels.

## METHODOLOGY

### Study design and sampling

This cross-sectional study was conducted among international undergraduate and postgraduate students at a selected public university between November 2018 and mid-April 2019. Ethical approval was obtained from the Ethics Committee for Research Involving Human Subjects, Universiti Putra Malaysia (Ref: JKEUPM-2018-215). Informed consent was obtained online prior to participation.

Participants were selected using cluster sampling technique. Three faculties were initially selected; five additional faculties were later included to increase the number of responses and meet the target sample size. All international students from the selected eight faculties received an e-mail invitation to participate in this study. In order to improve response rates, six reminder e-mails were sent to all international students following the initial invitation. An online questionnaire was distributed to 2,288 students; 619 completed the questionnaire, contributing to a response rate of 27%.

### Study instrument

An online questionnaire comprising three sections was used for data collection.

### Food environment

The food environment questionnaire consisted of seven items adapted from previous research (Donkin *et al.*, 2000; Nolan *et al.*, 2006). Students reported their responses using a three-point scale: "always" (three points), "sometimes" (two points), and "never" (one point). Each item addressed a specific domain of the food environment, including availability (items four and six), accessibility (items one, two, three, and five), and affordability (item seven). The items in the questionnaire are listed as follows:

- 1) The **distance** to food shops makes it difficult for me to buy or eat the food I want.
- 2) The lack of **transportation** (public, private, or university shuttle buses) limits my ability to access the food I want.
- 3) My limited **knowledge and cooking skills** make it harder for me to prepare and eat healthy meals.
- 4) **The absence of kitchen and cooking equipment** in my living space makes it hard for me to cook and eat the food I want.
- 5) I have limited **time** to shop for and prepare meals.
- 6) Culturally appropriate foods are not always **available**, which affects my ability to eat the foods I prefer.
- 7) The **price** of food influences whether I can buy and eat what I want.

For each domain, item scores were summed to generate a total domain score. The availability domain consisted of two items (items 4 and 6), resulting in a possible total score range of 2–6. The accessibility domain comprised four items (items 1, 2, 3, and 5), with a total possible score range of 4–12. The affordability domain was assessed using a single item (item 7) and was scored using a reversed scale.

Food environment domains were categorised into no issue / occasional issue / continuous issue using these scoring ranges: availability ( $\leq 2$ ; 3–4;  $> 4$ ), accessibility ( $< 7$ ; 8–10;  $\geq 10$ ), and affordability (reverse-scored: 1=no issue, 2=occasional issue, 3=continuous issue). The Cronbach's alpha for this section was 0.77, indicating a good internal consistency. Additionally, students were asked about their housing arrangement, with options of "on campus" and "off campus".

### **General Nutrition Knowledge Questionnaire**

The General Nutrition Knowledge Questionnaire consisted of two subscales: food groups (36 items) and diet, disease, and weight management (21 items) (Kliemann *et al.*, 2016). The food group section assessed students' awareness of different food groups and nutrient content, such as protein and fats. Meanwhile, the second subscale evaluated students' knowledge of diseases associated with diet, such as diabetes and heart diseases, and weight management practices. Each correct answer was given one point, with a maximum possible score of 36 points for the first section and 21 points for the second section, respectively.

### **Food Preference Questionnaire**

The Food Preference Questionnaire (FPQ) consisted of 77 food items, where 72 items were derived from Fildes *et al.* (2014) and local food items were supplemented from the Malaysian Adult Nutrition Survey (MANS) (IPH, 2014). The food items were categorised into six food groups, namely animal foods (14 items), starches (12 items), dairy products (8 items), fruits (15 items), vegetables (20 items), and snacks (8 items).

Students were asked to rate their preferences for each food item using a five-point Likert scale, where 1 =

"dislike a lot" and 5 = "like a lot". The average scores for each food group were calculated and converted to percentage scores (0–100), with higher scores indicating greater preference. If students were not familiar with the food item, they could select "not applicable" as their response. The Cronbach's alpha values for the six food groups were determined accordingly: animal foods (0.91), starches (0.90), dairy products (0.81), fruits (0.87), vegetables (0.83), and snacks (0.89). As all Cronbach's alpha values were more than 0.6, this questionnaire had a good internal reliability.

### **Data analysis**

Data were analysed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive findings, including means, standard deviations (SDs), frequencies, and percentages, were presented. Pearson's and Spearman's correlations were used to assess associations, while Mann-Whitney U tests compared preferences by housing arrangement. A simple linear regression (SLR) was conducted to determine potential predictors by identifying the independent variables that demonstrated preliminary relationships with each food preference outcome, followed by a multiple linear regression (MLR) to assess their combined predictive contributions. Statistical significance was defined at  $p < 0.05$ .

## **RESULTS**

### **Background of the respondents**

This study involved 619 international students, with a mean age of  $29 \pm 7$  years. About 61% were male and 67% were single. Participants were PhD (38%), undergraduate (34%), and Master's (28%) students, predominantly from the Arab/Middle Eastern, Asian, and African regions. Most lived off campus (83%). Mean monthly income was RM 2,244 $\pm$ 2,291.

**Table 1.** Distribution of food environment domains (n=619)

Domains	Participants with no issue n (%)	Participants with occasional issue n (%)	Participants with continuous issue n (%)	Summated Score (Mean±SD) [Possible Range] <sup>†</sup>
Food accessibility	132 (21.4)	418 (67.5)	69 (11.1)	8.53±1.56 [4-12]
Food availability	39 (6.3)	350 (56.5)	230 (37.2)	4.18±1.07 [2-6]
Food affordability	83 (13.4)	323 (52.2)	213 (34.4)	2.21±0.66 [1-3]

<sup>†</sup>Summated Score represents the mean of total points calculated for each domain. For accessibility (four items) and availability (two items), scores were based on a three-point scale (1 = never, 2 = sometimes, 3 = always), with higher scores indicating a higher frequency of barriers. Affordability (one item) used reversed scoring (1 = minimal difficulty, 2 = moderate difficulty, 3 = highest difficulty); a higher score reflects lower affordability.

**Table 2:** Distribution of nutrition knowledge (n=619)

Dimension	Knowledge Level	n (%)	Mean±SD [Range] <sup>†</sup>
Food groups	Low	112 (18.1)	15.85±5.82 [0-36]
	Fair	494 (79.8)	
	High	13 (2.1)	
Diet, disease and weight management	Low	115 (18.6)	10.39±4.38 [0-21]
	Fair	394 (63.7)	
	High	110 (17.8)	

<sup>†</sup>Mean±SD represents the average summated score for all participants (n=619) within each dimension. The [Range] indicates the minimum and maximum possible scores achievable; higher scores reflect greater nutrition knowledge.

**Table 3.** Mean percentage scores of food preferences by food groups (n=619)

Food Group	Rank	Preference Score (Mean±SD) <sup>†</sup>
Fruits	1	75.79±17.04
Starches	2	73.99±17.52
Snacks	3	72.67±21.85
Vegetables	4	71.44±19.52
Animal foods	5	63.35±20.89
Dairy	6	61.61±24.85

<sup>†</sup>The values represent mean preference scores expressed as percentages. Although the original scale ranged from 1 to 5, scores were converted to a 0–100 scale for better comparison (Formula: [Mean Score / 5] × 100).

### **Descriptive characteristics of the food environment, nutrition knowledge, and food preferences**

The distribution of food environment domains is tabulated in Table 1. A small group of students (6%) never faced issues regarding food availability. However, the

majority experienced problems with food availability, either occasionally (57%) or continuously (37%), indicating that most students faced barriers in consistently accessing their preferred foods. In terms of affordability, 87% mentioned that their purchases were sometimes or always

**Table 4.** Associations between various factors and food preferences ( $r=619$ )

Food Preference	Accessibility		Availability		Affordability		General nutrition knowledge groups		Diet, disease and weight management	
	Pearson Correlation	p-value	Pearson Correlation	p-value	Pearson Correlation	p-value	Spearman Correlation	p-value	Spearman Correlation	p-value
Animal foods	0.293**	<0.001	0.307**	<0.001	0.207**	<0.001	-0.008	0.853	-0.009	0.816
Starches	0.051	0.214	0.011	0.799	-0.055	0.178	-0.261**	<0.001	-0.303**	<0.001
Dairy	0.120**	<0.001	0.020	0.631	-0.115**	0.005	0.016	0.692	-0.043	0.294
Fruits	0.159**	<0.001	0.057	0.171	0.050	0.228	0.193**	<0.001	0.206**	<0.001
Vegetables	0.128**	<0.001	0.099*	0.016	0.079	0.057	0.213**	<0.001	0.172**	<0.001
Snacks	0.024	0.558	0.045	0.273	-0.030	0.470	-0.199**	<0.001	-0.219**	<0.001

\*Correlation is significant at the 0.05 level (2-tailed); \*\*Correlation is significant at the 0.01 level (2-tailed)

affected by food prices. For housing arrangements, most participants (83%) lived off campus, while 17% lived on campus.

Table 2 presents the distribution of nutrition knowledge related to food groups and diet, disease, and weight management. The majority of participants had fair nutrition knowledge of food groups (80%), while only a small proportion (2%) demonstrated good knowledge. In contrast, nearly two-thirds (64%) had fair knowledge about diet, disease, and weight management, whereas 18% demonstrated good knowledge in this topic.

Table 3 shows the food preferences of international students, calculated as mean percentage scores (0–100). Fruits (75.79±17.04) were the most preferred food group, followed by starches (73.99±17.52) and snacks (72.67±21.85). In contrast, dairy (61.61±24.85) was the least preferred food category among the participants. This pattern suggests a stronger preference for fruits, which may be influenced by the Malaysian food environment.

**Differences in food preferences based on housing arrangement**

Students who lived on campus reported significantly different food preferences in most food groups compared to those living off campus. Notably, a significant difference was observed for vegetable preferences ( $Z=-2.086$ ,  $p=0.037$ ), where students living off campus ( $M=75.49$ ,  $SD=20.10$ ) had a higher preference for vegetables than those residing on campus ( $M=72.84$ ,  $SD=22.20$ ). Off-campus students may prefer vegetables more because they have better access to kitchens and cooking equipment. On the other hand, limited cooking facilities on campus may reduce vegetable preparation and intake.

### **Associations of the food environment and nutrition knowledge with food preferences**

As shown in Table 4, significant positive correlations were observed between food accessibility and preferences for animal foods ( $r=0.293$ ,  $p<0.001$ ), dairy products ( $r=0.120$ ,  $p<0.001$ ), fruits ( $r=0.159$ ,  $p<0.001$ ), and vegetables ( $r=0.128$ ,  $p<0.001$ ), indicating that better access to food outlets may encourage greater food variety. Food availability also showed positive and significant correlations with preferences for animal foods ( $r=0.307$ ,  $p<0.001$ ) and vegetables ( $r=0.099$ ,  $p=0.016$ ), suggesting that having a wide range of foods available can influence food selection patterns. In contrast, affordability was positively associated with animal food preferences ( $r=0.207$ ,  $p<0.001$ ) but negatively correlated with dairy preferences ( $r=-0.115$ ,  $p=0.005$ ), implying that even when food is affordable, students may limit dairy intake due to personal, cultural, or health-related factors.

Regarding nutrition knowledge, both subscales of food groups and diet, disease, and weight management demonstrated positive correlations with preferences for fruits ( $\rho=0.193$  and  $0.206$ ,  $p<0.001$ ) and vegetables ( $\rho=0.213$  and  $0.172$ ,  $p<0.001$ ). In this study, students with better nutrition knowledge were more likely to make healthier food choices (Table 4). Conversely, negative correlations were observed between nutrition knowledge and preferences for starches ( $\rho=-0.261$  and  $-0.303$ ,  $p<0.001$ ) and snacks ( $\rho=-0.199$  and  $-0.219$ ,  $p<0.001$ ), suggesting that students with better nutrition knowledge tended to have lower preferences towards starchy and energy-dense foods. Among the two nutrition knowledge subscales, diet, disease, and weight management knowledge showed slightly stronger associations with food preferences, indicating that higher knowledge may align with healthier preferences.

### **Predictors of food preferences among international students**

Findings from the correlation analyses presented in Table 4 showed that food accessibility, availability, affordability, and nutrition knowledge were significantly associated with several food preferences. Therefore, these variables were entered into the regression models to identify key predictors of food preferences among international students (Table 5).

For animal foods, food accessibility, availability, and affordability were significant predictors, with food availability emerging as the strongest predictor ( $\beta=0.182$ ,  $p<0.001$ ). For starches, both general nutrition knowledge subscales (food groups and diet, disease, and weight management) showed significant negative relationships ( $\beta=-0.111$ ,  $p=0.036$ ;  $\beta=-0.225$ ,  $p<0.001$ , respectively), indicating that students with stronger nutrition knowledge were less likely to prefer starch-based options. Dairy preference were significantly predicted by food accessibility ( $\beta=0.135$ ,  $p=0.002$ ) and affordability ( $\beta=-0.165$ ,  $p<0.001$ ); the latter suggests that affordability challenges may limit dairy consumption.

Fruit preference were positively associated with housing arrangement, food accessibility, and knowledge of diet, disease, and weight management, with the latter emerging as the strongest predictor ( $\beta=0.257$ ,  $p<0.001$ ). Collectively, these variables explained 19% of the variance in fruit preferences. Similarly, vegetable preference were influenced by food accessibility ( $\beta=0.077$ ,  $p=0.047$ ) and both nutrition knowledge dimensions ( $\beta=0.154$ ,  $p=0.003$ ;  $\beta=0.161$ ,  $p=0.002$ ), accounting for 22% of the variance. Snack preference, on the other hand, were negatively influenced by nutrition knowledge (food groups:  $\beta=-0.106$ ,  $p=0.049$ ; diet and disease:  $\beta=-0.172$ ,  $p=0.002$ ), implying that better understanding of nutrition may reduce students' preference for energy-dense snacks.

**Table 5.** Multiple linear regression analysis for food preference predictors among international students (n=619)

Variables	Standardized coefficients	95% CI		p-value <sup>Δ</sup>
	$\beta$	Lower bound	Upper bound	
<b>Animal<sup>†</sup></b>				
Food environment				
Housing arrangement				
Food accessibility	0.154**	0.578	2.293	0.001
Food availability	<b>0.182**</b>	1.247	3.719	<0.001
Food affordability	0.106*	0.509	4.164	0.012
General nutrition knowledge				
General nutrition knowledge (food groups)				
General nutrition knowledge (diet, disease and weight management)				
<b>Starches<sup>‡</sup></b>				
Food environment				
Housing arrangement				
Food accessibility				
Food availability				
Food affordability				
General nutrition knowledge				
General nutrition knowledge (food groups)	-0.111*	-0.365	-0.012	0.036
General nutrition knowledge (diet, disease and weight management)	<b>-0.225**</b>	-0.759	-0.278	<0.001
<b>Dairy<sup>§</sup></b>				
Food environment				
Housing arrangement				
Food accessibility	0.135**	0.312	1.386	0.002
Food availability				
Food affordability	<b>-0.165**</b>	-3.727	-1.186	<0.001
General nutrition knowledge				
General nutrition knowledge (food groups)				
General nutrition knowledge (diet, disease and weight management)				
<b>Fruits<sup>¶</sup></b>				
Food environment				
Housing arrangement	0.09*	0.419	5.621	0.023
Food accessibility	0.135**	0.481	1.746	0.001
Food availability				
Food affordability				
General nutrition knowledge				
General nutrition knowledge (food groups)				
General nutrition knowledge (diet, disease and weight management)	<b>0.257**</b>	0.552	1.027	<0.001
<b>Vegetables<sup>††</sup></b>				
Food environment				
Housing arrangement				
Food accessibility	0.077*	0.013	1.997	0.047
Food availability				

To be continued...

**Table 5.** Multiple linear regression analysis for food preference predictors among international students ( $n=619$ ) (continued)

Variables	Standardized coefficients $\beta$	95% CI		p-value <sup>^</sup>
		Lower bound	Upper bound	
Food affordability				
General nutrition knowledge				
General nutrition knowledge (food groups)	0.154**	0.191	0.916	0.003
General nutrition knowledge (diet, disease and weight management)	<b>0.161**</b>	0.288	1.278	0.002
Snacks <sup>##</sup>				
Food environment				
Housing arrangement	-0.077	-3.623	0.067	0.059
Food accessibility	0.024	-0.315	0.583	0.558
Food availability	0.045	-0.288	1.015	0.273
Food affordability	-0.030	-1.464	0.676	0.470
General nutrition knowledge				
General nutrition knowledge (food groups)	-0.106*	-0.328	-0.001	0.049
General nutrition knowledge (diet, disease and weight management)	<b>-0.172**</b>	-0.578	-0.136	0.002

Dependent variable: six food preference categories. Independent variables: food environment dimensions and nutrition knowledge dimensions (food groups; diet, disease, and weight management). CI: confidence interval for unstandardised coefficients (B).

The most significant contributor for each food group are shown in bold.

<sup>^</sup>Multiple linear regression model:  $R^2=0.176$ , Adjusted  $R^2=0.165$ ,  $F=16.579$ ,

$p<0.001$ <sup>‡</sup>Multiple linear regression model:  $R^2=0.154$ , Adjusted  $R^2=0.146$ ,  $F=19.720$ ,

$p<0.001$ <sup>§</sup>Multiple linear regression model:  $R^2=0.092$ , Adjusted  $R^2=0.085$ ,  $F=13.863$ ,

$p<0.001$ <sup>¶</sup>Multiple linear regression model:  $R^2=0.205$ , Adjusted  $R^2=0.194$ ,  $F=19.714$ ,

$p<0.001$ <sup>††</sup>Multiple linear regression model:  $R^2=0.234$ , Adjusted  $R^2=0.220$ ,  $F=16.188$ ,

$p<0.001$ <sup>†††</sup>Multiple linear regression model:  $R^2=0.127$ , Adjusted  $R^2=0.115$ ,  $F=9.875$ ,

$p<0.001$ <sup>^</sup>Multiple linear regression ( $p<0.001$ )\* $p<0.05$ ; \*\* $p<0.01$

## DISCUSSION

Food accessibility, as a component of the food environment, plays a vital role in shaping an individual's food preferences. The present study revealed that food accessibility was significantly correlated with preferences for animal foods, fruits, and vegetables. This suggests that when participants have easier access to food, they are more likely to choose a wider variety of foods, including healthier options. Consistent findings have been reported in other countries. Ollberding *et al.* (2012) reported that increased access to food outlets in Hawaii increased fruit and vegetable consumption. In another study, improved food environments in

rural China led to higher consumption of meat and vegetables (Huang & Tian, 2019). In contrast, limited accessibility to food could reduce food variety. For example, people living in rural areas often have reduced accessibility to fresh produce due to transportation barriers (Bennion *et al.*, 2022).

The present study revealed that food availability was significantly related to preferences for animal foods ( $p<0.001$ ) and vegetables ( $p=0.016$ ). This finding aligns with the concept that food availability significantly influences consumption patterns, where individuals are more likely to increase intake when food is readily or easily accessible (Hartwell *et al.*, 2020). Comparable

associations have been reported in Detroit, where the availability of dark green and orange vegetables in local neighbourhoods was linked to higher consumption among low- to moderate-income residents (Izumi *et al.*, 2011). Likewise, Elshahat & Moffat (2020) also reported comparable relationships between vegetable availability and increased consumption.

In terms of affordability, this study identified a negative relationship between dairy preference and affordability ( $p=0.005$ ). While dairy products are often perceived as an affordable food option, they were less preferred by participants. This finding suggests that greater affordability does not necessarily translate into higher dairy preference among international students. This pattern implies that factors beyond affordability, including the taste of locally available dairy products, cultural habits, or limited availability of familiar dairy options in Malaysia, may have played a stronger role in shaping dairy preferences.

In addition, this finding may indicate a sustainable dietary pattern. Past studies have observed a similar trend, where consumers with greater awareness of sustainability and environmental issues were more likely to substitute dairy products with plant-based alternatives, regardless of affordability (Su *et al.*, 2024). Thus, future research should examine how affordability interacts with sustainability-related dietary behaviours to better understand dairy preferences in this population.

In this study, students who were staying off campus preferred vegetables more compared to those living on campus. International students living off campus may have kitchens and cooking equipment, which can promote the preparation and intake of vegetables. However, contrasting findings were reported by Brunt & Rhee (2008), who

found that American college students living on campus consumed higher intakes and varieties of fruits and vegetables compared to those living off campus. This difference could be attributed to the availability of prepaid meal plans, accessible salad bars, and point-of-purchase nutrition information on campus, which likely promote vegetable consumption (Brunt & Rhee, 2008). This is consistent with Gonzales (2013), who found that students staying off campus need to buy and prepare their own meals, which may discourage vegetable consumption due to several constraints, such as budget, time, or limited cooking skills. Taken together, these findings emphasise the multifactorial concept of how students' food preferences could be shaped, including cultural context, food environments, and support systems (Brunt & Rhee, 2008; Alakaam & Willyard, 2020).

A significant negative relationship was observed between nutrition knowledge and preferences for both starches and snacks ( $p<0.001$ ) in this study. International students with better nutrition knowledge were more likely to control their diet by limiting energy-dense and less nutritious foods. These findings are consistent with a previous study by Koch *et al.* (2021), where individuals with greater nutrition knowledge were less likely to consume refined starches and snacks. Similarly, Noronha *et al.* (2020) reported that individuals with lower nutrition knowledge tended to consume fewer fresh produce, such as fruits and vegetables, but higher intakes of snacks.

Moreover, general nutrition knowledge across both subdomains emerged as the strongest predictor of preferences for fruits and vegetables in the present study. These results suggest that students with a higher level of nutrition knowledge have greater preferences for healthier food options, especially fruits and vegetables, consistent with previous

studies demonstrating a positive association between nutrition knowledge and fruit intake (Noronha *et al.*, 2020). In addition, higher fruit and vegetable preferences are associated with a lower risk of cancer and cardiovascular disease mortality (Su *et al.*, 2024; Zurbau *et al.*, 2020). These findings have important implications for public health promotion, as food preferences greatly influence food choices and ultimately shape dietary patterns. Cultivating a liking towards fruits and vegetables may contribute to healthier long-term eating behaviours among international students, reducing the risk and burden of non-communicable diseases and lessening the strain on healthcare systems, aligning with national health goals in Malaysia.

This study had several limitations. Firstly, the cross-sectional design of this study limits causal interpretations. Secondly, data collection from a single public university restricts the generalisability of findings to the broader international student population in Malaysia. Thirdly, this study relied on self-reported food preference ratings rather than observed dietary behaviours or dietary recalls, which may introduce response bias. Participants' responses may reflect perceived or socially desirable responses rather than their actual food preferences, and may not fully represent habitual dietary choices in real-life settings.

Future studies should adopt longitudinal designs, expand sampling across multiple institutions, and include objective measures, such as measuring food intake using food frequency questionnaire, to increase the reliability and validity of data. Additionally, future research should examine the role of dietary acculturation, as cultural adaptation processes may further shape food preferences and influence students' ability to access and prepare meals in the host country.

## **CONCLUSION**

The present study revealed that food accessibility was significantly linked to fruit and vegetable preferences, whereas general nutrition knowledge was a consistent predictor of preferences for starchy foods, fruits, vegetables, and snacks. Intervention programmes aligned with the Malaysian Dietary Guidelines, such as basic nutrition workshops or online modules from the university's Nutrition Department, could improve students' nutrition knowledge. In addition, evidence-based nutrition materials or leaflets with simple information could be integrated into orientation programmes to improve the nutrition knowledge among international students and support healthier food preferences during their stay in Malaysia.

Future research should expand this study to other Malaysian universities to improve generalisability and strengthen the policy relevance of the findings for the Ministry of Higher Education (MOHE), including refinement of the 'Healthy Campus' standards in line with the Malaysia Higher Education Plan (PPTM) 2026–2035. Practical initiatives, such as fresh fruit stalls or healthier vending options, could be pilot-tested and evaluated across institutions. These evaluations would provide evidence to guide policies that support the overall well-being of international students.

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AI tools were used to assist with language refinement during manuscript preparation, while all analyses, interpretations, and final content reflect the author's original work.

## **Authors' contributions**

Nurunnisa KE, conducted the study, analysed and interpreted the data, and prepared the initial draft of the manuscript; Norhasmah S (principal investigator), conceptualised the study, provided guidance on data analysis and interpretation, and provided critical revisions to the final draft of the

manuscript; Gan WY, co-supervised the study. All authors participated in reading and approving the final version of the manuscript.

### Conflict of interest

The authors declare no conflict of interest.

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