Nutrient Patterns and Their Relation With Obesity in Iranian Adults: A Population-based Study

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Research note

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Abstract

Objective:

In spite of growing evidence on the associations between nutrient patterns and obesity. A few study examined the association between patterns of nutrient intake and obesity we aimed to explore the association between nutrient pattern and obesity in Iranian adults.

Results:

In this cross-sectional study, a total of 850 subjects aged years 20 to 59 were randomly selected. Our statistical analysis revealed three major nutrient patterns that show the principle factor loading of nutrient intake. We observed a significant association between quintiles in men for Fasting Blood Sugar (FBS) ($P<0.006$) in the first nutrient pattern. Moreover, we identified a significant difference between quintiles in the first nutrient pattern in women for obesity ($P=0.007$), Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) ($P<0.02$). In the third nutrient pattern, we identified a significant association for SBP in women ($P<0.02$).

Introduction

Obesity and overweight are identified as two major public health concerns which its prevalence is increasing at an alarming rate in both developed and developing countries [1]. According to the World Health Organization (WHO) report, in 2016, 39% and 13% of adults in the world were overweight and obese, respectively [1].

Some studies demonstrated a direct relationship between certain nutrients, particularly dietary fat [2] and carbohydrates [3], and the risk of obesity, while other studies indicated an inverse association between intake of dietary proteins [4] and fiber [5] or individual micronutrients, including vitamins A, B, C [6, 7] and D [8], and minerals, such as calcium [9], with obesity.

The preceding study indicated that a nutrient pattern with high thiamine, betaine, starch, folate, iron, selenium, niacin, calcium, and manganese was associated with a lower risk of general obesity, while a pattern characterized by high amounts of glucose, fructose, sucrose, vitamin C, potassium, total dietary fiber, copper and vitamin K was related with greater odds of general obesity, in men, but not in women [10].

Another study showed that nutrient pattern which was high in micronutrients and vitamins reduced odd of obesity and nutrient pattern characterized by high saturated and mono Saturated Fatty Acids (SFAs) was associated with a higher risk of obesity [11]. Studying patterns of nutrient intake to provide insights into combinations of nutrients might affect obesity risk. Therefore, we aimed to investigate the association of nutrient patterns with obesity as a prevalent condition.

Methods

Subjects

This cross-sectional study was conducted among 850 apparently healthy individuals of both sex, aged 20–59 years old who referred to Health Centers in Tehran. Participants with a history of diabetes, cancer, and CVD were excluded because of possible changes in their diet. Also, people in the age range of 20 to 59 years old,

Assessment of dietary intake

The usual diet of participants was assessed with three 24-hours recall. The first 24-hours recall was collected by interview and the other two recalls by a phone call to the participants on random days of the week. Finally, we extracted the meals and food groups from these questionnaires.

Assessment of anthropometric measures

Weight was measured by a digital scale with a sensitivity of 0.1 kg (seca 808, Germany), while the subjects were minimally clothed and not wearing shoes. Height measurement by wall stadiometer with a sensitivity of 0.1 cm (Seca, Germany). BMI was calculated and expressed in kg/m^2 . Waist (WC) and hip circumference (HC) were measured in the smallest girth and the largest girth, respectively, with accuracy nearest to 0.1 cm.

Assessment of biomarkers

A blood sample was drawn about 10 cc between 7 am to 10 am from all study participants after they fasted overnight for 12 h. After testing blood sample, people with a blood sugar above 126 mg, individuals with a history of diabetes and those taking blood sugar lowering medications, they are considered as diabetic patients. Serum glucose and lipids are measured using enzymatic methods, commercial kits (Pars test, Iran), and automatic devices (Selecta E, vitalab, Netherland). These tests are performed on the same day.

Statistical method

To identify the nutrient pattern in our study population, the principal component analysis was used. Also, we applied factor analysis with the varimax procedure to derive nutrient patterns based on the nutrients' loading factors. Comparison of dietary consumption and components of obesity were done in the nutrient pattern categories using Analysis of Variance (ANOVA) test and reported using mean $\pm$ standard deviation (SD) values. To determine any association between nutrient patterns and general or abdominal obesity, we used binary logistic regression, with three adjustment steps: First, unadjusted and then in the second model, we further controlled for age, total energy intake. Finally in the third model, additionally adjusted for current smoking, job status, education level, and physical activity. These analyses were done for both genders. In these analyses, the first quintile of the nutrient pattern scores was considered as the reference category. Clinical and demographical characteristics of participants based on obesity status were compared according to the classification of people into two groups of healthy and obese people separately. For this purpose, we used the independent sample t-test and Chi-square test. All statistical analyses were performed with Statistical Package for Social Science (SPSS version 24.0). Statistical significance was defined as $P \leq 0.05$.

Results

Clinical and demographical characteristics of participants based on obesity status are shown in Table 1. The mean age, weight, BMI, WC, Triglycerides (TG), DBP, SBP ($P < 0.001$ for all comparisons), WHR ($P = 0.002$), FBS ($P = 0.01$) and Total Cholesterol (TC) ($P = 0.03$) among obese subjects were higher than healthy subjects. **Additional file 1: Table S1** shows the principal factor loading of nutrients intake. Positive loading demonstrated strong associations between the nutrient groups and nutrient patterns, while negative loading demonstrated negative associations. The first nutrient pattern was characterized by high positive loading for the consumption of vitamins B1, B2, B6, B5, B3, B12, zinc, iron, SFAs, and protein. The second nutrient pattern showed positive loading for the consumption of zinc, SFAs, vitamin E, α -tocopherol, oleic acids, Polyunsaturated Fatty Acids (PUFAs), β -carotene, linolenic acids, Monounsaturated Fatty Acids (MUFAs), total fat. The third nutrient pattern was represented mainly by positive loading for potassium, magnesium, phosphorus, calcium, protein, carbohydrate, vitamin C, and folate. **Additional file 2: Table S2** shows the nutrient intake based on quintiles of nutrient patterns. In the first nutrient pattern, the individuals in the fifth quintile had a higher intake of vitamins B1, B2, B3, B5, B6, B12, zinc, iron, SFAs, molybdenum, vitamin E, PUFA, total fat, potassium, magnesium, phosphorus, calcium, carbohydrate, sodium, cholesterol, protein and had a lower vitamin K, caffeine and β -carotene. In the second nutrient pattern individuals in the first quintile had less consumption of zinc, SFAs, vitamin E, α -tocopherol, oleic acid, PUFA, β -carotene, linolenic acid, MUFA compared to the fifth quintile. Furthermore, in the third nutrient pattern, the individuals in the fifth quintile had a higher intake of potassium, magnesium, phosphorous, calcium, protein, carbohydrate, vitamin C, folate compared to other quintiles. Components of obesity across based on gender and across quintiles of nutrient patterns are shown in Table 2. We observed a significant association between quintiles in men for Fasting Blood Sugar (FBS) ($P < 0.006$) in the first nutrient pattern. Moreover, we identified a significant difference between quintiles in the first nutrient pattern in women for SBP and DBP ($P < 0.02$). In the third nutrient pattern, we identified a significant association for SBP in women ($P < 0.02$). There were no significant differences between other components of obesity based on quintiles of nutrient patterns. We examined the association between obesity, according to quintiles of nutrient patterns for both genders, by using an unadjusted, partially, and fully adjusted model. For every three nutrient patterns, we identified no effect of the nutrient pattern for men and women, even after adjustment for confounders in the second and third nutrient patterns. We identified a significant difference between quintiles in the first nutrient pattern in women (Model 1, $P = 0.01$). The result was similar after adjustment for confounding factors (Model 2, $P = 0.01$ and Model 3, $P = 0.007$) (Table 3). Characteristics of study participants across quintiles of major nutrient pattern scores are shown in **Additional file 3: Table S3**. There were significant associations for gender between quintiles in the first nutrient pattern ($P < 0.006$) and second nutrient pattern ($P < 0.01$), but not in the third ($P < 0.09$). Moreover, there was a significant association for job status between quintiles in the first nutrient pattern ($P < 0.05$), but not in the second and third. There was no significant association for smoking, education, marriage, and physical activity between quintiles in the three nutrient patterns.

Table 1
Clinical and demographical characteristics of participants based on obesity status

		Healthy subjects	Obese subjects	P value
Gender (%)	Male	15	5	0.73
	Female	59	21	
Age(years)		41.37 ± 11.22	45.00 ± 9.77	< 0.001
Weight(kg)		66.95 ± 9.65	87.09 ± 13.48	< 0.001
BMI(kg/m ²)		25.08 ± 2.85	33.82 ± 6.49	< 0.001
WHR		0.85 ± 0.08	0.88 ± 0.18	0.002
WC(cm)		85.36 ± 10.12	100.00 ± 10.45	< 0.001
TC (mg/dL)		194.08 ± 43.57	201.99 ± 47.72	0.03
TG(mg/dL)		139.88 ± 76.83	161.41 ± 84.60	0.001
HDL(mg/dL)		50.03 ± 10.18	49.47 ± 10.28	0.48
SBP (mmHg)		114.34 ± 19.51	122.78 ± 21.45	< 0.001
DBP (mmHg)		77.36 ± 12.14	80.99 ± 16.10	0.001
FBS(mg/dL)		106.11 ± 41.14	115.07 ± 46.47	0.01
Mean ± standard deviation (SD). P value Obtained from independent sample t test and Chi-square test. BMI , body mass index; WHR , waist to height; WC , waist circumference; TC , total cholesterol; TG , triglycerides; HDL-C , high-density lipoprotein-cholesterol; SBP , systolic blood pressure; DBP , diastolic blood pressure; FBS , fasting blood sugar,.				

Table 2
Components of obesity across quintiles of nutrient patterns' scores

Variables	First nutrient pattern				Second nutrient pattern				Third nutrient pattern			
	Q1	Q3	Q5	P	Q1	Q3	Q5	P	Q1	Q3	Q5	P
Men												
Age(years)	42.45 ± 13.77	44.39 ± 10.26	41.80 ± 11.34	0.89	44.23 ± 11.05	40.13 ± 10.22	45.04 ± 12.13	0.19	40.71 ± 14.09	42.74 ± 8.47	43.61 ± 10.47	0.83
Weight(kg)	79.20 ± 11.12	80.44 ± 18.78	84.83 ± 20.77	0.64	82.91 ± 16.02	86.25 ± 21.42	77.45 ± 14.93	0.28	77.90 ± 16.15	79.51 ± 15.99	84.90 ± 18.77	0.48
BMI(kg/m2)	26.35 ± 3.20	26.99 ± 7.19	27.70 ± 5.35	0.88	27.82 ± 4.12	27.86 ± 5.86	26.56 ± 6.73	0.75	26.18 ± 4.98	27.03 ± 4.25	28.08 ± 6.20	0.63
WHR	0.90 ± 0.06	0.91 ± 0.09	0.91 ± 0.09	0.90	0.90 ± 0.10	0.91 ± 0.07	0.89 ± 0.06	0.14	0.89 ± 0.07	0.92 ± 0.11	0.91 ± 0.08	0.80
WC(cm)	89.55 ± 8.79	91.64 ± 15.45	93.97 ± 16.77	0.59	125.87 ± 21.09	118.43 ± 21.86	120.58 ± 29.70	0.72	87.03 ± 12.71	90.29 ± 15.17	94.68 ± 16.53	0.17
TC (mg/dL)	191.25 ± 40.19	191.36 ± 35.99	192.50 ± 47.10	0.81	199.58 ± 40.62	193.51 ± 45.03	188.96 ± 42.51	0.71	194.54 ± 49.57	196.24 ± 32.41	191.25 ± 44.60	0.27
TG(mg/dL)	187.55 ± 128.57	180.71 ± 142.63	170.43 ± 87.99	0.51	171.58 ± 105.92	181.46 ± 89.15	192.96 ± 126.31	0.51	195.11 ± 142.97	162.62 ± 75.66	171.09 ± 91.17	0.74
HDL(mg/dL)	41.60 ± 6.41	45.29 ± 8.11	45.15 ± 9.83	0.08	44.29 ± 8.25	45.72 ± 11.77	41.21 ± 5.13	0.13	44.36 ± 10.51	44.94 ± 7.34	45.25 ± 10.19	0.94
SBP(mmHg)	124.25 ± 17.87	120.46 ± 30.43	127.56 ± 16.33	0.22	125.87 ± 21.09	118.43 ± 21.86	120.95 ± 29.70	0.61	125.03 ± 24.83	120.82 ± 24.37	122.59 ± 24.36	0.93
DBP(mmHg)	75.75 ± 17.39	78.57 ± 22.00	83.86 ± 12.05	0.35	82.87 ± 16.84	79.00 ± 15.83	76.33 ± 17.96	0.55	83.00 ± 18.55	80.17 ± 14.79	79.97 ± 22.14	0.88
FBS(mg/dL)	107.05 ± 37.41	109.36 ± 46.86	106.07 ± 23.30	0.006	109.81 ± 42.55	100.21 ± 12.79	116.67 ± 39.44	0.32	104.50 ± 31.39	104.79 ± 40.30	111.84 ± 27.8	0.76
Women												
Age(years)	42.26 ± 10.80	41.21 ± 11.57	41.28 ± 11.00	0.20	42.24 ± 10.64	42.72 ± 10.67	41.68 ± 10.75	0.94	42.52 ± 11.24	44.23 ± 11.28	41.66 ± 10.99	0.17
Weight(kg)	70.53 ± 12.03	68.92 ± 11.56	68.88 ± 11.95	0.61	70.73 ± 11.38	70.69 ± 12.24	69.54 ± 12.32	0.30	69.77 ± 11.06	69.16 ± 11.63	69.10 ± 11.64	0.77
BMI(kg/m2)	27.64 ± 4.86	27.48 ± 8.78	26.64 ± 4.54	0.65	27.63 ± 5.55	27.74 ± 4.58	26.97 ± 4.67	0.34	28.04 ± 9.02	27.16 ± 4.37	26.68 ± 4.32	0.36
WHR	0.83 ± 0.06	0.85 ± 0.07	0.86 ± 0.23	0.36	0.86 ± 0.23	0.85 ± 0.07	0.84 ± 0.07	0.52	0.83 ± 0.09	0.85 ± 0.07	0.86 ± 0.23	0.20
WC(cm)	88.12 ± 11.29	88.44 ± 10.59	86.87 ± 12.22	0.44	88.68 ± 11.48	90.00 ± 10.82	87.73 ± 11.70	0.15	87.81 ± 11.19	88.00 ± 11.24	87.88 ± 11.02	0.73
TC (mg/dL)	201.63 ± 44.69	195.74 ± 48.45	198.18 ± 45.62	0.48	193.21 ± 44.89	199.88 ± 44.63	197.39 ± 45.13	0.39	195.45 ± 43.36	194.91 ± 43.52	195.03 ± 41.13	0.79
TG(mg/dL)	143.68 ± 78.27	134.01 ± 65.88	137.66 ± 65.96	0.84	127.43 ± 60.97	79.19 ± 148.95	142.46 ± 78.59	0.19	136.88 ± 73.71	139.41 ± 69.02	139.42 ± 71.55	0.57
HDL(mg/dL)	49.67 ± 9.84	50.90 ± 8.79	51.50 ± 11.27	0.23	50.67 ± 9.69	52.10 ± 10.94	49.49 ± 10.02	0.15	52.18 ± 10.55	50.21 ± 8.95	51.86 ± 10.77	0.30
SBP(mmHg)	118.10 ± 22.09	114.45 ± 19.73	112.63 ± 19.72	0.02	113.52 ± 20.58	116.33 ± 18.16	117.98 ± 18.24	0.06	110.58 ± 24.45	117.02 ± 16.51	116.71 ± 21.43	0.02
DBP(mmHg)	79.05 ± 13.69	79.58 ± 14.36	77.70 ± 9.60	0.02	76.28 ± 12.21	78.66 ± 11.37	78.51 ± 12.74	0.30	77.14 ± 17.87	78.68 ± 12.11	78.80 ± 11.49	0.70
FBS(mg/dL)	107.13 ± 27.01	111.06 ± 44.05	103.66 ± 26.80	0.56	113.37 ± 77.45	109.56 ± 36.96	108.21 ± 28.37	0.39	103.09 ± 25.63	107.63 ± 20.50	112.73 ± 75.80	0.39

Data are presented as mean ± standard deviation. P Obtained from ANOVA test; **BMI**, body mass index; **WHR**, waist to height; waist circumference; **WC**, waist circumference; **TC**, total cholesterol; **TG**, triglycerides; **HDL-C**, high-density lipoprotein-cholesterol; **SBP**, systolic blood pressure; **DBP**, diastolic blood pressure; **FBS**, fasting blood Sugar.

Table 3
Odds ratio (95% CI) for obesity according to quintiles (Q) of nutrient patterns, stratified by gender

Variables	First nutrient pattern				Second nutrient pattern				Third nutrient pattern			
	Q1	Q3	Q5	P-trend	Q1	Q3	Q5	P-trend	Q1	Q3	Q5	P-trend
Men												
Model 1	1	2.68(0.62–11.57)	1.57(0.38–6.46)	0.81	1	0.95(0.37–2.43)	0.48(0.14–1.68)	0.25	1	0.77(0.23–2.56)	0.77(0.25–2.37)	0.45
Model 2	1	2.72(0.62–11.84)	1.64(0.36–7.52)	0.96	1	0.97(0.37–2.51)	0.50(0.14–1.75)	0.28	1	0.74(0.19–2.87)	0.70(0.13–3.67)	0.59
Model 3	1	2.48(0.56–11.02)	1.45(0.30–6.89)	0.84	1	0.98(0.37–2.58)	0.52(0.13–2.09)	0.36	1	0.59(0.14–2.41)	0.56(0.10–3.05)	0.50
Women												
Model 1	1	0.44(0.25–0.75)	0.52(0.30–0.91)	0.01	1	0.93(0.54–1.62)	0.89(0.52–1.53)	0.81	1	0.74(0.43–1.29)	0.93(0.54–1.61)	0.61
Model 2	1	0.45(0.25–0.79)	0.51(0.28–0.91)	0.01	1	0.92(0.53–1.60)	0.93(0.53–1.64)	0.72	1	0.66(0.36–1.22)	0.90(0.43–1.86)	0.60
Model 3	1	0.45(0.25–0.80)	0.50(0.27–0.90)	0.007	1	0.91(0.52–1.61)	0.95(0.53–1.68)	0.73	1	0.63(0.34–1.17)	0.86(0.41–1.79)	0.49
Model 1: unadjusted, Model 2: age, total energy intake, Model 2: additionally adjusted for current smoking, job status, education level and physical activity.												

Discussion

The present study resulted in a significant positive association between quintiles in men for FBS in the first nutrient pattern and a significant difference between quintiles in the first nutrient pattern in women for blood pressure. Moreover, the women in the top quintile of the first nutrient pattern compared to the first quintile have more chance to be obese even after adjustment for covariates.

Some community-based studies are done to investigate the association between nutrient patterns and obesity. For instance, in one study vegetarians consume more legumes, fruit, and whole grains and less refined cereals, desserts, fried foods, fruit juice less had a low chance to be overweight/obese compared to those consuming other nutrient patterns groups [12]. A Chinese study revealed that the traditional south pattern including rice as the key staple food with chicken and vegetables was associated with a lower risk of general and abdominal obesity [13].

In our study, the first nutrient pattern loaded mainly on vit (B1, B2, B6, B5, B3, B12) and zinc. The association of low levels of B vitamins such as B1, B2, and B6 and obesity was reported in some publications [14–16]. Low thiamine, niacin, and pyridoxine concentrations are linked to metabolic dysfunction like obesity [14–16]. Obese patients may have a greater amount of body thiamine reservation in cells that trigger lower plasma thiamine concentration [15]. Elevated total body water in obese subjects may also result in dilution of the extracellular compartment, further decreasing the plasma vitamin levels [14]. However, in a randomized placebo-controlled clinical trial conducted by Dollerup et al [17], supplementation with 1000 mg nicotinamide riboside two times per day for 12 week period had no significant effect on the body composition measures [18]. Moreover, the existence of abdominal obesity and elevated body fat were positively related to serum zinc concentrations in men. But, this association was not found in women [19]. In contrast, a cross-sectional study observed an inverse association between the BMI and plasma zinc levels [20].

Our second nutrient pattern (mainly representative of vitamin E, α -tocopherol, and unsaturated fatty acids such as oleic acid and PUFA_s) is positively associated with body weight and height. In contrast to our result, Amini MB et al concluded that serum vitamin E is negatively associated with WC, and Hip Circumference (HC). The reduction observed in body weight was not significant [21]. The ratio of omega-6/ omega-3 PUFA_s is a matter of importance. A diet which contains usually meat rather than fish can lead to an imbalance in that ratio. The fat reservation resulted from dietary omega-6 PUFA_s may have more progression in comparison with long-chain omega-3 or SFA_s when consumed besides a relatively high carbohydrate diet [22]. In a randomized cross-over study, overweight or obese men substituting a diet high in SFA with MUFA in four weeks duration, significantly decreased body weight and fat mass whereas the former amount of calories and fat being used [23].

The third nutrient pattern mainly containing potassium, magnesium, phosphorus, calcium, and protein. It could be expected that this nutrient pattern is likely the Mediterranean diet. This

diet mostly includes a high intake of fruits and vegetables which are a rich source

of minerals mentioned in our third food pattern. In a cohort study, men who had high adherence to the Mediterranean diet had a low risk of becoming obese up to 29% [24].

Conclusion

In conclusion, we observed a significant association between quintiles in men for FBS in the first nutrient pattern. Moreover, we identified a significant difference between quintiles in the first nutrient pattern in women for obesity, SBP and DBP. In the third nutrient pattern, we identified a significant association for SBP in women. More researches for nutrient patterns in the isocaloric clinical trials seem to be helpful to extend the presented data on the Iranian habitual diet in order to found nutritional recommendations to prevent obesity in the community.

Limitation

To state the strengths and limitations of our study, although the sample size was small, it was enough according to statistical calculations. We aware some limitations are inevitable. For instance, the effects of cooking on the bioavailability of the nutrients were not possible to measure, however, we try to control for possible potential confounding. The cross-sectional design of the study does not permit inference about causality. It is critical to note that because the nutrient intake was evaluated by an FFQ, recall bias is unavoidable.

Abbreviations

WHO, World Health Organization; CVD, Cardiovascular diseases; DPs, Dietary patterns; SFAs, Saturated Fatty Acids; IPAQ, International Physical Activity Questionnaire; METs, metabolic equivalents; BMI, Body Mass Index; WC, Waist Circumference, WHR, Waist to Hip Ratio; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; ANOVA, Analysis of Variance; SD, Standard deviation; SPSS, Statistical Package for Social Science; PUFAs, Polyunsaturated Fatty Acids; MUFAs, Monounsaturated Fatty Acids; TC, Total Cholesterol; HC, Hip Circumference; FFQ, Food Frequency Questionnaire;

Declarations

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Authors' contributions

MRA, ZA, HY, and FDj data collection and drafting the work; SS-b, supervising project performance and substantial contributions to the conception of the work; KDj, contributions to the conception of the work; MRA, FM and MM analysis and interpretation of results. All authors approved the final version to be published.

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Availability of data and materials

Data can be reached by contacting the corresponding author.

Ethics approval and consent to participate

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the ethical standards of the Tehran University of Medical Sciences (Ethic Number: IR.TUMS.VCR.REC.1398.429), who approved the protocol and informed consent form. All participants signed a written informed consent prior to the start of the study.

Consent for publication

This is formally to submit the article entitled "Nutrient patterns and their relation with obesity in Iranian adults: a population-based study" prepared by the Tehran University of Medical Sciences for review and, hopefully, publication in your prestigious journal. The authors would like to advise that all authors listed have contributed to the work. All authors have agreed to submit the manuscript to BMC Research Notes. No part of the work has been published before. There is no conflict of interest in this paper.

Conflict of Interests

The author declares that they have no competing interests

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