The Association between Dietary Patterns and Socio-Demographic and Lifestyle Characteristics: A Sample of Saudi Arabia

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Abstract
Dietary intake is an important risk factor that contributes to the development or prevention of many health conditions. The objective of the current study was to identify different dietary patterns and its relation to socio-demographic and lifestyle characteristics. A cross-sectional study of 299 Saudi adults, aged between 35-65 years without any significant health problems. Participants were interviewed individually and completed a pre-designed questionnaire with close-ended questions including socio-demographic and lifestyle characteristics. Dietary intake was assessed using food frequency questionnaire. Anthropometric measurements were obtained by a trained nurse in the clinic. Factor analysis technique was used to derive different food patterns. Five dietary patterns were identified, namely: sweet & starch, date & coffee, healthy, traditional, and protein patterns. Following sweet & starch pattern was significantly correlated to male gender, frequently visiting fast food restaurants and breakfast consumption behavior. Adherence to healthy pattern was associated with male gender, higher education with high income, older adults, breakfast consumption behavior and high levels of physical activity. Traditional pattern was correlated with married subjects and male gender, whereas compliance to date & coffee pattern was related to reduced number of meals and snacks. The protein pattern was significantly associated with younger age and breakfast consumption behavior. Dietary patterns were influenced by socio-demographic characteristic (age, gender, marital status, education level, income) and other lifestyle factors (breakfast consumption, number of meals, physical activity). A national cohort study is needed to assess the association with dietary pattern with the risk of cardiometabolic dysregulation.

Keywords
Dietary Pattern; Food Frequency Questionnaire; Factor Analysis; Lifestyle; Obesity; Tradition Saudi Pattern.
Introduction
The prevalence of overweight and obesity in Saudi Arabia has increased rapidly, reaching up to 37% and 41%, respectively.1 This is due to a major shift in dietary intake, decreased physical activity levels and accelerated nutrition transition, thereby increasing nutrition-related health problems and other related diseases.2-4 The traditional healthy diet consisting of dates, milk, vegetables, fruits, fish, and whole wheat grains has been replaced by the Western-style diet, with excess intake of calorie-dense food, high intake of fat and sugar, and low intake of fiber.2-6 Along with changes in dietary habits, unhealthy foods are easily affordable and accessible; additionally, a luxurious lifestyle in which vehicles are extensively used and an increased prevalence of sedentary behaviors have all resulted in high obesity rates, particularly in the Saudi population.5 In addition, obesity is also associated with many chronic diseases, such as hypertension, dyslipidemia, metabolic syndrome, type 2 diabetes, cardiovascular diseases, and cancers.7-10

Dietary intake is a risk factor that contributes to the management or prevention of many health problems.11, 12 Recently, many nutrition-related epidemiological studies have assessed the relationship between dietary patterns rather than just focusing on single nutrient in relation to disease risks.11, 12 The concept is such that dietary patterns reflect the effect of a combination of foods, nutrient content, and dietary behavior and are more representative of daily dietary intake.2, 3, 11-13 Previous studies have shown that Western dietary intake patterns are linked with an increased risk of obesity, metabolic syndrome, type 2 diabetes and elevated triglyceride levels, whereas prudent dietary patterns are correlated with a lower body mass index (BMI) and a decreased risk of type 2 diabetes, cardiovascular disease and mortality.11, 12, 14-16

To our knowledge, available published studies on dietary patterns in Saudi Arabia are limited.2 Henceforth, the objective of the current study was to study the explore different dietary pattern among Saudi population and examine the association between dietary patterns and socio-demographic and lifestyle factors. This will be particularly important and helpful for the promotion of effective prevention programs to maintain overall health and well-being in Saudi Arabia.

Methods
Study Design and Participants
A cross-sectional study was conducted in a group of Saudi adults living in Riyadh city in Saudi Arabia between June and December 2013. Participants were recruited from King Abdul-Aziz University Hospital who were the attendants of patients (i.e., accompanying the patient). A total of 299 Saudi men and women aged 35-65 years without any significant health problems were recruited for this study. Pregnant or lactating women and patients on a specific diet were excluded. All participants provided informed consent, and the purpose of the study was explained. The study protocol was approved by the Institutional Review Board (IRB # 13/3757/IRB, project number E-10-152) of the Medical College at King Saud University.

Demographic, Anthropometric and Lifestyle Characteristics
Participants were interviewed individually using a predesigned questionnaire with closed-ended questions that was developed based on the knowledge available in the literature. The questionnaire included socio-demographic information, including age, sex, education level, marital status, income per month, smoking status, and physical activity. It also included information on meal patterns, such as the number of meals consumed in a day, skipped meals, most meals eaten outside the home, places often visited for food, and the number of fast food or other restaurants visited per month. Participants were subjected to weight and height measurements by a trained nurse in the clinic.

Dietary Intake
A trained nutritionist has assessed the participant’s usual food intake using an adapted and validated food frequency questionnaire (FFQ) over the previous 6 months in the Saudi population.17 Participants were asked to report the frequency and the quantity consumption of each food item using possible responses: 1-7 times per week, 2-3 months, or rarely/never.17 To estimate the food portion size consumed by each participant, food models (Fort Atkinson, WI, USA), household units (e.g., bowls, spoons and cups), and photographic pictures (Nelson, MAFF, UK.) were used by the interviewer. The portion sizes and the frequency of each food items were converted to daily food intake.
Daily intakes of food items, energy, macronutrients and micronutrients intake of participants were calculated by multiplying the daily frequency of intake by the nutrient content of the specified portion size using Q-Builder Tinuviel software nutrition analysis program V3.0 software. Misreporting was considered any participants with daily Kcal intake < 800 kcal or > 4200kcal.18

| Food group                         | Components                                                                                                                                 |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Dairy products (whole & low Fat)  | Labenah - white cheese - proccesed cheese - milk - laban - yogurt - yogurt with cucumber                                                |
| Fresh & Cooked Vegetable          | Tomatoes - onion - cucumber -carrot - lettuce - watercress - celery pascal large outer stalk - cabbage - green salad - fatoosh - tabolah - cabbage with carrot - mixed vegetable cooked - pumpkin cooked - squash cooked - okra cooked - peas & carrots cooked - green Beans cooked - cauliflower cooked - Molokhiyah cooked - Spinach cooked - vegetable oven cooked - vegetable with white sauce “bashamel” - Metablbazngan - vegetable soup - ketchup - pickles. |
| Dates                             | Dates.                                                                                                                                 |
| Fruits                            | Melon -watermelon - apple - orange - mandarin - banana - grapes - pears - apricot - peach - strawberry - fruit salad - dried fruit - fresh fruit juice. |
| Meat & Poultry                    | Chicken meats (all types) - Beef meats (all types) - lamb - camel - variety meat & liver - mortadella - frankfurters - kebbah - kamooniah.    |
| Seafood                           | Fried fish - grilled fish - tuna oiled - watered tuna -shrimp.                                                                                                                                  |
| Eggs                              | Eggs (all types).                                                                                                                      |
| Cooked legumes                    | Balilah – homoss – foul (beans) – lentils – falafel - lentils soup.                                                                      |
| Breakfast cereal, bread & bakery  | White bread (mafoood) – Roll white (samoli) – white toast – tamees bread – tames biscuit bread – fateer – shaborah white - brown bread (mafoood) –Roll brown (samoli) – brown toast - Shaborah brown - bran corn flakes - whole bran cereals - Breakfast cereals - special cereals breakfast - pizza - fatayer (labenah, spinach, thyme) - croissants |
| Rice, pasta, potato and other dishes | Rice plain boiled, rice (kabsah, biryani, bokhari, mandy) –pasta plain boiled - pasta with meat–pasta with tomato sauce - pastabashamel /llazania - boiled potatoes peeled - fried potatoes - potatoes with bashamel - corn cooked -koshare - koskosi - mutbaq–sambosa (cheese, meat) stuffed vegetables - grape leaves stuffed - oat soup - creamed soup chicken or mushroom. |
| Tradition dishes                  | Gareesh - haress - qursan - mataziz - Mashghotha - areka -- saleeq - manto - yagmushaseedahborr – maasoob - Mohala – henini–aseedatamerr- gareesh soup. |
Dietary Pattern Derivation
The classification of food pattern was described previously.\textsuperscript{12, 14, 15} Factor analysis was used to develop different dietary patterns.\textsuperscript{12, 14, 15, 19} A total of 157 food items of the FFQ questionnaire were gathered into different groups. The food items were grouped based on similarity properties, ingredients and nutrient profiles to reduce the number of variables and improve their distribution.\textsuperscript{12, 14, 15, 20} Food items having a unique composition (e.g., dates, Arabic coffee and eggs) were classified individually. Fifteen food groups were formed (Table 1), which were included in the factor analyses to identify independent dietary patterns. The method of grouping the foods and labeling the food pattern was described previously.\textsuperscript{19}

### Statistical Analysis
Statistical Package for the Social Sciences (SPSS) version 21 was used to conduct all statistical analysis. All results considered statistically significant if p-values are less than 0.05. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as n number and percentages. The t-test was used for continuous variables, and the chi-square test was used for categorical variables. ANOVA was used to compare more than two groups. The partial Pearson correlation coefficient (r) was used to examine the direction of linear relationship between dietary pattern scores and total energy and nutrient intake. Multiple linear regression analyses were used to assess the association between the factor scores for each of the identified dietary patterns as dependent variables and the socio-demographic and lifestyle characteristics as independent variables. Daily intake (in grams) of food items, energy, and macronutrients intakes were computed using the Q-Builder Software nutrition analysis program (V2.0).

### Results
#### Demographic, Anthropometric and Lifestyle Characteristics
Table 2 represents the socio-demographic and anthropometric data of 299 Saudi adults (114 men (38%) and 185 women (62%). The mean age of this population was 49.6±6.9 years old. No significant difference was found in age between men (48.7±6.9 years) and women (50.1±6.9 years) (p=0.085). A significantly higher percentage of men were university graduates, had monthly incomes of more than 10,000 SR, and were active smokers. The mean BMI for the studied cohort was 30.6 ± 5.72 kg/m\textsuperscript{2}, with 53.5% not involved in any physical activity.

A total of 47.8% of participants reported consuming three daily meals, while 38.8% reported skipping one or more meals, with breakfast being the most frequently skipped meal, particularly among women. In this cohort, 183 (61.2%) had meals in restaurants, with dinner being the most frequently consumed restaurant meal among 78.7% of participants. On average, breakfast was consumed 5.7 ± 1.9 days/week. Meals comprising fast food and restaurant food were consumed 2.3 ± 3.7 times/week, with a higher number of such meals consumed among men (2.9 ± 3.4 times/week) than among women (1.9 ± 3.9 times/week) (p=0.015).
Table 2: Socio-demographic, Anthropometric and Lifestyle Characteristics of the Participants (n= 299)

|                                | Total (n=299) | Men (n=114) | Women (n=185) | P value |
|--------------------------------|---------------|-------------|---------------|---------|
| **Marital status**             |               |             |               |         |
| Married                        | 257 (86.0)    | 112 (98.2)  | 145 (78.4)    | <0.001  |
| Unmarried                      | 42 (14)       | 2 (1.8)     | 40 (21.6)     |         |
| **Education level**            |               |             |               |         |
| Illiterate                     | 36 (12.0)     | 0 (0.0)     | 36 (19.5)     | <0.0001 |
| Primary                        | 58 (19.4)     | 10 (8.8)    | 48 (25.9)     |         |
| Secondary                      | 106 (35.5)    | 42 (36.8)   | 64 (34.6)     |         |
| University & above             | 99 (33.1)     | 62 (54.4)   | 37 (20.0)     |         |
| **Income per month (SR)**      |               |             |               |         |
| <5000                          | 59 (19.7)     | 2 (1.7)     | 57 (30.8)     | <0.001  |
| 5000-10000                     | 90 (30.1)     | 28 (24.6)   | 62 (33.5)     |         |
| >10000                         | 150 (50.2)    | 84 (73.7)   | 66 (35.7)     |         |
| **Smoking status**             |               |             |               |         |
| Yes                            | 20 (6.7)      | 17 (14.9)   | 3 (1.6)       | <0.001  |
| No                             | 279 (93.3)    | 97 (85.1)   | 182 (99.4)    |         |
| **Physical Activity**          |               |             |               |         |
| No                             | 160 (53.5)    | 41 (36.0)   | 119 (64.3)    | <0.001  |
| 1-2 times/week                 | 60 (20.1)     | 28 (24.6)   | 32 (17.3)     |         |
| 3-4 times/week                 | 30 (10.0)     | 17 (14.9)   | 13 (7.0)      |         |
| ≥ 5 times/week                 | 49 (16.4)     | 28 (24.6)   | 21 (11.4)     |         |
| **No. of meals per day**       |               |             |               |         |
| Three meals                    | 143 (47.83)   | 67 (58.8)   | 76 (41.1)     | 0.016   |
| Two meals                      | 145 (48.5)    | 44 (38.6)   | 101 (54.6)    |         |
| One meal                       | 11 (3.67)     | 3 (2.6)     | 8 (4.3)       |         |
| **Skip some meals**            |               |             |               |         |
| Yes                            | 116 (38.8)    | 26 (22.8)   | 90 (48.7)     | <0.001  |
| Sometimes                      | 132 (44.2)    | 67 (58.8)   | 65 (35.1)     |         |
| No                             | 51 (17.0)     | 21 (18.4)   | 30 (16.2)     |         |
| **Most meal skipped**          |               |             |               |         |
| Breakfast                      | 104 (41.9)    | 29 (31.2)   | 75 (48.4)     | 0.046   |
| Lunch                          | 54 (21.8)     | 22 (23.6)   | 32 (20.6)     |         |
| Dinner                         | 90 (36.3)     | 42 (45.2)   | 48 (31.0)     |         |
| **Meal eaten outside home**    |               |             |               |         |
| Breakfast                      | 17 (9.3)      | 15 (17.4)   | 2 (2.1)       | 0.002   |
| Lunch                          | 22 (12.0)     | 9 (10.5)    | 13 (13.4)     |         |
| Dinner                         | 144 (78.7)    | 62 (72.1)   | 82 (84.5)     |         |
| **No. of snacks per day**      |               |             |               |         |
| ≤ 1 snack                      | 181 (60.5)    | 80 (70.2)   | 101 (54.6)    | 0.007   |
| ≥ 2 snacks                     | 118 (39.5)    | 34 (29.8)   | 84 (45.4)     |         |
| **BMI**                        |               |             |               |         |
| < 25                           | 41 (13.7)     | 19 (16.7)   | 22 (11.9)     | 0.031   |
| 25-29.99                       | 111 (37.1)    | 50 (43.8)   | 61 (33.0)     |         |
| ≥ 30                           | 147 (49.2)    | 45 (39.5)   | 102 (55.1)    |         |

SR, Saudi Riyals, BMI, body mass index
Table 3: Factor analysis for the Five Dietary Patterns Identified of the Participants (n= 299)

| Food groups                              | Sweet & Starch | Date & Coffee | Healthy   | Traditional | Protein
|------------------------------------------|----------------|---------------|-----------|-------------|---------|
| Beverages and Drinks                     | 0.692          | -             | -         | 0.293       | -       |
| Sweets, Dessert and other snacks         | 0.644          | -             | -         | 0.265       | -       |
| Breakfast cereal, bread and bakery       | 0.608          | 0.225         | 0.205     | -0.265      | 0.230   |
| Cooked legumes                           | 0.573          | -             | -         | -           | -       |
| Rice, Pasta, Potato and other dishes     | 0.499          | 0.289         | -         | -           | -0.277  |
| Dates                                    | -              | 0.861         | -         | -           | -       |
| Arabic coffee                            | -              | 0.850         | -         | -           | -       |
| Fresh and Cooked Vegetables              | -              | -             | 0.755     | -           | -       |
| Fruits                                   | -              | -             | 0.635     | 0.483       | -       |
| Seafood                                  | 0.305          | -             | 0.579     | -           | -       |
| Meat and Poultry                         | -              | -             | -0.287    | 0.605       | 0.204   |
| Tradition dishes                         | -              | -             | -         | 0.577       | -       |
| Fat and Oil                              | 0.271          | -             | 0.257     | 0.494       | -       |
| Eggs                                     | -              | -             | -         | -           | 0.799   |
| Dairy products (Whole & low Fat)         | -              | -             | -         | 0.228       | 0.601   |

% variance explained per pattern          | 20.68          | 11.60         | 8.21      | 7.66        | 6.74    |

Total variance explained by all of the patterns is 54.89%
For simplicity, value below 0.2 were excluded from the table

Table 4: Correlation of Dietary Pattern and Total Energy and Energy-adjusted Nutrient Intakes in the Participants (n= 299)

| Nutrients                              | Dietary pattern |
|----------------------------------------|-----------------|
|                                        | Sweet & Starch  | Date & Coffee | Healthy   | Traditional | Protein |
| Energy (Kcal)1                         | 0.520**         | 0.264**       | 0.163**   | 0.158**     | 0.143*  |
| Protein (g)                            | 0.011           | -0.022        | -0.104    | 0.136*      | 0.168** |
| Carbohydrate (g)                       | 0.108           | 0.034         | 0.070     | -0.134*     | -0.083  |
| Fat (g)- 0.103                         | -0.004          | -0.025        | 0.097     | 0.023       |         |
| Total fibre (g)                        | -0.023          | -0.013        | 0.549**   | -0.054      | 0.048   |
| Cholesterol (mg)                       | -0.156**        | -0.057        | -0.146*   | 0.144*      | 0.443** |
| Sodium (mg)                            | 0.172**         | -0.039        | 0.185**   | -0.095      | 0.199** |
| Calcium (mg)                           | 0.142*          | 0.026         | 0.299**   | -0.235**    | 0.252** |
| Iron (mg)                              | 0.139*          | -0.025        | 0.213**   | -0.151**    | 0.103   |
| Carotene (μg)                          | -0.052          | 0.100         | 0.508**   | -0.049      | 0.027   |
| Vitamin D (µg)                         | 0.097           | -0.069        | -0.001    | -0.044      | 0.387** |
| Vitamin E (mg)                         | 0.031           | -0.078        | 0.417**   | 0.081       | 0.047   |
| Vitamin B12 (µg)                       | 0.047           | -0.081        | 0.228**   | -0.053      | 0.125*  |
| Folate (µg)                            | -0.038          | -0.020        | 0.529**   | -0.120*     | 0.156** |
| Vitamin C (mg)                         | -0.024          | -0.102        | 0.172**   | 0.116*      | 0.077   |

1 Energy were adjusted for age and gender
For simplicity, value below 0.2 were excluded from the table
*P < 0.05 and **P < 0.005 were considered significantly different.
Table 5. Relationship between Sociodemographic and Lifestyle Variables and Dietary Pattern (n= 299)

| Socio-demographic characteristics | Sweet & Starch Pattern | Date & Coffee Pattern | Healthy Pattern | Traditional Pattern | Protein Pattern |
|-----------------------------------|------------------------|-----------------------|----------------|---------------------|----------------|
|                                   | β 95 % CI               | β 95 % CI             | β 95 % CI      | β 95 % CI           | β 95 % CI      |
| Age                               | -0.101 -0.032, 0.002   | -0.009 -0.019, 0.016  | 0.055 -0.009, 0.025 | 0.066 -0.008, 0.027 | -0.160* -0.041, -0.006 |
| Gender                            | -0.219* -0.742, -0.173 | 0.133 -0.024, 0.562  | -0.140* -0.580, -0.001 | -0.213* -0.733, -0.144 | -0.028 -0.351, 0.233 |
| Marital status                    | -0.029 -0.447, 0.278   | -0.085 -0.613, 0.134 | 0.103 -0.068, 0.669 | -0.139* -0.774, -0.024 | 0.012 -0.339, 0.406 |
| Education                         | 0.003 -0.213, 0.222    | 0.048 -0.149, 0.298  | 0.141* 0.002, 0.443 | -0.013 -0.245, 0.204 | 0.080 -0.097, 0.349 |
| Income                            | -0.062 -0.264, 0.101   | -0.051 -0.253, 0.123 | 0.072 -0.091, 0.280 | -0.114 -0.337, 0.041 | 0.029 -0.149, 0.226 |
| Smoking                           | 0.085 -0.119, 0.814    | -0.006 -0.504, 0.457 | 0.116 -0.006, 0.943 | -0.001 -0.485, 0.481 | 0.015 -0.417, 0.542 |
| Physical activity                 | 0.021 -0.193, 0.277    | -0.015 -0.272, 0.212 | 0.078 -0.080, 0.397 | 0.058 -0.127, 0.359 | -0.027 -0.295, 0.187 |
| Body Mass Index                   | 0.049 -0.012, 0.029    | 0.017 -0.018, 0.024  | 0.073 -0.008, 0.034 | -0.116 -0.042, 0.001 | 0.047 -0.013, -0.030 |
| No. of meals per day              | -0.067 -0.335, 0.094   | -0.167* -0.512, -0.071 | -0.109 -0.413, 0.023 | 0.014 -0.196, 0.248 | -0.116 -0.427, 0.014 |
| No. of snacks per day             | 0.046 -0.084, 0.203    | -0.130* -0.312, -0.016 | 0.054 -0.076, 0.216 | -0.041 -0.201, 0.096 | 0.017 -0.126, 0.169 |
| Meal eaten outside home/month     | 0.068 -0.030, 0.111    | -0.097 -0.129, 0.016 | 0.013 -0.064, 0.080 | 0.037 -0.051, 0.095 | -0.023 -0.086, 0.058 |
| Fast food and restaurant/month    | 0.16* 0.013, 0.075     | -0.024 -0.039, 0.026 | -0.064 -0.049, 0.014 | 0.075 -0.012, 0.053 | 0.051 -0.018, 0.046 |
| Breakfast per week                | 0.162* 0.015, 0.113    | -0.115 -0.095, 0.006 | 0.049 -0.030, 0.069 | -0.038 -0.065, 0.036 | 0.225* 0.038, 0.139 |

† All the Socio-demographic and lifestyle variables were used in one multivariate model, β and 95% CI were significant at *P< 0.05.
Dietary Patterns
Factor loading analysis demonstrated five dietary patterns with total variance of 54.9% in dietary intake, as shown in Table 3. The five dietary patterns were classified as follows: the "sweet and starch" pattern, "date and coffee" pattern, "traditional" pattern, and "protein" pattern. The sweet and starch pattern was positively correlated with beverages and drinks, sweets, desserts and other snacks, breakfast cereals, breads, bakery goods, beans, rice, pasta and cooked dishes. The date and coffee pattern was positively correlated with the consumption of dates and coffee. The healthy pattern was positively correlated with foods that were considered healthy, including fruits, vegetables and seafood, while the traditional pattern was positively correlated with traditional Saudi food patterns, including meat and poultry, traditional Saudi dishes, fat, oil and fruits. Finally, the protein pattern was associated with the consumption of eggs and dairy products.

The Relationship between Dietary Patterns and Socio-demographic and Lifestyle Characteristics
The correlation between different dietary patterns with energy- and energy-adjusted nutrient intake is demonstrated in Table 4. The sweet and starch pattern had the strongest significant positive correlation with energy (r=0.520, p<0.01) when compared to other dietary patterns. In addition, cholesterol had a significant negative correlation, while sodium, calcium and iron had significant positive correlations with sweet and starch patterns. In the healthy pattern, higher scores indicate higher intake of total fiber, folate, carotene, vitamin E, calcium, vitamin B12, iron, sodium and vitamin C and lower cholesterol intake. For the traditional pattern, protein and cholesterol intake had significant positive correlations, while carbohydrate, calcium, iron and folate had significant negative correlations. Furthermore, higher protein pattern scores indicate higher intake of protein, cholesterol, sodium, calcium, and vitamin D.

The association of dietary pattern scores with socio-demographic and lifestyle characteristics was examined using multivariate linear regression analyses in Table 5, which revealed that sweet and starch patterns correlate strongest to male gender, frequent visits to fast food restaurants and breakfast consumption behavior, followed by being young, highly educated and having less income. The date and coffee pattern had a significant negative correlation with the number of meals and snacks per day. The healthy pattern was found to be associated with male gender, higher education with high income, older adults, breakfast consumption behavior and high level of physical activity. The traditional pattern was significantly associated with married subjects and male gender, whereas the protein pattern was strongly correlated with younger age and breakfast consumption behavior.

Discussion
Dietary pattern describes the overall dietary intake (in terms of quantity and variety) of foods and nutrients.21 The objective of the current study was to assess dietary patterns in Saudi adults. In the current study, five dietary patterns were identified: sweet and starch, date and coffee, healthy, traditional, and protein patterns. Adherence to sweet and starch patterns was associated with male gender, frequent visits to fast food restaurants and breakfast consumption behavior. Adherence to a healthy pattern was associated with male gender, higher education with high income, older adults, breakfast consumption behavior and high levels of physical activity. The traditional pattern was associated with married subjects and male gender, whereas following date and coffee pattern was associated with a reduced number of meals and snacks. The protein pattern was associated with younger age and breakfast consumption behavior.

Limited studies have examined food intake in Saudi Arabia.2, 22, 23 Studies have shown that Saudi food intake is based on white rice, wheat bread, dates and Arabic coffee.22 A national study found that adult Saudis (older than 24 years) had higher intakes of fruit and vegetables than younger ages, and this is more likely linked to fruit consumption.2 In the current study, five dietary patterns were revealed from the analysis, which is consistent with the previously identified number ranging between 3 and 7 patterns.12, 14, 15, 24, 25 Together, these factors explained 54.89% of the variance in dietary intake, with the largest variance interpreted by the sweet and starch pattern (20.68%). The current study reported similar result to previous studies where the percentage of variance ranged between 27-63%.12, 14, 15
Although the labeling of dietary pattern was based on author interpretation of factors, the correlation coefficient of dietary pattern scores with energy and energy-adjusted nutrient intake further explored the characteristics of the identified dietary pattern and explained the labeling. The higher dietary pattern score "sweet and starch" pattern reflected a diet that is composed of high amounts of sugar, sweets, and starchy foods and dishes, which could explain its strongest correlation with energy intake. It has been reported that a high variety of foods, particularly added sugar foods (sweets), snacks, condiments, and other carbohydrates, along with a low variety of vegetables, promotes higher intake of energy, thereby contributing to increasing rates of obesity and diabetes. In addition, energy-dense foods and beverages consumed within this pattern could also affect the dietary quality of its consumers by prohibiting them from meeting the required daily nutrients intakes. In contrast, the healthy pattern reflected characteristics of healthy dietary intake, as it had the highest correlation with dietary fiber and many vitamin and mineral intakes and had a negative correlation with dietary cholesterol. This was expected, as foods in this healthy pattern are considered to be a good source of soluble fiber and other micronutrients and have been considered protective dietary factors associated with lower cardio-metabolic mortality risk in Middle East and North Africa region. Similarly, the protein pattern that correlated with egg and dairy product consumption was associated with protein, cholesterol, sodium, calcium and vitamin D consumption.

The current study showed differential relationship between dietary patterns and socio-demographic and lifestyle factors. Our findings revealed that the predominant dietary pattern was a "sweet and starch" pattern among Saudi adults. The strongest correlations with this pattern were male gender, frequent visits to fast food restaurants followed by being young, being educated and having less income. This observation was in line with previously reported dietary habits among Saudis, wherein fast food consumption behavior and energy dense foods such as sweets, sugar-sweetened beverages and savory snacks were widespread eating patterns among different age groups, especially young adults. The increasing number of franchised fast food restaurants and attractive Westernized high calorie snacks found in supermarkets with affordable prices resulted in this major lifestyle change. This change in dietary habits observed in Saudi adults had chronic health conditions and a high intake of starches, including starchy vegetables, rice, white bread and baked goods known to have a high glycemic load. Although dates and Arabic coffee are associated with a reduced number of meals and snacks per day, it did not reduce the obesity rate, which could indicate that date consumption in the Saudi culture is significantly high, which may increase the total calorie intake, leading to overweight and obesity. This had a negative effect on appetite regulation, energy expenditure and body weight and contributed to the obesity and diabetes epidemic in Saudi adults.

In this study, the healthy dietary pattern was linked with male gender, higher education with high income, older adults, breakfast consumption behavior and high level of physical activity. These findings are consistent with previous studies, where being older adults and males had healthy lifestyle practices and with higher socioeconomic status measured by education and income appeared to be significantly associated with a healthier dietary pattern. This could be explained by the fact that older people with higher education tend to be more health conscious and aware about the importance of a healthy lifestyle in promoting health and wellbeing.

Despite tremendous changes in the habitual dietary intakes of Saudis, some common traditional practices remain intact, such as the consumption of some traditional dishes and dates. The traditional pattern is characterized by Saudi tradition dishes, such as harees, qorsan, marqooq and gerish (Table 1). This study demonstrated that married subjects and males consume more of the Saudi traditional pattern, which could be explained by the fact that Saudi families consume more traditional food than Saudi singles, and males favor the consumption of red meat and other Saudi traditional dishes. Furthermore, people who are using traditional Saudi whole grain-based foods are associated with low BMI, which could be explained by the fact that traditional food has lower total calories and contains more dietary fiber than nontraditional foods, thus improving insulin resistance and protecting from many chronic diseases.
Finally, the protein dietary pattern was significantly associated with a younger age group and breakfast behavior consumption. This is in line with the findings from a similar Lebanese study.\textsuperscript{12, 14, 15} A positive correlation between higher protein intake and younger age group has been observed and previously reported wherein protein intake decreases with increasing age.\textsuperscript{37}

To our knowledge, the current study is one of the first studies to assess gains in dietary patterns in a sample of Saudi adults using a validated FFQ in the same population, where the FFQ is known to be the most commonly used method to assess usual food intake and a valid tool to identify dietary patterns by factor analysis.\textsuperscript{17, 38} This study is limited by its cross-sectional design, which does not allow us to further explore causal associations between dietary patterns and socio-demographic and lifestyle variables in Saudi adults. In addition, although the study was recruited the participants randomly, the results of the current study can not be generalized to the Saudi population.

In conclusion, five dietary patterns were identified in a sample of Saudi adults, which are the “sweet and starch” pattern, “date and coffee” pattern, “healthy” pattern, “traditional” pattern, and “protein” pattern. Findings from the current study support the differences in dietary patterns based on the population and these differences influenced by socio-demographic characteristics (age, gender, marital status, education level, income) and other lifestyle factors (breakfast consumption, number of meals, physical activity). Hence, there is an immediate need for implementing a national cohort study to examine the relationship between dietary pattern and the risk of cardiometabolic dysregulation.

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Conflict of Interest

The author(s) declares no conflict of interest.

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