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KNOWLEDGE, ATTITUDE AND PERCEPTION ON CLIMATE CHANGE AND DIETARY CHOICES IN A PREDOMINANTLY CHINESE UNIVERSITY STUDENTS POPULATION IN KLANG VALLEY

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ABSTRACT

Climate change is a public health threat that is aggravated by the food supply chain. A dietary shift to climate-friendly foods is a feasible strategy to mitigate it. This study aimed to investigate the associations between knowledge, attitude, perception towards climate change, and barriers to climate-friendly foods with dietary choices of university students in Klang Valley. A cross-sectional study was conducted among 303 Malaysian university students (71.9% Chinese) aged 18 to 30 years in Klang Valley, by using Google form to assess knowledge, attitude, perception towards climate change, barriers to climate-friendly food, and climate-friendly dietary choices. The average climate-friendly diet score (CFDS) was 0.36±2.21, with a significantly higher CFDS among females than males (p=0.012). The majority of them were having good knowledge (76.6%), a good attitude (66.3%), and a moderate level of perception (62.0%) towards climate change. About two-thirds of them reported social media as the main (63.0%) and preferred (63.7%) sources to receive information about climate change. Through multiple linear regression, barriers to climate-friendly food choices (β=-0.084; p<0.001) significantly contributed to climate-friendly dietary choices (F=4.215; p<0.001), whereby 14.9% of the variances were climate-friendly dietary choices of university students. Findings could be incorporated into dietary education to tackle barriers to climate-friendly foods among university students.

Key words: Barriers, climate change, climate-friendly, source of information, university students

INTRODUCTION

Climate change has been observed through frequency and severe changes in extreme weather since the early 20th century which affects human health in several ways, notably by causing losses in agricultural production as well as increasing the transmission of vector-borne infectious diseases (Smith *et al*., 2014). Natural processes contributed to climate change, but human activity is the primary contributor (IPCC, 2014). The food supply chain is a significant source of anthropogenic greenhouse gas emissions and its contribution was estimated to be about 26% of anthropogenic greenhouse gas emissions (Poore & Nemecek, 2018). Food subgroups differ in the amount of greenhouse gas emissions due to their production. For instance, mutton contributes 24 kg CO_2-equivalents per kg product whereas fish emits between 3 kg and 5 kg CO_2-equivalents per kg product (Poore & Nemecek, 2018). Foods associated with lower greenhouse gas emissions are often referred to as climate-friendly foods (Korkala *et al*., 2014). Shifting to climate-friendly foods could be a feasible strategy to mitigate climate change. As of 2015, the United Nations has established Sustainable Development Goal (SDG) 12 which ensures responsible consumption patterns in response to the high amount of greenhouse gas emissions generated from the food sector (Grunert, 2011).

The National Health and Morbidity Survey (NHMS) 2019 reported that the prevalence of obesity among Malaysian adults was 19.7% whereas a higher prevalence was shown among females (24.7%) than males (15.3%) (IPH *et al*., 2020). The growing prevalence of obesity is one of the public health problems that may hinder the achievement of the Sustainable Development Goals (SDGs). Acting on climate change can benefit both climate and health, such as the dietary shift to climate-friendly foods (e.g. legumes & fresh vegetables), reduced greenhouse gas emissions as well as improved health due to the partial or full replacement of animal-based foods with plant-

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based foods (Grunert, 2011; Korkala *et al*., 2014; Tilman & Clark, 2014; Ranganathan *et al*., 2019).

Similarly, the health co-benefits of this climate change mitigation may address the existing high prevalence of obesity and overweight rates in Malaysia as well as contribute to SDG 3 which aims to promote health and well-being (Kendrovski *et al*., 2019). The younger population are the key consumers of the next decade who shapes the future of dietary patterns, particularly university students who are starting their lives independently from family influence and their dietary patterns are forming. Dietary patterns often persist throughout adulthood thus, a study among university students is important in climate change mitigation (Vermeir & Verbeke, 2008; Barbara & Pego, 2020).

To the best of our knowledge, 35% to 79% of the university and school students had good levels of knowledge and understanding of climate change (Calvo & Apilado, 2015; Odonkor *et al*., 2020; Puspita *et al*., 2020; Gazzaz & Bassam, 2021). However, more than 51% to 93% of the university and school students possessed a poor attitude toward climate change and 23% did not perceive a global dietary shift toward a more plant-based diet could reduce climate change (Calvo & Apilado, 2015; Leiserowitz *et al*., 2020; Puspita *et al*., 2020). To date, poor knowledge has impacted absent success in dietary shifts to climate-friendly foods. Furthermore, a lack of knowledge on climate change limits the consumer's interest to practice climate-friendly dietary behavior (Makiniemi & Vainio, 2014; Mann *et al*., 2018). Evidence has shown that those with a good understanding and concern for climate change had higher CFDS, thus indicating a more climate-friendly dietary behavior (Korkala *et al*., 2014). Similarly, barriers to climate-friendly food choices such as high prices, poor supply, and bad taste were found to be negatively associated with dietary choices (Makiniemi & Vainio, 2014). Therefore, predictors of climate-friendly dietary choices are of interest to be studied. Earlier studies have focused on knowledge, attitude, and perception towards general climate change and its health impact. However, the aspect of food choice has not been examined in detail (Tobler *et al*., 2012; Calvo & Apilado, 2015; Siegrist *et al*., 2015; Sulistyawati *et al*., 2018; Odonkor *et al*., 2020; Puspita *et al*., 2020; Gazzaz & Bassam, 2021). Therefore, this study aimed to investigate the association between knowledge, attitude, perception towards climate change, and barriers to climate-friendly foods with dietary choices of university students in Klang Valley.

MATERIALS AND METHODS

Study setting and subjects

This cross-sectional study was conducted among Malaysian university students aged 18 to 30 years old in Klang Valley, Malaysia and this study used Google form to collect data. The participants were recruited using convenience sampling from May 2021 to July 2021 through the online platform, including social media applications (Facebook & Instagram) and academic social networking sites of the universities in Klang Valley, Malaysia. Ethical approval of this study protocol was obtained from the Institutional Ethics Committee (IEC) of UCSI University (Ethics approval code: IEC-2021-FAS-024). Participants were given an informed consent form before the data collection. University students who are under any specific diet or diet restriction were excluded.

Study instruments

Socio-demographic characteristics

This section consisted of six questions including sex, age, ethnicity, education level, current university, and monthly allowance.

Knowledge of climate change

The questions about knowledge of climate change were adopted from previous studies (Sulistyawati *et al*., 2018; Kause *et al*., 2019; Puspita *et al*., 2020). This part consisted of 56 items whereby one (1) point was given for each correct answer and zero (0) point was given for the wrong answer. Total scores were summed up with a possible range of zero to 56. A higher score indicated a higher level of knowledge. The overall knowledge scores were later categorized as poor (<18), moderate (18–36), and good (>36) based on the formula for the width of class interval (w_i) (Paternoster & Bachman, 2016). In the current study, the internal consistency reliability of this instrument was good with a Cronbach's alpha coefficient of 0.824.

Attitude towards climate change

The questions about the attitude towards climate change were adopted from past studies (Shariff *et al*., 2012; Odonkor *et al*., 2020; Puspita *et al*., 2020). It consisted of 20 items and the response options were strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). Total scores were summed up with a possible range of 20 to 100. A higher score indicated a higher level of attitude towards climate change. The overall attitude scores were further categorized into poor (<46), moderate (46–72), and good (>72) according to the formula for the width of class interval (w_i) (Paternoster & Bachman, 2016). In this study, the internal consistency reliability of this instrument was good with a Cronbach's alpha coefficient of 0.835.

Perception towards climate change

The questions about the perception of climate change were adopted from past studies (Siegrist *et al*., 2015; Gazzaz & Bassam, 2021). It consisted

of 24 items and the response options were strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). Total scores were summed up with a possible range of 24 to 120. A higher score indicated a higher level of perception of climate change. The overall perception scores were later categorized into poor (<56), moderate (56–88), and good (>88) according to the formula for the width of class interval (w_i) (Paternoster & Bachman, 2016). In this study, the internal consistency reliability of this instrument was acceptable with a Cronbach's alpha coefficient of 0.790.

Barriers to climate-friendly food choices

This section consisted of 10 barriers including a disbelief in climate-friendly foods, poor knowledge, high prices, lack of time, difficulty in making climate-friendly food choices, poor supply, not wanting to be different, bad taste, food consumption habits, and unhealthy food choices. The response options were completely irrelevant (1), irrelevant (2), slightly irrelevant (3), slightly relevant (4), relevant (5), and completely relevant (6) (Makiniemi & Vainio, 2014). The mean score was expressed with a possible range of 10 to 60. A higher mean score indicated the more relevance of these barriers to influencing their climate-friendly food choices. In this study, the internal consistency reliability of this instrument was good with a Cronbach's alpha coefficient of 0.869.

Main and preferred sources of information about climate change

This section consisted of 10 types of sources including social media, websites, television and movies, school or university, newspapers, friends, government programs, messaging applications, family, and radio (Banerjee *et al*., 2020). Data were expressed as a percentage to identify the main and preferred sources of information about climate change.

Climate-friendly dietary choices

This section consisted of eight food groups based on the habitual intake of Malaysian adults (Karim *et al*., 2008). Participants rate the intake frequency of food groups during the past 12 months using a five-point scale (less than once a month, one to three times a month, one to three times a week, almost daily & at least once a day) to capture their usual dietary intakes over a longer period (Korkala *et* al., 2014). The estimated greenhouse gas emissions data was adopted from a past study that used a meta-analysis approach to published life cycle assessment of food systems (Poore & Nemecek, 2018). The climate-friendly food groups included legumes, vegetables, and fruits (Kanyama & Gonzalez, 2009; KeTSA, 2014). Non-climate-friendly food groups included cereals, meats, fish, seafood, eggs, and milk (Pathak *et al*., 2010; Preece *et al*., 2012; FAO, 2017). The intake frequency of each climate-friendly food group was measured using the scale in ascending order, ranging from one (less than once a month), two (1–3 times a month), three (1–3 times a week), four (almost daily) to five (at least once a day). In contrast, the intake frequency of each non-climate-friendly food group was measured in descending order. The median intake frequency of the study population was expressed and used in the classification of individual intake frequency of the food groups as high (more than median), average (equal to median), and low (less than the median) intake frequency (Korkala *et al*., 2014). The CFDS of each participant was generated. One plus (+1) point was given for the high-frequency intake of each climate-friendly food group and the low-frequency intake of each non-climate-friendly food group. One minus (-1) point was given for the low-frequency intake of each climate-friendly food group and the high-frequency intake of each non-climate-friendly food group. Zero (0) point was given for average frequency intake. The mean CFDS of the study population was calculated with a possible range of -8 to +8. A higher mean of CFDS indicated a climate-friendlier dietary choice (Korkala *et al*., 2014).

Statistical analysis

Data analysis was performed using IBM SPSS Statistics 23 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to analyze socio-demographic data and described the distribution of data with the mean score, standard deviation, frequency, and percentage. Data with skewness values between -2 and +2 were considered normally distributed (George & Mallery, 2010). Independent-sample *t*-test was used to compare the difference in climate-friendly dietary choices between male and female participants. One-way ANOVA was used to determine the differences in climate-friendly dietary choices across age categories, education levels, monthly allowance categories as well as knowledge, attitude, and perception levels. Pearson correlation was used to determine the correlation between barriers and climate-friendly dietary choices. Multiple linear regression analysis was performed to determine predictors of climate-friendly dietary choices. The statistical significance level was set at $p<0.05$.

RESULTS

A total of 303 participants (32.0% males & 68.0% females) completed the study (Table 1). The majority (71.9%) of the participants were Chinese, had a bachelor's degree education background (68%), and had a monthly allowance of less than RM500 (47.2%).

Table 2 presents the distribution of knowledge, attitude, perception towards climate change, and barriers to climate-friendly food choices. A total of

76.6% and 66.3% of participants in this study were categorized as having good knowledge and attitude respectively. About two-thirds (62.0%) of participants were reported to have a moderate level of perception. Figure 1 shows a total of 63.0% and 63.7% of participants who reported social media as the main and preferred sources to receive information about climate change respectively.

Table 3 shows that climate-friendly dietary choices were significantly different between sex (t=-2.526; p=0.012), whereby females (0.58 ± 2.27) rated significantly higher CFDS than males (-0.10 ± 2.00). Similarly, barriers to climate-friendly food choices were also significantly correlated with climate-friendly dietary choices (r = -0.346; p<0.001). However, knowledge (F=1.256; p=0.286), attitude (F=1.655; p=0.193), and perception (F=0.901; p=0.407) were not associated with climate-friendly dietary choices of participants in this study.

Multiple linear regression analysis was performed to determine predictors of climate-friendly dietary choices (Table 4). Barriers to climate-friendly food choices (β=-0.084; p<0.001) were found to be significantly and negatively associated with climate-friendly dietary choices (F=4.215; p<0.001). The R-square value was 0.149 indicating that 14.9% of the variances in climate-friendly dietary choices were explained.

DISCUSSION

The findings in the current study provided evidence of climate-friendly dietary behavior among university students in Klang Valley, Malaysia. The positive CFDS found in this study was consistent with a previous study (Korkala *et al*., 2014), which also found the existence

Table 1. Socio-demographic characteristics of respondents (n=303)

Characteristics		Male (n=97)	Female (n=206)	Total (n=303)
Age (years old)	18 – 21	23 (23.7)	43 (20.9)	66 (21.8)
	22 – 25	56 (57.7)	138 (67.0)	194 (64.0)
	26 – 30	18 (18.6)	25 (12.1)	43 (14.2)
Ethnicity	Malay	16 (16.5)	36 (17.5)	52 (17.2)
	Chinese	71 (73.2)	147 (71.4)	218 (71.9)
	Indian	9 (9.3)	19 (9.2)	28 (9.2)
	Others	1 (1.0)	4 (1.9)	5 (1.7)
Education level	Foundation/A-level/Diploma or equivalent	14 (14.4)	28 (13.6)	42 (13.9)
	Bachelor's degree	67 (69.1)	139 (67.5)	206 (68.0)
	Master's degree/Doctoral degree/PhD or equivalent	16 (16.5)	39 (18.9)	55 (18.1)
Monthly allowance (RM)	< 500	40 (41.2)	103 (50.0)	143 (47.2)
	500 – 999	25 (25.8)	43 (20.9)	68 (22.4)
	1000 – 1999	13 (13.4)	37 (18.0)	50 (16.5)
	≥ 2000	19 (19.6)	23 (11.2)	42 (13.9)

Note. n = frequency; RM = Ringgit Malaysia

Table 2. Distribution of knowledge, attitude, perception of climate change, and barriers to climate-friendly food

Factors	Poor	Moderate	Good	
	n (%)	*n* (%)	*n* (%)	Mean ± SD
Knowledge of climate change	1 (0.3)	70 (23.1)	232 (76.6)	41.62 ± 6.80
Attitude towards climate change	3 (1.0)	99 (32.7)	201 (66.3)	75.42 ± 9.56
Perception of climate change	2 (0.7)	188 (62.0)	113 (37.3)	85.83 ± 9.80
Barriers to climate-friendly food choices				36.64 ± 9.05
Climate-friendly diet score (CFDS)				0.36 ± 2.21

Note. n = frequency; SD = Standard deviation

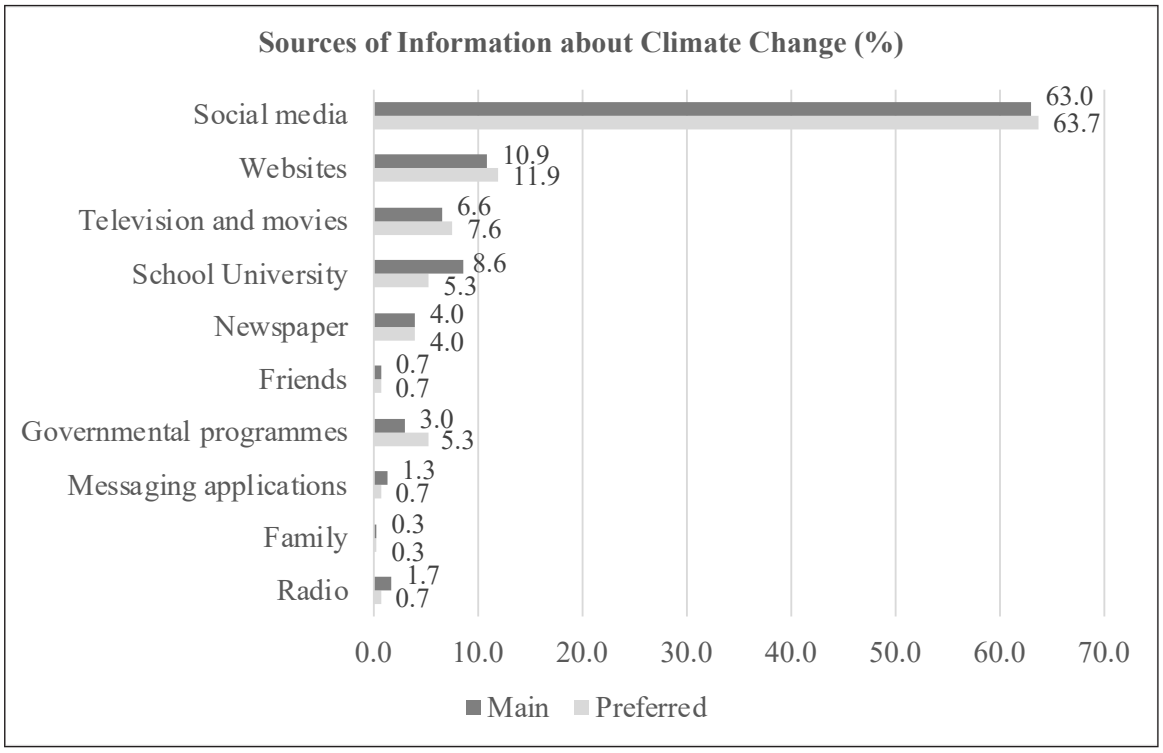

Fig. 1. Distribution of main and preferred sources of information about climate change (n=303).

of climate-friendly dietary behavior. Likewise, this finding supports a Malaysian study, in which the studied Malaysian population's diet was low in carbon footprint (Moy *et al*., 2020). On the contrary, the findings in Indonesia showed higher greenhouse gas emissions than the 2050 target set by the EAT-*Lancet* commission (Pee *et al*., 2021). Nonetheless, the CFDS of the present study was slightly lower than the CFDS found in the Finland study (Korkala *et al*., 2014). It is important to highlight that the ranges of CFDS in the past and current studies were different due to the use of 14 food items in the past study whereas this study only included eight food groups due to the different habitual dietary intake between countries. Nevertheless, cultural differences across countries could explain the disparity between findings of the past and current studies. Cultural influences lead to substantial differences in food preferences and habitual food consumption (Rozin, 2007).

By comparing sex, females were found to rate a significantly higher CFDS compared to males in this study. The average CFDS of males was in the negative range and the CFDS of females was in the positive range, indicating males had less climate-friendly dietary choices on average. A Finnish study reported similar findings and found that females have higher CFDS by 1.92 (95% CI 1.59, 2.25) as compared to males (Korkala *et al*., 2014). The possible explanation for this finding could be the differences in personality traits between genders. Females expressed a higher concern about climate change and were more likely to make climate-friendly dietary choices as compared to males (Korkala *et al*., 2014; Brough *et al*., 2016). Another study from Finland showed that females were more conscious of the environmental impacts of meat consumption than males. Thus, females have perceived higher environmental benefits from reducing meat consumption (Siegrist *et al*., 2015; Pohjolainen *et al*., 2016).

In this study, knowledge, attitude, and perception toward climate change were not significantly associated with climate-friendly dietary choices. These findings were inconsistent with past studies in Malaysia (Shariff *et al*., 2012; Alam *et al*., 2020), Finland (Korkala *et al*., 2014), and Southern Germany (Menrad *et al*., 2018) which reported that attitude and perception toward climate-friendly foods had significant impacts on the intention to consume climate-friendly foods. A possible explanation for the findings of this study was attitude and perception alone are not sufficient to translate intention into actual climate-friendly dietary choices. Thus, a strong efficacy belief may be needed to promote this translation (Mead *et al*., 2012). Furthermore, the current study found no significant association between knowledge of climate change and climate-friendly dietary choices. This finding was consistent with a Finnish study that reported a good knowledge of climate change was not associated with climate-friendly dietary choices because knowledge is not always translated into a positive attitude (Korkala *et al*., 2014; Puspita *et al*., 2020). Conversely, a Malaysian study reported that knowledge was a predictor of behavioral intention toward the consumption of climate-friendly foods

Table 3. Association between socio-demographic factors, knowledge, attitude, perception of climate change, and barriers to climate-friendly food choices with climate-friendly dietary choices (*n*=303)

Factors	Climate-friendly dietary choices				
	Mean ± SD	*t*	F	*r*	*p*-value
Socio-demographic factors					
Sex					
Male	-0.10 ± 2.00	-2.526			0.012*
Female	0.58 ± 2.27				
Age *(years old)*					
18 – 21	0.33 ± 2.36				
22 – 25	0.34 ± 2.11		0.118		0.889
26 – 30	0.51 ± 2.43				
Education level					
Foundation/A-level/Diploma or equivalent	0.17 ± 2.78				
Bachelor's degree	0.33 ± 2.08		0.616		0.541
Master's degree/Doctoral degree/PhD or equivalent	0.64 ± 2.20				
Monthly allowance *(RM)*					
< 500	0.26 ± 2.10				
500 – 999	0.40 ± 2.19		0.334		0.801
1000 – 1999	0.36 ± 2.22				
≥ 2000	0.64 ± 2.60				
Knowledge of climate change					
Poor	-3.00 ± 0		1.256		0.286
Moderate	0.27 ± 1.93				
Good	0.40 ± 2.28				
Attitude towards climate change					
Poor	0.33 ± 3.06		1.655		0.193
Moderate	0.03 ± 2.17				
Good	0.52 ± 2.21				
Perception of climate change					
Poor	2.00 ± 1.41		0.901		0.407
Moderate	0.43 ± 2.16				
Good	0.22 ± 2.29				
Barriers to climate-friendly food choices				-0.346	<0.001**

Note. SD = Standard deviation
˙Significant association was determined by independent t-test at $p<0.05$.
¨Significant association was determined by Pearson correlation analysis at $p<0.001$.

Table 4. Predictor model of climate-friendly dietary choices (*n*=303)

	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*-value
	β	Std. error	Beta		
(Constant)	1.442	1.304		1.106	0.269
Barriers to climate-friendly food choices	-0.084	0.014	-0.344	-5.847	<0.001*

Note. R=0.385; R^2=0.149; adjusted R^2=0.113; F=4.215; $p<0.001$
*Significant association at $p<0.05$.

(Shariff *et al*., 2012). Similarly, another Switzerland study found that causal knowledge was a significant predictor of climate change concern (Tobler *et al*., 2012).

Furthermore, the current study found that climate change information was mainly received through social media such as Facebook, Instagram, TikTok, YouTube, and Twitter. Similar findings were reported in another Malaysian study (Banerjee *et al*., 2020). Advancements in technology shifted traditional media to digital media. Therefore, it is important to deliver climate-related messages through social media (Menrad *et al*., 2018; Puspita *et al*., 2020). Conversely, a minority of the participants in the current study reported family as the main and preferred source to receive climate change-related information which was inconsistent with an Indonesian study, whereby more than half of the participants reported talking with family was the main preferred source to receive climate change-related information (Gazzaz & Bassam, 2021). An explanation for this finding could be that university students live independently from their family influence and has less time spent with their families (Banerjee *et al*., 2020).

In this study, barriers to climate-friendly food choices include disbelief in climate-friendly foods, poor knowledge, high prices, lack of time, difficulty in making climate-friendly food choices, poor supply, not wanting to be different, bad taste, food consumption habits, and unhealthy food choices were the predictors of climate-friendly dietary choices. The findings were similar to previous literature that reported barriers such as high prices, poor supply, bad taste, disbelief in climate-friendly foods, and lack of time were negatively associated with climate-friendly dietary choices (Makiniemi & Vainio, 2014). Indeed, it was found that factors such as time and taste are determinants of food choices that affect food preferences and consumption (Contento, 2008; Chen & Antonelli, 2020). Thus, a dietary shift from animal-based foods to climate-friendly foods, in particular, a plant-based diet would affect the taste and texture of the foods (Bussel *et al*., 2019). As found in another study, consumers were not aware of the climate actions such as campaigns about sustainable food consumption patterns, resulting in disbelief in climate-friendly foods (Mann *et al*., 2018).

This study has several limitations. Firstly, the cross-sectional study design is not able to make a causal inference between predictors (barriers to climate-friendly food choices) and climate-friendly dietary choices as the data was collected at a one-time point. A cohort study should be carried out in Malaysia to provide more comprehensive evidence about the factors associated with climate-friendly dietary choices. Besides, recall bias might be exhibited due to the data about past exposure being collected. Secondly, the information such as intake frequency of food groups was self-reported, thus the accuracy of the data was at risk of being under- or over-reported. Thirdly, the current study was recruited only among university students who studied in the public and private universities located in the Klang Valley, Malaysia. As a result, the conclusion drawn from the data cannot represent all Malaysian university students. Future studies should be carried out in all universities in Malaysia to provide evidence about climate-friendly dietary behavior among university students. Additionally, the information gathered in this study might not be comprehensive due to the intake frequency of food groups being measured, but not specific food items. The amount of food packaging used and food waste that is responsible for high greenhouse gas emissions were also not measured in this study. Other variables such as personal norms towards sustainable food consumption could be included in the future because it was reported to have a significant influence on the intention toward climate-friendly food consumption (Shariff *et al*., 2012).

CONCLUSION

Although the knowledge, attitude, and perception toward climate change were not significantly associated with climate-friendly dietary choices in this study, the climate-friendly dietary choices were significantly different between males and females. In line with previous studies, barriers to climate-friendly food choices are significantly associated with climate-friendly dietary choices. Besides, this study confirmed the role of social media in the delivery of information about climate change. The government and public health practitioners could incorporate the findings in this study to plan intervention programs such as dietary education to raise awareness of climate-friendly dietary behaviors among university students. Policies such as a subsidy on climate-friendly foods can be considered to address the barriers to healthy and climate-friendly foods.

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ETHICAL STATEMENT

This study was approved by the Institutional Ethics Committee (IEC) of UCSI University (Ethics approval code: IEC-2021-FAS-024).

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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