Research Square

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The Relationship Between Recommended and None Recommended Food Scores on Cardiovascular Risk Factors in Obese and Overweight Adult Women: A Cross Sectional Study

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Abstract

Objective: No studies have examined the relationship between recommended food score (RFS), none recommended food score (NRFS) and cardiovascular risk factors. This study was conducted to evaluate the association of RFS and NRFS with cardiovascular risk factors in overweight and obese women.

Methods: This cross-sectional study was performed on 379 overweight and obese (BMI ≥25 kg/m^2) women aged 18-48 years. Anthropometric measurements and body composition analysis were assessed in all participants. Dietary intake was assessed by a valid and reliable food frequency questionnaire (FFQ) containing 147 items and RFS and NRFS calculated. Biochemical assessments including TC, HDL, LDL, TG, FBS, insulin, HOMA-IR and hs-CRP were quantified by ELISA.

Results: The mean age and BMI of participants were 36.73±9.21 (y) and 31.17±4.22 (kg/m^2) respectively. Binary logistic analysis showed that participants in the highest quartile of the RFS compared to the lowest quartile had 82% lower risk for Hypertriglyceridemia [OR=0.18, 95%CI=0.06-0.53, P=0.002] and 91% lower risk for abdominal obesity [OR=0.09, 95%CI=0.008-1.04, P=0.05]. in addition, Participants who were in the highest quartile of the RFS compared to the lowest quartile had lower HOMA-IR [OR=0.29, 95%CI=0.08-1.00, P=0.05]. subjects with high adherence to the NRFS had lower HDL [OR=2.11, 95%CI=1.08-4.12, P=0.02] and higher risk for Hypertriglyceridemia [OR=2.95, 95%CI=1.47-5.94, P=0.002] compared to low adherence.

Conclusions: There was an inverse significant association between adherence to RFS and risk of Hypertriglyceridemia, insulin resistance, and abdominal obesity. There was a significant association between NRFS and Hypertriglyceridemia, and also we found an inverse relationship between NRFS and HDL.

Introduction

Currently, one third of the world's population is overweight or obese, and expected that if current trends continue, in 2030, 57.8% of the world's population will be overweight or obese(1). Recent estimates indicate that the prevalence of obesity in Iran is increasing and may now be more than 26%, also obesity is higher in Iranian women than men(2). obesity in women is higher than men, because difference between sex hormones in men and women and lower resting metabolic rate (RMR) in women(3). Obesity negatively affects almost all physiological functions of the body and increases blood pressure (BP)(4), blood sugar(5), triglyceride(TG), and low-density lipoprotein cholesterol (LDL-C), and decreases high-density lipoprotein cholesterol (HDL-C)(6). These changes increase the risk of cardiovascular disease (CVD). Studies have also shown that obesity is an independent risk factor for CVD(7, 8). The etiology of obesity is complex and multifactorial and arises from the interaction of genetic, physiological, environmental, psychological, social and economic factors. Among these factors, diet play an important role in development of both obesity and CVD(9, 10).

Many methods have been proposed to evaluate diet quality. In some methods, the amount of single nutrients is assessed, and also there are various indicators that focused on total diet and several food groups. One way to evaluate dietary patterns is to separate good and bad foods to describe a “healthy diet” and a “less healthy diet”(11). recommended food score(RFS)(12) and none recommended food score (NRFS)(13) were developed on this basis. RFS is included fruits, vegetables, whole grains, lean meats or meat alternates, and low-fat dairy(12). NRFS is included red meat, Processed meat, chips, High-fat dairy, Solid oil, Refined grains, and variety of sweetened foods(13).

Numerous studies have reported the beneficial effects of diets rich in whole grains or fruits and vegetables on weight management and cardiovascular risk factors(14, 15). These diets are high in fiber, folate, nitrate, vitamins, and flavonoids and These compounds play their role by different mechanisms including reduce oxidative stress and modify lipid levels(16). The results of studies have shown that women with higher RFS have lower mortality(12), particularly lower coronary heart disease (CHD) and stroke mortality. It is also observed that adherence to the dietary approaches to stop hypertension (DASH) diet, which is high in fruit, vegetables, and low-fat dairy foods, significantly lowers BP, LDL(17), TG(18), high-sensitivity C-reactive protein (hs-CRP) and increases HDL(19). The NRFS did not appear to play an important role for mortality from cancer, CHD, and stroke(13), but high consumption of red and processed meat raises BP and LDL(20, 21). Studies have also shown that consuming high-fat dairy products increases LDL(22), and the consumption of high- carbohydrate foods with high glycemic indices (GI) increases glucose, Homeostatic model assessment insulin resistance (HOMA-IR) and insulin levels(23).

We hypothesized that RFS and NRFS may associate with cardiovascular risk factors; however, there is no study to clarify the association between RFS or NRFS and cardiovascular risk factors. Therefore, the current study was designed to examine the association between RFS, NRFS and cardiovascular risk factors in overweight and obese women.

Method

Study population

The present cross-sectional study was performed on 379 obese or overweight women who were randomly selected from individuals referred to health centers in Tehran. Inclusion criteria were being female, age 18–48 years, and body mass index (BMI) ≥ 25. Exclusion criteria were included cancer, liver or kidney disease, thyroid disease, other acute and chronic diseases, smoking, take weight loss supplements, use of drugs to lower blood sugar, blood pressure and blood lipids, use of alcohol, pregnancy or lactation, adherence to a specific diet over the past year. we also excluded patients who reported a total energy intake outside the range of 800–4,200 kcal/day. The protocol was approved by ethics committee of Tehran University of Medical Sciences (IR.TUMS.VCR.REC.1397.577). All protocols are carried out in accordance with relevant guidelines and all participants signed an informed consent form.

Dietary Assessment

To assess the dietary intake of participants, a 147- item semi-quantitative food frequency questionnaire (FFQ) was used. The validity and reliability of FFQ were approved in Iran(24).The FFQ evaluates the usual food intake over the previous year and consisted of a list of foods with standard serving sizes usually consumed by Iranians. We used FFQ in previous studies and have described it in detail(25). All FFQ questionnaires were completed by trained dietitians during face-to-face interviews. Food analysis was done using Nutritionist IV software modified to reflect the Iranian context (First Databank Division, The Hearst Corporation, San Bruno, CA, USA).

Recommended food score and none recommended food score

The RFS was developed by Kant et al. to measure overall diet quality, and it’s based on the consumption of foods recommended by dietary guidelines(12). We rearranged RFS based on the Iranian diet, so some of its components are different from the RFS provided by Kant et al. The RFS included the following foods: apples or pears; oranges; cantaloupe; grapefruit; orange or grapefruit juice; other fruit juices; tomatoes; broccoli; spinach; turnip; carrots; green vegetables; potatoes; baked or stewed chicken; baked or broiled fish; beans; whole wheat bread; dark toast; low fat milk; low fat yogurt. The RFS is calculated by summing up these 20 items that consumed at least once a week, so the maximum score is 20. NRFS was develop by Michels KB et al. to complete RFS(13). We also rearranged NRFS based on the Iranian diet, our NRFS included: meat; beef; minced meat; liver/kidney; bacon/ sausages; cold cuts; fried potatoes; chips; high fat milk/ yogurt; cheese; ice cream; cream; butter/margarine; hydrogenated vegetable oil; white bread; spaghetti; sugar; candy; biscuits. Table 1 shows the components of RFS and NRFS. All dietary components were adjusted for energy. For each food item that consumed at least once a month score 1 was considered and the maximum score is 19.

Table 1
Foods and food groups in RFS and NRFS

Food items	
RFS	NRFS
apple or pear	Meat
Orange	Beef
grapefruit	minced meat
cantaloupe	liver/kidney
orange or grapefruit juice	bacon/ sausages
other fruit juice	Cold cut
Tomato	High fat milk/ yogurt
broccoli	Cheese
Spinach	Ice cream
Turnip	Cream
Carrot	butter/margarine
Green vegetable	hydrogenated vegetable oil
Potato	fried potatoes
baked or stewed chicken	Chips
baked or broiled fish	white bread
Beans	spaghetti
whole wheat bread	Sugar
dark toast	Candy
low fat milk	Biscuits
low fat yogurt	

Biochemical assessment

After 12 to 14 h of overnight fasting, blood samples were obtained from all participants. Serum samples were centrifuged for 10 min at 3000 rpm, divided into 1 ml tubes and were frozen at -80 °C. Serum concentrations of total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglyceride (TG) were evaluated by using of enzymatic approaches using related kits (Pars Azmun, Iran) and auto analyzer system. The serum fasting glucose concentration was measured using an enzymatic colorimetric method with the glucose oxidase technique and Insulin level was assessed using the enzyme linked immunosorbent assay (ELISA) kit (Human insulin ELISA kit, DRG Pharmaceuticals, GmbH, Germany). Serum high-sensitive C-reactive protein (hs-CRP) was evaluated with the use of the immunoturbidimetric assay. All blood analyses were done at the Endocrinology and Metabolism Research Institute (EMRI) Bio nanotechnology laboratory of Tehran University of Medical Science.

The HOMA-IR calculation

IR was calculated by the homeostatic model assessment (HOMA) according to the following equation: HOMA-IR= [fasting plasma glucose (mmol/l) × fasting plasma insulin (mIU/l)]/22.5(26).

Resting metabolic rate (RMR) Measurement

The RMR was determined using indirect calorimetry based on the device protocol. Indirect calorimetry calculates the RMR by measuring the amounts of consumed oxygen and produced carbon dioxide. The amount of inhaling and exhaled breath was transmitted by a filter attached to the mask that completely covers a person’s nose and mouth, and sensor. The device measured the concentration of CO_2 and O_2 using the ventilated hood and analyzed the amount of RMR. All measurements were assessed in the morning, after a comfortable night’s sleep. Participants were instructed to fast and drink only water for 12 h before testing and wear comfortable clothing and don’t do any sever physical activity(27).

Anthropometric assessment

Height was measured while participants were standing, without shoes, with their shoulders in a normal position, using a stadiometer (Seca, Hamburg, Germany), and was recorded to the nearest 0.5 cm. While subjects were minimally clothed and not wearing shoes, weight was measured with the use of a digital scale (Seca, Hamburg, Germany) and recorded to the nearest 100 g. Obesity and overweight were defined as BMI $\geq$ 30 kg/m2 and 25 $\leq$ BMI $\leq$ 29.9 kg/m2, respectively. BMI was calculated as weight divided by height squared (kg/m2).

body composition analysis

Body composition parameters included amount and proportion of body fat percentage (BF %), fat mass (FM) and fat free mass (FFM), waist circumference (WC) and waist-to-hip ratio (WHR) were taken by multi-frequency bioelectrical impedance analyzer (BIA): InBody 770 Scanner (InBody Co., Seoul, Korea). Measurements were performed in the morning in fasting state and with light clothing. Participants were asked not to exercise, carry any electric devices, and urinating just before the body composition analysis to get a more accurate result. According to the instructions, participants stood on the scale in bare feet and held the handles of the machine for 20 seconds, then, the output was printed. Measurement method previously described in detail (27).

Assessment of blood pressure

Blood pressure and pulse were measured using a standard sphygmomanometer (Omron, Germany, European) by a trained physician, while the participants were at rest for 15 minutes.

Hypertension was defined as systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg(28).

Assessment of other variables

International Physical Activity Questionnaire (IPAQ), that was calculated as metabolic equivalent hours per week (METs h/week) used to assess physical activity (PA) (29).

demographic characteristics including age, marital condition, education status, particular diets, chronic disease history, and medicine consumption were asked by a trained nutritionist.

Statistical Analysis

Normality distribution was evaluated by applying Kolmogorov-Smirnov's test. For describing the baseline characteristics of the study population descriptive analysis was used. Data on quantitative characteristics were reported as the mean ± standard deviation (SD) and data on qualitative characteristics were expressed as a number. A score indicating adherence to the RFS and also a score for NRFS were calculated. All subjects were ranked according to their scores to the 4 RFS groups and also to the 3 NRFS groups. One-way Analysis of variance (ANOVA) and Chi-square tests were used to compare quantitative and qualitative characteristics of participants across different values of adherence to the RFS and NRFS. To determine the relationship between RFS and NRFS and cardiovascular risk factors, logistic binary regression was utilized in crude model and adjusted model. Adjustments were made for age, energy, PA, BMI, RMR, education level, marital status, diet resistance, age of onset of obesity Family history of obesity and economic status. In all multivariate models, Q1 of the RFS and T1 of the NRFS were considered as reference. Statistical analysis was performed using SPSS v23 software. Also P-value less than 0.05 was defined as the significance level.

Results

Study population

The mean age, weight, and BMI of participants were 36.73 ± 9.21 (y), 80.94 ± 12.08 (kg), and 31.17 ± 4.22 (kg/m^2) respectively. The biochemical, anthropometric and demographic characteristics of the subjects are reported across the RFS quartiles in Table 2. Our results demonstrated a significant difference in distribution of pulse (P = 0.03) and LDL (P = 0.04) across RFS groups in the crude model, but after adjustment for age, BMI, energy, and PA these associations disappeared. Also after adjustment a marginal significant difference in distribution of FBS (P = 0.05) and a significant difference in distribution of marital status (P = 0.04) across RFS groups were observed. Other variables did not significantly differ between the RFS quartiles.

Table 2
Participant characteristics in RFS quartiles

Variables	RFS				P value*	P value**
	Q1 (n = 94)	Q2 (n = 95)	Q3 (n = 95)	Q4 (n = 95)		
	mean ± SD					
Demography						
Age(y)	36.08 ± 9.18	36.08 ± 9.64	38.20 ± 9.30	36.55 ± 8.66	0.33	0.09[a]
Weight(kg)	80.44 ± 12.46	80.70 ± 12.43	81.39 ± 11.58	81.22 ± 12.01	0.94	0.99
Height(cm)	161.04 ± 5.69	161.90 ± 6.18	160.61 ± 6.32	161.19 ± 5.34	0.50	0.47
PA(METs h/week)	1207.97 ± 281.51	1484.35 ± 392.48	1209.70 ± 213.50	973.31 ± 109.64	0.61	0.66[b]
Blood pressure						
SBP(mmHg)	111.22 ± 17.83	112.66 ± 14.74	110.54 ± 11.27	110.75 ± 14.49	0.84	0.08
DBP(mmHg)	76.39 ± 13.37	77.69 ± 10.38	78.82 ± 7.44	77.13 ± 9.57	0.57	0.53
Pulse	82.00 ± 11.79	77.83 ± 9.82	80.86 ± 10.78	77.55 ± 8.90	**0.03**	0.36
RMR	1600.89 ± 278.27	1561.88 ± 254.66	1562.57 ± 262.19	1584.75 ± 249.36	0.77	0.91
Body composition						
BFM(kg)	34.57 ± 8.75	34.04 ± 8.72	35.36 ± 8.08	34.17 ± 8.93	0.71	0.19[c]
FFM(kg)	45.96 ± 5.45	46.84 ± 6.06	46.40 ± 5.69	46.65 ± 5.4	0.73	0.73[c]
SMM(kg)	25.33 ± 3.45	25.73 ± 3.60	25.44 ± 3.39	25.58 ± 3.26	0.87	0.70[c]
BMI (kg/m²)	31.02 ± 4.35	30.84 ± 4.16	31.65 ± 4.20	31.15 ± 4.21	0.58	0.90[c]
PBF(%)	42.37 ± 5.24	41.72 ± 5.22	42.89 ± 5.11	41.48 ± 6.30	0.27	0.72[c]
WHR	0.93 ± 0.05	0.93 ± 0.05	1.89 ± 9.34	0.92 ± 0.04	0.39	0.25[c]
WC(cm)	99.29 ± 10.23	99.46 ± 10.37	100.40 ± 9.55	98.57 ± 9.82	0.65	0.18[c]
Biochemical assessment						

Variables	RFS				P value*	P value**
	Q1 (n = 94)	Q2 (n = 95)	Q3 (n = 95)	Q4 (n = 95)		
	mean ± SD					
FBS(mg/dl)	87.72 ± 11.79	88.19 ± 9.82	87.47 ± 8.53	86.16 ± 7.87	0.70	**0.05**
T-Chol (mg/dl)	182.93 ± 39.93	183.45 ± 35.42	195.01 ± 33.30	179.64 ± 32.63	0.10	0.33
HDL(mg/dl)	47.63 ± 9.39	45.47 ± 12.74	46.89 ± 11.30	47.74 ± 10.30	0.65	0.65
LDL(mg/dl)	92.00 ± 24.02	92.52 ± 24.42	103.08 ± 25.45	93.71 ± 21.17	**0.04**[d]	0.90
TG(mg/dl)	117.90 ± 61.71	116.83 ± 54.04	114.20 ± 57.55	122.92 ± 63.41	0.86	0.72
ALT(U/L)	17.56 ± 7.37	17.19 ± 4.79	18.73 ± 9.45	18.22 ± 7.36	0.68	0.54
AST(U/L)	19.40 ± 14.21	16.80 ± 7.22	22.08 ± 16.04	18.64 ± 12.66	0.18	0.77
Hs.CRP(mg/L)	3.83 ± 4.31	4.26 ± 4.96	4.48 ± 4.44	4.49 ± 4.75	0.84	0.26
HOMA-IR	3.01 ± 1.16	3.32 ± 1.16	3.35 ± 1.34	3.48 ± 1.33	0.34	0.31
Insulin(IU/ml)	1.21 ± .25	1.22 ± .24	1.17 ± 20	1.24 ± .22	0.35	0.53
Qualitative variables [€]						
Marital status Single Married	27(26.5) 66(24)	33(32.4) 61(22.2)	23(22.5) 72(26.2)	19(18.6) 76(27.6)	0.10	**0.04**
Education Illiterate Diploma Bachelor and higher	0(0) 11(22.9) 82(25.2)	2(50) 15(31.3) 77(23.7)	1(25) 15(31.3) 79(24.3)	1(25) 7(14.6) 87(26.8)	0.38	0.60

Variables	RFS				P value*	P value**
	Q1 (n = 94)	Q2 (n = 95)	Q3 (n = 95)	Q4 (n = 95)		
	mean ± SD					
Economic status Poor Moderate Good Rich	9(23.7) 39(24.2) 34(23.1) 6(31.6)	10(26.3) 37(23) 38(25.9) 5(26.3)	15(39.5) 41(25.5) 33(22.4) 5(26.3)	4(10.5) 44(27.3) 42(28.6) 3(15.8)	0.43	0.32
History of weight loss Yes No	43(22.6) 43(27.4)	54(28.4) 36(22.9)	48(25.3) 38(24.2)	45(23.7) 40(25.5)	0.58	0.41
Resistant to diet Yes No	24(26.1) 62(24.8)	22(23.9) 66(26.4)	20(21.7) 64(25.6)	26(28.3) 58(23.2)	0.57	0.25

¥: Data are presented as Mean ± SD. €: Data are presented as n (%). Abbreviations: PA: physical activity; SBP: systolic blood pressure; DBP: diastolic blood pressure; RMR: resting metabolic rate; BFM: body fat mass; FFM: fat free mass; SMM: Skeletal muscle mass; BMI: body mass index; PBF: Percent body fat; WHR: Waist hip ratio; WC: Waist circumference; FBS: free blood sugar; HDL: high-density lipoprotein; LDL: low-density lipoprotein; ALT: Alanine aminotransferase; AST: aspartate aminotransferase; hs-CRP: high sensitivity C-reactive protein. HOMA-IR: Homeostatic Model Assessment for Insulin Resistance

*P values resulted from ANOVA analysis. P value < 0.05 is significant

**P values presented resulted from ANCOVA analysis and were adjusted for age, BMI, energy and physical activity.

a: age considered as collinear and this variable adjusted for BMI, energy and physical activity.

b: PA considered as collinear and this variable adjusted for age, BMI and energy.

c: BMI considered as collinear and this variable adjusted for age, energy and physical activity.

d: association between quartile 1 and quartile 3 of recommended food score groups, resulted by Tukey analysis.

Table 3 presents the characteristics of the participants by tertiles of NRFS. Our findings showed a marginal significant difference in distribution of RMR (P = 0.05) and a significant difference in distribution of economic status (P = 0.03) across NRFS groups, but after adjustment these differences disappeared. Other variables did not significantly differ between the NRFS groups.

Table 3
Participant characteristics in NRFS tertiles

variables	NRFS			P value*	P value**
	T1 (n = 126)	T2 (n = 127)	T3 (n = 126)		
	mean ± SD				
Demography					
Age(y)	36.36 ± 9.67	37.01 ± 8.97	36.82 ± 9.02	0.84	0.60[a]
Weight(kg)	81.37 ± 12.25	79.16 ± 11.05	82.29 ± 12.76	0.10	0.54
Height(cm)	161.51 ± 5.33	160.53 ± 6.50	161.52 ± 5.78	0.30	0.80
PA(METs h/week)	1231.94 ± 271.23	1116.79 ± 197.87	1315.42 ± 238.51	0.83	0.83[b]
Blood pressure					
SBP(mmHg)	109.23 ± 15.66	112.70 ± 14.76	111.83 ± 13.93	0.26	0.43
DBP(mmHg)	75.95 ± 11.24	78.00 ± 9.66	78.43 ± 10.52	0.24	0.24
Pulse	79.57 ± 11.32	79.75 ± 9.24	79.67 ± 11.18	0.99	0.92
RMR	1595.51 ± 237.09	1526.38 ± 257 ± 05	1612 ± 16280.07	**0.05**	0.89
Body composition					
BFM(kg)	34.87 ± 8.69	33.67 ± 7.75	35.06 ± 9.31	0.37	0.20[c]
FFM(kg)	46.64 ± 5.39	45.77 ± 5.94	46.99 ± 5.63	0.21	0.90[c]
SMM(kg)	25.59 ± 3.22	25.17 ± 3.67	25.81 ± 3.34	0.32	0.83[c]
BMI(kg/m^2)	31.21 ± 4.35	30.80 ± 3.76	31.49 ± 4.52	0.42	0.61[c]
PBF(%)	42.30 ± 5.10	42.06 ± 5.28	41.98 ± 6.09	0.89	0.18[c]
WHR	1.66 ± 8.11	0.93 ± 0.05	0.93 ± 0.05	0.36	0.65[c]
WC(cm)	99.88 ± 10.41	98.37 ± 9.21	100.05 ± 10.27	0.34	0.48[c]
Biochemical assessment					
FBS(mg/dl)	86.02 ± 7.21	87.66 ± 11.75	88.24 ± 9.11	0.34	0.41
T-Chol (mg/dl)	185.50 ± 40.62	182.42 ± 32.36	187.49 ± 35.14	0.65	0.78
HDL(mg/dl)	46.77 ± 12.27	48.36 ± 10.64	45.75 ± 9.91	0.29	0.29

variables	NRFS			P value*	P value**
	T1 (n = 126)	T2 (n = 127)	T3 (n = 126)		
	mean ± SD				
LDL(mg/dl)	94.67 ± 27.48	94.19 ± 22.37	96.61 ± 22.89	0.79	0.78
TG(mg/dl)	114.85 ± 55.03	125.75 ± 56.20	114.53 ± 67.33	0.41	0.36
ALT(U/L)	18.17 ± 6.88	17.19 ± 6.29	18.42 ± 8.74	0.52	0.66
AST(U/L)	19.07 ± 10.58	18.42 ± 12.74	20.17 ± 15.13	0.68	0.80
Hs.CRP (mg/L)	4.04 ± 4.04	4.04 ± 4.85	4.64 ± 4.76	0.64	0.29
HOMA-IR	3.38 ± 1.13	3.44 ± 1.49	3.09 ± 1.15	0.25	0.10
Insulin(IU/ml)	1.21 ± .24	1.24 ± .23	1.18 ± .19	0.23	0.14
Qualitative variables €					
Marital status Single Married	41(40.2) 84(30.5)	30(29.4) 96(34.9)	31(30.4) 95(34.5)	0.20	0.58
Education Illiterate Diploma Bachelor and higher	1(25) 14(29.2) 110(33.8)	2(50) 15(31.3) 109(33.5)	1(25) 19(39.6) 106(32.6)	0.83	0.45
Economic status Poor Moderate Good Rich	8(21.1) 61(37.9) 42(28.6) 10(52.6)	18(47.4) 51(31.7) 47(32) 7(36.8)	12(31.6) 49(30.4) 58(39.5) 2(10.5)	**0.03**	0.35
Resistant to diet Yes No	32(34.8) 81(32.4)	35(38) 76(30.4)	25(27.2) 93(37.2)	0.34	0.21
Family history of obesity Yes No	77(30.1) 40(39.2)	93(36.3) 27(26.5)	86(33.6) 35(34.3)	0.13	0.34

variables	NRFS			P value*	P value**
	T1 (n = 126)	T2 (n = 127)	T3 (n = 126)		
	mean ± SD				
¥: Data are presented as Mean ± SD. €: Data are presented as n (%). Abbreviations: PA: physical activity; SBP: systolic blood pressure; DBP: diastolic blood pressure; RMR: resting metabolic rate; BFM: body fat mass; FFM: fat free mass; SMM: Skeletal muscle mass; BMI: body mass index; PBF: Percent body fat; WHR: Waist hip ratio; WC: Waist circumference; FBS: free blood sugar; HDL: high-density lipoprotein; LDL: low-density lipoprotein; ALT: Alanine aminotransferase; AST: aspartate aminotransferase; hs-CRP: high sensitivity C-reactive protein. HOMA-IR: Homeostatic Model Assessment for Insulin Resistance					
*P values resulted from ANOVA analysis. P value < 0.05 is significant					
**P values presented resulted from ANCOVA analysis and were adjusted for age, BMI, energy and physical activity.					
a: age considered as collinear and this variable adjusted for BMI, energy and physical activity.					
b: PA considered as collinear and this variable adjusted for age, BMI and energy					
c: BMI considered as collinear and this variable adjusted for age, energy and physical activity.					

Association between cardiovascular risk factors and RFS

The relationship between RFS quartiles and each of the cardiovascular risk factors in crude model and adjusted model are reported in Table 4. We found that Participants who were in the highest quartile of the RFS compared to the lowest quartile had 82% lower risk for Hypertriglyceridemia [OR = 0.18, 95%CI = 0.06–0.53, P = 0.002] and 91% lower risk for abdominal obesity [OR = 0.09, 95%CI = 0.008–1.04, P = 0.05]. Our results also shown that there is a marginal significant association between RFS and HOMA-IR. Participants who were in the highest quartile of the RFS compared to the lowest quartile had lower HOMA-IR [OR = 0.29, 95%CI = 0.08-1.00, P = 0.05]. However, there were no statistically significant differences in other cardiovascular risk factors included FBS, HDL, LDL, and BP, among the RFS quartiles (P > 0.05).

Table 4
Association between RFS and cardiovascular risk factors

Variables	RFS				P trend
	Q1	Q2	Q3	Q4	
FBS(mg/dl)					
Crude	1	1.47(0.81–2.67)	1.41(0.78–2.56)	1.29(0.71–2.35)	
P value	0.57	0.19	0.25	0.39	
Model 1	1	1.31(0.35–4.88)	1.56(0.41–5.89)	0.96(0.25–3.72)	0.97
P value	0.86	0.68	0.51	0.96	
T-Chol (mg/dl)					
Crude	1	1.21(0.68–2.14)	1.50(0.84–2.69)	1.02(0.57–1.80)	
P value	0.48	0.51	0.16	0.94	
Model 1	1	2.34(0.76–7.19)	3.20(1.00-10.15)	1.19(0.38–3.75)	0.81
P value	0.13	0.13	**0.04**	0.75	
HDL(mg/dl)					
Crude	1	1.07(0.60–1.90)	0.98(0.55–1.74)	0.86(0.48–1.53)	
P value	0.90	0.81	0.95	0.61	
Model 1	1	0.86(0.33–2.22)	0.85(0.32–2.20)	0.67(0.26–1.72)	0.41
P value	0.86	0.76	0.74	0.40	
LDL(mg/dl)					
Crude	1	1.39(0.77–2.48)	1.39(0.77–2.48)	1.12(0.62–2.01)	
P value	0.60	0.26	0.26	0.69	
Model 1	1	2.86(0.83–9.80)	2.88(0.83–10.02)	1.69(0.47–5.98)	0.55
P value	0.29	0.09	0.09	0.41	
Homa-IR					
Crude	1	0.81(0.38–1.72)	0.87(0.40–1.86)	0.93(0.43–2.02)	

All values are presented as odds ratio (OR) and 95% Confidence intervals (95% CI).

Model 1: Adjusted for age, energy, physical activity, RMR, BMI, education, marriage, diet resistance, age at onset of obesity, Family history of obesity and socio economic status. P value < 0.05 is significant.

Quartile 1 of recommended food score was considered as a reference group.

Variables	RFS				P trend
	Q1	Q2	Q3	Q4	
P value	0.95	0.58	0.72	0.87	
Model 1	1	0.85(0.23–3.06)	0.40(0.11–1.39)	0.29(0.08-1.00)	**0.02**
P value	0.15	0.80	0.15	**0.05**	
TG(mg/dl)					
Crude	1	0.53(0.29–0.95)	0.65(0.36–1.17)	0.44(0.25–0.80)	
P value	**0.04**	**0.03**	0.15	**0.007**	
Model 1	1	0.48(0.16–1.43)	0.36(0.12–1.08)	0.18(0.06–0.53)	**0.002**
P value	**0.01**	0.19	0.06	**0.002**	
WC(cm)					
Crude	1	0.63(0.27–1.49)	1.13(0.44–2.94)	0.63(0.27–1.49)	
P value	0.42	0.29	0.79	0.29	
Model 1	1	0.53(0.05–5.22)	0.64(0.04–8.44)	0.09(0.008–1.04)	0.06
P value	0.24	0.59	0.73	**0.05**	
Hypertension					
Crude	1	1.41(0.64–3.10)	0.78(0.33–1.85)	0.92(0.39–2.14)	
P value	0.55	0.39	0.58	0.84	
Model 1	1	3.19(0.79–12.79)	1.71(0.43–6.70)	0.59(0.12–2.72)	0.23
P value	0.08	0.10	0.44	0.50	
All values are presented as odds ratio (OR) and 95% Confidence intervals (95% CI).					
Model 1: Adjusted for age, energy, physical activity, RMR, BMI, education, marriage, diet resistance, age at onset of obesity, Family history of obesity and socio economic status. P value < 0.05 is significant.					
Quartile 1 of recommended food score was considered as a reference group.					

Association between cardiovascular risk factors and NRFS

Table 5 shows the relationship between cardiovascular risk factors and NRFS tertiles in two crude and adjusted models. The results shown that Participants who were in the highest tertile of the NRFS compared to the lowest tertile had lower HDL [OR = 2.11, 95%CI = 1.08–4.12, P = 0.02]. Also the Participants who were in the highest tertile of the NRFS compared to the lowest tertile had higher risk for Hypertriglyceridemia [OR = 2.95, 95%CI = 1.47–5.94, P = 0.002]. There were no statistically significant differences in other cardiovascular risk factors included FBS, LDL, WC, HOMA-IR, and BP, among the NRFS tertiles ($P > 0.05$).

Table 5
Association between NRFS and cardiovascular risk factors

Variables	Not recommended food score			P trend
	T1	T2	T3	
FBS(mg/dl)				
Crude	1	0.73(0.44–1.21)	0.67(0.40–1.11)	
P value	0.26	0.22	0.12	
Model 1	1	0.81(0.35–1.87)	0.59(0.25–1.36)	0.21
P value	0.46	0.63	0.22	
T-Chol(mg/dl)				
Crude	1	0.73(0.44–1.20)	0.82(0.49–1.35)	
P value	0.47	0.22	0.44	
Model 1	1	0.81(0.40–1.66)	0.80(0.40–1.61)	0.54
P value	0.79	0.58	0.54	
HDL(mg/dl)				
Crude	1	1.28(0.77–2.14)	1.68(1.02–2.79)	
P value	0.12	0.32	**0.04**	
Model 1	1	1.40(0.72–2.72)	2.11(1.08–4.12)	**0.02**
P value	0.09	0.32	**0.02**	
LDL(mg/dl)				
Crude	1	0.55(0.33–0.91)	0.57(0.35–0.95)	
P value	**0.03**	**0.02**	**0.03**	
Model 1	1	0.38(0.17–0.84)	0.47(0.22–0.99)	0.44
P value	**0.03**	**0.01**	0.44	
Homa-IR				
Crude	1	1.12(0.58–2.16)	1.05(0.55–2.01)	

All values are presented as odds ratio (OR) and 95% Confidence intervals (95% CI).

Model 1: Adjusted for age, energy, BMI, RMR, education, marriage, diet resistance, age at onset of obesity, Family history of obesity and socio economic status. P value < 0.05 is significant.

Tertile 1 of NRFS was considered as a reference group.

Variables	Not recommended food score			P trend
	T1	T2	T3	
P value	0.93	0.71	0.86	
Model 1	1	1.21(0.49–2.97)	0.78(0.34–1.79)	0.53
P value	0.59	0.67	0.56	
TG(mg/dl)				
Crude	1	1.99(1.20–3.28)	2.38(1.44–3.96)	
P value	**0.002**	**0.007**	**0.001**	
Model 1	1	2.78(1.38–5.60)	2.95(1.47–5.94)	**0.002**
P value	**0.003**	**0.004**	**0.002**	
WC(cm)				
Crude	1	0.82(0.40–1.69)	1.16(0.54–2.49)	
P value	0.65	0.60	0.69	
Model 1	1	0.70(0.16–3.03)	0.48(0.09–2.44)	0.38
P value	0.68	0.64	0.38	
hypertension				
Crude	1	1.56(0.73–3.30)	1.46(0.69–3.12)	
P value	0.46	0.24	0.31	
Model 1	1	1.90(0.78–4.63)	1.46(0.59–3.63)	0.44
P value	0.36	0.15	0.41	
All values are presented as odds ratio (OR) and 95% Confidence intervals (95% CI).				
Model 1: Adjusted for age, energy, BMI, RMR, education, marriage, diet resistance, age at onset of obesity, Family history of obesity and socio economic status. P value < 0.05 is significant.				
Tertile 1 of NRFS was considered as a reference group.				

Discussion

The results showed an inverse and significant association between adherence to RFS and risk of Hypertriglyceridemia, insulin resistance, and abdominal obesity. In this study, there was a significant association between NRFS and Hypertriglyceridemia, and also we found an inverse relationship between NRFS and HDL. There was no statistically significant relationship between other cardiovascular risk factors with RFS and NRFS.

According to our Knowledge, the present study is the first study to investigate the relationship between RFS and NRFS with cardiovascular risk factors. So, further prospective or intervention research is needed to confirm whether the association truly represents a cause–effect relationship.

To supporting our findings, a cross sectional study including 1008 adults in Korea found women with higher RFS and PA have lower risk of abdominal obesity(30). In another cross sectional study of Australian adults, it was observed in men, RFS was significantly inversely associated with systolic blood pressure (SBP) and diastolic blood pressure (DBP) and there was no associated between RFS and BP in women. Contrary to our results RFS was not significantly associated with obesity in both men and women(31). In a Prospective Cohort study of Korean Adults who were followed from 2001 to 2014, it was observed the incidence of metabolic syndrome in the 5th RFS quintile group significantly decreased compared to the 1st quintile group after adjusting for age and energy intake in women, but after adjusting for additional covariates this association disappeared(32).

There are also many reports on other different healthy dietary patterns such as DASH diet and Mediterranean diet and cardiovascular risk factors that we expect our findings are similar to these mentioned studies because the components of the RFS, based on the consumption of fruits, vegetables, grains, dairy products, and fish, are similar to these dietary patterns. In a cross sectional study including 6874 older adults in Spain, Participants with better adherence to the Mediterranean diet, Compared with low adherence, had significantly lower average TG levels, BMI, and WC(33). In another cross sectional study conducted in Iran, being in the higher category of the Mediterranean diet score was associated with lower WC, TG, hs-CRP, and higher HDL-C. Also, adherence to the DASH diet was associated with lower DBP, insulin levels, and hs-CRP(34). As can be seen, following the DASH diet also lowers BP, which is because the DASH diet emphasizes reducing salt intake, but does not measure salt intake in RFS. In contrast, in some clinical studies, the DASH diet had no effect on improving insulin sensitivity and TG(35)(36)

RFS seems to be associated with reduced cardiovascular risk factors such as TG, insulin resistance, and WC due to high amounts of fruits and vegetables, whole grains, and low-fat dairy products. fruit and vegetables contain a wide range of potentially cardio protective components such as fiber, folate, nitrate, vitamins, and flavonoids. Dietary flavonoids act via different mechanisms of action to reduce cardiovascular risk factors. They reduce oxidative stress, modify lipid levels, and regulate glucose metabolism(16). Whole grains, fruits and vegetables are high in soluble and insoluble fiber. Soluble fiber slows gastric emptying and increases satiety and regulates cholesterol and blood sugar(2, 37). The intestinal microflora ferments the indigestible carbohydrates in cereals into short-chain fatty acids (acetate, butyrate, and propionate), which are effective in reducing body weight, FBS, BP, and TG and increasing HDL(2).

On the other hand, NRFS seems to be associated with increased cardiovascular risk factors due to high consumption of red and processed meats, saturated fats, refined carbohydrates, and a variety of sweetened foods.

In a study conducted in Japan, participants who ate high amounts of meat and fat, had higher WC, BMI, BP, and blood lipid profile(38). Although the results of some studies contradict this(39), the results of a meta-analysis study showed that total, red, and processed meat intake is positively associated with metabolic syndrome(40). Red meat contains high amounts of saturated fat and heme-iron. Iron is a strong pro-oxidant, which can damage tissues such as pancreatic beta cells. So, a high iron level can impair glucose metabolism and decrease insulin levels(41, 42). Nitrate used as a preservative in processed meat can be change into nitrosamines. Nitrosamine have been shown to be toxic to pancreatic cells and lead to insulin resistance(43, 44).

It was observed that a diet high in sugar and refined carbohydrates increases TC, TG, LDL, the ratio of TC/HDL(45), glucose, HOMA-IR and insulin levels. It also increases the expression of enzymes involved in fat synthesis, reduces the expression of enzymes effective in lipolysis and increases the accumulation of fat in the body(23). In contrast, in another study conducted on Iranian women, diets lower in carbohydrate were not associated with overweight, obesity and cardiovascular risk factors(46).

The current study had some limitations. Due to the cross-sectional design, we could not evaluate causality between the RFS and cardiovascular risk factors. use of FFQs can result in under- or over-reporting of food intake. Our study was conducted only on obese and overweight women, so we cannot attribute the results to the whole community. only the RFS was used to evaluate the dietary quality, and no instruments were used for assessing other nutrients(47).

This study also has several strengths. this study is the first to show the relationship between RFS and cardiovascular risk factors in adult women. The number of study participants was relatively high and known potential confounding factors were measured and controlled for in the analysis.

Conclusion

In general, the results of the study show that adherence to RFS is inversely associated with hypertriglyceridemia, abdominal obesity and insulin resistance. There is a direct link between NRFS and hypertriglyceridemia. Adherence to NRFS is also associated with decreased HDL.

List Of Abbreviations

RMR	resting metabolic rate
BP	blood pressure
TG	triglyceride
LDL	low-density lipoprotein
HDL	high-density lipoprotein
CVD	cardiovascular disease
RFS	recommended food score
NRFS	none recommended food score
CHD	coronary heart disease
DASH	dietary approaches to stop hypertension
hs-CRP	high-sensitivity C-reactive protein
GI	glycemic index
HOMA-IR	Homeostatic model assessment insulin resistance
BMI	body mass index
FFQ	food frequency questionnaire
TC	total cholesterol
ELISA	enzyme linked immunosorbent assay
BF	fat percentage
FFM	fat free mass
FM	fat mass
WC	waist circumference
WHR	waist-to-hip ratio
BIA	bioelectrical impedance analyzer
IPAQ	International Physical Activity Questionnaire
PA	physical activity
OR	odds ratio
SBP	systolic blood pressure
DBP	diastolic blood pressure

Declarations

Ethics approval and consent to participate

All protocols are carried out in accordance with relevant guidelines and regulations. Each participant was informed completely regarding the study protocol and provided a written and informed consent form before taking part in the study. The study protocol was approved by the ethics committee of Tehran University of Medical Sciences (TUMS) with the following identification IR.TUMS.VCR.REC.1397.577.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Maryam Sabbari (MS), Atieh Mirzababaeib (AM), Farideh Shirasebb (FSh), Khadijeh Mirzaei (KhM) designed their search; KhM and FSh conducted the sampling; AM and KhM performed statistical analysis; MS and AM wrote the paper; Khadijeh Mirzaei primary responsibility for final content. All authors read and approved the final manuscript.

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