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Comparison of the Number of Daily Servings from Different Food Groups in Metabolic Syndrome Patients with the Control Groups

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Authors' contributions

This work was carried out in collaboration between all authors. Authors KD and AE contributed to the study design, coordination of the project and interpretation of the data. Author VB designed the study, wrote the protocol, did the data collection, performed the statistical analysis, and wrote the manuscript. Author KA managed the sample size estimation and statistical analysis. Author BH revised the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study aimed to compare the number of daily servings intake from different food groups in metabolic syndrome (MetS) patients with the control groups.
Study Design: Case control, comparative cross-sectional study.
Place and Duration of Study: Endocrinology and Metabolism Research Center, Vali-Asr Hospital,

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and Clinical Nutrition Department, School of nutritional Sciences and Dietetics, Tehran University of Medical Sciences, from April 2014 to March 2015.

Methodology: In this cross-sectional study the number of daily servings intake of seven major food groups including grain, meat, fruit, vegetable, fat and oils, milk and sweets was compared between 50 MetS patients (Group 1) and 50 obese or overweight participants without MetS (Group 2) and 48 normal weight participants without MetS (Group 3). The demographics, anthropometric and biochemical variables were assayed. Feeding and food frequency were collected using a modified food frequency questionnaire. USDA food pyramid was used to classify the food groups.

Results: The total and per 1000 kcal daily servings intake from all the aforementioned food groups were significantly different among the study groups ($p \leq .01$). The numbers of daily servings from meat, fruit, vegetable, and milk groups were significantly higher, while, quantity of daily servings by considering fat and oil, sweets and grain groups were significantly lower in the normal weight controls in comparison with the patients suffering from metabolic syndrome and overweight/obese controls, as well ($P < .001$). No significant difference was noticed by considering all food groups' consumption between patients with metabolic syndrome and overweight/obese controls ($P \geq .09$). In addition, meat group was categorized to its subgroups including red meat, poultry, fish, tuna, egg, and nuts. The numbers of total and per 1000 kcal of daily servings intake from meat subgroups were respectively higher with regards to nuts, egg, poultry, red meat and fish and tuna subgroup ($P \leq .07$). To illustrate, the normal weight controls had the highest consumption of meat group, which was due to the high intake of nuts, eggs and poultry subgroups.

Conclusion: In conclusion, the number of daily servings intake from meat, fruit, vegetable and milk groups were significantly higher, while, fat and oil, sweets and grain groups were significantly lower in the normal weight controls in comparison with the patients with metabolic syndrome and overweight/obese controls. No significant difference was observed among patients with metabolic syndrome and overweight/obese controls.

Keywords: Metabolic syndrome; food group; obesity; normal weight.

1. INTRODUCTION

MetS is defined by a constellation of an interconnected physiological, biochemical, clinical, and metabolic factors that directly increase the risk of atherosclerotic cardiovascular disease (ASCVD), type II diabetes mellitus (T2DM), and all causes of mortality [1-3]. Based on the IDF estimation, about one-quarter of adults are suffering from MetS worldwide [4]. Compelling evidence has reported that metabolic syndrome has a high prevalence in Iran. According to the findings from Tehran lipid and glucose study the prevalence of metabolic syndrome is 42% in Iranian women and 24% in Iranian men [5]. Metabolic syndrome was first defined as glucose intolerance or insulin resistance along with 2 of the following disorders: dyslipidemia, hypertension, obesity and micro-albuminurea [6]. In spite of various definitions of this syndrome, abdominal obesity and insulin resistance play an important role in its etiology. The other diagnostic factors of this syndrome include hypertension, high triglycerides levels (TG) and low levels of high-density lipoprotein cholesterol (HDL-c). Modifying life style factors is regarded as the most effective treatment approaches for this syndrome. Obesity has been known as the most important factor in developing the metabolic syndrome. Although the high prevalence and related adverse health consequences of obesity have been observed almost everywhere, human obesity is not always necessarily along with disease. To illustrate, fat mass risk threshold is various among different people, and can be affected by both environmental and genetic factors [7]. Among environmental factors, low physical activity and high availability of food play an important role in developing the metabolic syndrome [8,9].

On the other hand, diet and eating habits have critical roles in protection and promotion of human health. Poor diet can lead to obesity, as well as nutritional deficiencies and consequently, increase risk of various diseases. Unhealthy dietary patterns such as Western diet with high energy density, can predispose people to non-contagious diseases particularly T2DM, hypertension, cardiovascular diseases; all of which are related to overweight and obesity. Calorie dense diet is also linked with high BMI (Body Mass Index), waist circumference, fasting serum insulin and consequently metabolic syndrome [10]. The calorie density of diet can be decreased by increasing fruits and vegetables

consumption as well as decreasing foods intakes containing saturated and trans fatty acids. In other words, high-calorie density diet reflects a diet rich in saturated and trans fatty acids and refined carbohydrates, as well [11,12]. In this regard Vegetarianism has been reported as an protective approach against metabolic syndrome and related disorders [13]. Furthermore, metabolic syndrome patients are at a high risk of increased oxidative stress. It has been demonstrated that oxidative stress is associated with insulin resistance. Therefore, it seems that supplementation with antioxidants maybe linked with decreased insulin resistance in diabetic patients. Since fruits and vegetables contain phenolic components, which can affect the antioxidant capacity, a diet rich in fruits and vegetables increases plasma antioxidant capacity [14]. The beneficial effects of polyphenolic components on glucose absorption, insulin level and lipid metabolism have been reported in several studies [15]. According to a review study, antioxidant supplementation can be effective in treating metabolic syndrome [16]. Mediterranean diet is considered as a suitable approach to improve health, and prevent metabolic syndrome, obesity and T2DM. The main components of the aforementioned diet are fruits, vegetables, whole grains and olive oil [17]. As this diet is rich in unsaturated fatty acids, grains, nuts, fruits and vegetables and poor in meat and its products, it can be an effective treatment in metabolic syndrome [18].

In conclusion, there are many known and unknown factors related to metabolic syndrome. Despite its high incidence as an adverse health consequence associated with obesity, there are many obese people who never suffer from metabolic syndrome [7]. In contrast, many normal weight people have been diagnosed with this syndrome [7]. In spite of the extensive development in this field of science, the cause of this fact has been remained unknown yet. Since nutrition and daily servings intake of various food groups have major role in incidence of obesity; they are regarded as the most important factor in both developing or preventing the metabolic syndrome [10]. Hence, comparison of number of daily servings from each of the seven major food groups in metabolic syndrome patients with two control groups consist of normal weight individuals without MetS and overweight/obese participants without MetS may find the right answer to this question. To our knowledge, no study has investigated the quantity of daily servings intake from different food groups separately in the mentioned population. The aim of our study was to compare the number of daily servings intake from different food groups in metabolic syndrome patients with the control groups.

2. MATERIALS AND METHODS

This cross-sectional study was accepted and funded by Tehran University of Medical Sciences. The whole protocol was approved by the ethics committee of Tehran University of Medical Sciences with the ethical no of IR.TUMS.REC.1394.267.

2.1 Participants

All participants were selected from referrals to the Endocrine and Metabolism center of Tehran University of Medical Sciences by consecutive sampling method and based on the fulfilling of exclusion and inclusion criteria. After obtaining written informed consent forms from all participants, they were allocated in to the case and two control groups. A total of 153 participants were enrolled in the study and divided in to 3 groups, one of each had 51 participants. Two participants from overweight / obese controls refused the participation due to the lack of time. Inclusion criteria by considering the cases (patients with metabolic syndrome) namely were having the metabolic syndrome (base on the ATPIII panel criteria [19]) and BMI≥25 kg/m^2, with regards to the control group (overweight/obese controls) include not suffering from the metabolic syndrome and having BMI≥25 kg/m^2, and finally, by considering the other healthy control group (normal weight controls) namely were not suffering from the metabolic syndrome and having BMI<25kg/m^2. Exclusion criteria for all three groups include pregnancy, lactation, suffering from any kinds of cancer, liver disorder, kidney disorder, blood disorder, uncontrolled thyroid disease and ischemic heart diseases, using medications for modifying serum lipids and glucose, sedative or hypnotic drug, antihistamine, immune system inhibitors, following any special diet under the supervision of a diet therapist, being professional athletes, and having smoking habit for at least once a week. All participants were matched according to age and gender. BMI was matched just between patients with metabolic syndrome and overweight / obese controls.

2.2 Anthropometric and General Information

After obtaining a written and informed consent from each participant, the demographic information was obtained. Participant were weighed and measured with a light clothing and without wearing shoes using a Seca™ (Hanover, MD) portable scale as well as wall-mounted stadiometer. Waist circumference (WC) was measured using a flexible anthropometric tape midway between the lower rib margin and iliac crest. Body mass index (BMI) was calculated by means of the weight (kg) to height (m2) ratio. In order to analyze the body fat and free fat mass, simple and non-invasive bioelectrical impedance analysis (BIA) method and Tanita body composition analyzer (Model BC-418MA) were used. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured taken from the right arm using GAMMA oscillo-metric method. SBP and DBP were taken from participants in a seated, relaxed position after taking at least 10 min rest. BP measurements were repeated two times and the average was reported.

2.3 Biochemical Analyses

Fasting Blood Sugar (FBS), High Density Cholesterol (HDL-c), Low Density Cholesterol (LDL-c), Total Cholesterol (TC), Triglyceride (TG) and serum insulin were measured after having 8-12 hours fasting. HDL-c, LDL-c and TC were assayed by enzymatic method. TG and FBS were measured through Glycerol Phosphate Oxidase (GPO) method and Glucose Oxidase (GOD) method, respectively. Radioimmunoassay (RIA) method was used to measure serum insulin.

2.4 Dietary Intake

Seven major food groups were investigated in this study including grain, meat, fruit, vegetable, fat and oils, milk and sweets. They were all measured through obtaining the validated food frequency questionnaire (FFQ) from participants by an expert nutritionist. This reliable questionnaire contains a list of 168 food items and clarifies the frequency intake and amount of each consumed food item during a day / a week / a month or a year. It can be also possible to obtain data regarding consumption of food group by FFQ. Reliability and relative validity of this questionnaire for Iranian population has been proved previously by Mirmiran et al. [20] in the Tehran lipid and glucose study in 2010. As there has been no specific food guide for Iranian yet, the USDA food guide pyramid is commonly used for clinical and research purposes in Iran. Accordingly, after calculating the amount of each food item in gram, they were categorized to their appropriate food group based on the 2005 MyPyramid, available at http://MyPyramid.gov. Finally, the quantity of daily servings from each food group was calculated.

2.5 Analysis

Preliminary analyses were performed for all variables to ensure there was no violation of the normality assumption. Descriptive statistics, particularly mean and standard deviation were calculated for quantitative variables and the abundance was reported for qualitative variables. The normality of the variables distribution was examined using One-Sample Kolmogorov-Smirnov test. To compare means of the normally distributed variables in the case and control groups, One-way Analysis of Covariance (ANOVA) was performed. Moreover, Kruskal-Wallis Test was used for the variables without normal distribution. In order to compare the means of the normally distributed variables within groups, LSD Test was used and pair-wise comparison Test was performed for the variables without normal distribution. We also used chi-square ($\chi 2$) to describe the qualitative variables distribution among the study groups. P value < .05 was set to significant. Analyses were performed using the Statistical Package for the Social Sciences (SPSS) software, version 22 (SPSS Inc., Chicago, IL, USA) and Nutritionist Four (First Data Bank, San Bruno, CA, USA) software was used to analyze the dietary data.

3. RESULTS AND DISCUSSION

Data regarding the numbers of daily servings from each food group were presented for 50, 48 and 50 participants including patients with metabolic syndrome, overweight/obese controls and normal weight controls, respectively. The average age of the participants was 36.78±6.40 years (mean ± standard deviation). The preliminary analysis of the basic variables frequency distribution among the study groups is shown in the Table 1.

Table 1. Characteristic of participants

Variables		Metabolic syndrome	Overweight/obese	Normal weight	p
		N=50	N=48	N=50	
Gender (male/female), n (%) / n (%)		44 (88%) / 6 (12%)	42 (87.5%) / 6 (12%)	43 (86%) / 7 (14%)	.953
Marital (married/single) n (%) / n (%)		47 (94%) / 3 (6%)	41 (85.4%) / 7 (14.6%)	41 (82%) / 9 (18%)	.182
Education, n (%)	Illiterate	0 (0%)	0 (0%)	0 (0%)	0.532
	Elementary	0 (0%)	2 (4.2 %)	2 (4%)	
	Intermediate	6 (12 %)	9 (18.8%)	6 (12%)	
	Diploma	28 (56 %)	19 (39.6 %)	27 (54%)	
	Academic	16 (32 %)	18 (37.5%)	15 (30%)	
Age, years		37.6±6.50	37.19±6.36	35.89±6.43	.315
Body weight, kg		92.73±13.36	89.11±13.55	69.53±6.22	<.001
Height		171.80±7.49	172.74±6.67	171.25±6.89	.572
BMI [1], kg/m2		31.39±3.75	30.01±3.67	23.77±1.15	<.001 [5]
Body free fat mass, %		73.11±6.13	74.25±6.7	80.37±5.96	<.001
Body fat mass, %		26.88±6.13	25.74±6.70	19.62±5.96	<.001
Waist circumference		105.06±8.24	100.42±11.52	87.44±6.39	<.001
Hip circumference		107.76±7.45	106.80±6.29	97.09±3.80	<.001
Clinic systolic blood pressure, mmHg		121.12±11.87	113.73±8.83	111.14±12.22	<.001
Clinic diastolic blood pressure, mmHg		80.42±8.7	75.54±6.8	73.82±8.15	<.001
FBS [2], mg/dl		116.48±37.73	98.83±20.40	95.04±7.58	<.001
Triglycerides, mg/dl		265.44±205.57	133.91±89.12	118.60±68.15	<.001
HDL-c [3], mg/dl		50.50±8.35	54.27±5.68	54.80±9.04	.01
LDL-c [4], mg/dl		102.67±20.76	110.22±30.14	101.14±25.74	0.20
Total Cholestrol, mg/dl		199.72±29	190.10±31.42	178.92±31.84	0.004
Serum Insulin, micIU/ml		8.69±3.69	7.61±4.15	6.31±3.46	<.001

Values are the means ± SD; blood was drawn, and clinic blood pressure was measured from participants after a 10-hour fast, p ≤ .05. [1]BMI, Body Mass Index; [2] FBS, Fasting Blood Sugar; [3] HDL-c, High Density Cholesterol; [4] LDL-c, Low Density Cholesterol; [5] BMI was significantly different among all 3 study groups (p<.001) except first and second groups (p=.127)

The data on total daily caloric intake showed that the highest daily caloric intake was respectively ascribed to patients with metabolic syndrome (2410.25±289.39 kcal/d), overweight/obese controls (2388.62±254.44 kcal/d) and normal weight controls (1943.29±275.53 kcal/d). According to the Table 2 and Fig. 1 as well, the total and per 1000 kcal daily servings from all food groups were significantly different among the study groups (P for total and per 1000 kcal daily serving intake of all food groups except the fat group was <.001 and it was .01 for per 1000 kcal serving intake from the fat and oil group).

The number of total and per 1000 kcal daily servings from meat, fruit, vegetable, and milk groups were significantly higher, while, with regards to the fat and oil, sweet and grain groups they were significantly lower in the normal weight controls compared to the patients with metabolic syndrome and overweight / obese controls (P<.001). However, no significant difference was observed by considering all food groups consumption between the patients with metabolic syndrome and overweight/obese controls (P=.13, 1, 1, .45, 1, .09 and .9, for meat, fruit, vegetable, milk, fat and oil, sweet and grain respectively).

As it was mentioned before, surprisingly, normal weight participants consumed more from meat group in comparison with the two other groups. In order to clarify the cause of this difference, we decided to analyze meat subgroups separately. Meat group was categorized to its subgroups including red meat, poultry, fish and tuna, egg, and nuts. Consumption of all of these subgroups was significantly different among the study groups (P<.001 for total and per 1000 kcal daily servings from all subgroups except for the number of per 1000 kcal daily servings from eggs which was .07). The number of total and per 1000 kcal of daily servings was respectively higher regarding the nuts, egg, poultry, red meat and fish and tuna subgroup (Table 3 and Fig. 2).

Grain group consisted of bread, cereal, rice and pasta. Grain consumption was significantly different among the study groups (P< .001 for

total daily servings from all subgroups (except for cereal which was 0.002). Also, P= .173, .002, .001and .003 for per 1000 kcal daily servings from bread, cereal, rice and pasta, respectively). The number of total and per 1000 kcal of daily servings was respectively higher regarding the rice, bread, pasta, cereal subgroup (Table 3 and Fig. 3).

Moreover, milk group was categorized to its subgroups including milk, yogurt and cheese. The total and per 1000 kcal daily servings intake of this group were significantly different among the study groups (P<.001). The number of total and per 1000 kcal of daily servings was respectively higher regarding milk, yogurt and cheeses subgroup (Table 3 and Fig. 4).

Our findings has indicated that the number of total and per 1000 kcal daily servings from all food groups including the grain, meat, fruit, vegetable, fat and oils, milk and sweets were significantly different among all the study groups. Although, this difference was just statistically significant among the normal weight controls which had normal weights compared to the other two groups. In addition, the number of total and per 1000 kcal daily servings from meat, fruit, vegetable, and milk groups were higher in the normal weight controls compared to the patients with metabolic syndrome. However, an inverse association was observed by considering the grain, sweets, and fat and oils groups.

Table 2. Comparison of the total daily serving intake of food groups among study groups

Food groups	Metabolic syndrome	Overweight / obese	Normal weight	P
	Mean±SD	Mean±SD	Mean±SD	
Grain group (serving)	19.7±4.9	19.8±4.2	13.7±3.9	< .001
Meat group (serving)	1. 36±.5	1.6±.5	2.22±.69	< .001
Fruit group (serving)	1.49±.71	1.71±1.07	2.58±1.04	< .001
Vegetable group (serving)	2.3±1.6	2.4±2.7	6.02±4.5	< .001
Milk group (serving)	.9±.77	1.1±.64	2.4±1.07	< .001
Fat and oils group(serving)	7. 5±2. 25	7.4±2.9	5.12±1.96	< .001
Sweets group (serving)	9.1±6.3	6.1±3.3	2.5±2.8	< .001

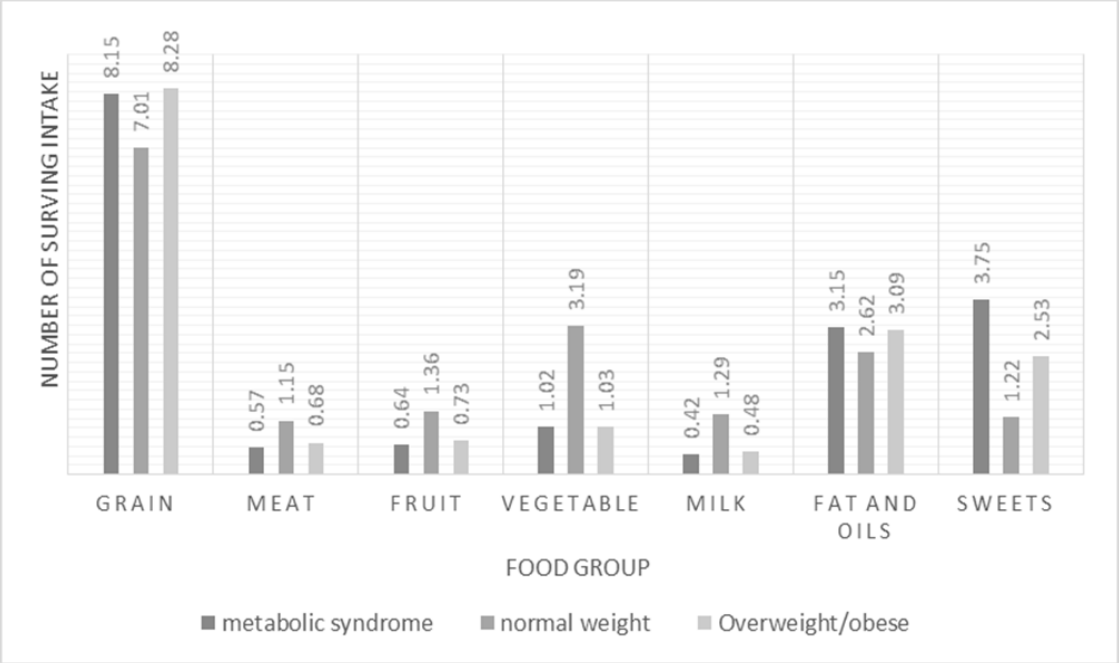

Fig. 1. Comparison of per 1000 kcal daily serving intake of food groups

Table 3. Comparison of the total daily servings intake of meat, grain and milk subgroups among study groups

Subgroup	Subgroup	Metabolic syndrome	Overweight / obese	Normal weight	*P*
		Mean±SD	Mean±SD	Mean±SD	
Meat subgroups	Red meat (serving)	.14±.07	.23±.12	.25±.14	< .001
	Nuts (serving)	.55±.33	.61±.31	1±.52	< .001
	Poultry (serving)	.13±.16	.21±.16	.40±.15	< .001
	Egg (serving)	.45±.29	.44±.20	.29±.24	< .001
	Fish and tuna (serving)	.07±.15	.09±.15	.27±.18	< .001
Grain subgroups	Bread (serving)	7.42±2.7	6.76±3.08	5.23±2.61	< .001
	Cereal (serving)	.89±.65	.55±.40	.73±.45	.002
	Rice (serving)	10.12±4.26	11.60±3.66	7.15±2.66	< .001
	Pasta (serving)	1.21±.87	.92±.81	.52±.41	< .001
Milk subgroups	Milk (serving)	.41±.49	.36±.36	1.07±.70	< .001
	Yogurt (serving)	.31±.25	.48±.28	.81±.42	< .001
	Cheeses (serving)	.27±.36	.32±.23	.52±.28	< .001

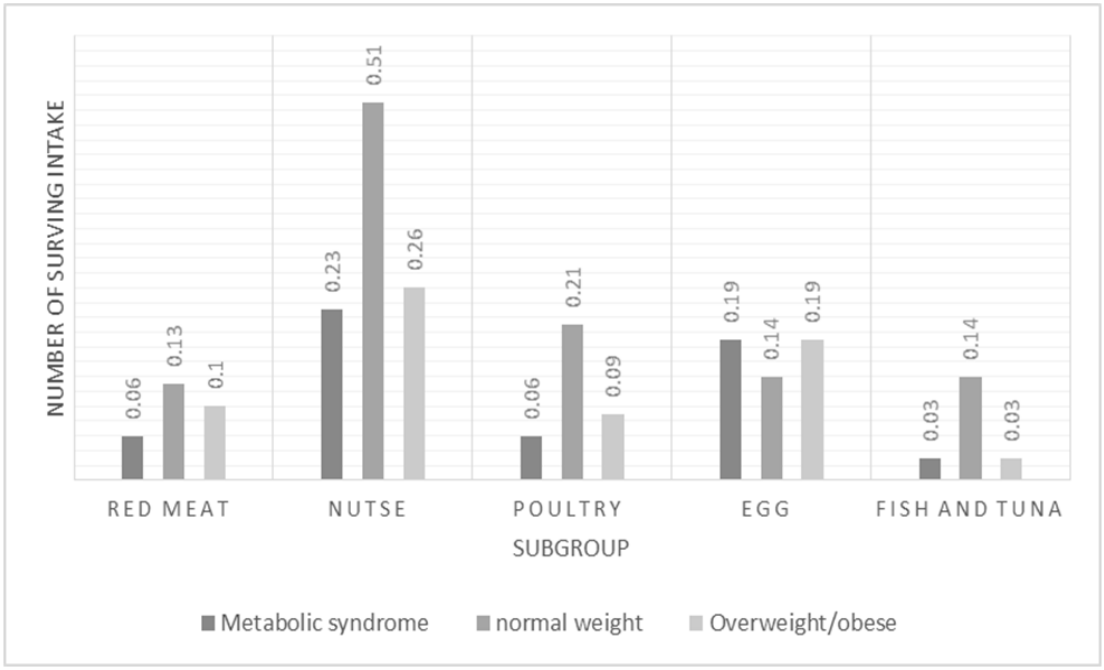

Fig. 2. Comparison of per 1000 kcal daily serving intake of meat subgroups

In our study milk group consisted of milk and dairy products in particular yogurt, cheese. The normal weight group had the highest consumption of milk and the lowest consumption of cheese. Regarding the number of daily servings from milk group, our study has confirmed the role of dairy products consumption in the weight management and metabolic syndrome. Our finding is in line with the previous researches which have suggested that overweight and obesity as the most important risk factors of metabolic syndrome can be influenced by dairy products intake, since the calcium and vitamin D contents of these products increase the thermo-genesis and fat oxidation [21,22]. Furthermore, casein protein in milk stimulates satiety sense and consequently control the appetite [23]. Milk and dairy products consumption play a beneficial role in the glycemic control [24,25]. Moreover, the bioactive peptides, which are formed by proteins via the actions of the microbiota and gastrointestinal enzymes, have angiotensin-converting enzyme–inhibiting activities and can control the blood

pressure as a consequence [26,27]. Impairing the blood lipid profile is regarded as an important risk factor of metabolic syndrome, and milk and dairy products consumption inhibits cholesterol synthesis [28].

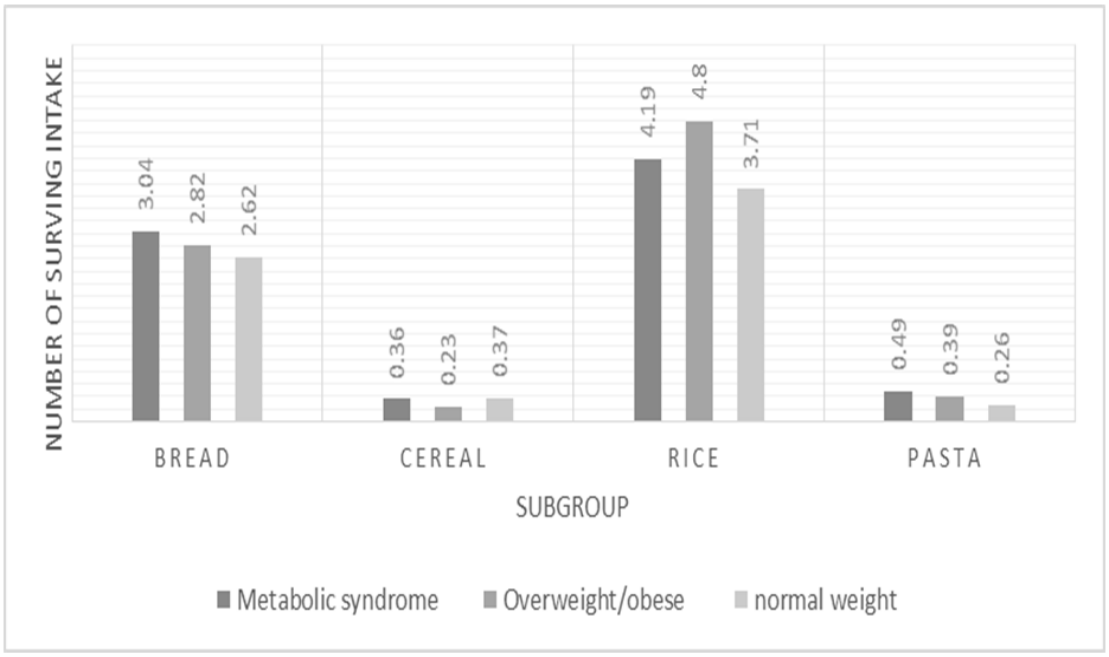

Fig. 3. Comparison of per 1000 kcal daily serving intake of grain subgroups

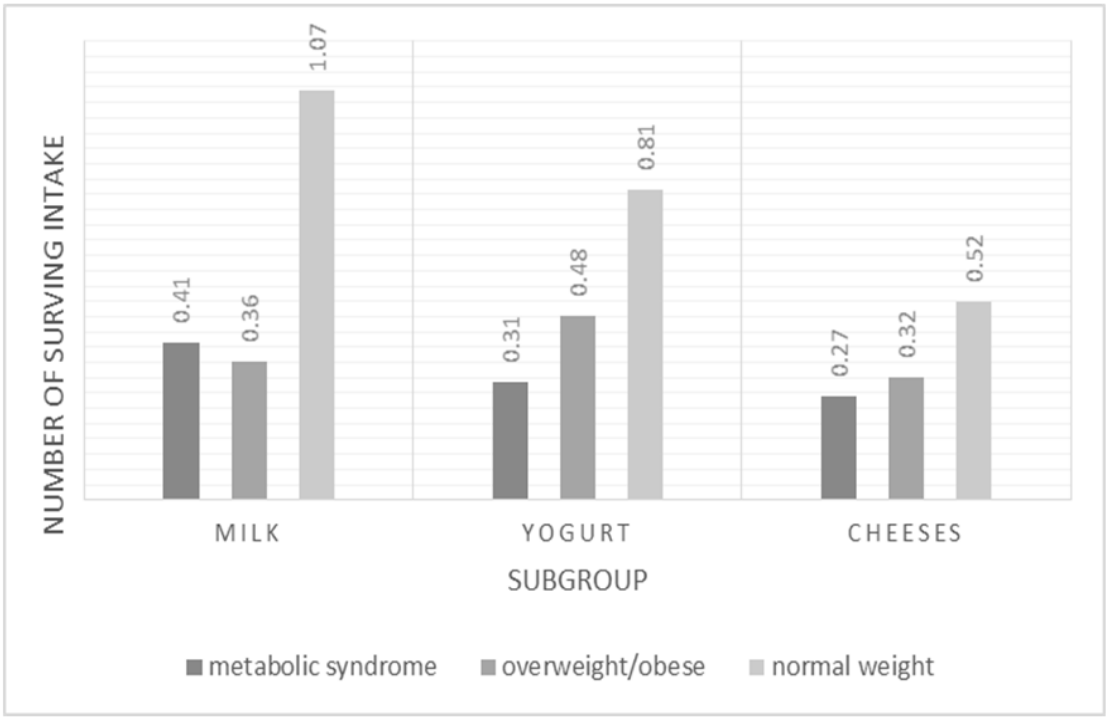

Fig. 4. Comparison of per 1000 kcal daily serving intake of milk subgroups

Several studies have demonstrated that metabolic syndrome patients are at the high risk of increased oxidative stress which is led to insulin resistance [15]. Our findings suggest that higher consumptions of fruits and vegetables may be associated with lower body weight and decreased the risk of metabolic disorders incidence. As fruits and vegetables contain phenolic components, a diet rich in these foods can increase the plasma antioxidant capacity.

By considering the consumption of fat and oils, and sweets groups our findings showed that normal weight controls had lower consumption of fat and oils, and sweets compared to overweight/obese participants. However, no difference was observed among patients with metabolic syndrome and overweight / obese controls. increasing fruits and vegetables consumption and limiting the foods which contain saturated and trans fatty acids such as fried foods can decrease the calorie density of the diet and consequently reduce the risk factors of obesity and metabolic disorders [11,12].

In our study the highest consumption of meat group was dedicated to the normal weight controls, while, the lowest consumption was ascribed to the cases. As it seemed unusual to have higher consumption of meat group in the normal weight people compare to the overweight/obese ones, we decided to analyses meat subgroups separately. In this study investigating the number of total and per 1000 kcal daily servings from each of meat subgroups showed that it is respectively higher with regards to the nuts, egg, poultry, red meat and fish and tuna. Previous study indicated that red meat intake increases the risk of T2DM incidence as an important risk factor of metabolic syndrome [29]. The increased blood glucose as well as blood pressure after red meat consumption can be due to some of its components, particularly trans and saturated fatty acids, cholesterol, protein and amino acids, heme-iron, sodium, nitrosamine, AGEs (Advanced Glycation End products) and TMAO (TriMethyl Amine N-oxide) [30]. Nuts are rich in protein, complex carbohydrates, fiber, essential vitamins, and minerals and poor in sodium and fat and totally free from cholesterol. Hence, consumption of nuts decreases the risk of chronic diseases' incidence [31]. Consuming fish and its derivatives oil increase insulin sensitivity, insulin secretion, and improves the β cells function and glucose tolerance. In addition, its ω3 fatty acid prevents the incidence of T2DM [32].

Finally, Tortosa et al. [18] previously suggested that lower incidence of metabolic syndrome was associated with higher grain consumption. This study indicated that the normal group had the highest number of complex carbohydrate daily servings intake, while, and the metabolic syndrome patients had the lowest. In contrast, the cases had the highest number of refined carbohydrate daily servings, whereas, their normal counterparts had the lowest daily serving. Analyzing the grain subgroups showed that daily servings were respectively higher regarding the rice, bread, pasta, cereal consumption; which reflect the Iranian food habit that tend to consume more rice and bread as the dominant food in their diet and less pasta and cereal.

Our observations suggest that the number of daily servings from different food groups clearly is associated with obesity and metabolic disorders. In this regard, refined grain, fat and oils, sweets, and red meat group consumption can positively affect the risk of obesity and metabolic syndrome, while, vegetables, fruits, milk, poultry, egg, fish and tuna, and nuts group consumption may have inhibitory effects on obesity and metabolic syndrome risk as a consequence.

The present study has some limitations that need to be taken into account. As the data was collected by self-report questionnaires, they may have measurement bias. Secondly, the number of female participants (14%) was considerably lower than male ones (86%) due to the lower female referral to our clinic in comparison with the male. Furthermore, it is suggested that the intakes of a new group including metabolic syndrome patients with normal weight adds to the other data in this study in order to make sure about the current consequences. As the income level, exercise and leisure activities and economic situation of the participants can influence the choice and quantity of food consumed in our studies they all recommended to be assessed in the next studies. In our study, not only we confirmed the previous researches, but also we investigated the number of daily servings from seven major food groups and some subgroups in the same study population; while, previous researches investigated only the amount of different foods and nutrients intakes. Moreover, designing two control groups provided us to investigate the differences between overweight or obese people with MetS and the subjects without MetS in terms of food groups intake.

4. CONCLUSION

In conclusion, although all food groups daily servings intake were significantly different among the cases and their normal weight counterparts, they were not significantly different among the cases and overweight/obese group.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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