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Examining the relationship between fast-food and sit-down restaurant consumption frequency and dietary patterns among adults in Riyadh City, Saudi Arabia

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ABSTRACT

Introduction: This study assessed the association between dietary patterns and the frequency of eating at fast-food or sit-down restaurants. **Methods:** A cross-sectional study, with a sample of adults living in Riyadh, Saudi Arabia (SA), was conducted between January and March 2021. An online, self-administered survey was conducted using social media and WhatsApp. A total of 399 adults living in Riyadh were included; 40.4% were males, with a mean age of 35 and standard deviation (*SD*) of 12 years, and had no significant health problems. **Results:** Using principal component analysis to analyse 15 food groups based on the food items consumed, four dietary patterns were extracted: Western, unhealthy, plant-based, and healthy. After adjusting for potential covariates, a higher frequency of eating at fast-food restaurants was significantly associated with unhealthy dietary patterns [odds ratio (OR) = 4.85, 95.0% confidence interval (CI) = 1.80, 12.59]. In contrast, participants in the highest tercile of the frequency of eating at fast-food restaurants showed lower odds of adhering to a healthy dietary pattern (OR = 0.29, 95.0% CI = 0.11, 0.71). No significant association was found between participants in the highest tercile of the frequency of eating at sit-down restaurants and their dietary patterns. **Conclusion:** Frequently eating at fast-food restaurants was associated with increased odds of adherence to less healthy dietary patterns and negatively associated with adherence to a healthy pattern. No association was found between sit-down restaurants and any of the identified dietary patterns. The present findings can assist stakeholders and policymakers in developing strategic plans and policies for targeted interventions for this population.

Keywords: dietary pattern, fast-food restaurants, principal component analysis, Saudi Arabia, sit-down restaurants

INTRODUCTION

In Saudi Arabia (SA), the eating behaviours and lifestyle habits of the general population have dramatically shifted over the past few decades, mostly towards unhealthy food habits, contributing to a considerable increase in the eating of fast-food items

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(Naeem, 2012). Furthermore, fast-food manufacturers and marketers have aggressively extended their services nationwide (Benajiba, 2016). In 2014, there were 15,782 restaurants nationwide providing various food services (General Authority for Statistics, 2014), including sit-down and fast-food restaurants. However, the latter is widely known to produce unhealthy and quick, easy-to-make foods (Naeem, 2012).

Fast-food restaurants are characterised by inexpensive, energy-dense foods with high amounts of saturated fat (Benajiba, 2016). In contrast, sit-down restaurants provide food services within their establishments and have a variety of dishes (Bouznif *et al.,* 2018). Although these two types of restaurants show clear distinctions, neither consistently offers healthy food to their customers. Notwithstanding, research shows that sit-down restaurants typically have a higher proportion of healthy dishes to offer compared with fast-food restaurants, even if the availability and variety of these healthier options differ by restaurants (Saelens *et al.,* 2007).

The frequency of eating out is correlated with an increase in total calorie and saturated fat intakes in daily diet, unhealthy dietary practices, and decreased intake of micronutrients (Lachat *et al.,* 2012). Furthermore, research shows that eating out one meal contributes an additional 134 kcal to a subject's daily energy intake (Todd, Mancino & Lin 2010). Eating out is also associated with an increase of 0.6–0.8 kg/m^2 in body mass index (BMI) (Bhutani *et al.,* 2018). A study conducted at the national level revealed a high prevalence of obesity (BMI ≥ 30 kg/m^2) in SA, with rates ranging between 24.7% and 46.9%; whereby dietary patterns and eating habits were among the main factors causing obesity (Althumiri *et al.,* 2021).

Interestingly, investigating dietary patterns allows for an examination of the overall diet of a group, while considering the interactive and cumulative effects of dietary components, and acknowledging the complexity of the human diet. This is important because the nutrients and dietary components consumed by humans are intricately combined, correlated, and difficult to examine in isolation (Zhang, Tapera & Gou 2018). Currently, we have a plethora of scientific data backing up that lifestyle greatly influences dietary patterns (Beck *et al.,* 2018; Krieger *et al.,* 2018). However, the influence of frequency of eating out on dietary patterns has yet to be determined and remains in the field of speculation. Therefore, identifying factors contributing to specific dietary patterns seems crucial for enabling public health authorities to develop and implement well-informed nutrition strategies, as well as disease prevention and control policies.

Riyadh City is the capital of SA with a population density of ~ 5 million Saudis and a total number of 3,245 restaurants. Riyadh faces rapid development, with increased markets and cuisine types including fast-food and sit-down restaurants. The relationship between eating at fast-food restaurants, dietary patterns, and body weight is well-reported (Poti, 2014). However, information on how other restaurant types, such as sit-down restaurants, contribute to changes in dietary patterns and body weight is lacking.

Therefore, we aimed to examine the association between the frequency of eating at fast-food restaurants and dietary patterns, as well as between the frequency of eating at sit-down restaurants and dietary patterns in adults living in Riyadh, SA. The hypothesis was that frequent eating at fast-food restaurants is strongly associated with unhealthy eating patterns compared

with eating at sit-down restaurants. As healthy and unhealthy options are available at sit-down restaurants, consumers can choose healthier options from the menu.

MATERIALS AND METHODS

Study design

A cross-sectional study, with a sample of the adult population living in Riyadh, SA, was conducted between January and March 2021. The study protocol was approved by the Institutional Review Board of Princess Nourah bint Abdulrahman University (IRB no. H-01-R-059, dated 17/01/2021). All participants, before participating in the study, provided informed consent by clicking the 'I agree' button that was presented before starting the online questionnaire. It was explained, on the first page of the questionnaire, that the participants had the right to withdraw from the study at any time and that they had no obligations to participate in this study.

Participants

The inclusion criteria were male and female adults aged 18 years and above living in Riyadh, SA. The exclusion criterion was dietary restriction owing to any health conditions that may affect food choices (e.g., coeliac disease, food allergies, diabetes, heart diseases, and renal problems). Sample size was calculated based on the sample size equation using the total population of 5 million, , where Z for 95% confidence level=1.96, p= prevalence of factor under study, estimated to be 50%, q=1-p =50%, and d= margin of error=0.05% (Daniel, 1995). Therefore, we estimated a minimum study sample of 384 Saudi citizens. A total of 399 participants enrolled in this study. Convenience sampling was used for recruitment.

Study tools

Data were collected using an online self-administered survey. The research team posted the link on social media and sent it via WhatsApp to their contacts and encouraged people to disseminate it to others. The online survey included items regarding the following topics.

Sociodemographic information

These included age, sex, nationality, marital status, monthly household income, education level, and occupation.

Frequency of eating at fast-food and at sit-down restaurants

Fast-food restaurant examples were those that served Shawarma, bakery items, chicken nuggets, burgers, or chips; they could be found at local takeaway food places, canteens, cafeterias, or fast-food franchises, such as McDonald's, Hardee's, IHOP, Domino's Pizza, and others. Sit-down restaurants were defined as those that served full menus with various food choices, including breakfast menus, soups, salads, hot and cold appetisers, main courses, desserts, juices, and drinks (e.g., Lebanese, Italian, Chinese, and mixed international restaurants).

The response options for frequency of eating at each of these two types of restaurants were: never, 1–3 times per month, 1–2 times per week, 3–4 times per week, and five times or more per week. We used a continuous variable that represented the overall frequency of eating at fast-food and sit-down restaurants by adding breakfast, lunch, and dinner responses to assess participants' overall frequency of eating according to restaurant type. The overall frequency of eating at each restaurant type was categorised into terciles, with the lowest number of visits used as the reference.

The eating habits assessment tool

The tool used for eating habits over the past few months was adapted from a scale used by Paxton *et al.* (2011). Nonetheless, we added some questions to this tool to ensure that our tool covered all food groups based on the latest US Department of Agriculture and US Department of Health and Human Services dietary guidelines for Americans, 2020-2025.

Accordingly, the adapted eating habits tool included questions on the frequency of eating fruits, vegetables, dairy, whole and refined grains, poultry, chicken and eggs, red and processed meat, fish, beans, nuts, seeds, and soy products, fried and junk food, sweetened beverages, dessert and sweets, and butter and margarine. There were three different frequency options per day or week, depending on the food group and their relevant dietary recommendations. For example, the options for the frequency of consumption for fruit and vegetable groups were as follows: two or less per day, 3–4 per day, and five or more per day; whereas for meat groups, the options were as follows: five or more per week, 3–4 per week, and 0–2 per week.

The questionnaire was first developed in English. The authors then translated it into Arabic. The translated version was reviewed by three nutrition professional experts using a scoring sheet to determine the accuracy of the actual translation and its content. The experts were asked to score each question and add comments if necessary. All comments given by the experts were discussed and considered. The final translated questionnaire was tested for readability on 15 adults that were representative of the target study population. Our sampling process was conducted to ensure that these participants varied in their educational and socioeconomic characteristics. Participants were interviewed about the questionnaire layout, information, length, ease and time for completion, and any difficulties in understanding the questions. They were given a chance to ask any questions and raise queries. This step revealed the need to further clarify the definition of each restaurant type by giving examples and increasing the comprehensibility of the questionnaire by modifying the language.

Food component derivation

Principal component analysis (PCA) was used to identify dietary patterns that specifically reflected the food items consumed. Patterns were extracted based on the 15 food groups entered into the PCA. The Kaiser-Meyer-Olkin (KMO) measurement of adequacy and Bartlett's test of sphericity were performed. For Bartlett's test of sphericity, a $p<0.05$ showed statistical significance and a KMO value of >0.6 indicated that the data were suitable for factor analysis. An orthogonal rotation using the varimax option of the retained components was then obtained to interpret the dietary patterns following the extraction of the components. The number of principal components using Kaiser's criterion with eigenvalues >1, the Eigen plot (scree plot), and the interpretability of the principal components were identified.

In our data, the KMO and Bartlett's tests were 0.67 and $\chi^2=690.92$, $p<0.001$, respectively. This meant that the correlation among the variables was sufficiently strong, and homogeneity in the variance for the intake of different food groups was observed. When identifying the major dietary patterns and reducing bias induced by multiple testing, we extracted only the factor components with eigenvalues >1. Based on the principal component interpretability and scree plots (Figure 1), the established cut-off point showed an obvious break after the fourth factor, with an eigenvalue >1.

Food groups with factor loadings ≥0.3 were accepted as crucial contributors to the component. In contrast, those with factor loadings <0.3 were ignored because they corresponded only to small displacements in the direction of the variables they multiplied. Furthermore, the dietary patterns were named according to those with factor loadings ≥0.3.

Covariates

Self-reported demographic characteristics were sex (male or female), nationality (Saudi or non-Saudi), marital status (married or not married), education level (less than bachelor's degree or bachelor's degree or above), and monthly household income (Saudi Riyals [SR]) (≤ SR 5,000, SR 6,000–10,000, or ≥ SR 11,000).

Data analysis

All data were analysed using the IBM SPSS Statistics for Windows version 26.0 (IBM Corp., Armonk, New York, USA). We conducted a descriptive analysis of the participants' sociodemographic characteristics. Continuous and categorical data were presented as mean and standard deviation (*SD*), and numbers and percentages (%), respectively. The factor scores for each dietary pattern were divided into quartiles (the first quartile represented low adherence to the pattern and the fourth quartile represented high adherence to the pattern), and the distribution of sociodemographic characteristics across these quartiles was explored. Furthermore, to compare the differences in the participants' sociodemographic

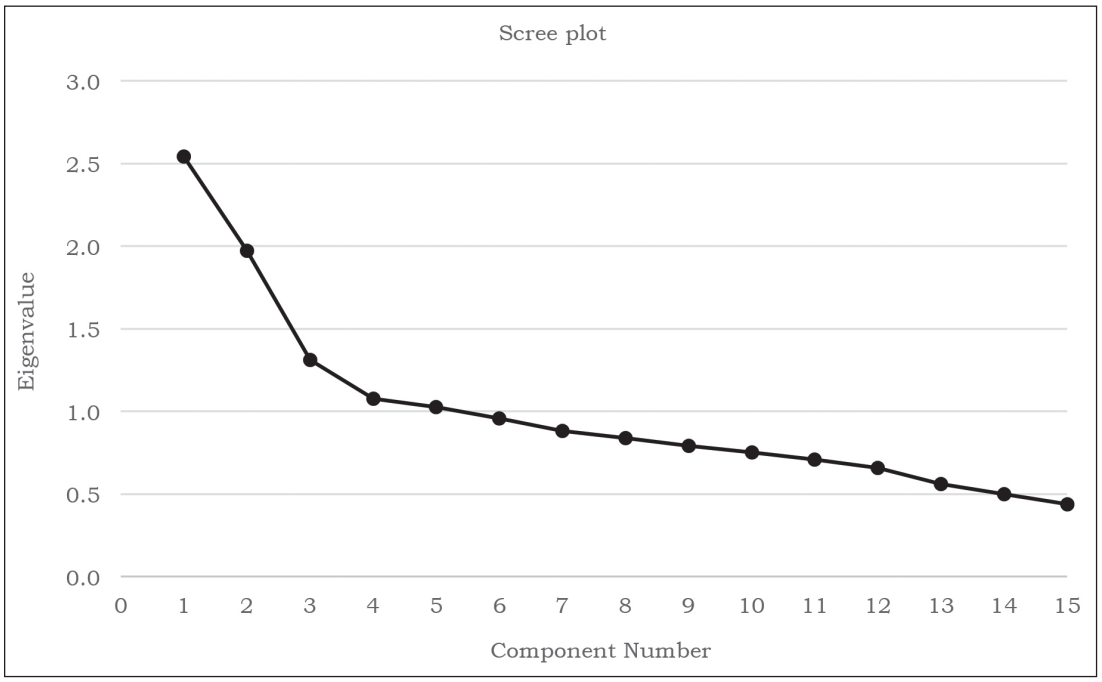

Figure 1. Scree plot for identification of dietary patterns (components) by principal component analysis. Food intakes were aggregated into 15 food groups and used as input variables. Factors considered appropriate for the pattern shown in Table 2 were the four factors with eigenvalues >1.00

Table 1. Demographic characteristics of the studied participants (*N*=399)

Characteristics	*mean±SD*	*n*	*%*
Age (years)	35±12		
Sex			
Female		238	59.6
Male		161	40.4
Marital status			
Married		218	54.6
Not married		181	45.4
Nationality			
Saudi		381	95.5
Non-Saudi		18	4.5
Education			
Less than bachelor's degree		85	21.3
Bachelor's degree or above		314	78.7
Occupation			
Governmental sector		112	28.1
Private sector		83	20.8
Business		9	2.3
Retired		24	6.0
Student		91	22.8
Housewife/Do not work		80	20.1
Household income (SR)†			
≤ 5000		169	42.4
6000 – 10,000		84	21.1
≥ 11,000		146	36.6
Fast-food restaurant frequency, by tercile			
Low tercile		189	47.4
Mid tercile		172	43.1
High tercile		38	9.5
Sit-down restaurant frequency, by tercile			
Low tercile		322	80.7
Mid tercile		71	17.8
High tercile		6	1.5

†SR: Saudi Riyal; 1 US dollar = SR 3.75 (as of May 28, 2023)
Frequency of restaurants by tercile: low tercile (less than 7), mid tercile (7–11), and high tercile (12–15) times per month

characteristics across these quartiles, a chi-square test for categorical data and a test of variance (ANOVA) for continuous data were performed.

Additionally, to evaluate the associations between the frequency of eating at restaurants (independent variable) and dietary patterns (dependent variable), the odds ratios and 95.0% confidence intervals (CIs) were computed using a multiple logistic regression test. Based on the scores for dietary patterns, we generated dichotomous dependent variables for each dietary pattern, representing either low or high adherence to that pattern. In Model 1, the relationships between dietary patterns and eating at fast-food restaurants, and between dietary patterns and eating at sit-down restaurants were examined.

Table 2. Factor loading matrices for the four dietary patterns among the studied participants

Food groups	*Dietary patterns*			
	Western pattern	*Unhealthy pattern*	*Plant-based pattern*	*Healthy pattern*
Fresh or dried fruits	-0.168	-0.026	**0.830**	-0.157
Fresh or cooked vegetables	-0.222	-0.048	**0.527**	**0.343**
Dairy products	-0.088	0.114	0.221	0.030
Refined grains	0.013	-0.286	0.076	-0.055
Whole grains	0.230	**0.307**	**0.470**	-0.179
Sweetened beverages	**0.621**	0.164	0.238	0.206
Poultry meat and chicken	**0.554**	0.101	-0.037	-0.088
Red meat	**0.642**	0.078	-0.118	-0.129
Processed meat	**0.683**	0.050	-0.201	-0.227
Fish meat	-0.168	-0.054	0.163	**0.756**
Beans	-0.109	0.026	-0.080	**0.687**
Nuts, seeds, and soy products	0.109	-0.149	**0.400**	**0.366**
Fried food and pre-packaged snacks (high in salt/fat)	0.221	**0.756**	0.057	-0.121
Desserts, sweet baked goods, and candy (not low-fat)	-0.071	**0.810**	-0.122	0.121
Butter and margarine	0.208	**0.518**	0.090	-0.085
% variance explained per pattern	12.2	11.7	10.2	10.1

Numbers in bold represent food groups strongly loaded in the factor component
Factor loadings ≥|0.30| were considered significant
The total variance for the four dietary patterns is 44.2%

In Model 2, the following covariates: age, sex, marital status, education, and income were adjusted. A *p*-value <0.05 was considered statistically significant.

RESULTS

Participants' sociodemographic and basic information

The demographic characteristics of the 399 participants are shown in Table 1. Mean age was 35±12 years, 59.6% were females, 54.6% were married, 95.5% were Saudis, 42.4% earned < SR 5,000 (~USD 1333), and just over three-quarters (78.7%) had a bachelor's degree or higher. Almost half worked in the government sector (28.1%) or the private sector (20.8%). On average, approximately 50.0% of the participants reported eating at fast-food restaurants 7–15 times per month, while only 19.3% ate at sit-down restaurants 7–15 times per month.

Identification of dietary patterns

Table 2 presents the factor loading matrices of the dietary patterns. PCA with the 15 food groups revealed four major dietary patterns, which explained 12.2%, 11.7%, 10.2%, and 10.1% of the variances in dietary intake, respectively. The four factors accounted for 44.2% of the total variance in dietary intake.

The four components were labelled based on the food items that showed high factor loadings. First, the Western pattern, which was characterised by high intakes of sweetened beverages,

Table 3. Distribution of sociodemographic characteristics across highest and lowest quartiles of dietary patterns scores

Variable	*Western pattern*			*Unhealthy pattern*			*Plant-based pattern*		*Healthy pattern*		
	Q 1	*Q 4*		*Q 1*	*Q 4*		*Q 1*	*Q 4*	*Q 1*	*Q 4*	
Age in years (mean±*SD*)	39±11	29±9	***	35±11	32±12	*	34±11	35±22	31±11	39±12	***
Sex, *n* (%)											
Female	70 (73.3)	41 (41.4)	***	67 (67.0)	42 (42.4)	***	69 (69.0)	50 (51.0)	59 (59.0)	54 (54.5)	
Male	25 (26.3)	58 (58.6)		33 (33.0)	57 (57.6)		31 (31.0)	48 (49.0)	41 (41.0)	45 (45.5)	
Marital status, *n* (%)											
Married	67 (70.5)	36 (36.4)	***	61 (61.0)	38 (38.4)	**	54 (54.0)	50 (50.0)	41 (41.0)	67 (67.7)	**
Not Married	28 (29.5)	63 (63.6)		39 (39.0)	61 (61.6)		46 (46.0)	48 (49.0)	59 (59.0)	32 (32.3)	
Nationality, *n* (%)											
Saudi	91 (95.8)	96 (96.0)		95 (95.0)	95 (96.0)		96 (96.0)	94 (95.9)	95 (95.0)	93 (93.9)	
Non-Saudi	4 (4.2)	3 (3.0)		5 (5.0)	4 (4.0)		4 (4.0)	4 (4.1)	5 (5.0)	6 (6.1)	
Education, *n* (%)											
Less than bachelor's degree	19 (20.0)	20 (20.2)		25 (25.0)	18 (18.2)		17 (17.0)	21 (21.4)	19 (19.0)	20 (20.0)	**
Bachelor's degree and above	76 (80.0)	79 (79.8)		75 (75.0)	81 (81.8)		83 (83.0)	74 (74.7)	81 (81.0)	79 (79.8)	
Income level (SR), *n* (%)											
≤ 5000	29 (30.5)	50 (50.5)	**	33 (33.0)	52 (52.4)		42 (42.0)	44 (44.9)	56 (56.0)	36 (36.4)	**
6000 – 10,000	22 (23.2)	22 (22.2)		24 (24.0)	16 (16.2)		20 (20.0)	21 (21.4)	22 (22.0)	19 (19.2)	
≥ 11,000	44 (30.3)	27 (27.3)		43 (43.0)	31 (31.3)		38 (38.0)	33 (33.7)	22 (22.0)	44 (44.4)	

SR: Saudi Riyal; 1 US dollar = SR 3.75 (as of May 28, 2023)
Categorical variables *n* (%), number and percentages, and continuous variables are represented as mean±*SD*; *p*-values for continuous variables (Analysis of variance) and categorical variables (chi-square test); *$p<0.05$, **$p<0.01$, ***$p<0.001$

Table 4. Associations between frequency of restaurant eating occasions and the major dietary pattern scores

	Western pattern		Unhealthy pattern		Plant-based pattern		Healthy pattern	
	Model 1 OR [CI]	*Model 2 OR [CI]*	*Model 1 OR [CI]*	*Model 2 OR [CI]*	*Model 1 OR [CI]*	*Model 2 OR [CI]*	*Model 1 OR [CI]*	*Model 2 OR [CI]*
Fast-food restaurant								
Low tercile	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Mid tercile	2.36***	1.21	1.99***	1.91**	0.68	0.65	0.46***	0.52**
	[1.54, 3.60]	[0.73, 2.00]	[1.30, 3.04]	[1.17, 3.13]	[0.45, 1.04]	[0.39, 1.05]	[0.30, 0.71]	[0.32, 0.86]
High tercile	6.37***	2.20	3.34**	4.85***	1.97	1.88	0.25***	0.29**
	[2.76, 14.67]	[0.84, 5.80]	[1.15, 7.04]	[1.80, 12.59]	[0.93, 4.13]	[0.78, 4.52]	[0.11, 0.54]	[0.11, 0.71]
Sit-down restaurant								
Low tercile	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Mid tercile	1.47	0.53	1.08	0.80	1.09	2.00	0.67	0.65
	[0.87, 2.47]	[0.75, 3.83]	[0.65, 1.82]	[0.46, 1.40]	[0.21, 5.48]	[0.32, 12.23]	[0.40, 1.14]	[0.11, 3.83]
High tercile	2.15	0.62	0.00	0.00	0.65	1.08	0.92	0.51
	[0.38, 11.93]	[0.08, 4.54]	[0.00]	[0.00]	[0.12, 3.45]	[0.17, 6.68]	[0.18, 4.66]	[0.08, 3.05]
Age		0.95**		1.01		0.99		1.02
		[0.93, 0.98]		[0.98, 1.03]		[0.97, 1.02]		[0.99, 1.04]
Sex								
Female		0.35***		0.78		0.74		0.71
		[0.21, 0.58]		[0.48, 1.24]		[0.46, 1.17]		[0.44, 1.15]
Education		1.09		1.15		0.70		1.17
Bachelor's degree or above		[0.62, 1.90]		[0.68, 1.96]		[0.42, 1.17]		[0.69, 1.99]
Marital status								
Married		1.34		0.75		0.89		0.95
		[0.71, 2.49]		[0.41, 1.33]		[0.49, 1.59]		[0.52, 1.72]
Income level (SR)								
6000 – 10,000		0.76		0.58		1.18		0.69
		[0.42, 1.37]		[0.32, 1.03]		[0.67, 2.06]		[0.38, 1.23]
More than 10,000		0.53*		0.81		1.27		1.31
		[0.29, 0.97]		[0.46, 1.42]		[0.72, 2.21]		[0.74, 2.30]

OR: odds ratio; CI, 95.0%: confidence interval; Ref: reference; SR: Saudi Riyal; 1 US dollar = SR 3.75 (as of May 28, 2023)
Model 1 the association between fast-food and sit-down restaurant eating frequency with dietary patterns extracted by PCA; Model 2, estimation of models after adjustment for sociodemographic factors
*p<0.05, **p<0.01, ***p<0.001

as well as poultry, chicken, red, and processed meats. Second, the unhealthy pattern, characterised by high intakes of fried food, pre-packaged snacks (high in salt/fat), desserts, sweet baked goods, candy (not low in fat), butter, margarine, and whole grains. Third, the plant-based pattern, which was characterised by a high intake of fresh or dried fruits, fresh or cooked vegetables, whole grains, nuts, seeds, and soy products. Fourth was the healthy pattern, characterised by a high intake of fresh or cooked vegetables, fish meat, beans, nuts, seeds, and soy products.

Dietary patterns and sociodemographic characteristics

The distribution of the participants' general characteristics across quartiles (Q1–Q4) for the four dietary patterns is presented in Table 3. Regarding the Western pattern, compared with participants in the lowest quartile, those in the highest quartile were more likely to be younger, male, not married, and have a lower income level. Regarding the unhealthy pattern, those in the highest quartile were more likely to be younger, male, and not married. The healthy pattern was significantly associated with older participants who had a bachelor's degree or higher, had higher income levels, and were married. Regarding the plant-based pattern, we found no significant associations with any sociodemographic characteristics across the quartiles.

The association between dietary patterns and frequency of eating at either fast-food or sit-down restaurants

Results of the multiple logistic regression analysis for the two models are shown in Table 4. In Model 1, regarding the frequency of eating at fast-food restaurants, participants in the highest tercile were associated with higher odds of adherence to the Western pattern (*OR*=6.37, 95.0% *CI*=2.76, 14.67) and unhealthy pattern (*OR*=3.34, 95.0% *CI*=1.15, 7.04). Moreover, they were significantly associated with lower odds of adherence to the healthy pattern (*OR*=0.25, 95.0% *CI*=0.11, 0.54) compared with those in the lowest tercile. No statistically significant associations were found between participants in the highest tercile of eating at sit-down restaurants and dietary patterns.

In Model 2, after adjusting for potential covariates, the association between the frequency of eating at fast-food restaurants and the Western pattern was attenuated; however, this association remained significant for the unhealthy pattern (*OR*=4.85, 95.0% *CI*=1.80, 12.59) and healthy pattern (*OR*=0.29, 95.0% *CI*=0.11, 0.71).

DISCUSSION

The findings of this study suggested that a higher frequency of eating at fast-food restaurants was positively associated with unhealthy dietary patterns. Another study that discussed several factors associated with unhealthy eating habits among Saudis found that a lack of knowledge about healthy diets, lack of enjoyment, and lack of family support in healthy food preparation were the main contributing factors to unhealthy eating; while inaccessibility and inability to buy healthy foods were the most common barriers to healthy eating (AlQuaiz *et al.,* 2021).

Comparing the frequency of eating at the two types of restaurants, fast-food restaurants were higher than sit-down restaurants. Furthermore, four major dietary patterns were identified for our sample: Western, unhealthy, plant-based, and healthy patterns. The correlation coefficients between food groups of the extracted dietary patterns

justified the labelling of patterns. After adjusting for potential covariates, the findings indicated that those who frequently ate at fast-food restaurants were 4.8 times more likely to have an unhealthy dietary pattern. A previous study demonstrated that fast-food consumers with poor diets had dietary patterns characterised by a higher consumption of energy, fat, sodium, and sweetened beverages, and a lower consumption of fruits and vegetables (Powell & Nguyen, 2013).

After adjusting for potential covariates, no significant associations were observed between those who ate more frequently at sit-down restaurants and their dietary patterns. This could be explained by relatively fewer participants eating at sit-down restaurants than at fast-food restaurants. However, according to the Riyadh Chamber of Commerce and Industry, the proportion of fast-food restaurants in Riyadh is much higher (56%) than that of other restaurants (Bouznif *et al.,* 2018). Therefore, the availability of Western fast-food restaurant chains in Riyadh might explain the more frequent choice to visit fast-food restaurants compared with sit-down restaurants (Benajiba, 2016). Another explanation for the lack of a clear association between sit-down restaurants and the identified dietary patterns could be due to the nature of the various dishes served in sit-down restaurants, which include both healthy and unhealthy options.

We cannot rule out the possible interference of cravings for fast-food items either. Frequent intake of energy-dense foods significantly increases the cravings for high-fat foods and reduces the cravings for healthy options. In contrast, calorie-restricted diets reduce cravings for energy-dense foods, including sweets, fats, and starches, and increase cravings for fruits and vegetables (Anton *et al.,* 2012). Furthermore, research shows that hunger susceptibility and the dose-response effect of energy-dense foods could be possible mechanisms for the frequent intake of fast-food items compared to other foods (Gilhooly *et al.,* 2007).

Other research has examined the association between the frequency of eating out and dietary intake (Lachat *et al.,* 2012). The current study differed from previous research (Bhutani *et al.,* 2018) in that it identified different dietary patterns associated with eating at fast-food and sit-down restaurants. Research conducted on a healthy population showed that the high density of restaurants has contributed to poor quality diets. This, in turn, has been found to significantly affect metabolic functions, particularly blood pressure, in the studied population (Alsabieh *et al.,* 2019). Therefore, the results of the current study can be helpful in designing effective intervention programmes about nutrition and policies to promote healthier lifestyles. A community-based intervention review found that point-of-purchase advertising and increased availability of healthy choices were effective strategies for enhancing healthier dietary intake outside the home (Valdivia Espino *et al.,* 2015). Additionally, increasing the awareness of calorie labelling in menus could improve food choices in restaurants (Bawazeer *et al.,* 2021). Moreover, improving cooking skills has been reported to decrease eating out (Robson, Crosby & Stark, 2016), promote healthier eating behaviours (Tani, Fujiwara & Kondo, 2020), and improve diet quality and cooking frequency (Alpaugh *et al.,* 2020).

The current findings also highlighted the role of sociodemographic characteristics in dietary patterns and their association with frequent eating out. Specifically, a significant effect was found based on age, sex, education, marital status, and income level. This

supports the idea that dietary patterns vary according to sociodemographic factors (Beck *et al.,* 2018; Krieger *et al.,* 2018). Notably, in this study, sex was positively associated with less healthy eating habits; male adults had a higher tendency to have Western and unhealthy eating patterns, whereas female adults tended to adhere more to healthy eating patterns. A similar result has been observed at global levels (Muga *et al.,* 2017).

Differences in dietary patterns by age were observed, where younger individuals tended to have less healthy dietary patterns and older individuals were more adherent to healthier diets. The findings of the National Nutrition Survey *menuCH* corroborate age as a determinant of eating patterns (Krieger *et al.,* 2018). Furthermore, age is negatively correlated with the frequency of eating fast food, thereby, contributing to unhealthy food choices (Hidaka *et al.,* 2018). In our sample, we hypothesised that these age-related results could be partially attributed to the lower income levels of younger people. This hypothesis stemmed from one of our observations that the significant association between the Western pattern and a higher frequency of eating at fast-food restaurants (which have more accessible prices) was stronger among participants who had a monthly income of < USD 1333. Contrastingly, those with a monthly income of > USD 2933 showed greater adherence to healthy eating patterns. These patterns were inversely associated with a higher frequency of eating at fast-food restaurants in our sample.

In the current study, education may have mediated the relationship between income differences and dietary patterns. It has been shown that participants who had a bachelor's degree or higher were more conscious about health and had higher healthy pattern scores. Greater adherence to healthy dietary patterns can be attributed to the role of education in evoking higher health consciousness and its indirect impact on food purchase patterns. Specifically, education has often been associated with higher income (Beck *et al.,* 2018), thus affecting food purchase patterns. Research shows that lower income significantly contributes to people's decision to purchase less healthy foods, and vice versa (French *et al.,* 2019).

Strengths

This study was the first to investigate the association between dietary patterns and frequency of eating at either fast-food or sit-down restaurants in a sample of adults living in Riyadh city. Additionally, using data-driven approach was a strength of this study; the use of PCA in dietary pattern analysis has been proven to be consistently reproducible longitudinally and across different dietary assessment methods in different populations (Murakami *et al.,* 2019). Moreover, significant differences in sociodemographic characteristics regarding adherence to dietary patterns and the relationship between dietary patterns and frequency of eating at different types of restaurants were demonstrated. Furthermore, multiple advanced analyses were used to control for different potential covariates (i.e., age, sex, marital status, income, and education level).

Study limitations

Firstly, the cross-sectional design of this study and its data hindered our ability to establish longitudinal and causal inferences for the associations; thus, the results need to be verified in future prospective studies. Secondly, the data collected through an online self-report survey may be prone to recall or selection bias. However, online surveys are becoming a more popular research

method for assessing dietary patterns because they have the advantages of being low cost, easy to access, large population recruitment, and rapid data collection (Nayak, MSDP & Narayan, 2019). Thirdly, the convenience sampling technique used was vulnerable to selection bias; thus, the findings did not comprehensively reflect the target population. However, our population was clearly defined, and regular participation was guaranteed. Furthermore, the relatively small sample size may have affected the reliability of the results, thereby limiting their generalisability to different populations. Nevertheless, the sample size was calculated and the optimal number was achieved. Lastly, using PCA was subjected to researchers' decisions during the process. This involved subjective choices regarding appropriate rotation methods, factor loadings (correlation coefficients) to interpret the components, eigenvalues, quantity, and labelling of the identified patterns. These choices may lead to inconsistent results; however, PCA is a well-known method used in many nutritional epidemiological studies.

CONCLUSION

The results suggested that frequently eating fast food was strongly associated with increased adherence to less healthy dietary patterns and negatively associated with healthy dietary patterns. Furthermore, the frequency of eating at sit-down restaurants was not associated with any of the identified dietary patterns. Despite the relatively limited sample size, the current study offered valuable insights into the relationship between the frequency of eating out and dietary patterns in an understudied population (the Saudi population in Riyadh) experiencing rapid lifestyle changes. The study's findings can assist stakeholders and policymakers in developing strategic plans and policies for targeted interventions for this population.

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Authors' contributions
Enas A, performed data analysis and evaluation, and drafted the paper; Nahla MB, contributed towards project administration, designed research study and methodology, interpreted data, and reviewed the paper; Arwa A, Salma A, Shahad A, Haya A, and Hajer A, drafted the research proposal, conducted research, and data collection. All authors reviewed and approved the final manuscript.

Conflict of interest
The authors declare that there are no conflicts of interest.

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