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Original Article

The associations between dietary practices and dietary quality, biological health indicators, perceived stress, religiosity, culture, and gender in multicultural Singapore

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A B S T R A C T

Background: Dietary quality, biological health, culture, religiosity, and perceived stress are co-related. However, there is a dearth of research conducted on Asian populations in secularized and harmonious multicultural societies.

Methods: This study addresses these gaps by conducting an investigation in the multicultural and multireligious Singapore to examine the parameters of culture and gender and the associations with (1) dietary quality, (2) biological health indicators, (3) religiosity, and (4) perceived stress. One hundred fifty participants (18–60 years old) were recruited, and their blood pressure (BP), body mass index (BMI), and body fat percentage (BF%) were also measured along with a 5-part questionnaire on demographics, dietary practice, food frequency, religiosity, and perceived stress.

Results and conclusion: Results showed that cultural differences are associated with certain dietary practices, where the three ethnic groups of Chinese, Malays, and Indians significantly differed in their choices of meal locations such as Western fast food restaurants ($H = 12.369$, $p = .002061^*$). Our analysis revealed that perceived stress significantly correlated with fat intake ($r_s = .169$, $N = 150$, $p = .03865$) and sugar intake ($r_s = .172$, $N = 150$, $p = .03575$). On the other hand, biological parameters such as diastolic BP ($r_s = -.0473$, $N = 150$, $p = .565$), systolic BP ($r_s = -.00972$, $N = 150$, $p = .906$), BMI ($r_s = -.0403$, $N = 150$, $p = .6246$), and BF% ($r_s = -.110$, $N = 150$, $p = .1811$) did not have significant correlations with perceived stress. Similarly, religiosity did not significantly correlate with perceived stress ($r_s = -.025$, $N = 150$, $p = .7616$). In conclusion, our findings provide insights into the changing intersection of food practices mitigated by ethnicity, religiosity, stress, and gender in the harmonious multiracial and multicultural Singapore.

1. Introduction

A plethora of factors influence the selection of food options. For instance, the accessibility of food, cultural/societal norms, human biology/cognition, and economic elements all play into the complex mechanism of food selection. Among them, cultural norms have a very significant influence [1]. Besides cultural influences, psychological factors (particularly, perceived stress [2,3]) are reported to play a role in diet and are also linked to biological health [4,5]. Within biology, gender can also influence food choices and preference patterns [6], particularly in comfort food preferences [7]. Men were found to prefer meal-related comfort foods while women preferred snack-related comfort foods [7]. There was also different prevalence of psychiatric disorders in gender [8], possibly contributed by different stress-coping styles [9], where women generally experienced more stress than men and having more emotion-focused coping styles [9]. Furthermore, gender differences contributed to health beliefs and dieting, with more women avoiding high-fat foods and consuming more fruits and fiber while limiting salt intake better than men [10].

Above the level of gender, culture plays an overarching role in impacting dietary practices [11] and patterns—i.e., the number of

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meals, snacking behaviors, individual food or nutrient consumption [12], regular meal locations, food product selections, consumption of specific food types, and to an extent, health-conscious behaviors [13]. The consumption of food types is often upheld consistently over certain events and festive periods [14], and food customs have been observed to prevail even when apart from the place of origin, where for example, Southeast Asian refugee families in the United States continue to maintain their cultural diet of native foods [15]. Similarly, obesity was more prevalent in ethnic minorities in the United States due to the local food portions and the tendency to feast [16].

Culture norms also intertwined with religion to determine the acceptability of food types (e.g., vegetarianism, Kosher, Halal, etc.), as well as offer protective effects from migrant stress in the example where Latin American immigrants exhibited an inverse correlation between religiosity and perceived stress in both genders [17]. Such inverse correlation was also found for religiosity and work-related stress and burnout [18]. However, there are also reports of negative religious coping which was positively correlated with increased levels of perceived stress in domestic students [19]. From these, the multidimensional construct of religiosity (i.e., religious beliefs, attitudes, and behavior) may relate differently to perceived stress [20,21] and indirectly influence food habits on top of obvious food-type restrictions. Given that religion is often tied to culture and ethnicity, there is an interesting intersection between these parameters with dietary practices.

Although there has been extensive research on the interactions among the variables of gender, culture, diet, perceived stress, health, and religiosity, limitations exist in that they are usually conducted against a backdrop of relatively homogenous populations. In fact, the majority of such studies on religiosity and perceived stress involved mainly Western participants [22–25], lacking the exploration of the various religious dimensions and stress. Even in multicultural places like Singapore, the last National Nutrition Survey (NNS) in Singapore was conducted in 2010 [13] without in-depth consideration of religion. Thus, this study aims to investigate the interactions of culture, stress, religiosity, health, and diet in greater detail, utilizing the diverse yet harmonious multicultural, multiethnicity, and multireligion backdrop of Singapore.

This study thus aims to study the following hypotheses:

There would be significant differences in dietary practices as captured in the Dietary Practice Questionnaire (DPQ) between the three major ethnic groups in Singapore (i.e., Chinese, Malay, and Indian).

Dietary quality, as measured by total fat and sugar intake in the past month would be positively correlated with perceived stress levels.

Biological well-being parameters, such as blood pressure (BP), body fat, and body mass index (BMI), would be positively correlated with perceived stress.

Religiosity would be negatively correlated with perceived stress.

The three dimensions of the Religiosity scale (RS; i.e., religious activity, religious devotion, and religious belief) would correlate differently with their level of perceived stress.

There would be gender differences, even when accounting for demographics and stress on food habits and behavior.

There would be significant differences in perceived stress levels among ethnic and gender groups respectively.

There would be significant differences in RS among ethnic and gender groups respectively.

2. Materials and methods

The DPQ was adapted from the Singapore Health Promotion Board 2010 NNS [13]. It collects information on individual dietary practices and consists of 25 multiple choice questions on “usual eating places,” choices of food products, consumption of selected foods, and several food-related health-conscious behaviors.

Food frequency questionnaire (FFQ) adapted from the NNS 2010, assesses the consumption of various food items in the past month, for the estimation of energy, major nutrients, and selected food group intake. The FFQ includes a total of 182 food items tailored to the typical Singaporean food variety. It gathers information on the dietary quality (i.e., total fat and sugar intake in the past one month) and calculates energy value of the food based on the “Energy and Nutrient Composition of Foods” system created by the Health Promotion Board of Singapore [26].

The RS by Reisig et al [27], consists of 10 survey items that reflect the three important domains of religiosity: activity, devotion, and belief. The religious activity component is a two-item scale: “How often do you pray?” and “How often do you attend religious services?” with a response scale ranging from 1 (*never*) to 4 (*frequently*). The devotion dimension captures intrinsic motivation through questions such as: “My religious beliefs lie behind my whole approach to life” and “I try hard to carry religion over to all my other dealings in life” with response scales ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). The belief dimension is a single-item of “Do you believe in a life after death?” (1 = yes, 0 = no). The RS has an overall high internal consistency (Cronbach $\alpha = .943$). High scores reflect high levels of the reported religiosity.

The perceived stress questionnaire (PSQ) by Levenstein et al [28] is a questionnaire in which participants respond to 30 statements based on their experiences in the past month. The response scale ranges from 1 (*almost never*) to 4 (*usually*). Eight statements are reverse-scored to ensure accuracy of response. A PSQ index was derived from the raw scores, varying from 0 (lowest possible level of stress) to 1 (highest possible level of stress).

3. Procedure

Upon ethics approval (H5431) by the James Cook University Human Research Ethics Committee, the participants were recruited, and informed consent was obtained; 150 volunteers (60 males, 90 females) with the ethnic makeup of 106 Chinese (70.7%), 16 Malay (10.7%), and 28 Indian (18.6%) participants aged between 18 and 60 years [mean (M) = 28.35, standard deviation (SD) = 12.00] were recruited by convenience sampling from Singapore tertiary institutions with no incentives. This ethnic distribution was reflective of the Singaporean ethnic group makeup of Chinese 74.2%, Malays 13.3%, and Indians 9.2% [29]. Recruitment excluded participants with pacemakers [due to electrical impedance measurement for body fat percentage (BF%) measurement present on the device] and those with a history of having existing eating disorders. The participants were provided with an information sheet and consent forms of the study, stating that they could withdraw without prejudice from the study at any time. They were then asked to complete the demographics form while seated for the 10 minutes to allow the BPs to enter resting states. Three consecutive BP readings were taken (using the automated BP machine on the left arm) at 2-minute intervals (adapted from a study by Gan et al [30]). To improve the accuracy, the average of all three BP readings was utilized although additional BP measurements were not taken when the readings differed by more than 5 mmHg. BF% was measured using bioelectrical impedance analysis [31], factoring the age, sex, and height of the participants with the fat analyzer weighing machine. Participants were advised to remove accessories and step barefooted onto the designated areas on the machine. A small electrical signal was sent through the body via signaling electrodes linked to the footpad. The displayed BF% and

BMI were recorded. After these measurements, participants were provided with the four questionnaires (DPQ, FFQ, RS, and PSQ) which took around 30 minutes to complete. Upon completion, participants were debriefed.

4. Design and data analysis

This study utilized a between-subjects design. All statistical analysis was carried out using RStudio, version 1.0.153. Microsoft Excel (2013) was utilized to calculate the total fat and sugar intakes. Kruskal-Wallis test and Spearman's rank–order correlations were utilized for hypotheses testing.

5. Results and discussion

This research set out to study the differences in food practices mitigated by ethnicity, religiosity, stress, and gender in the harmonious multiracial and multicultural Singapore. Singapore's cultural and religious diversity serves as an attractive and illustrative population for this project, and this study also aims to validate past research on Asian populations for the design of more personalized interventions of healthier food practices taking into consideration stress, cultural, gender, and religious factors.

The demographic data of the three major ethnic groups and gender in Singapore are shown in Tables 1 and 2, respectively. Weight, BMI, BF%, systolic and diastolic BP, total fat intake, total sugar intake, PSQ index, and RS scores are shown.

Hypothesis 1. There would be significant difference in dietary practices as captured in the DPQ between the three major ethnic groups in Singapore (i.e., Chinese, Malay, and Indian).

Table 1
Mean weight, BMI, BF%, BP, total fat, and sugar intake, PSQ index, and score on Religiosity scale categorized by ethnicity.

Mean ± 95% CI range	Ethnicity		
	Chinese	Malay	Indian
Weight (kg)	59.14 ± 2.08	60.56 ± 7.22	66.43 ± 5.13
BMI (kg/m^2)	21.74 ± 0.65	23.34 ± 2.37	23.73 ± 1.74
BF% (%)	22.64 ± 1.58	28.19 ± 4.84	26.58 ± 4.01
Systolic BP (mm HG)	114.67 ± 2.66	112.02 ± 6.75	115.52 ± 4.28
Diastolic BP (mm HG)	72.75 ± 1.76	71.23 ± 4.29	73.91 ± 3.03
Total fat intake (g)	3918.55 ± 658.05	4863.89 ± 1688.05	3460.82 ± 800.52
Total sugar intake (g)	2812.84 ± 496.50	3149.44 ± 771.295	2546.31 ± 653.73
PSQ index	.41 ± .015	.43 ± .045	.40 ± .030
Total score on Religiosity scale	27.83 ± 1.56	32.69 ± 2.36	29.29 ± 2.70

BMI, body mass index; BP, blood pressure; BF%, body fat percentage; PSQ, perceived stress questionnaire; CI, confidence interval.

Table 2
Mean weight, BMI, BF%, BP, total fat, and sugar intake, PSQ index, and score on Religiosity scale categorized by gender.

Mean ± 95% CI range	Gender	
	Male	Female
Weight (kg)	67.11 ± 2.62	56.35 ± 2.29
BMI (kg/m^2)	22.71 ± 0.77	22.00 ± 0.88
BF% (%)	18.21 ± 1.50	27.80 ± 1.80
Systolic BP (mm HG)	121.42 ± 2.95	109.97 ± 2.57
Diastolic BP (mm HG)	74.18 ± 2.20	71.89 ± 1.84
Total fat intake (g)	4747.32 ± 963.44	3391.69 ± 554.95
Total sugar intake (g)	3025.75 ± 477.73	2647.82 ± 545.13
PSQ index	.42 ± 0.02	.41 ± .02
Total score on Religiosity scale	27.37 ± 2.36	29.46 ± 1.37

BMI, body mass index; BP, blood pressure; BF%, body fat percentage; PSQ, perceived stress questionnaire; CI, confidence interval.

The first hypothesis that differences would exist in dietary practices between Chinese, Malay, and Indian participants was tested and accepted given that differences, albeit small, were significant. Nine questions (see Table 3) from the DPQ reflecting multiple aspects of dietary practices (i.e., eating locations and consumption of water and selected foods) were analyzed. Kruskal–Wallis test was performed to identify any significant difference in dietary practices among the ethnic groups. As observed in Table 3, there were statistically significant differences in answers to questions 2, 4, 5, and 7 among the three ethnic groups. There were no statistically significant differences among the ethnic groups in their responses for the remaining questions listed in Table 3.

To explore further which specific ethnic group significantly differs among the other ethnic groups, boxplots of the DPQ question responses were plotted in Fig. 1, and *post hoc* comparisons using the Wilcoxon Mann–Whitney U-test were conducted. For question 2 on Western food, the scores for Chinese (M = 4.36, SD = 1.88) were significantly higher than Indians (M = 3.07, SD = 2.02) and Malays (M = 3.13, SD = 2.19), while on the other hand, no significant difference was found between Malay and Indian scores. For question 4 on fruits, the scores for Chinese (M = 4.63, SD = 3.16) were significantly higher than both Malays (M = 2.81, SD = 2.23) and Indians (M = 2.89, SD = 2.63). The scores between the Malays and Indians did not differ significantly. For question 5 on vegetables, the scores for Malays (M = 2.44, SD = 2.39) were significantly higher than the Chinese (M = 1.12, SD = 1.27) and Indians (M = 1.16, SD = 1.16). There was no significant difference found between Chinese and Indian scores. For question 7 on sweets, the scores for Chinese (M = 1.66, SD = 0.86) were significantly higher than the Malays (M = 1.25, SD = 0.68) and Indians (M = 1.21, SD = 0.69). There was no significant difference found between Malay and Indian scores.

Our first hypothesis stated that there would be significant difference in dietary practices as captured in the DPQ between the three major ethnic groups in Singapore. This hypothesis was supported in a way that significant differences in specific dietary practices were found between the three major ethnic groups in Singapore. The ethnic Chinese participants dined more often at Western fast food restaurants than both Malay and Indian participants. These findings were different from the NNS 2010 findings on meal locations among ethnic groups [13] which reported more

Table 3
Kruskal–Wallis test results for questions in the DPQ among ethnicity.

Questions measuring dietary practices	Kruskal–Wallis test	
	Test value	p-value
1. How often do you eat at hawker centers/food courts/coffee shops? (times per week)	$H = 0.25814$	$p = .8789$
2. How often do you eat at Western fast food restaurants? (times per week)	$H = 12.369$	$p = .002061^*$
3. How many eggs (including salted/century egg) do you usually eat per week?	$H = 3.248$	$p = .1971$
4. How many servings of fruits do you usually eat? (per month)	$H = 14.006$	$p = .0009092^*$
5. How many servings of vegetables do you usually eat? (per month)	$H = 7.0498$	$p = .02946^*$
6. How often do you drink sweetened drinks? (times per week)	$H = 2.1242$	$p = .3457$
7. How often do you eat sweet desserts and snacks? (times per week)	$H = 10.639$	$p = .004894^*$
8. How often do you eat deep fried foods? (times per week)	$H = 4.7658$	$p = .09228$
9. How many glasses of plain water do you usually drink per day? (1 glass = 250ml)	$H = 2.6457$	$p = .2664$

DPQ, Dietary Practice Questionnaire.
*Significant at the $p < .05$ level *(2-tailed)*.

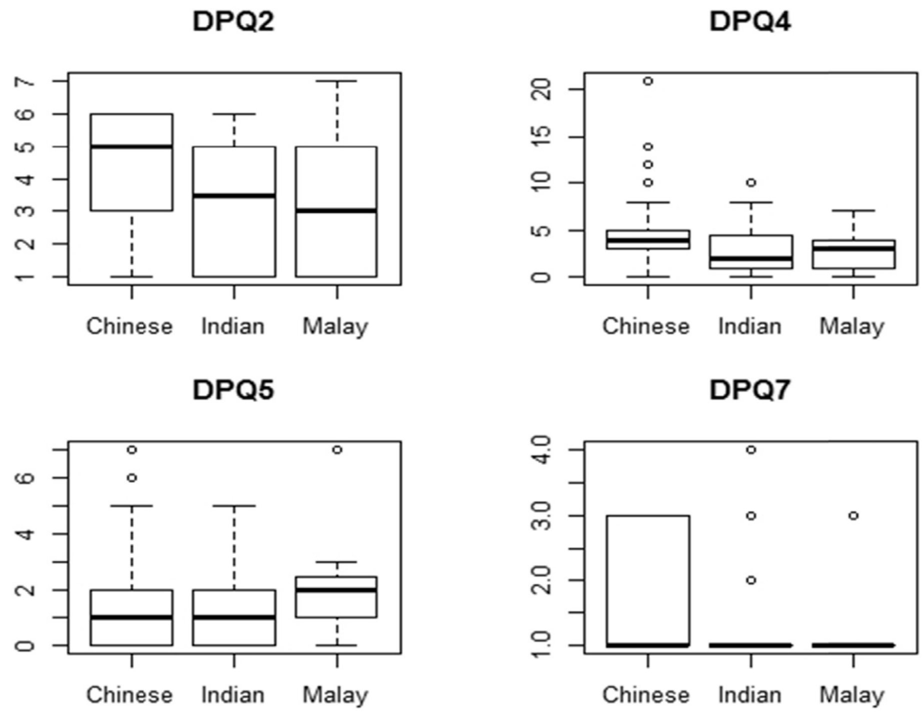

Fig. 1. Boxplot of DPQ index among ethnic groups. DPQ, Dietary Practice Questionnaire.

Malays eating at Western dinning. Chinese participants had significantly higher intake of fruits when compared to both Indian and Malay participants. Additionally, Malay participants had significantly higher intake of vegetables as compared to Chinese and Indian participants, a finding that is likely influenced by the cuisine option of the various ethnic groups. Chinese participants also had a significantly higher intake of sweet desserts and snacks as compared to Malay and Indian participants. On the contrary, no significant ethnic differences were found in the consumption of deep fried foods and specific liquids such as sweetened drinks and water. This was interesting despite generally having more vegetarians in the Indian group (due to more Hinduism being more prevalent among the Indians); there were no differences in vegetable intake between the Indian and Chinese participants, suggesting that these food groups have become normalized regardless of ethno–cultural–religious backgrounds.

From our demographics analysis, we found the Singaporean Indian participants to have the highest mean weight and BMI even though they did not have the highest mean BF% (Table 1), this was an observation that agreed with study by Deurenberg-Yap et al [32] suggesting that BMI often underpredicted body fat when compared to Caucasians. Nonetheless, participants from this study generally showed significant positive correlation between BMI and BF% (Table 4).

Hypothesis 2. Dietary quality, measured by total fat and sugar intake in the past month is positively correlated with perceived stress levels.

The Spearman's rank–order correlation test was conducted to explore the relationship between perceived stress (as measured by the PSQ index) and dietary quality (as measured by total fat and sugar intake in the past month as reported in the FFQ). There was no violation of the assumption of monotonicity, and the variables were continuous. A statistically significant positive correlation was found between PSQ index and total fat intake (r_s = .169, N = 150, p = .03865). Similarly, PSQ index and total sugar intake (r_s = .172, N = 150, p = .03575) showed significant positive correlation, thus Hypothesis 2 was accepted.

Table 4
Spearman's rank–order correlations between biological health indicators and perceived stress.

Scale	1	2	3	4	5
1. PSQ index	–	−.01	−.05	−.11	−.04
2. Systolic BP		–	.738**	−.04	.388**
3. Diastolic BP			–	.165*	.336**
4. BF%				–	.590**
5. BMI					–

BMI, body mass index; BP, blood pressure; BF%, body fat percentage; PSQ, perceived stress questionnaire.
**Significant at the p < .01 level (2-tailed).
*Significant at the p < .05 level (2-tailed).

A statistically significant positive correlation between PSQ index and total sugar intake (r_s = .243, n = 106, p = .01191) was found in Chinese. On the contrary, no significant correlation was found between PSQ index and total sugar intake in Malays (r_s = .080, n = 16, p = .7695) and Indians (r_s = -.046, n = 28, p = .8181).

Similarly, a statistically significant positive correlation between the PSQ index and total fat intake (r_s = .217, n = 106, p = .02499) was found in Chinese whereas no significant correlation was found between PSQ index and total fat intake for Malays (r_s = -.094, n = 16, p = .7282) and Indians (r_s = .102, n = 28, p = .6055).

In general, the analysis revealed that perceived stress showed a significant positive correlation with poor dietary quality, specifically, fat and sugar intake, present only among the Chinese participants. Overall, perceived stress was correlated with poor quality dietary habits (i.e., a diet high in fat and sugar), in agreement with the studies by Sims et al [33] (where emotional eating i.e., consumption of high-fat and high-sugar foods were found) and Ng and Jeffery [2], where higher fat diets were found for working men and women with high levels of perceived stress. Nonetheless, there was no significant difference for perceived stress between the various ethnic groups and gender groups when analyzed separately.

Hypothesis 3. The biological well-being parameters, such as BP, body fat, and BMI, positively correlated with perceived stress

Spearman's rank–order correlation showed that all the biological health parameters: diastolic BP ($r_s = -.0473$, $N = 150$, $p = .565$), systolic BP ($r_s = -.00972$, $N = 150$, $p = .906$), BMI ($r_s = -.0403$, $N = 150$, $p = .6246$), and BF% ($r_s = -.110$, $N = 150$, $p = .1811$) did not have significant correlations with the PSQ index despite a slight negative trend as observed in Table 4. The assumptions of monotonicity and continuous variables were met.

In this third hypothesis, a positive relationship between perceived stress and the physiological measurements of well-being (BP, body fat, and BMI) was not supported by our statistical analysis. This was unexpected given that there were previous findings of BMI being positively correlated to perceived stress [34,35]. The differences may be explained by the fact that our participants were younger with a lower mean age of 28.35 years which likely masked predisease states such as white coat hypertension [30]. In addition, readings on physiological stress markers such as BP, BF%, and BMI may in fact reflect accumulative effects of stress on the body over a more substantial period of time than the PSS survey, which may simply be reflective of more recent stress states.

Hypothesis 4. Religiosity would be negatively correlated with perceived stress.

The Spearman's rank–order correlation showed no significant correlations between the total scores of the RS and the PSQ index ($r_s = -.025$, $N = 150$, $p = .7616$) even though the assumptions of monotonicity and continuous variables were met. Thus the hypothesis was rejected.

This was interesting as perceiving oneself to be more religious did not translate into resilience to stress in our study population. Although this contradicted studies by Kirchner and Patiño and Kutcher et al [17,18], where religiosity was inversely associated with reported levels of perceived stress, we were not able to investigate the type of religiosity nor the specific religions and the associated activities. It should be noted that our study population generally comprised of the younger adults, and religiosity dimensions are often positively associated with age [20]. In addition, the interpretation of certain questions in the RS may be subjective where “Do you believe in a life after death?” may be interpreted differently across religions and by people of all ages, with younger participants perceiving death to be a distant event or the afterlife to comprise anything between reincarnation, eternal heaven or hell, or wandering invisible and permeable amongst the living, etc. Questions such as “I try hard to carry religion over to all my other dealings in life” may have different connotations for different religious sections even within the main classes of religions. While our findings did not agree with some previous studies [20,21], this may also reflect the societal and national context of generally more moderated (“secularized”) religiosity in Singapore, especially given that we were also unable to find significant differences in religiosity among the various ethnic groups or between male and female in our study population. Yet, these interpretations are not likely to be confounding since we are focused on the religious cultural influences on dietary habits.

Hypothesis 5. The three dimensions of the RS (i.e., religious activity, religious devotion, and religious belief) would correlate differently with the levels of perceived stress.

Further analysis of the three dimensions in the RS (“religious activity”, “religious devotion”, and “religious belief”) and perceived stress were conducted. Spearman's rank–order correlation showed no significant correlations for all the three dimensions of the RS with perceived stress. A weak positive trend was found between “religious belief” and PSQ index ($r_s = .0422$, $N = 150$, $p = .6085$). On the other hand, weak negative trends were found for both religious activity ($r_s = -.0351$, $N = 150$, $p = .67$) and devotion ($r_s = -.0201$, $N = 150$, $p = .8075$) to the PSQ score but were not significant. Since the assumptions of monotonicity and continuous variables were met, Hypothesis 5 stating that the three dimensions of the RS would correlate differently with the levels of perceived stress was rejected. Similar to the discussion pertaining to Hypothesis 4, perceiving oneself to be more religious did not translate into stress resilience in our study population, though as discussed earlier, there may be many factors to this, but this is likely to be inconsequential in our study exploring the religious cultural influences on dietary habits rather than direct religiosity.

Hypothesis 6. There would be gender effects in food habits and behavior.

Expectedly in accordance to gender biology, female participants had significantly higher body fat percentage ($Z = 908.5$, $p = 6.373e-12$) even though male participants had significantly higher total fat intake ($Z = 3625$, $p = .0003902$) and total sugar intake ($Z = 3342$, $p = .01386$) as compared to the female participants.

Fisher's exact test and Wilcoxon rank–sum test were conducted accordingly to test any significant difference in DPQ questions between genders. DPQ questions with significant difference found between genders are listed in Tables 5 and 6 below.

Notably, compared to the female participants, male participants had significantly higher average systolic BP ($Z = 4087.5$, $p = 1.03e-07$), ate more eggs ($Z = 3714$, $p = 8.812e-05$), ate more deep-fried food ($Z = 3227.5$, $p = .03867$), and dieted significantly less ($p = .01877$, Fisher's exact test). It was also found that male participants were more likely to trim visible fat off meat ($p = 8.704e-06$, Fisher's exact test) and remove the skin from poultry ($p = .002216$, Fisher's exact test). Males drank more water (p = .0008963, Wilcoxon rank sum).

Table 5
Fisher's exact test results for DPQ questions between male and female.

Questions measuring dietary practices	Mean		Fisher's exact test
	Male	Female	Test value
DPQ18—When you eat meat with visible fat, how much visible fat will you trim off?	2.13	1.73	$p = 8.704e-06^*$
DPQ19—When you eat poultry, how much skin do you remove?	2.27	1.87	$p = .002216^*$
DPQ23—Have you ever been on a diet to lose weight?	0.37	0.80	$p = .01877^*$

DPQ, Dietary Practice Questionnaire.
*Significant at the $p < .05$ level *(2-tailed)*.

Table 6
Wilcoxon rank–sum test results for DPQ questions between male and female.

Questions measuring dietary practices	Mean		Wilcoxon rank–sum	
	Male	Female	Test value	p-value
DPQ12—How many eggs do you usually eat per week?	5.90	3.41	$Z = 3714$	$p = 8.812e-05^*$
DPQ15—How often do you drink sweetened drinks? (times per week)	4.73	2.60	$Z = 3471.5$	$p = .002837^*$
DPQ17—How often do you eat deep fried foods? (times per week)	3.02	2.32	$Z = 3227.5$	$p = .03867^*$
DPQ22—How many glasses of plain water do you usually drink per day? (1 glass = 250ml)	2.13	1.73	$Z = 3507$	$p = .0008963^*$

DPQ, Dietary Practice Questionnaire.
*Significant at the $p < .05$ level *(2-tailed)*.

Spearman's rank–order correlation test was also conducted to explore the relationship between perceived stress and DPQ questions. As observed from Table 7, there exists significant positive correlation between PSQ index and questions 2 (Western food), 6 (sweetened drinks), 7 (sweets), and 8 (fried foods).

We found that male participants had higher average systolic but not diastolic BP when compared to female participants (Table 2). It may not be surprising via stereotypical assumptions and general gender biological energy expenditures that the men in the study consumed more eggs and deep fried food and drank more sweetened drinks and water (Table 6). However, it was interesting to note contradicting findings that the male participants tend to be more conscientious at removing visible fat or removing skin from poultry despite having a higher total fat intake (Table 5). This may be a compensatory reaction for their general higher fat consumption. Given the less healthy eating habits of the male participants with increased sweetened drinks, outside eating, and higher total fat, it is not surprising that the higher systolic BP may have a food cause apart from general biological factors. While the direction of the associations with the mental exhaustion cannot be easily established, the parameters of systolic BP, lower religiosity, and food habits are associated in this case. Speculatively, these factors may contribute to the shorter lifespan of males compared to females [29].

From Table 7, participants with higher perceived stress levels (PSQ index) tend to eat at Western fast food restaurants more often, drink more sweetened drinks, and consume more sweet deserts, snacks, and deep-fried food.

This further supports the acceptance of Hypothesis 2—where there exists significant positive correlation in total fat and sugar intake with perceived stress levels.

Hypothesis 7. There would be significant differences in perceived stress levels among ethnicity and gender respectively.

Fig. 2 shows the boxplots of PSQ index scores among the various ethnic groups. The Kruskal-Wallis test was performed to identify any significant difference in PSQ index among the various ethnic groups. There were no statistically significant differences in PSQ index and ethnic groups ($H = 1.1802$, $p = .5543$) found.

Table 7
Spearman correlation test results for questions in the DPQ and PSQ index.

Questions measuring dietary practices	Spearman rank–order correlation	
	Spearman's r	p-value
1. How often do you eat at hawker centres/food courts/coffee shops? (times per week)	$r_s = .0248$	$p = .7628$
2. How often do you eat at Western fast food restaurants? (times per week)	$r_s = .176$	$p = .03101^*$
3. How many eggs (incl, salted/century egg) do you usually eat per week?	$r_s = .145$	$p = .07637$
4. How many servings of fruits do you usually eat? (per month)	$r_s = -.0469$	$p = .5687$
5. How many servings of vegetables do you usually eat? (per month)	$r_s = .105$	$p = .1994$
6. How often do you drink sweetened drinks? (times per week)	$r_s = .185$	$p = .02374^*$
7. How often do you eat sweet desserts and snacks? (times per week)	$r_s = .213$	$p = .008868^*$
8. How often do you eat deep fried foods? (times per week)	$r_s = .261$	$p = .001276^*$
9. How many glasses of plain water do you usually drink per day? (1 glass = 250ml)	$r_s = -.0656$	$p = .425$

DPQ, Dietary Practice Questionnaire; PSQ, perceived stress questionnaire.
* Significant at the $p < .05$ level (2-tailed).

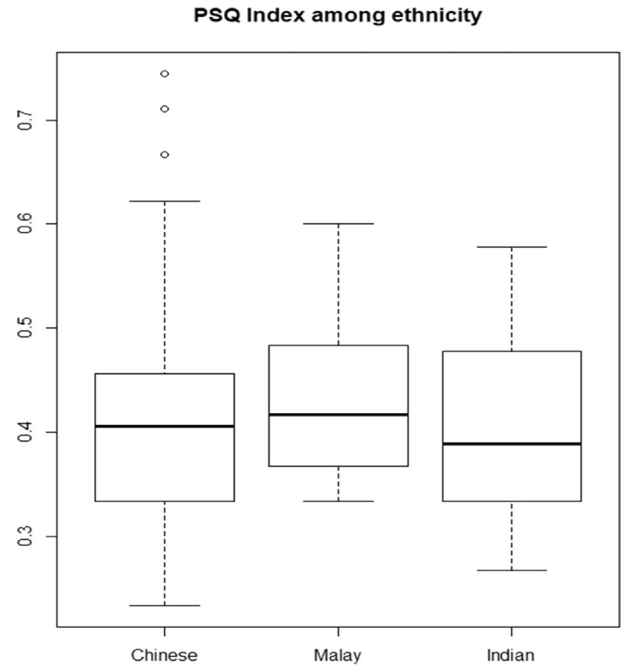

Fig. 2. Boxplot of PSQ index among ethnic groups. PSQ, perceived stress questionnaire.

Fig. 3 shows the boxplot of PSQ index scores between male and female. The Kruskal-Wallis showed no statistically significant differences in PSQ index between the gender groups ($H = 2893$, $p = .4597$).

Hence, Hypothesis 7 on differences in perceived stress levels among ethnic groups and the genders respectively was rejected.

While our perceived stress did not agree with innumerable studies demonstrating gender differences in perceived stress, our study population being much younger, captured mostly students, which would be less exposed to gender discriminations in workplaces since student pressures are generally homogenous across.

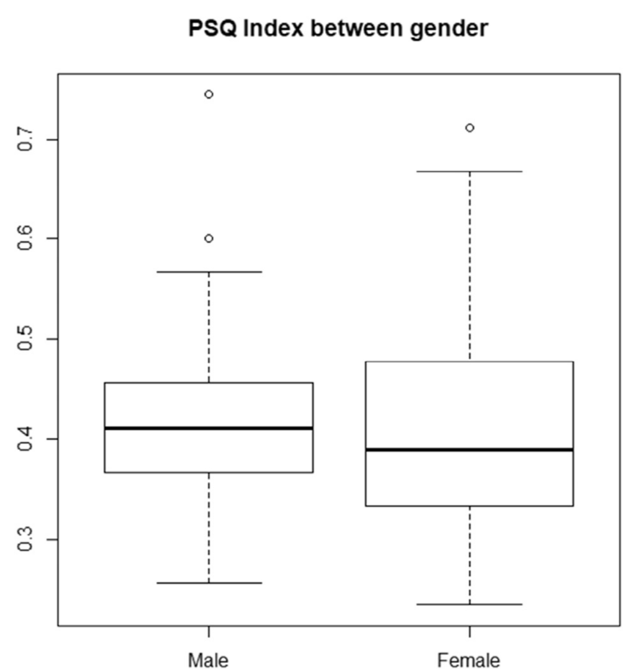

Fig. 3. Boxplot of PSQ index between genders. PSQ, perceived stress questionnaire.

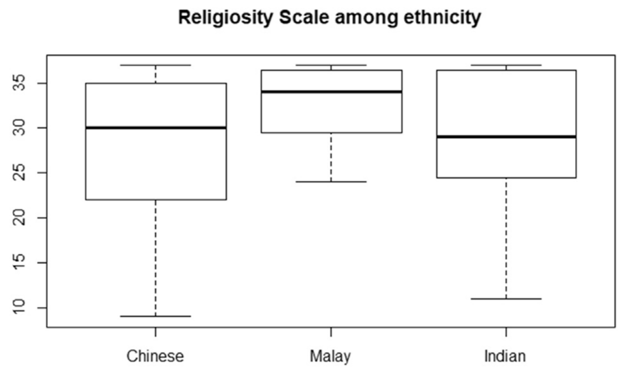

Fig. 4. Boxplot of Religiosity scale among ethnicity.

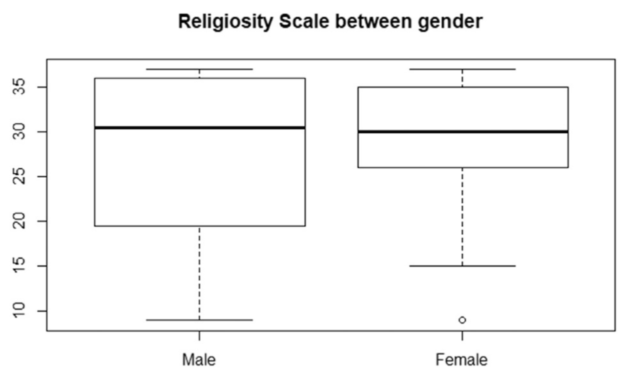

Fig. 5. Boxplot of Religiosity scale between genders.

For this same possible factor, we did not detect perceived stress differences across the ethnic groups in the more protected education environment. In this, further studies would have to be performed to determine if this was indeed the case.

Hypothesis 8. There would be significant differences in RS among ethnicity and gender respectively.

Fig. 4 shows the boxplot of RS scores by the various ethnic groups. The Kruskal-Wallis test was performed to identify any significant differences in RSs among ethnicity. No significant differences ($H = 1.1802$, $p = .554$) were found for the ethnic groups.

Fig. 5 shows the boxplot of RS between male and female participants. No significant differences in RS scores were found for gender ($Z = 2508.5$, $p = .4624$) after conducting the Wilcoxon rank-sum test.

Hence, Hypothesis 8 focusing on significant differences in RS among ethnicity and gender, respectively, was rejected, thus ruling out religiosity as a major factor in dietary practices in our study population. This reflects that individual religiosity did not significantly exert effects on dietary practices despite clear restrictions on certain food choices (e.g., vegetarian for religious reasons, Halal, etc.)

Apart from already mentioned population differences between our studies and that of others, there are limitations in our study where self-reported measures may have resulted in socially desirable answers being a confounding variable. The DPQ, FFQ, and PSQ required participants to recall the activities and state of the past month, allowing recall bias in over or underreporting of the actual amounts and types of food consumed or the level of perceived stress experienced. Future research could also examine the important moderators such as exercise, sleep, and smoking. We also acknowledge the sample size of 150, despite being representative of gender and ethnic distribution, to be small against the national population, possibly resulting in no clear correlations when analyzing effects for the smaller non-Chinese groups. In addition, given that many biological parameters and food dietary practices may have a childhood dietary effect, the fact that we only sampled those above the age of 18 years may not be sufficient to investigate these further. Therefore, there is a need for a larger more representative national survey to be performed.

In conclusion, our study showed that in multicultural Singapore, the influence of ethnicity on food intake differs more on choice of places and that perceived stress is positively associated with high sugar and fat intake amidst small gender differences. On the other hand, there were no clear associations between religion and body physiological measures with that of food intake. Applying these findings to the larger context of Singapore, a deeper knowledge on cultural influences in diet can enhance appreciation toward cultural dietary practices and that stress-coping strategies may need to come together with the promotion of healthy dietary habits.

Conflict of interest

The authors declare no competing financial interests.

Author contributions

R.Y-X.N., J-Y.Y., S.K-E.G contributed in drafting the manuscript. R.Y-X.N., Y-S.W., J-Y.Y., C.L-Z.K. contributed to data curation. C.L-Z.K. and C.W. contributed in statistical analysis. S.K-E.G. conceptualized the study.

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