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Original Article

Food Habits, Weight Status and Metabolic Risk Factors in a Group of Adults in Tehran

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ABSTRACT

Background and Objectives: This study was carried out to assess food habits and their associations with weight status and metabolic risk factors in adults in Tehran, Capital of Iran.

Materials and Methods: A cross-sectional survey was conducted in a sample of adults (n=227) over 18 years old residing in Tehran. Demographic, anthropometric and food frequency questionnaires were filled out for all of the participants. Food habits were recorded using dietary habit questionnaires. Serum concentrations of glucose and lipids (total cholesterol [TC], triglycerides [TG] and high-density lipoprotein-cholesterol [HDL-C]) were analyzed from fasting blood samples.

Results: The mean body mass index (BMI) was 28.52 kg/m^2 and a minority of the participants (22.2%) had normal BMI. The participants rarely used table salt, fast food and crispy foods, dined at restaurants and had two snacks, three or more meals a day, five or more breakfast episodes a week and regular meals. They used vegetable oils for cooking and frying and/or cooking oil for frying. Drivers ($p < 0.001$) and less educated participants ($p= 0.012$) were susceptible to overweight. Positive associations were found between the BMI and the participant age (r_s =0.28, p<0.001) and serum glucose (r_s = 0.22, p =0.005), TG (r_s = 0.34, p< 0.001) and TC (r_s = 0.36, p < 0.001). Participants with normal weights had regular meals (p= 0.034) and frequent snacks (p = 0.048). Overweight and obese participants had a higher rate of dyslipidemia (serum TG ≥ 150 mg/dL), compared to that of the normal weight participants (18.0 and 35.0% vs.7.9%, p=0.004).

Conclusions: The present participants had relatively healthy food habits, except for the order of meals and saturated fat consumptions. This study confirms the associations between overweight/obesity and dyslipidemia. Nutrition education with emphases on regular meals and frequent snacks (as protective habits against obesity) is recommended, especially for susceptible groups.

Keywords: Food habits, Adults, Metabolic risk factors, Overweight

Introduction

In recent decades, shifts in suboptimal lifestyle, especially unhealthy dietary habits, along with socioeconomic changes have been seen in the Middle East (1, 2). Studies have suggested that poor diet may predispose people to many serious health problems, especially cardiovascular disease (CVD) and diabetes (3). Findings from a 20-year systematic assessment in Middle Eastern and North African countries have shown that suboptimal diet is the principal leading cause of mortality from cardio-metabolic disease (CMD) in the region (3) and CMD is the leading cause of death in Iran. Although food is primarily consumed in response to hunger, food selection and habits are seriously affected by external factors, including food accessibility, price, sociocultural, physiological and psychological factors as well as marketing techniques and nutritional knowledge (4). It is well documented that dietary habits, such as fast food consumption, meals frequency and meal size, are positively connected to weight gain, obesity, poor diet quality, and insulin resistance (5-9). Excessive salt (sodium) intake is also assumed to increase blood pressure and consequent heart events. Likewise, low consumptions of fruits and

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vegetables and high intake of trans fatty acids are other known risk factors for CMD in the Middle East (3). Eating frequency, as well as rate and regularity of food consumption, can cause metabolic disorders. Studies have demonstrated that irregular meal consumption and breakfast skipping are significantly associated with obesity (10, 11). In comparison to irregular meal pattern, regular meal episodes may increase thermic effect of food (TEF) and insulin sensitivity, which potentially is in favor of weight management and metabolic health (12).

Considering the aforementioned impacts of food habits on health and disease, it is of great importance to assess the status of the current food habits in the society and to target dietary habits with potentially harmful effects on chronic diseases, namely diabetes and CVD (13). Therefore, this study was carried out to describe food habits in a population of adults in Tehran and to show associations between food habits, weight status and metabolic risk factors.

Materials and Methods

Design: This cross-sectional study was carried out on adults aged 18 years and older, residing in Tehran (n = 227), 2016. The study was approved by the National Nutrition and Food Technology Research Institute's (NNFTRI) Ethics Committee (Ethics Code: IR.SBMU.nnftri.Rec.1395.43).

Participants: Participants included ≥ 18 year-old, non-smoker, non-pregnant and nursing adult volunteers. The participants were living in Tehran, without any clinical situations affecting their food consumptions (such as diabetes, malignant diseases, or malabsorption syndrome), and were not on a specific diet.

General characteristics: Demographic data, such as age, gender, education level, occupation and disease history were recorded using questionnaires.

Dietary data: Usual dietary consumptions were collected using a validated 142–item dish-based food frequency questionnaire (DBFFQ) (14, 15). The questionnaires were subsequently analyzed using modified version of Nutritionist-IV Software for Iranians (version 4.0; N-squared Computing, Salem, USA), and energy, macro and micronutrient compositions were extracted (16).

Food habits data: Dietary habit data were assessed using 15-item questionnaires. These included meal habits (frequency and regulation of meals consumption, and breakfast/snacks consumption), food preparation (removing visible fats from meat and skin of poultry), cooking habits (type of oil/fat used for cooking and frying, food preparation methods, weekly consumptions of fried foods), and other questions, including consumption of fast food, dining at restaurant, use of salt and supplements intake.

Anthropometric assessments: Weights were measured with minimum cloths and barefoot in standing position using portable digital scale (SECA, model 840, Maximum: 140 kg, Germany) with accuracy of 0.1 kg. Height was measured to the nearest 0.1 cm at standing position posture adjacent to the wall without shoes using non-elastic tape measure (SECA, Germany). Body mass index (BMI, kg/m^2) was determined by dividing weight (kg) by squared height (m^2). BMI was categorized as the following: < 18.5 kg/m^2 as "underweight", 18.5–24.9 kg/m^2 as "normal weight", 25–29.9 kg/m^2 as "overweight", and ≥ 30 kg/m^2 as "obese"(17).

Biochemical assessments: Concentrations of glucose and lipids, including total cholesterol [TC], triglycerides [TG], and high-density lipoprotein-cholesterol [HDL-C]), were assessed in serum samples after 12 hours fasting using Pars Azmun kits (Pars Azmun, Karaj, Iran). Values were categorized as abnormal when fasting blood sugar (FBS) ≥ 100 mg/dL, HDL-C < 50 mg/dL in women and < 40 mg/dL in men, TG ≥ 150 mg/dL, and cholesterol ≥ 200 mg/dL (18, 19).

Statistical analyses: Statistical analyses were performed using SPSS Software (version 21.0, SPSS Inc., Chicago, IL, USA). Data were reported as mean ±SD (standard deviation) and percentage. Categorical variables were compared using chi-square test, binary logistic regression, one-way analysis of variance (ANOVA) and Kruskal-Walis tests with 95% confidence interval. The p-values less than 0.05 were reported as significant.

Results

Totally, 227 adults (47.6% men) were participated in the study. Demographic data, dietary energy and macronutrient intakes and biochemical measures are shown in Table 1. Only 22.2% of the participants had normal BMI. Table 2 shows the associations between weight status, demographic data and food habits of the participants. There was a slight positive correlation between age and BMI (r_s = 0.275, p<0.001). The mean age of participants differed significantly among the BMI subgroups (p = 0.001, Table 2). Despite similar energy and macronutrient intakes, obese and overweight participants were averagely 7.73 and 6.20 years older than normal weight participants (p=0.001 and p=0.006, respectively, Table 2). Most of the overweight and obese participants were drivers (p < 0.001), and most of the normal weight participants had academic degree (p=0.012). Regularity of meals and frequency of snack consumption were the only dissimilar habits within various BMI subgroups (p=0.005). As shown in Table 2, overweight and obese participants had lower snack occasions per day (p=0.048). Participants who always or often consumed regular meals had significantly lower rates of obesity or overweight (p=0.034).

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Table 1. Demographic data of a sample of adults in Tehran (*n* = 227), 2016

variable	Value n(%)
Participants	227 (100)
Male,	108 (47.6)
Female	119 (52.4)
Total	227
Education,	
Under diploma	49 (21.6)
High School diploma	107 (47.1)
Academic degree	71 (31.3)
Total	227(100)
Occupation,	
Driver	84 (37.3)
Clerk	43 (19.1)
College student	22 (9.8)
Housekeeping	51 (22.7)
Other	25 (11.1)
Total	225(100)
Weight status,	
Normal	49 (22.2)
Overweight	92 (41.6)
Obesity	80 (36.2)
Total	221(100)
Variable(unit)	Mean ± SD
Age (yr)	42.18±11.63
n	227
BMI (kg/m2)	28.52±4.66
n	226
CHO (gr/d)	571.30±247.97
n	222
Pr (gr/d)	112.21±46.41
n	220
Fat (gr/d)	110.85±47.68
n	222
FBS (mg/dL)	85.11±9.48
n	162
TG (mg/dL)	126.95±57.06
n	161
Chol (mg/dL)	187.84±33.45
n	164
HDL (mg/dL)	50.45±10.71
n	164

BMI body mass index, *CHO* carbohydrate, *Chol* cholesterol, *FBS* fasting blood sugar, *HDL* high density lipoprotein, *Pr* protein, *TG* triglyceride. n indicates total number of cases. Values are Mean ± SD except stated. *P* <0.05 is significant.

When this association was adjusted by gender, it was only significant in males (p=0.044 for males vs. p=0.094 for females). Analyses revealed that obese participants were less likely to use multivitamin/mineral supplements than normal weight participants (p=0.058). The participants who had three or more meals a day possibly had more weekly breakfast episodes (five or more per week) compared to others (91.2% vs.52.0%, $p < 0.001$). Our findings showed that 23.4% and 2.5% of the participants used hydrogenated vegetable oil and/or animal fat for cooking and frying, respectively. No difference was observed among BMI subgroups regarding type of consumed fat/oil for frying or cooking. Participants in all BMI categories mostly used frying oil in combination with cooking oil for frying. Furthermore, hydrogenated vegetable oils or animal fats were mostly used in cooking process, regardless of BMI status (Table 2).

Nearly one-third (34.4%) of the participants consumed supplements routinely. Only 11.9% of the participants used vitamin D supplement, 92.6% of them had a daily to monthly supplement intake. Consumptions of other supplements were as the following: 4.4% for vitamin C (90% daily to monthly use), 4.0% for vitamin A (33.3% daily and 66.7% weekly use), and 3.1% for zinc supplements (57.1% daily and 42.9% weekly use). Other frequent food habits included never to rare use of table salt (68.4%), rare consumption of fast food (i.e. ≤ 1 time/month) (43.1%), 2 snacks/day (42.3%), ≥ 5 breakfast episodes/week (78.0%), ≥ 3 meals/day (66.4%), always regular meals (39.6%), rare dining at restaurant (≤ 1 time/month) (51.8%), use of vegetable oils for cooking (except saturated and frying oils, 59.6%), rare consumption of crispy foods (< 1 time/month) (63.1%), and use of frying or cooking oils for frying (76.4%). Biochemical analyses demonstrated that 5.6, 21.7, 23.8 and 31.1% of the participants had abnormal concentrations of FBS, TG, HDL-C and TC, respectively. Significant associations were seen between HDL-C and frying method and also TC and regulation of meals, consumption of crispy fried foods, dining at restaurant and removing trimming fats from red meat. Deep frying rather than Sauté frying elevated the chance of abnormal HDL-C concentrations (binary logistic regression, B = 6.51, p = 0.024). The TC levels were associated with regular meals consumption (B = -5.88, p = 0.011), < 1 time/m Crispy fried foods (B = 5.29, p = 0.044), monthly dining at restaurant (B = 3.27, p = 0.033), and partial trimming of visible fats from red meat (B = -6.69, p = 0.048). The BMI was positively correlated with FBS (r_s = 0.223, p = 0.005), TG (r_s = 0.342, $p < 0.001$) and TC (r_s = 0.359, $p < 0.001$), but not with serum HDL-C (r_s = -0.130, p = 0 .099). However, the association of energy and macronutrient intakes with FBS, TG and HDL-C abnormalities was not statistically significant. There was a noteworthy association between BMI categories and TG status (p=0.004, Table 3). Logistic regression revealed that obese participants had higher odds of abnormal TG values (OR=6.28, 95% CI=1.72- 22.89, p=0.005). This association remained significant even after adjusting for age, energy and macronutrient intakes (OR = 5.28, 95% CI=1.37-20.35, p=0.016). However, after further adjustments for other confounding factors (e.g., job and education), this association was near significant (binary logistic regression, p=0.052).

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Table 2. Association of BMI and food habits in a sample of adults in Tehran (*n* = 227), 2016

Variable	BMI (kg/m^2)			p-value
	18.5-24.9 (Normal weight)	25-29.9 (overweight)	≥30 (obesity)	
Age (year)	37.00± 11.73	43.08± 11.48	44.68± 10.68	0.001*
Total	50	94	79	
Sex				0.143
Male	24 (48.0%)	51(54.3%)	31(39.2%)	
Female	26(52.0%)	43(45.7%)	48(60.8%)	
Total	50 (100.0%)	94(100.0%)	79(100.0%)	
Education				0.012*
under diploma	10(20.0%)	16(17.0%)	23(29.1%)	(male=0.280;
diploma	17(34.0%)	47(50.0%)	41(51.9%)	female=0.041*)
academic degree	23(46.0%)	31(33.0%)	15(19.0%)	
Total	50(100.0%)	94(100.0%)	79(100.0%)	
Occupation				<0.001**
driver	6(12.0%)	40(43.5%)	36(45.6%)	(male<0.001**;
others	23(46.0%)	27(29.3%)	25(31.6%)	female=0.063)
clerk	9(18.0%)	20(21.7%)	14(17.7%)	
college student	12(24.0%)	5(5.4%)	4(5.1%)	
Total	50(100.0%)	92(100.0%)	79(100.0%)	
Energy (kcal/d)	3546.68± 1430.66	3784.97± 1548.70	3659.84± 1654.08	0.622
Total	50	91	78	
Carbohydrate (g/d)	537.75± 212.06	597.85± 270.48	562.45± 245.48	0.552
Total	50	92	77	
Protein (g/d)	107.62± 39.39	113.08± 42.33	109.96± 48.14	0.588
Total	49	90	76	
Fat (g/d)	112.18± 53.89	114.42± 44.76	105.89± 47.70	0.293
Total	50	91	78	
No. of meals taken per day				0.254
<3				(male=0.285;
≥3	13(26.0%)	30(31.9%)	31(39.7%)	female= 0.692)
Total	37(74.0%)	64(68.1%)	47(60.3%)	
	50(100.0%)	94(100.0%)	78(100.0%)	
No. of breakfasts taken per week				0.362
≤4				(male=0.594;
≥5	10(20.0%)	17(18.5%)	21(27.3%)	female=0.268)
Total	40(80.0%)	75(81.5%)	56(72.7%)	
	50(100.0%)	92(100.0%)	77(100.0%)	
Frequency of regular meals				0.034*
Never or Sometimes				(male=0.044*,
Often or Always	13(26.5%)	31(33.7%)	37(48.1%)	female=0.094)
Total	36(73.5%)	61(66.3%)	40(51.9%)	
	49(100.0%)	92(100.0%)	77(100.0%)	
No. of Snacks eaten per day				0.048*
1				(male = 0.389;
2	15(30.6%)	33(35.9%)	30(40.0%)	female= 0.138)
3-5	16(32.7%)	42(45.7%)	34(45.3%)	
Total	18(36.7%)	17(18.5%)	11(14.7%)	
	49(100.0%)	92(100.0%)	75(100.0%)	
Trimming of visible fat from meat before cooking				0.362
I do not eat meat at all				(male=0.615;
I trim most of it	2(4.1%)	2(2.1%)	5(6.5%)	female=0.362)
I trim little of it	36(73.5%)	63(67.0%)	49(63.6%)	
I do not trim it	2(4.1%)	13(13.8%)	6(7.8%)	
Total	9(18.4%)	16(17.0%)	17(22.1%)	
	49(100.0%)	94(100.0%)	77(100.0%)	
Removal of poultry skin before cooking				0.288
Never				(male=0.445;
Sometimes	3(6.0%)	1(1.1%)	0(0.0%)	female=0.296)
Often	1(2.0%)	3(3.2%)	2(2.6%)	
Always	1(2.0%)	2(2.1%)	3(3.9%)	
Total	45(90.0%)	88(93.6%)	72(93.5%)	
	50(100.0%)	94(100.0%)	77(100.0%)	

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Variable	BMI (kg/m^2)			p-value
	18.5-24.9 (Normal weight)	25-29.9 (overweight)	≥30 (obesity)	
No. of fried food eaten per week				0.176
Never	1(2.0%)	4(4.3%)	7(9.2%)	(male=0.158;
1-3	35(70.0%)	73(77.7%)	53(69.7%)	female=0.259)
4-6	10(20.0%)	16(17.0%)	14(18.4%)	
Every day	4(8.0%)	1(1.1%)	2(2.6%)	
Total	50(100.0%)	94(100.0%)	76(100.0%)	
Method of frying				0.985
Deep	4(8.7%)	8(9.2%)	8(11.3%)	(male= 0.894;
Superficial	33(71.7%)	63(72.4%)	51(71.8%)	female= 0.558)
Sauté	9(19.6%)	16(18.4%)	12(16.9%)	
Total	46(100.0%)	87(100.0%)	71(100.0%)	
Type of oil/fat used for frying				0.523
Frying oil or combination of cooking & frying oil	37(77.1%)	58(71.6%)	53(80.3%)	(male=0.074; female=0.732)
Olive or other veg. oils (including cooking oil, hydrogenated, etc.) or combination of them	11(22.9%)	20(24.7%)	11(16.7%)	
Hydrogenated veg. oil, animal fat (rump, ghee, butter, etc.) or combination of any veg. oil & animal	0(0.0%)	3(3.7%)	2(3.0%)	
Total	48(100.0%)	81(100.0%)	66(100.0%)	
Type of oil/fat used for cooking				0.963
Frying oil	3(8.1%)	8(11.0%)	9(15.5%)	(male=0.994; female=0.684)
Other veg. oil (olive, corn, soy, sunflower, sesame, etc.)	23(62.2%)	43(58.9%)	34(58.6%)	
Hydrogenated veg. oil, animal fat (rump, ghee, butter, etc.) or combination of them	9(24.3%)	18(24.7%)	12(20.7%)	
Combination of oils/fats (frying, olive, corn, soy, hydrogenated, animal, etc.)	2(5.4%)	4(5.5%)	3(5.2%)	
Total	37(100.0%)	73(100.0%)	58(100.0%)	
Frequency of salt use on table				0.138
Always	8(16.3%)	14(14.9%)	9(11.5%)	(male= 0.191;
Sometimes or Often	9(18.4%)	10(10.6%)	20(25.6%)	female= 0.516)
Never or rarely	32(65.3%)	70(74.5%)	49(62.8%)	
Total	49(100.0%)	94(100.0%)	78(100.0%)	
No. of Crispy fried foods eaten out				0.431
Never	27(54.0%)	49(52.7%)	42(53.8%)	(male=0.796,
<1 / month	2(4.0%)	9(9.7%)	11(14.1%)	female=0.645)
1 / month	13(26.0%)	16(17.2%)	15(19.2%)	
>1/month	8(16.0%)	19(20.4%)	10(12.8%)	
Total	50(100.0%)	93(100.0%)	78(100.0%)	
Frequency of fast food consumption				0.360
Never	20(41.7%)	40(42.6%)	40(51.9%)	(male= 0.268;
Weekly	7(14.6%)	13(13.8%)	5(6.5%)	female= 0.206
Monthly	18(37.5%)	28(29.8%)	26(33.8%)	
Rarely (<1 time/Mo.)	3(6.3%)	13(13.8%)	6(7.8%)	
Total	48(100.0%)	94(100.0%)	77(100.0%)	
Eating food at restaurant				0.445
Weekly	22(44.0%)	27(29.3%)	24(30.8%)	(male=0.277;
Monthly	6(12.0%)	13(14.1%)	15(19.2%)	female=0.526)
Rarely (<1/mo.)	18(36.0%)	40(43.5%)	27(34.6%)	
Never	4(8.0%)	12(13.0%)	12(15.4%)	
Total	50(100.0%)	92(100.0%)	78(100.0%)	
Use of multivitamin-mineral supplements				0.058
No	26(54.2%)	55(61.1%)	57(74.0%)	(male=0.356;
Yes	22(45.8%)	35(38.9%)	20(26.0%)	female=0.062)
Total	48(100.0%)	90(100.0%)	77(100.0%)	

Shapiro-Wilk test used to check normality. Analyses were done after removing outliers. Chi-square, One-way ANOVA and Kruskal-Wallis tests were used to analyze data.

*p<0.05

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Table 3. Biochemical analyses and weight status in a sample of adults in Tehran (*n* = 227), 2016

Factor	BMI			p value[i]
	18.5-24.9 (Normal weight)	25-29.9 (overweight)	≥30 (obesity)	
FBS, mg/dL				0.649
<100	37(97.4%)	60(93.8%)	54(93.1%)	(male=0.201;
≥100	1(2.6%)	4(6.3%)	4(6.9%)	female=0.053)
Total	38(100.0%)	64(100.0%)	58(100.0%)	
Crude OR	1	2.47 (p=0.427)	2.74 (p=0.376)	
Adjusted OR[ii]	1	1.99 (p=0.495)	2.24 (p=0.495)	
TG, mg/dL				0.004*
<150	35(92.1%)	50(82.0%)	39(65.0%)	(male= 0.050;
≥150	3(7.9%)	11(18.0%)	21(35.0%)	female= 0.017*)
Total	38(100.0%)	61(100.0%)	60(100.0%)	
Crude OR	1	2.57 (p=0.170)	6.28 (p=0.005)*	
Adjusted OR[ii]	1	2.30 (p=0.251)	5.28 (p=0.016)*	
HDL-C, mg/dL				0.009*
≥40 m or ≥50 f	35(92.1%)	49(76.6%)	39(65.0%)	(male= 0.305;
<40 m or <50 f	3(7.9%)	15(23.4%)	21(35.0%)	female= 0.020*)
Total	38(100.0%)	64(100.0%)	60(100.0 %)	
Crude OR	1	3.57 (p=0.057)	6.28 (p=0.005)*	
Adjusted OR[ii]	1	4.28 (p=0.038)*	8.01 (p=0.003)*	
TC, mg/dL				0.006*
<200	32(84.2%)	47(73.4%)	33(55.0%)	(male=0.023*;
≥200	6(15.8%)	17(26.6%)	27(45.0%)	female=0.125)
Total	38(100.0%)	64(100.0%)	60(100.0%)	
Crude OR	1	1.93 (p=0.213)	4.36 (p=0.004)*	
Adjusted OR[ii]	1	1.46 (p=0.505)	3.48 (p=0.023)*	

BMI body mass index, FBS fasting blood sugar, F Female HDL -C high density lipoprotein cholesterol, M Male, OR odds ratio, TC total cholesterol, TG triglyceride (* p<0.05)

[i]Chi-square test was used.

[ii] adjusted for age, energy and macronutrients *(*Binary logistic regression*).*

Discussion

In general, it is not precisely clear which food habits may increase or decrease risks of obesity and other metabolic disorders. For example, the Adventist Health Study-2 over 30 years proposed that habits like less frequent meals, no snacking, breakfast consumption, and consumption of the largest meal in the morning may prevent weight gain in long term (20). However, other studies have suggested irregular (10, 11) and less frequent meals (21-24) as obesity risk factors. The present study demonstrated an inverse association between overweight and frequency of snacks. Some observational studies have suggested an inverse relationship between frequency of eating and adiposity (21-24). Proposed explaining mechanisms might be better appetite control (25, 26), improved glucose homeostasis (27-29) and increased TEF (30, 31). Furthermore, our data showed that adults consuming 3 meals/day possibly had more breakfast episodes in a week. Although no direct association was found between breakfast consumption and obesity or other metabolic disorders in this study, previous studies suggested that daily consumption of breakfast is linked to 1.9 kg less weight gain compared with infrequent breakfast consumption (0–3 days/week) in participants over 18 years (32). Furthermore, eating breakfast was claimed to decrease risk of diabetes and hypertension (33), and larger breakfast is associated with a significant decrement in BMI (20). Nevertheless, no data were available on breakfast size in this study.

Although no association was found between weight status and meal episodes in this study, some studies proposed that a higher eating frequency is associated with healthier lifestyle (e.g. lower smoking and alcohol use, greater physical activity and a healthier diet) (34). Middle-aged population with three or less daily meals had greater chance of both general and central obesity in males, but not in females (34). In a population-based study, higher daily eating episodes were associated with lower serum cholesterol and LDL-C concentrations, as participants with four and more meals per day had 0.23 mmol/L lower TC (p = 0.01) and had 0.16 mmol/L lower LDL-C (p = 0.06)

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than those with 1–2 meals per day. That proposes the possibility of serum cholesterol decline by increasing meal frequency (35). We found no association between food frequency and serum lipids. However, those with regular meals had lower TC concentrations. Previous findings suggested a positive association between irregular meal pattern and BMI (36) and obesity (10, 11). Based on these findings, overweight is inversely associated with meal regularity, especially in men. Greater TEF, greater insulin sensitivity, and favorable appetite changes in a regular against an irregular meal consumption may mediate a better weight control and metabolic health (12).

In the current study, an inappropriate use of saturated fats/oils for cooking were seen. Hydrogenated vegetable oils and animal fats were the second most used oils by the participants (23.4%). These are major sources of saturated (SFAs) and trans-fatty acids (TFAs) in diet (37, 38). Several evidence have specified that TFAs increase chance of coronary heart disease (CHD) development (39, 40), which might be due to its adverse effects on serum lipids and lipoproteins (39, 41, 42), enhanced systemic inflammation (43-46) and endothelial dysfunction (43, 45). Systematic reviews and meta-analyses have demonstrated that replacement of SFAs with poly unsaturated fatty acids (PUFAs) and monounsaturated fatty acids (MUFAs) may decrease CHD risk (47, 48). In previous studies, saturated fats have been connected to cancers, like gastric cancer (49). Also, a relatively high prevalence of overweight and obesity in this study was in consistence with recent findings in Iranian population (50). According to a recent investigation, non-optimal BMI was the third leading cause of CMD mortality in most Middle Eastern and North African countries (3). Obese participants had nearly six times higher odds of abnormal serum TG and higher BMIs accompanied by higher serum FBS, TG and TC levels. Nevertheless, these had no association with energy and macronutrient intakes. Previous studies have demonstrated that 60–70% of obese and 50–60% of overweight people had dyslipidemia and higher chance of diabetes (51). According to our results, older adults had higher BMIs which could be due to physical inactivity, lower lean body mass or poor food habits. Further studies are needed in this regard. In spite of high prevalence of vitamin D deficiency in Iranian population (52), a small proportion of the participants received vitamin D supplements routinely. A recent study has revealed that vitamin D deficiency is positively linked to abdominal and general obesity (53). Therefore, public health professionals should further focus on this matter.

The current study had several strengths: First, data collected using food frequency questionnaires accompanied by food habits can widely capture food intake in long-term. Second, a wide number of food habits were questioned.

We also faced some limitations: First, meal's composition and size and their possible connection with metabolic risk factors were not assessed. Second, the mediating role of the physical activity in obesity and other metabolic risk factors was ignored in this study.

Conclusion

To conclude, in spite of acceptable manner for most food habits, high consumption of saturated oils/fats as well as excessive body weight and elevated blood lipids in studied participants were seen. There was an association between obesity and dyslipidemia along with its correlation with some food habits, like snacks and regular meals consumption, which suggests that modification of food habits may mitigate the risk of non-communicable diseases, especially CVD, through weight and lipid control. It is recommended that health authorities focus on nutrition education with emphasis on regular meals and more snacks in policies regarding non-communicable disease control. Further studies should be carried out on meal composition and physical activity and underling mechanisms of food habits' effect on metabolic health. To overcome drawbacks, further investigations with greater sample sizes and longer durations are encouraged.

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