

ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Risk factors of metabolic syndrome among food suppliers

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SUMMARY

Introduction/Objective As a risk factor for chronic diseases, metabolic syndrome (MS) is increasing at an alarming rate. The prevalence of MS varies according to lifestyle and occupation in different populations. The present study aimed to determine the prevalence of MS and its components in food suppliers.

Methods A total of 112 food suppliers were randomly selected from all around the city. Data collection tools included demographic, physical activity, and food frequency questionnaires. Body composition was measured using Bio-Electrical Body Analyzer. A sample of 5 ml of fasting blood was taken from participants to assess lipid profile, blood sugar, insulin, and liver enzymes. The data were analyzed using χ^2 , Kolmogorov–Smirnov and ANOVA tests.

Results Participants' mean BMI was 27.1 ± 3.9 kg/m², 43.6% were overweight, and 26.4% were obese. Consumption of vegetables was less and of meats more than recommended amounts. The prevalence of MS was 45.5% (51 people), which increased with aging ($p = 0.02$). Among factors causing MS, the most common one was waist-to-hip ratio (WHR) > 0.09 (72.7%), followed by high triglyceride and low HDL.

Conclusion In this study, the prevalence of MS among food suppliers was higher than the world average and than prevalence in other countries. WHR (or obesity) was found to be the most important risk factor for MS. To reduce the risk of MS, changing dietary consumption habits and increased physical activity are recommended to persons with high risk and sedentary occupations.

Keywords: metabolic syndrome; food suppliers; body mass index; risk factors

INTRODUCTION

Metabolic syndrome (MS) is a series of metabolic disorders and cardiovascular diseases and type II diabetes risk factors, including central obesity, insulin resistance, lipid disorders, and hypertension. MS increases the risk of cardiovascular diseases and type II diabetes two-fold and five-fold, respectively [1]. Several factors can affect the incidence of MS, including genetic and environmental factors such as lifestyle, regular exercise, diet, and smoking [2]. The prevalence of MS is increasing at an alarming rate.

Other studies have shown that job can also affect the incidence of MS [3]. A number of recent studies have shown that the prevalence of obesity and MS is different in different occupation groups. The prevalence of MS was reported to be 15% among administration employees of oil industry, 17.5% in bank clerks, and 56.6% among firefighters [3, 4, 5]. In the United States, the prevalence of MS among food serving workers or food suppliers and those in transportation has been reported higher compared to other occupations [3].

An interesting point recently addressed in some studies was easy access to prepared food outside home, which further increases its consumption [6]. To taste and look better, more fat is added to the food in restaurants and fast food outlets. Thus, their consumption is associated with adverse health risks, including increased risk of overweight, obesity, diabetes, insulin resistance, low quality diet, and MS [7]. In recent years, consumption of foods with high trifluoroacetic acid content has adversely affected people's health. Adverse effects of this fat in plasma lipoproteins increase low-density lipoproteins (LDL), and decrease lipoprotein and high-density lipoproteins (HDL) [6].

Therefore, studying people who routinely deal with industrial and ready-made foods can produce important and interesting results. Considering varying prevalence according to jobs, and also since no study has yet been conducted in the country to assess the prevalence of MS and diet among people working in food supply, this study aims to determine the prevalence of MS and its components among such workers.

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METHODS

This cross-sectional study was conducted in 2015 on 112 all-male workers in the 30–65 years age range working in patisseries, sandwich shops, restaurants, pizza and doughnut outlets, lamb liver kebab shops, and lamb head and offal cookeries. Participants were randomly selected from among those with more than three years' experience in their current jobs.

Study questionnaires included demographic, physical activity, and Food Frequency Questionnaire (FFQ). Demographic questionnaire contained questions on age, education, work history, smoking, and daily, weekly, and monthly frequency of consumption of fried and barbecued foods.

Participants' normal food intake was assessed using FFQ, whose validity and reliability had been confirmed in some local studies [8]. FFQ contains a list of 168 food items and standard portion size. Amounts of foods, as recommended portion size, were converted into daily units. According to Food Guide Pyramid recommended by the Ministry of Health, recommended number of units per day for each food group was as follows: bread and cereals 6–11 units, fruits 2–4, vegetables 3–5, meats and pulses 2–3, milk and dairy products 2–3, and miscellaneous little.

To assess the participants' level of physical activity, International Physical Activity Questionnaire (IPAQ), whose validity and reliability had been confirmed in Iran [9], was used, and participants were classified according to the Total Met scores based on instructions provided by this questionnaire, so that over the previous seven days, Met-min/week less than 600 meant low physical activity, Met-min/week equal to 600 moderate physical activity, and Met-min/week reaching 3000 meant intense physical activity.

The participants' body composition was measured using Avis 333 Body Analyzer system (Jawon Medical Co., Ltd., Gyeongsan-si, South Korea) in terms of weight, height, body fat mass, percentage body fat (PBF), soft lean mass (SLM), total body water, body mass index (BMI), body impedance, body protein, minerals, lean body mass, and waist-to-hip ratio (WHR). Height was measured using tape measure in standing position by the wall, without shoes, and with shoulders heels and buttocks touching the wall, with 1 cm precision. WHR for normal and obese upper body are defined by the WHO (WHR > 0.9 for men). According to the World Health Organization (WHO) criteria, BMI \geq 30 is considered obese, and $25 < \text{BMI} < 29.9$ overweight. Systolic and diastolic blood pressures were measured using a calibrated digital brachial sphygmomanometer (Omron, Kyoto, Japan).

With prior knowledge of participants, and to assess blood factors such as fasting blood sugar and lipid profile including triglycerides (TG), LDL, HDL, total cholesterol, and insulin and liver enzymes (alkaline phosphatase, alanine aminotransferase, aspartate aminotransferase), 5 ml of fasting blood was drawn from each participant, and, after serum separation, kept frozen at -40°C ; the samples were then sent to the laboratory under the same conditions. RA1000-RAXT autoanalyzer (Technicon Corporation,

Tarrytown, NY, USA) was used to measure fasting blood sugar, RA-XT and standard kits from Pars Company to measure lipid profiles using photometric method and a Monobind kit. Insulin level measured using ELISA reader, and a Biosystems Company kit. RA-1000 autoanalyzer was used to measure liver enzymes.

Insulin resistance (HOMA-IR) and β -cell function (HOMA-% β) calculated by applying following formulas (for the conversion of fasting glucose units from mg/dl to mmol/l, the number was multiplied by 18 [10]:

$$\text{HOMA-IR} = [\text{FPI (mIU / L)} \times \text{FPG (mmol/L)}] / 22.5$$

$$\text{HOMA-}\beta = [20 \times \text{FPI (mU/L)}] / (\text{FPG (mmol/L)} - 3.5)$$

MS was defined according to the criteria of the third report of the National Cholesterol Education Program / Adult Training Program (NCEP / ATP III) in 2005 [11].

According to the current ATPIII criteria, the presence of three of the following five criteria is necessary for MS to be considered:

1. TG \geq 150 mg/dl or receiving medication for high TG;
2. HDL cholesterol < 40 mg/dl in men and less than 50 in women;
3. Blood pressure \geq 130/85 mmHg or receiving medicinal treatment for hypertension;
4. Fasting plasma glucose (FPG) \geq 100 mg/dl or receiving medication for high FPG;
5. WHR of more than 0.9 cm in men and more than 0.85 cm in women.

Data is analyzed using χ^2 test to determine the relationship between the prevalence of MS and age groups, Kolmogorov–Smirnov test to verify normal distribution of data, ANOVA to compare mean values in three age groups, and Tukey's post hoc for comparison of pairs in SPSS for Windows, Version 16.0 (SPSS Inc., Chicago, IL, USA). A value of $p < 0.05$ is considered significant.

RESULTS

This study was conducted on 112 all-male food suppliers with a mean age of 43.4 ± 9.1 years, of whom only 18 (16.1%) had university education and the rest had high school diploma or below, and 69 (61.6%) had more than 10 years of work experience. Eighty (71.4%) participants had low to moderate physical activity, and the rest were highly active. Thirty (26.9%) reported daily smoking or hookah use.

Among participants, mean weight and BMI were 80.8 ± 13.5 kg and 27.1 ± 3.9 kg/m², respectively. Mean WHR, PBF, and SLM were 0.9 ± 0.06 , $26.1 \pm 4.9\%$ and 54.6 ± 7.6 kg, respectively.

Mean protein and minerals were found to be 11.9 ± 1.6 kg and 4.6 ± 0.7 kg, respectively. Mean systolic and diastolic blood pressures were 125 ± 17.2 mmHg and 81.5 ± 10.8 mmHg, respectively. Mean TG and total cholesterol were 177 ± 6.2 mg/dl and 196.1 ± 35.9 mg/dl, respectively, and fasting blood sugar was 81.2 ± 15.7 mg/dl (Table 1).

Mean consumption of meats and protein products was found to be 4.97 ± 1.4 units/day, which was higher than recommendation level, and mean vegetable consumption

Table 1. Study variables in participating food suppliers

Variables		Mean ± SD	Normal range	Max.	Min.
Lipid profile	TG (mg/dl)	177 ± 6.2	< 200	490	70
	TC (mg/dl)	196.1 ± 35.9	< 200	307	145
	LDL (mg/dl)	170.7 ± 20.1	< 130	149	70
	HDL (mg/dl)	40.1 ± 7.5	> 35	65	30
Blood sugar	FBS (mg/dl)	81.2 ± 15.7	70–110	200	66
Insulin	(μIU/ml)	4.2 ± 3.1	0.7–9	15	0.3
HOMA-IR	Unit	0.81 ± 0.60	≤ 2.5	2.89	0.07
HOMA-β	Unit	16.35 ± 15.23	-	67.95	-2.30
Liver enzymes	AST (U/L)	24.9 ± 9.8	< 45	48	4
	ALT (U/L)	25.2 ± 9.8	< 45	47	6
	ALK-P (U/L)	180.6 ± 57.5	40–306	317	82
Blood pressure	Systolic (mmHg)	125 ± 17.2	120	175	90
	Diastolic (mmHg)	81.5 ± 10.8	80	113	58

TG – triglycerides; TC – total cholesterol; FBS – fasting blood sugar; HOMA-IR – insulin resistance index; HOMA-β – beta-cell function index

Table 2. Daily consumption of food groups in food suppliers

Food groups (servings/day)	Mean ± SD	Daily recommendation
Bread and cereals	7.47 ± 3.61	6–11
Meats	4.97 ± 1.4	2–3
Dairy products	4.07 ± 2.93	2–3
Fruits	2.91 ± 1.30	2–4
Vegetables	2.46 ± 1.15	3–5

Table 3. Consumption of food by subjects according to the type of cooking

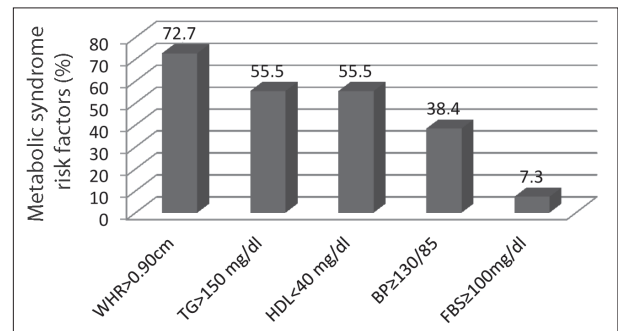
Fried n (%)	Grilled or steamed n (%)	Use frequency
11 (9.8)	10 (8.9)	Daily
28 (25)	12 (10.7)	3–5 days per week
53 (47.3)	32 (28.6)	1–2 days per week
15 (13.4)	43 (38.4)	1–2 times per month
5 (4.5)	15 (13.4)	Never

was 2.46 ± 1.15 units/day, which was less than recommended amount (Table 2).

Elevated level of HOMA-IR ($2.5 \leq$ HOMA-IR) and insulin resistance ($p < 0.05$) was found in 2.7% of the participant. Significant positive correlation was observed between TG and HOMA-IR ($p < 0.05$). However, negative correlation was found between BMI and WHR with HOMA-B ($p = 0.04$ and $p = 0.05$, respectively).

In this study, 25% of participants consumed fried foods three to five days per week, 10.7% used kebabs or steamed food, and 9.8% consumed fried foods every day (Table 3).

According to BMI classification, 48 (43.6%) participants were overweight, and 29 (26.4%) were obese. The prevalence of MS was found to be 45.5% (51 participants). Among factors causing MS, the most common was WHR > 0.9 cm, found in 80 (72.7%) participants, followed by TG > 150 mg/dl and HDL < 40 mg/dl (Figure 1). In body composition components, WHR showed a significant relationship with MS ($p = 0.003$). The prevalence of MS was 30.4% in age group < 40 years, 51.4% in the 40–49 age group, and 61.3% in the ≥ 50 years age group, and the difference between age groups was statistically significant ($p = 0.02$).

**Figure 1.** Frequency of MS risk factors in food suppliers

The prevalence of MS showed an increase with increasing consumption of fried foods ($p = 0.06$), but showed no significant relationship with other cooking methods ($p = 0.16$).

DISCUSSION

According to the literature, very few studies have reported high prevalence of MS in food suppliers. In the present study, the prevalence of MS was found to be more than 40%, which was relatively high compared to other studies conducted in Iran. Prevalence of MS from 22.5% to 55.6% has been reported in various studies in Iran [4, 12, 13]. In a study conducted on firefighters in Tabriz, the prevalence of MS was higher compared to the present study, which was believed to be due to their stressful job. However, it may have been due to the difference in study population, since occupation was not considered in these studies.

In other countries, different prevalence rates have been reported for MS for different occupations, including 7.5% in radiologists and 17.5% in bank clerks in Brazil. Low prevalence was reported in European countries, but higher prevalence was reported in China compared to Iran, which may have been due to the older study population [3, 14, 15, 16]. Compared to various countries in the world, Iran has a high prevalence of MS, which may be due to occupation of participants in the present study, who were all shopkeepers with little daily physical activity. More importantly, because of their jobs, participants had easier access to ready-made and high-fat foods (or generally foods that do not comply with principles of healthy diet). In the United States, the prevalence of MS among food serving workers or food suppliers and those in transportation has been reported higher compared to other occupations [7].

As well as the difference in the prevalence of MS reported in various studies, factors affecting MS have also been reported differently. In the USA, the most common reported risk factor was abdominal obesity and low HDL-C, and in China, the most common factor was high blood pressure [17, 18]. In another study, mean BP, BMI, WHR, and TG were significantly higher in participants with MS compared to those without it, but their HDL-C was lower [19]. In the present study, the most common risk factor was WHR > 0.9 cm, followed by high TG and low HDL-C, which may have been due to a lack of physical activity

and greater accumulation of fat around the waistline. High starch consumption in the form of bread and rice can also increase TG and abdominal obesity.

People with wrong food habits more frequently suffer obesity. Thus, perhaps one of the causes of obesity is improper dietary pattern. In this study, consumption of meats and foods from the miscellaneous group was high, and consumption of vegetables and fruits was low. More extensive studies investigating the relationship between dietary pattern and MS, including a study on Korean adults, have shown that consumption of fruits and dairy products is associated with reduced risk of MS [20]. A study by Bodor et al. [21] in New Orleans showed that easier access to ready-made foods in restaurants and food outlets (especially in workers), increased the risk of obesity in these people.

Using healthy methods of cooking such as boiling, grilling, and steam cooking was less common among the studied subjects. High consumption of fried foods may increase the risk of overweight, obesity, and their resulting with cardiovascular diseases is very common. Trans-fatty acids production during frying may increase the risk of cancer and coronary heart diseases [21, 22].

A study conducted in the USA showed that high consumption of restaurant and buffet foods increased the risk of obesity, indicating a relationship between easy access to local restaurants and diet and high BMI [23]. In a longitudinal study, Wright et al. [24] reported that consumption of restaurant food once a week significantly increased likelihood of overweight compared to those that did not consume restaurant food at all. Moreover, buying food for the family from restaurants once a week also increased mean percentage of body fat and incidence of cardiovascular diseases [24]. Frequent consumption of ready-made foods by adults is associated with increased BMI and body weight and increased body weight affects insulin resistance over time and metabolic outcomes [25, 26]. Comparison of the present study results to other studies showed the undeniable effect of frequent consumption of ready-made and restaurant foods on increased BMI, body fat, and incidence of chronic diseases.

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Obese people have significantly higher levels of TG, glucose, and systolic and diastolic blood pressures compared to normal-weight people, and obesity is significantly related to their food habits. Furthermore, the relationship of BMI and food habits with cardiovascular risk factors has been demonstrated [25]. Thus, given the effect of lifestyle (including physical activity) and especially food habits, special attention should be paid to people's diet, especially in people working in food outlets and have to have their meals at work. A healthy lifestyle with a balanced diet, consumption of more fruits and vegetables, adequate physical activity, regular aerobic exercise, keeping the right weight, and weight loss is the best strategy for preventing obesity and MS, which should be observed by most people.

CONCLUSION

The present study shows high prevalence of MS among workers in food supply industry, and the prevalence increased with aging. In the study population, obesity is considered a risk factor for incidence of MS, and WHR was found to be the most common risk factor. Another notable result is low consumption of fruits and vegetables and high consumption of meats in participants due to easier access to meat. A high prevalence of MS is an important predictor of cardiovascular diseases. Thus, workers in food outlets should receive appropriate dietary recommendations, and periodic medical examination and health check.

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Фактори ризика метаболичког синдрома код снабдевача храном

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САЖЕТАК

Увод/Циљ Метаболички синдром (МС) као фактор ризика хроничних болести је у алармантном порасту. Учесталост МС-а варира зависно од начина живота и врсте занимања. Циљ овог рада је да се одреди учесталост МС-а и његових компоненти код снабдевача храном.

Метод Од свих снабдевача храном у граду случајним узорком је издвојено 112. Путем упитника прикупљени су демографски подаци и подаци о физичкој активности и врсти исхране. Грађа тела је одређена уређајем *Bio-Electrical Body Analyzer*. Од испитаника је узето по 5 ml крви ради одређивања липодног профила, шећера, инсулина и ензима јетре у крви. Подаци су анализирани χ^2 тестом, Колмогоров–Смирновљевим и Фишеровим тестом.

Резултати Индекс телесне масе испитаника је $27,1 \pm 3,9 \text{ kg/m}^2$, 43,6% испитаника има повећану телесну масу, а 26,4% чине

гојазни. У исхрани је поврће коришћено мање, а месо више од препоручених количина. Учесталост метаболичког синдрома је 45,5% (51 испитаник) и расте са старењем ($p = 0,02$). Најчешћи узроци метаболичког синдрома су однос струкукови (ОСК), потом висока триглицеридемија и ниска HDL-холестеролемија.

Закључак У овој студији учесталост МС-а код снабдевача храном је већа од светског просека. ОСК (или гојазност) најважнији је фактор ризика за МС. Особама са високим ризиком и седантерним послом, ради умањивања ризика МС-а, препоручује се промена начина исхране и повећање физичке активности.

Кључне речи: метаболички синдром; индекс телесне масе; фактори ризика; снабдевачи храном