Progress in Nutrition 2020; Vol. 22, N. 3: e2020013 DOI: 10.23751/pn.v22i3.8242

Original article

Consumption of some food groups is associated with the risk of cardiovascular disease among Jordanians

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Summary. *Background:* Strong evidence hypothesizes possible effects of certain food groups on the risk of cardiovascular diseases (CVDs). However, findings seem to be inconsistent across different populations and even few in Middle Eastern setting where cardiovascular diseases are endemic. *Aim:* To test the hypothesis, the present study aimed at investigating the associations between food groups consumption and risk of CVDs among Jordanians. *Methods:* A case control study was conducted using convenient sampling method with a total of 395 participants who underwent coronary angiography. Diagnosis of CVDs was confirmed by coronary angiography. Standardized and validated questionnaires were used to collect socio-demographic, health, lifestyle, and dietary data. *Results:* Mean age of participants was 52.7±0.7 and 50.7±0.7 years for cases and controls, respectively. While controls were found to be more active compared to controls, cases were less obese than controls. The study findings indicated that significant intake differences were detected between cases and controls in fruits (P=0.024), vegetables (P=0.025) and added sugar (P=0.007). Controls showed higher consumption of fruits (527.6±32.5 controls vs 431.7±27.1g cases) and vegetables (313.8±12.0 controls vs 275.5 ± 12.1 cases), while lower consumption of sweets and sugar (33.6±2.g cases vs 43.7±2.9g controls) was detected among cases of CVDs. A U-shape relationship was identified between risk of CVDs and consumption of vegetable oil, nuts and seeds (P>0.05)**.** *Conclusion:* While increased consumption of vegetable oil, seeds and nuts may be associated with decreased risk of CVDs among the study participants, the other tested food groups didn't show any significant associations with CVDs risk.

Key words: Cardiovascular Disease, Coronary Angiography, Food Groups

Introduction

One of the leading causes of death from diseases worldwide is cardiovascular diseases (CVDs). CVDs are considered as a significant cause of morbidity and mortality (1,2). An indispensable factor in this present reality is unhealthy lifestyle, promoted by the western dietary pattern and inadequate or absence of physical activity, both playing key roles in predisposing an individual to chronic diseases such as CVDs and their associated comorbidities (e.g., dysglycemia, hypertension, and dyslipidemia) (3). Global cardiovascular deaths are projected to increase from 16.7 million in 2002 to 23.3 million in 2030 (4). In 2008, CVDs was identified as the major cause of mortality in adults younger than 60 years old. By the year 2030, the World Health Organization (WHO) estimates that over 23.3 million deaths will be due to CVDs and this will continue to be a leading cause of death across the world if nothing is done (5). Furthermore, WHO identify unhealthy diets as one of the numerous risk factors causing CVDs which are modifiable, and their influence should be determined when considering CVDs incidence (5). This significant finding has made the analysis of lipid fractions in diets important in the prevention and management of CVDs (6). The link between the consumption of saturated fat (from animal products) and mortality has been identified by international statistics and has been implicated in coronary heart disease (7). Growing evidence supports that food-based dietary pattern which is usually loaded with whole grains, fruits, vegetables, legumes, nuts and seeds, and fish and heart-healthy fats is now considered as the best means to reduce CVDs, obesity, and type II diabetes mellitus (DM II) (8). On the other hand, diet rich in refined grains, red and processed meats, fast foods, fried foods, sweets and sugary foods and drinks is accused for the increased prevalence of many diseases including CVDs (3, 8).

Although evidence shows that some food groups can reduce the risk of developing CVDs, other indicates that these food groups can pose a risk on having CVDs. It is likely to find contradictory association between the consumption of the same food groups and the risk of CVDs among studies, especially that the components of each food group depend on culture and way of cooking. Therefore, this study aimed to test this hypothesis by evaluating the association between the intake from different food groups and the risk for developing CVDs in a Middle Eastern setting where CVDs is endemic.

Subjects and Methods

Participants and Study setting

Recruitment of participants was from Prince Hamzah catheterization section of the cardiology department. Recruitment took place between January and December 2015. Three hundred ninety seven (198 cases and 199 controls; 159 females and 238 males) in total were recruited and they all have undergone coronary angiography. Eligible patients were 18 years or older, were clinically stable, had no medical or social conditions that would limit their ability to participate, and who underwent coronary angiography. The exclusion criteria were: suffering from kidney, liver or gastrointestinal diseases, and all CVDs patients who have already been diagnosed with CVDs before angiography. Prior education was given to all participants about the study and all of them were requested to sign a consent form before commencement of the study. . The study was approved by Institutional Review Board Ethics Committee at Prince Hamzah Hospital (IRB number 2285/32/MH) and the Ethical guidelines of the 1975 declaration of Helsinki were followed.

Data Collection

Before commencement research assistants were selected, trained and given the standardized questionnaires to record participant's socio-demographic factors, previous health issues (hypertension, diabetes mellitus, dyslipidaemia), smoking status, and family history of CVDs information. These data were collected before the participants underwent coronary angiography.

Coronary Angiography

For this procedure trained cardiologist was recruited to use the seldinger technique to insert a catheter into the radial artery, and the tip was advanced to the aortic sinus cusp. A radio-contrast medium was passed through the coronary arteries to enable visualisation of the arterial tree while the X-ray is taken. To determine the area of narrowing, the degree of obstruction was estimated by comparing the arterial lumen to the adjacent normal artery and the value recorded in percentage (9). Consistent with prior studies, CAD was defined as ≥20% stenosis of one or more coronary arteries. Participants with no stenosis (0%) were enrolled as controls (9).

Nutrients Intake Assessment

A validated food frequency questionnaire (FFQ) was administered by trained dietician to assess the dietary intake pattern (10). The questionnaire was interview-based and participants were asked to record how frequently, on average, during the past year they had consumed one standard serving of specific food items in nine categories below (<1/month, 2–3/month, 1–2/week, 3–4/week, 5–6/week, 1/day, 2–3/day, 4–5/day, or 6/day). The classifications of food groups were: Dairy Products; Starches (Whole grains, Refined grains, Starchy Vegetables, Stuffed Vegetables Crackers and Snacks); Fruits (Fruits and Fruit Juices); Vegetables; Proteins (Cheeses, Eggs, Poultry, Red meat, Fish, Processed meat); Legumes; Sweets, Desserts, and Other Carbohydrates (Desserts, Sweets and Sugar, Sugary Drinks); Fats and Oils (Olive Oil, Vegetables Oils, Nuts and seeds, Animal Fats); Coffee; and Tea. To allow proper estimation of portion size, the food models and standard measuring tools were used. For analysis of dietary intakes, dietary analysis software (ESHA Food Processor SQL version 10.1.1; ESHA, Salem, OR, USA) was used with additional data on foods consumed in Jordan (11)

7-day Physical Activity Recall (PAR)

A 7-day PAR validated and an organized questionnaire was used to calculate a participant's recall of time spent doing exercise over a seven-day period (12). This questionnaire helps to ascertain the individual physical activity level into 3 categories: inactive, minimally active, and health-enhancing physical activity (12).

Anthropometric Measurements

For anthropometric measurements were taken correctly by a trained dietician according to Lee and Nieman (13). The body weight was measured to the nearest 0.1 kilogram and before doing this we made sure it was taken without shoes, with minimal clothing and using a calibrated scale (Seca, Hamburg, Germany). With the participants not wearing any shoe and in standing position the height was measured to the nearest 0.1 cm using a portable calibrated measuring rod (13). The body mass index (BMI) was calculated afterwards by dividing weight in kilograms to the square of height in meters and was categorized as normal body weight, 18.5-24.9; overweight, 25.0 to 29.9; and obese, >30.0 according to the World Health Organization (14).

Statistical Analyses

For the statistical analysis, SPSS version 20.0 software (SPSS Inc., Chicago, IL, USA) was used. The means ± standard error of means (SEM) and percentages were used for descriptive statistics and the significance level was set at $P \leq 0.05$. For continuous variables unpaired student's *t*-test was used to evaluate the differences between the mean values for cases and controls, while to detect the categorical variables differences, Chi-square test was used. Odd ratios (OR), 95% confidence interval (CI), and *P-value-trend* were all calculated using the multinomial and linear logistic regression models. Finally, based on the reported CVDs risk factors the potential confounders (age, gender, BMI, smoking, physical activity, total energy intake, occupation, education level, marital status and family history) were chosen (15).

Results

Table 1 shows general characteristics of the study participants (239 males and 160 females). Mean age of participants was 52.7 ± 0.7 and 50.7 ± 0.7 years for cases and controls, respectively. There were differences in physical activity measured as MET (min/week). Overall, the cases were less active compared to controls, and reported more previous health problems than controls, in both men and women. Additionally, the occurrence of obesity is higher in controls than in controls.

Table 2 presents means of reported daily consumption from different food groups among cases of CVDs versus controls. Patients with CVDs reported lower consumption of fruits (*P*=0.024) and vegetables (p=0.025) as compared to controls. No differences were detected between cases of CVDs and controls with regard to mean daily consumption of dairy products (p=0.790), starches [whole grains (*P*= 0.178); refined grains (*P*= 0.508); starchy vegetables (*P*= 0.107); stuffed vegetables (*P*= 0.328); crackers and snacks (*P*= 0.112)], animal and plant proteins [cheeses (*P*= 0.635); eggs (*P*= 0.704); poultry (*P*= 0.525); red meat (*P*= 0.146); fish (*P*=0.988); processed meat (*P*= 0.493) and legumes (*P*= 0.917)], fruits juice (*P*=0.417), coffee (*P*=0.585), and tea (*P*=0.459). Surprisingly, the cases of CVDs reported lower mean daily consumption of sweets and sugar (33.6±2.3g) than controls (43.7±2.9g) with p= 0.007.

Table 3 represents the risk of CVDs across quartiles of food groups consumption. Interesting U-shape relationship was identifies between risk of CVDs and vegetable oil, seeds and nuts. For instance, participants in quartile 2 of vegetable oil consumption had about 60% lower risk (OR=0.41; CI 0.19-0.91) of CVDs

Table 1: General Characteristics of Participants (16)

Variables		Cases (n =198) (mean ± SE)	Controls (n=199) (mean ± SE)
Age (y)		52.7 ± 0.7	50.7 ± 0.7
BMI (kg/m²)		30.5 ± 0.5	30.8 ± 0.4
Waist circumferences		107.7 ±1.3	106.1 ± 1.2
MET (min/week)		9878.2 ± 531.1	12206.1± 543.1
		n (%)	**n (%)**
Marital status	**Married**	178 (89.9)	185(93.0)
	Single	5 (2.5)	4 (2.0)
	Divorced	1 (0.5)	3 (1.5)
	Widowed	14 (7.1)	7 (3.5)
Education	**Illiterate**	29(14.7)	14 (7.0)
	Primary	88 (43.0)	85 (42.7)
	Secondary	49 (24.9)	54 (27.1)
	Diploma	18 (9.1)	19 (14.6)
	Bachelor	10 (5.1)	2 (8.0)
	Master & PhD	3 (1.5)	1 (0.5)
Work	**Yes**	95 (48.0)	91 (45.7)
	No	103 (52.0)	108 (54.3)
BMI categories	**Underweight**	0 (0.0)	0 (0.0)
	Normal	32 (16.2)	15 (15.6)
	Overweight	81 (40.9)	85 (26.1)
	Obese	85 (42.9)	116 (58.3)
MET categories	**Inactive**	15 (7.5)	5(2.5)
	Minimally active	56 (28.3)	28 (14.1)
	Health Enhancing physical activity	127 (64.1)	166 (83.4)
Smoking	**Yes**	94 (47.5)	74 (37.2)
	No	53 (26.8)	71 (35.7)
	Previous	15 (7.6)	10 (5.0)
	Passive	36 (18.2)	44 (22.1)
Argali/water pipe	**Yes**	10 (5.1)	16(8.0)
	No	179(90.4)	173 (87.0)
	Previous	14 (4.5)	8 (4.0)
	Passive	0 (0)	2 (1.0)
Family history of CVD	**Yes**	81 (40.9)	72 (45.3)
	No	117 (59.1)	87 (54.7)

Abbreviations: SEM, standard error of mean; BMI, body mass index; MET, metabolic equivalent-minute.

Table 2. Mean daily food groups/food item intakes among cases and controls.

Food Groups / Food Items	Cases (n=198) Mean ± SEM	Controls (n=199) Mean ± SEM	*P*-value
Dairy Products(g/day)	197.7 ± 12.0	203.3 ± 17.3	0.790
Starches			
Whole grains (g/day)	24.7 ± 3.6	32.5 ± 4.5	0.178
Refined grains (g/day)	256.2 ± 9.8	247.2 ± 9.4	0.508
Starchy vegetables (g/day)	39.1 ± 3.3	47.9 ± 4.3	0.107
Stuffed vegetables (g/day)	20.1 ± 1.6	22.3 ± 1.6	0.328
Crackers and snacks (g/day)	16.0 ± 1.8	20.1 ± 1.9	0.112
Fruits (g/day)	**431.7 ± 27.1**	**527.6 ± 32.5**	**0.024**
Fruit juices (ml/day)	76.6 ± 9.0	67.1 ± 7.5	0.417
Vegetables (g/day)	**275.5 ± 12.1**	**313.8 ± 12.0**	**0.025**
Protein			
Cheeses (g/day)	61.5 ± 3.8	64.2 ± 4.0	0.635
Eggs (g/day)	26.3 ± 2.4	27.7 ± 2.6	0.704
Poultry (g/day)	38.7 ± 2.5	36.6 ± 2.2	0.525
Red meat(g/day)	39.7 ± 3.4	33.7 ± 2.4	0.146
Fish (g/day)	19.4 ± 1.5	19.4 ± 1.6	0.988
Processed meat (g/day)	7.1 ± 1.5	6.0 ± 0.78	0.493
Legumes (g/day)	186.4 ± 13.0	184.6 ± 10.8	0.917
Sweets, Desserts, and Other Carbohydrates			
Desserts (g/day)	52.3 ± 4.9	60.1 ± 7.3	0.374
Sweets and sugar (g/day)	**33.6 ± 2.3**	**43.7 ± 2.9**	**0.007**
Sweets (g/day)	11.5 ± 1.2	13.6 ± 2.3	0.412
Sugary Drinks (ml/day)	391.8 ± 47.7	365.7 ± 44.7	0.689
Fats and Oils			
Vegetables oils (ml/day)	10.6 ± 0.56	10.6 ± 0.52	0.925
Animal fats (g/day)	3.8 ± 0.87	4.7 ± 1.0	0.491
Nuts and seeds (g/day)	14.1 ± 2.1	13.4 ± 1.6	0.802
Coffee (ml/day)	157.7 ± 10.4	149.4 ± 11.1	0.585
Tea (ml/day)	545.3 ± 32.7	580.4 ± 34.4	0.459

Abbreviations: SEM, standard error of mean.

compared to those in quartile 1 of consumption. However, participants in the quartile 3 and quartile 4 of vegetable oil consumption were at similar risk of CVDs to those participants in quartile 1. Similar relationship was identified with regard to seeds and nuts consumption. Participants in quartile 2 of vegetable oil

Table 3: The OR (95%CI) for Food items intake among Jordanian participants.

Food Items	Q1	Q2	Q3	Q4
Fruit (g/day)				
Number of Cases	53	55	47	43
Number of Controls	46	44	51	56
OR (95%CI)	1	1.23 (0.68-2.23)	0.92 (0.51-1.68)	0.72 (0.40-1.31)
Vegetables (g/day)				
Number of Cases	52	64	39	43
Number of Controls	47	36	60	56
OR (95%CI)	1	1.65 (0.90-3.0)	0.63 (0.35-1.14)	0.72 (0.40-1.30)
Sweets and sugar (g/day)				
Number of Cases	52	54	52	40
Number of Controls	47	46	47	59
OR (95%CI)	1	1.08 (0.60-1.93)	0.95 (0.53-1.70)	0.58 (0.32-1.07)
Whole grains (g/day)				
Number of Cases	58	65	26	49
Number of Controls	56	61	32	50
OR (95%CI)	1	1.13 (0.67-1.93)	0.97 (0.50-1.90)	0.85 (0.48-1.50)
Refined grains (g/day)				
Number of Cases	49	50	48	51
Number of Controls	50	49	52	48
OR (95%CI)	1	1.1(0.62-2.0)	0.85 (0.47-1.5)	1.1 (0.62-2.1)
Vegetables Oils(ml/day)				
Number of Cases	72	58	12	56
Number of Controls	62	64	30	43
OR (95%CI)	1	0.81 (0.48-1.3)	**0.41 (0.19-0.91)**	1.3 (0.72-2.2)
Nuts and seeds (g/day)				
Number of Cases	57	56	37	48
Number of Controls	44	42	66	47
OR (95%CI)	1	1.3(0.69-2.3)	**0.48 (0.26-0.86)**	0.97 (0.54-1.8)

[a] Reference quartiles. [b] Adjusted for age, gender, body mass index, smoking, physical activity, total energy intake, education level and family history.

consumption had 52% lower risk (OR=0.48; CI 0.26-0.86) of CVDs as compared to those in quartile 1 of consumption.

Discussion

The current case control study investigated the associations between the consumption of different food groups on the risk of cardiovascular disease. For instance, in the current study, participants in the control group reported higher mean daily consumption of fruits and vegetables when compared to participants with CVDs. This finding is consistent with previously published work that revealed an inverse association between these food groups intake and CVDs (16-19) as well as the risk for stroke (18, 20, 21). This can be attributed to the fact that vegetables and fruits, influence inflammatory processes, help to reduces free radicals from redox reactions within the body just like nutrients and phytochemicals. Therefore, these mechanisms could be responsible for the beneficial risk-reducing attributes of consumption of vegetable and fruit and the resultant benefits to help reduce risk factors for cardiovascular and other diseases (21).

Furthermore, we observed an association between nuts and seeds consumption and risk of CVDs which was in line findings in previous analyses, where an association between higher nuts consumption and reduced risk of CVDs was noticed (19, 22-26). In another study by Schwingshackl *et al*. (2017), an inverse association was seen between the risk of CVDs, hypertension, and lower levels of total cholesterol and LDL-cholesterol and nuts consumption (27). The contents of nuts (unsaturated fatty acids, protein, fiber, vitamin E, potassium, magnesium, and phytochemicals) may explain how increasing consumption of nuts could be linked to reduced cardiovascular risk (27). Moreover, various epidemiological studies showed that consumption of nuts frequently has been associated with decreased risk of coronary heart disease (CHD). For a clearer understanding of the association between nuts and its protective effect on cardiovascular health, further research is required. Although, studies have recommended addition of nuts as part of healthy diet plan for reduction of cardiovascular related diseases (28).

The current study showed also a potential beneficial effect of moderate consumption of vegetable oil on risk of CVDs. Studies investigated the impact of vegetable oil on risk of CVDs found contradicting results (29, 30). For instance, it was reported by Okuyama *et al* (2016) that certain types of vegetable oil may lead to inhibition of vitamin K_2-dependent processes which in turn increases risk of CVDs (29). In Jordan, the major constituent of consumed vegetables oil is olive oil (31, 32). Recent meta- analysis reported that olive oil consumption improves several outcomes related to CVDs including measures of malondialdehyde, total cholesterol, HDL-cholesterol, inflammatory markers and blood pressure (33).

Previous studies showed that added sugar is associated with increased triglycerides, triglyceride: HDL ratio and reduced HDL-cholesterol (34). A study by Yang *et al*. (2014) also observed that sugar consumption and CVDs mortality relationship is significant (35). Studies have reported that increased sugar consumption is associated with increased blood pressure, increased de novo hepatic lipogenesis, and increased inflammation (35).

Furthermore, added sugars have been related to vascular risk factors and CHD although findings are inconclusive (36). DiMeglio and Mattes (2000) attributed this risk-increasing association to impairments of the regulation of hunger and satiety which may lead to weight gain and obesity (37). Inconsistent to the previously reported data, our findings suggested lower consumption of sugar among cases (about 10 g/day less) compared to that reported by the controls. This inconsistency in the findings could be due to our study design in which the temporal relationship between the risk factor (sugar intake) and outcome (CVDs) is questioned. A similar results were obtained in a case-control study investigated the association between colorectal cancer and dietary patterns among Jordanians. Tayyem *et al* (2017) showed in their study that most of the consumed sugar was coming from sugar added to tea (38). They also reported tea, which is the main carrier of added sugar in Jordanian diet, contains polyphenols that may protect against colorectal cancer (38). Siddiqui *et al* (2004) documented that tea drinkers appear to have lower risk diseases such as simple infections, like bacterial and viral, to chronic debilitating diseases, including cancer, coronary heart disease, stroke, and osteoporosis (39).

The main strength points of this study are the use of a validated Arabic FFQ that was modified to reflect the food consumption pattern in Arab countries, especially Jordan. The use of food models and measuring tools to estimate portion sizes is another point that can improve the accuracy of the collected data. One of the main limitations in this study is using a dietary assessment tool that depends on memory recall. The one year dietary recall period which is usually used in the FFQ may not be an accurate amount of time in which to conclude that an association exists between different food groups consumption and CVDs risk. However, we believe that the recall period of one year is very likely reflective of the previous years. Another limitation is the difficulty of matching in age between females in cases and controls. Being case or control was depending on the results of the coronary angiography which could not be done for the subjects to enroll cases or controls. Therefore, females who underwent angiography and showed no artery occlusion were enrolled in the cases groups. However, we attenuated the effect of this possible difference in age by adjusting for age in all used statistical analysis. Even though sample size was relatively small, calculating the sample size estimated the required size should be around 385 subjects. Data collection took around one year to be reach to this sample size.

In conclusion, findings of this study provide additional evidence about the protective effect of vegetables oils, seeds and nuts. The association between sugar and sweets with CVDs as obtained in this study needs further studies using different research design to assure the temporal direction of the food intakes and the clinical CVDs outcome. Hence, the hypothesis of our study could be accepted for the possible protective effect of vegetables oils, seeds and nuts consumption on declining CVDs risk.

Acknowledgement

We thank the patients who participated in the study, and the hospital management for facilitating the data collection and all other aspects of this research. Also, we would like to thank Qatar University for funding the publication of this article.

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