Diet quality in obese/overweight individuals with/without metabolic syndrome compared to normal weight controls

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Abstract

Background: Metabolic syndrome (MetS) is a serious public health concern worldwide; however, the pathogenesis of this disease has not been yet cleared. This study aimed to compare diet quality in obese/overweight participants with/without metabolic syndrome with normal weight controls.

Methods: This was a comparative study on 147 Iranian adults under treatment at the Endocrinology Center of Tehran University of Medical Sciences. They were assigned into three groups (normal weight, obese weight with/without MetS) according to the inclusion- exclusion criteria. Metabolic syndrome was defined according to the NCEP ATPIII consensus criteria. Healthy Eating Index Data were obtained from the validated FFQ to determine the diet quality index scores, using the Healthy Eating Index-2010.

Results: Our findings demonstrated that FBS, TG, SBP, WC and weight were higher among MetS patients compared to the both weight matched and non-weight matched participants, while HDL-c was lowest in this group (p<0.05). A statistically significant difference was found between healthy weight controls and obese/overweight participants with/without MetS in HEI-2010, and 9 of the 12 HEI-2010 components score (p<0.05).

Conclusion: Our study revealed that low diet quality was a risk factor in developing MetS.

Keywords: Obesity, Metabolic Syndrome, Diet.

Introduction

The term" metabolic syndrome" (MetS) was first defined by Reaven (1988) (1). MetS is characterized by having cardiovascular risk factors including insulin resistance, central obesity, impaired glucose metabolism, hypertension, and dyslipidemia (2-5). Concurrence of the risk factors in an individual may lead to unfavorable outcomes such as increased morbidity and mortality of cardiovascular disease (CVD) as well as Type 2 diabetes mellitus (DM2) (6-7). Furthermore, MetS has been an increased public health concern for the last three decades worldwide (8).

Since the pathogenesis of the syndrome has not been yet cleared, several underlying mechanisms, particularly genetic predispo-

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sition, stress, nutritional, lifestyle factors, and abnormal hormonal status have been suggested (9). However, modified diet and healthy eating habits might have beneficial roles in managing and treating MetS (10). A combination of nutrients in a diet might have synergistic effects on developing chronic diseases; therefore, assessing overall diet quality can be more effective than assessing a single nutrient (11). Diet quality indexes such as HEI "an instrument for measuring the overall nutritional status and chronic disease risk" have been developed and widely used in the recent years (12). The HEI, is a single summary measure of overall diet quality, and an important tool for monitoring the nutrition goals and eating habits to either prevent or promote diseases (13-14). Hence, this study aimed to compare the diet quality in obese/overweight participants with/without metabolic syndrome and the normal weight controls.

Methods
Participants
This was a comparative study on 49 obese patients suffering from MetS, 49 obese participants without MetS and 49 normal weight individuals without MetS. Patients who referred to the Endocrinology Center of Tehran University of Medical Sciences were assessed for MetS criteria. Age and gender matched to the MetS patient made up of 49 weights matched overweight/obese participants (without MetS) and 49 normal weight participants from those attending the Center for routine medical care. The Participants were selected using sequential sampling method based on the inclusion and exclusion criteria. All participants provided written consent forms.

Ethic committee of Tehran University of Medical Sciences approved was approved our study (approved number: 92-2-161-26504).

The Exclusion criteria were as follows: Having a history of coronary artery disease, acute or chronic renal failure, acute infec-

tion within the seven days prior to the study, acute or chronic hepatic failure, hematological disorder, presence of any chronic inflammatory or autoimmune disease and any known malignancy, pregnancy, breast feeding, post-menopause, smoking, being a professional athlete, having uncontrolled thyroid disorder, taking medications for dyslipidemia or hypertension, using hypnotics, sedatives and immunosuppressive drugs and being on a special diet prescribed by a dietitian for any reason.

The inclusion criteria were as follows: Adults aged 20-55 years, having BMI≥ $25kg/m^2$ for overweight/obese groups with and without MetS and BMI<$25kg/m^2$ for normal weight counterparts without MetS.

Moreover, metabolic syndrome was defined according to the NCEP ATPIII consensus criteria. A participant was diagnosed as MetS patient if three or more of the following criteria were met: (a) Waist circumference greater than or equal to 102 cm for men and greater than or equal to 88 cm for women; (b) Triglyceride level greater than or equal to 150mg/dL; (c) High-density lipoprotein (HDL) cholesterol less than 40mg/dL for men and less than 50mg/dL for women; (d) Systolic blood pressure greater than or equal to 130 and/or diastolic blood pressure 85 mmHg; (e) Fasting glucose greater than or equal to 100mg/dL.

Anthropometric and Clinical Parameter Measurement
Participants' body weight (in kilograms − kg) and height (in meters−m) were measured using standard approach (15). Body mass index (BMI) of each participant was calculated as body weight divided by height squared (kg/m2) to the nearest 0.01kg and 0.1 cm. WC was measured using a flexible tape measure in the midline between the lower rib margin and the iliac crest after normal expiration. A professional nurse measured the systolic and diastolic blood pressure on the non-dominant brachial artery in the participants in a sitting position after they rested at least for 10 minutes.

Blood pressure was measured twice separately over a 3-minute time interval. The average blood pressure was considered as blood pressure value.

Fasting blood samples were obtained from each participant by venipuncture and immediately centrifuged. The serum samples were frozen and stored at −80°C for subsequent analyses. HDL-C, TG and FBS concentration were measured by Standardized procedures on fasting samples.

HEI: Healthy Eating Index Data obtained from a validated FFQ were used to determine diet quality index scores using the Healthy Eating Index-2010 (HEI-2010) (16). We used the FFQ estimated annual intake of participants, to evaluate the food intake. HEI, created by the US Department of Agriculture (USDA) in 1995, is **a** tool to measure diet quality, which assesses compliance to federal dietary guidance. HEI has recently been revised and a new scoring system has been developed for it.

The HEI-2010 has 12 components, including nine adequacy components (total fruit, whole fruits, total vegetables, greensand beans, whole grains, dairy, total protein foods, seafood and plant proteins s, and fatty acids), and three moderation components (refined grains, sodium, and empty calories). The HEI-2010-scoring standards are density-based with a minimum score of zero for all components, whose maximum score varies between 5, 10, and 20. More details on the HEI-2010 scoring can be found in a report provided by the U.S. Department of Agriculture (17-18).

Statistical Analysis

Data were analyzed using SPSS 16. To compare the difference among the three study groups, we analyzed the continuous variables using one-way ANOVA. When the result of the ANOVA test was significant, a LSD test was used to identify which pairs of means were statistically different. Qualitative variables were analyzed using chi-square test. Multinomial logistic regression was utilized to estimate the odds ratio of obesity/overweight compared to normal weight patients across the HEI score. A two-tailed $p<0.05$ was considered statistically significant.

Results

The general characteristics of the participants are demonstrated in Table 1. Almost 92% of the participants were male. The mean (±SD) age of the participants was 35.5 (±7.3) yrs. No statistically significant

Table 1. Frequency distribution of general characteristics of participantss of the study groups

		Obese with MetS (n=49)	Obese without MetS (n=49)	Normal weight (n=49)	total (n=147)	p*
		N (%)	N (%)	N (%)	N (%)	
Sex*	Male	45 (91.8)	46 (93.9)	45 (91.8)	136 (92.5)	0.906
	Female	4 (8.2)	3 (6.1)	4 (8.2)	11 (7.5)	
Marital	Single	8 (16.3)	13 (26.5)	15 (30.6)	36 (24.5)	0.390
status*	Married	41 (83.7)	36 (73.5)	34 (69.4)	111 (75.5)	
age**	20-29.9	6 (12.2)	10 (20.4)	15 (30.6)	31 (21.1)	0.277
	30-39.9	27 (55.1)	23 (46.9)	24 (49)	74 (50.3)	
	40-55	16 (32.7)	16 (32.7)	10 (20.4)	42 (28.6)	

*chi-square, **Fisher

Table 2. Comparison of biochemistry parameters among participantss of case and control groups

	Obese with MetS (n=49)	Obese without MetS (n=49)	Normal weight (n=49)	Total (n=147)	p*
	SD± mean	SD± mean	SD± mean	SD± mean	
FBS	109±48[a]	93.7±16.9[b]	91.8±6.4[b]	98.2±30.2	0.008
TG	199.8±95.5[a]	119±58.5[b]	109.7±54.4[b]	143±82.2	<0.001
HDL-c	52.2±7[a]	54.2±7	56.2±8[b]	54.2±7.4	0.029
SBP	135.9±12.76[a]	127.6±14.3[b]	118.9±12.2[c]	127.5±14.7	<0.001
WC	106.3±7.4[a]	102.6±10.2[a]	88.3±6.9[b]	99.1±11.3	<0.001
BMI	29.8±3.26[a]	29.7±3.2[a]	22.9±2.3[b]	27.46±4.4	<0.001

Values are analyzed by one–way ANOVA, values are mean ± SD.
Dissimilar values (a, b, c) of each row are significantly different.

differences were found between the three groups in terms of age, sex and marital status (Table 1) (p>0.05). The biochemistry as well as anthropometric measures (FBS, TG, HDL-C, SBP, WC and weight and height) are shown in Table 2. FBS, TG, SBP, WC and weight were significantly higher among MetS patients compared to both weight matched and non-weight matched participants, while HDL-c was the lowest in this group (p<0.05) (Table 2).

Nearly 80% of the participants with MetS and 57.14% of the obese/overweight participants without MetS had a poor diet quality. The majority of the healthy weight individuals (96%) needed to improve their diet (p<0.05) (Table 3).

The mean HEI-2010 score for obese/overweight participants with/without MetS were 47.51 (poor diet quality) and 52.25 (need improvement), respectively (p<0.05). However, HEI score was 66.85 in normal weight participants, which was significantly higher compared to the average HEI in the obese/overweight with/without MetS (p<0.05) (Table 4).

The HEI-2010 component scores are presented in Table 4. A statistically significant difference was observed between healthy weight participants and obese/overweight patients with/without MetS in 9 out of 12 HEI-2010 components score, including total fruit, whole fruit, total vegetable, greens and beans, whole grain, dairy, seafood and plant proteins, fatty acids, sodium (p<0.05). Furthermore, a statistically significant difference was obtained between obese/ overweight participants in five components of whole grain, dairy, total protein food, seafood and plant proteins and refined grain (p<0.05) (Table 4).

The Odds Ratio (OR) from multinomial logistic regressions for overweight/obese patients with and without MetS compared to the normal weight controls were achieved by Stata software. By each unit reduction in HEI-2010 score, the odds of obese/overweight patients with/without MetS to normal participants increased by 1.25 and 1.16 times, respectively. Thus, HEI serves as a protective factor against development of Mets and obesity.

Table 3. Comparison ofHEIQ among participantss of case and control groups

		Obese with MetS (n=49)	Obese without MetS (n=49)	Normal weight (n=49)	Total (n=147)	p*
		N (%)	N (%)	N (%)	N (%)	
HEI	Poor diet[a]	36 (73.47)	28 (57.14)	1 (2)	65 (44.22)	0<0.001
	Need improvement [b]	13 (26.53)	21 (42.86)	47 (96)	81 (55.1)	
	Good diet[c]	0	0	1 (2)	1 (0.68)	

*chi-square, a: HEI score≤ 50, b: HEI> 50, c: HEI≥ 80

Table 4. Comparison of HEI-2010 and 12 its component among in study groups

	Obese with MetS (n=49)	Obese without MetS (n=49)	Normal weight (n=49)	Total (n=147)	p*
	SD± mean	SD± mean	SD± mean	SD± mean	
HEI-2010	7.53[a]±47.51	9.87[b]±52.25	8.67[c]±66.85	12±55.61	<0.001
Total fruit	37.7±22.09[a]	44.7±27.2[a]	88.2±20.7[b]	57.12±32.4	<0.001
Whole fruit	65.2±23.1[a]	69.6±25.2[a]	97.1±10.4[b]	77.4±24.9	<0.001
Total vegetables	55±16.6[a]	51.07±16.1[a]	70.9±21.7[b]	59.1±20.2	<0.001
Greens and beans	49.2±26.8[a]	55.4±24.3[a]	88.1±21.6[b]	64.4±24	<0.001
Whole grain	17.9±8.02[a]	12.7±9.3[b]	17.1±10.4	15.9±9.5	0.015
Dairy	32.9±14.3[a]	45.6±27.01[b]	78.8±26.6[c]	52.6±30.3	<0.001
Total protein food	86.05±8.09[a]	86.4±7.3[b]	85.5±14.7[c]	85.9±10.5	0.918
Seafood and plant proteins s	24.6±23.7[a]	44.8±29.8[b]	73.4±30.02[c]	47.8±34.3	<0.001
Fatty acids[a]	39.6±37.1[a]	37.8±37.2[a]	57.1±37.7[b]	44.9±38.1	0.021
Refined grain	9.4±18.8[a]	14.8±26.8[b]	15.6±26.7[c]	13.3±24.4	0.398
Sodium	65.02±26.04[a]	75.48±23.01	78.8±28.4[b]	73.14±26.41	0.027
Empty calories	74.8±24.5[a]	79.9±25.8[b]	83.5±27.4[c]	79.4±26.03	0.253

Values are analyzed by one–way ANOVA, values are mean ± SD.
Dissimilar values (a, b, c) of each row are significantly different.
[a]: PUFA and MUFA/SFA

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Discussion

To our knowledge, this was the first study to examine the associations between obesity, MetS and diet quality in the three groups using HEI-2010. We found significant differences in diet quality of the obese participants with/without MetS and healthy weight individuals using HEI-2010. In this study, HEI-2010 score was the highest for participants with healthy weight (66.85), the obese/overweight participants without Mets had the HEI-2010 score of 52.25, and the obese/overweight participants with MetS had the lowest HEI-2010 score (47.51). Furthermore, odds of having obesity and MetS were significantly lower with increased HEI scores. This result is in agreement with the study by Nicklas TA et al. who found that individuals with the highest diet quality were less likely to be overweight/obese (34%) or have elevated WC, BP (26%), MetS (35%), and decreased HDL-C (21%) than those with the lowest diet quality (19). Moreover, another study suggested older version of the HEI as a strong independent negative predictor of BMI, LDL and HDL cholesterol (MetS parameter) (20-21). This study confirmed the findings of previous studies that utilized the most recent version of HEI as a diet quality measure (HEI-2010). Unique to this study, however, was that individuals with the higher diet quality were 0.8 less likely to have obesity and 0.86 less likely to have MetS. Moreover, in this study, the mean HEI-2010 for all the participants was 55.61 (needed improvements). Consistent with our study, Tardivo AP and Ş Direktör study reported that HEI score was 56.6 and 58.8 in their study sample, respectively (22-23).

According to our findings, diet quality of healthy weight participants is more in compliance with the DGA (The Dietary Guidelines for Americans) as measured by HEI-2010 compared to the obese/overweight participants with/without MetS. Furthermore, our data revealed that diet quality of obese/overweight patients without MetS is more in compliance with the DGA compared to the obese/overweight patients suffering from MetS. These results are in agreement with the studies by Boynton et al. and Tardivo AP reporting that the risk of poor diet is significantly higher with elevated WC (22,24).

Therefore, weight management might be associated with improvements in diet quality. Lin CT, et al. study demonstrated that the diet quality score of those who tried to control their weight is higher than that of others who reported no method to control their weight (25).

In this study, HEI-2010 assessment revealed that diet was of poor quality in 44.22% of the participants (73.47% of obese/overweight patients with MetS, 57.14% of obese/overweight participants without MetS and 2% of healthy weight controls). Moreover, 55.1% of the participants needed to improve their diet (26.53% of obese/overweight participants with MetS, 42.86% of obese/overweight participants without MetS and 96% of healthy weight counterparts). Surprisingly, only 0.68% of the total participants had good diet quality (0% of obese/overweight participants with MetS, 0% of obese/ overweight participants without MetS, and 2% of the healthy weight controls); and such poor quality diet was attributed to insufficient intake of total fruit, whole fruit, total vegetable, whole grain, dairy, seafood and plant proteins and high intake of sodium and fatty acids, which can negatively affect the metabolic risk factors. Obese/ overweight participants with/without MetS tended to gain low scores on these HEI components. Based on Tardivo AP et al. study, only 3% of the participants' diet was of good quality, while 48.5% of the diets needed improvement and 48.5% were of poor quality (22).

Score of 9.4 refined grain and 12.7 whole grains accounted for the lowest component score in obese/overweight participants with and without MetS, respectively. An average score of 15.6 refined grains was accounted for the lowest component score in healthy weight participants (high intake). According to the results of Santos's study, the

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HEI component scores from the highest to the lowest were meat (8.9), sodium (8.5), fat (8.1), cholesterol (8.1), saturated fat (7.0), variety (6.7), grain (4.7), fruit (4.9) and milk (4.6)(26). In this study, the intake of total fruit, whole fruit, total vegetable, whole grain, dairy, seafood and plant proteins were insufficient in obese/overweight participants compared to the healthy weight participants, while sodium and fatty acids intake were high. A statistically significant difference was obtained between obese/overweight participants and healthy weight participants in these components, while no difference was found among the three groups with respect to the calorie score. Moreover, whole grain intake was insufficient in healthy weight controls.

Ağören et al. study was conducted on a general population of Cyprus, and Direktör Ş and Santos et al. study was conducted on people with diabetes mellitus, both of which indicated that milk consumption was insufficient. According to Ağören et al. study and Ş Direktör et al. study, meat and vegetable consumption were inadequate and saturated fat intake was high (23,27). However, no previous study assessed diet quality using HEI-2010. Thus, our findings were comparable with the results of the studies that investigated diet quality by HEI 2005.

One of the strengths of this study was using HEI-2010 as a diet quality index and comparing this index in three groups for the first time. This study had some limitations. Because of the small number of female participants, the study population was not representative of the general population. Furthermore, to our knowledge, no specific study on diet quality using HEI-2010 on obese people with MetS is was available, making it difficult to compare our finding to the literature; therefore, our finding should be interpreted with caution.

Conclusion

We found that the majority of the participants needed to improve their diet. There-
fore, we recommend that individuals with MetS and obesity improve their diet quality. Moreover, we highly recommend that the officials and authorities develop nutrition educational programs to minimize this urgent health problem. In addition, this study suggests that individuals consume more total fruit, whole grain, dairy, seafood and plant proteins and use less fatty acids.

Acknowledgments

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