Endocr (2008) 33:9–20
DOI 10.1007/s12020-008-9044-3

ORIGINAL PAPER

Prevalence of metabolic syndrome and associated risk factors among Turkish adults: Trabzon MetS study

Cihangir Erem · Arif Hacıhasanoglu · Orhan Deger · Murat Topbaş · Ilgın Hosver · Halil Onder Ersoz · Gamze Can

Received: 29 October 2007 / Accepted: 14 January 2008 / Published online: 13 March 2008

Abstract *Objective* In order to estimate the prevalence of metabolic syndrome (MetS) as defined by NCEP Adult Treatment Panel III (ATP III) criteria in the Trabzon Region and its associations with demographic factors (age, sex, marital status, reproductive history in women, and level of education), socioeconomic factors (household income and occupation), family history of selected medical conditions (diabetes, hypertension, and obesity), lifestyle factors (smoking habits, physical activity, and alcohol consumption) in the adult population. *Research Methods and Procedures* In this cross-sectional survey, a sample of households was systematically selected from the central province of Trabzon and its nine towns. A total of 4,809 adult subjects ≥20 years (2,601 women and 2,208 men) were included in the study. Blood pressure levels were measured for all subjects. The persons included in the questionnaire were invited to the local medical centers for blood examination between 08:00 and 10:00 following 12 h of fasting. Fasting serum glucose (FBG) levels and lipid profile were measured with autoanalyzer. MetS was defined according to guidelines from the NCEP ATP III diagnostic criteria. *Results* The prevalence of MetS was 26.9%: 31.3 in women and 21.7% in men. The prevalence increased with age, being highest in the 60–69-year-old age group (53.4%) but lower again in the ≥70 age group. MetS was associated positively with marital status, parity, cessation of cigarette smoking, and negatively with the level of education, alcohol consumption, current cigarette use, household income, and physical activity. Hypertension was found as the most common MetS component in our study (57.4%). Others in decreasing order were abdominal obesity (40.9%), low high-density lipoprotein-C (HDL-C) (31.8%), hypertriglyceridemia (30.7%), and high FBG levels (9.2%). Similarly, in the subjects diagnosed with MetS, HT had the highest prevalence (91.9%). This was followed by abdominal obesity (82.3%), hypertriglyceridemia (74%), low HDL-C (68.6%), and high fasting blood glucose levels (28.6%). *Discussion* MetS is moderately common and an important health problem in the adult population of Trabzon. In order to control MetS and its components, effective public health education and taking urgent steps are needed. These steps include serious education, providing a well-balanced diet and increasing physical activity.

Keywords Metabolic syndrome · Prevalence · Associated risk factors · Turkish population · Trabzon

C. Erem (✉) · A. Hacıhasanoglu · H. O. Ersoz
Division of Endocrinology and Metabolism, Department of Internal Medicine, Karadeniz Technical University, Biyokimya Anabilim Dalı, Endokrinoloji ve Metabolizma Hastalıkları Bilim Dalı, Trabzon 61080, Turkey
e-mail: cihangirerem@hotmail.com; cihangirerem@yahoo.com

O. Deger · I. Hosver
Department of Biochemistry, Karadeniz Technical University, Biyokimya Anabilim Dalı, Endokrinoloji ve Metabolizma Hastalıkları Bilim Dalı, Trabzon 61080, Turkey

M. Topbaş · G. Can
Department of Public Health, Karadeniz Technical University, Halk Sagligi Anabilim Dalı, Endokrinoloji ve Metabolizma Hastalıkları Bilim Dalı, Trabzon 61080, Turkey

C. Erem · O. Deger · M. Topbaş
The Trabzon Endocrinological Studies Group, Karadeniz Technical University, İç Hastalıkları Anabilim Dalı, Endokrinoloji ve Metabolizma Hastalıkları Bilim Dalı, Trabzon 61080, Turkey

Introduction

The metabolic syndrome (MetS) has been described as a "clustering" of several risk factors for cardiovascular disease (CVD) such as hypertension, dyslipidemia [specifically high triglycerides, low levels of high-density lipoprotein (HDL), and increased small dense low-density lipoprotein (LDL)], obesity (particularly central or abdominal obesity), insulin resistance, and impaired glucose tolerance or diabetes mellitus [1]. Insulin resistance or hyperinsulinemia has been suggested to be the underlying characteristic of the MetS [2], although a central role for insulin resistance in the MetS is still controversial [3]. This syndrome is a good predictor of Type 2 diabetes and CVD and is associated with an all-cause mortality [4, 5]. In 2001, The Third Report of National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) (ATP III) draws attention to the importance of the MetS and provides a working definition of this syndrome for the first time [6]. However, most of the data on MetS are based on the studies from Western countries. Obesity, physical activity, high alcohol intake, cigarette smoking, and certain dietary factors have been identified as important modifiable-risk factors for MetS and its consequences [7–9]. The primary goals of treating MetS are prevention of Type 2 diabetes mellitus and cardiovascular events. According to the American Diabetes Association and the ATP III, the starting point for treatment is therapeutic lifestyle changes [6].

The Prevalence of the MetS is directly dependent upon the definition used to describe the syndrome [10]. Without a unifying definition, reports of prevalence have a varied in the USA and Europe [11]. Differences in genetic background, diet, levels of physical activity, population age and sex structure, levels of over- and undernutrition, and body habitus all influence the prevalence of both MetS and its components [12]. The prevalence of MetS in adult population worldwide varies from 8 [13] to 24.2% [14] in men and from 7 [15] to 46.5% [16] in women.

Several studies have illustrated a high prevalence of diabetes, obesity, and hypertension among Turkish adult populations [17–19]. In our country, we do not have enough data about prevalence of MetS and associated risk factors [20, 21]. In the previous two studies [20, 21], the prevalence of MetS has been investigated, but relationships of MetS with socioeconomic and lifestyle factors have not been done. In our knowledge, the present study is a first one about the relationships of MetS in Turkey.

The aim of this study is to assess the prevalence of MetS according to the NCEP ATP III diagnostic criteria in the Trabzon Region and to examine its associations with a number of risk factors in a large sample of the Turkish adult population.

Research methods and procedures

Study population

The study was carried out in the central province of Trabzon city and its nine towns, namely, Akcaabat, Duzkoy, Arakli, Surmene, Of, Caykara, Vakfıkebir, Macka, and Yomra, from September 2003 to September 2005. Trabzon city, located in the northeastern part of Turkey, includes a population of ~975,000 people. The towns of Yomra, Arakli, Of, Caykara, and Surmene were selected from the east, Akcaabat, Duzkoy, and Vakfikebir were selected from the western part of the Trabzon city, and Macka was selected from the south. Selection of the towns was based on geographic distribution and logistic considerations, such as the presence of a health center in which the study procedures could be performed. The sample size was calculated based on a 50.0% prevalence (p) of MetS with a 2% uncertainty level (d), using the formulae $n = Z^2{}_{1-\alpha/2}/[p(1-p)/d^2]$ ($z = 2.576$, with 99% CI). We estimated that this would necessitate studying the 4,147 subjects. From 22 health districts, a total of 5,000 eligible study subjects (2,300 men and 2,700 women) were selected in accordance with household registration records for the year 2000. Of those, 4,809 subjects (2,601 women and 2,208 men) were participated in the study. All subjects were chosen by the age-standardized procedures. Random cluster sampling was applied to select the study subjects. In the first phase of the study, each health station region was considered as a unit. In the second phase, individuals ≥20 years old were selected from their family health cards. A written invitation was sent ~2 weeks before the survey. All of the households in the study were visited by the field workers. All subjects were investigated for the presence of the MetS and its components. A structured questionnaire was administered to the all members of the household. Anthropometric and demographic data were obtained for each subject. Demographic and socioeconomic variables included age, sex, marital status, level of education, occupation, household income, reproductive history in women, and family history of obesity, diabetes, hypertension, and CVD. Questions on lifestyle included physical exercise, smoking habits, and frequency of alcohol consumption. Physical exercise was defined as exercising strenuously for at least 20 min and outside professional activity (never, less than once a week = mild, at least once a week = moderate-heavy). Systolic and diastolic blood pressures were measured thrice in sitting position after 15 min rest, and the mean was taken for all cases. Participants were advised to avoid cigarette smoking, alcohol, caffeinated beverages, and exercise for at least 30 min before their blood pressure measurement. Waist circumference (WC) and hip circumference were measured in duplicate, with subjects standing relaxed and in underclothes only. WC was measured at the narrowist horizontal point between the costal margin and the iliac crests, and at the end of normal expiration to the nearest 0.1 cm. Hip circumference was measured at the horizontal level around the buttocks that yielded the maximum measurement. Central obesity was defined as WC > 102 cm in men and >88 cm in women. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m^2). All subjects gave informed consent, and the study protocol was approved by the Local Ethical Board (No: 2000/65). Study procedures were carried out in the local health centers in each town over an 18-month period.

Serum glucose and lipid analyses

Blood samples were obtained from an antecubital vein into vacutainer tubes without anticoagulant in the morning after 10–12 h fasting for the measurements of the lipid profile and plasma glucose. Blood was allowed to clot for 2 h at room temperature and the serum was obtained by centrifugation (3,000*g* for 15 min). Serum obtained was transferred immediately in cold boxes filled with ice to the laboratory and analyzed at a central, certified laboratory (K.T.U Farabi Hospital, Clinical Chemistry Laboratory) on the same day. Serum triglycerides were measured using a glycerol oxidase enzymatic method; HDL-cholesterol by a cholesterol oxidase enzymatic method in supernatant after precipitation with phosphotungistic acid-$MgCl_2$; fasting serum glucose (FBG) was measured using an enzymatic (glucose oxidase) colorimetric method. All determinations were performed with an autoanalyzer (Roche, Modular, Switzerland). Reagent used was supplied by the same manufacturer.

Definition of MetS

Subjects were considered to have MetS if they had any three or more of the following, according to the ATP III:

- Abdominal obesity: WC > 102 cm in men and >88 cm in women.
- Hypertriglyceridemia: serum triglycerides level $\geq$ 150 mg/dl (1.69 mmol/l).
- Low HDL-cholesterol: <40 mg/dl (1.04 mmol/l) in men and <50 mg/dl (1.29 mmol/l) in women.
- High blood pressure: SBP $\geq$ 130 mmHg and/or DBP $\geq$ 85 mmHg or on treatment for hypertension.
- High fasting glucose: serum glucose level $\geq$ 110 mg/dl (6.1 mmol/l) or on treatment for diabetes.

Participants receiving pharmacological treatment for hypertension (i.e., ACE inhibitors, angiotensin receptor blockers, α-blockers, β-blockers, calcium channel blockers, or diuretics) were included in the high blood pressure group, while participants receiving pharmalogical treatment for diabetes (i.e., sulphonylurea, biguanide, α-glucosidase inhibitors, or insulin) were included in the high fasting blood glucose group.

Statistical methods

Data normality was assessed by the Kolmogorov–Smirnov test. Comparisons among MetS groups were done with ANOVA (Bonferroni test as post hoc) for normally qualitative data, and Kruskal–Wallis test (Mann–Whitney *U*-test with Bonferroni correction as post hoc) for otherwise. Comparisons between groups for quantitative data and prevalence of MetS were done with χ^2 test. For associated risk factors of MetS, it was done logistic regression analysis. In this analysis, MetS was taken as dependent variables. Cardiovascular, demographic, socioeconomic, lifestyle factors, and family history of selected medical conditions were taken as independent variables. Results are shown as arithmetic mean $\pm$ SD for quantitative data, and percentage for qualitative. Odds ratio (OR) (95% CI) in logistic regression analysis was used. $P < 0.05$ was considered as significant.

Results

The clinical and metabolic characteristics of subjects with MetS and without MetS included in the study are given in Table 1. The overall prevalence of MetS was 26.9%: 31.3 in women and 21.7% in men. Prevalence of MetS was higher in women than that in men ($P < 0.0001$). There was no difference in the prevalence of MetS in men between towns. However, a significant difference in the prevalence of MetS between towns was observed in women ($P < 0.0001$).

Prevalence of obesity increased with age ($P < 0.0001$), with the highest prevalence in the 60–69-year-old age group (53.4%), and the prevalence declined thereafter. The prevalence of MetS among women increased markedly from the 20–29 (7.4%) to the 60–69-year-old age groups (63.9%, $P < 0.0001$). Among men, there was a steadily increase in the prevalence of MetS from the 20–29 to the 60–69-year-old age groups (Table 2).

Table 3 shows relationships of MetS with various associated factors. When level of education is considered, an inverse relationship is observed between level of education and prevalence of MetS ($P < 0.0001$). Prevalence was highest in illiterate people and lowest in people who

Table 1 Clinical and metabolic characteristics of subjects with MetS and without MetS[a]

Parameter	No MetS ($n = 3{,}515$)	MetS ($n = 1{,}294$)	All ($n = 4{,}809$)	P
All				
Age (years)	37.6 ± 13.7	48.8 ± 13.7	40.6 ± 14.6	0.0001
BMI (kg/m^2)	26.3 ± 4.7	31.7 ± 4.2	27.8 ± 5.4	0.0001
Waist girth (cm)	88.3 ± 12.5	103.1 ± 10.5	92.3 ± 13.7	0.0001
Hip girth (cm)	102.8 ± 10.4	112.5 ± 10.8	105.4 ± 11.4	0.0001
Waist–hip ratio	0.86 ± 0.42	0.92 ± 0.53	0.87 ± 0.61	0.0001
SPP (mmHg)	124.2 ± 18.7	141.4 ± 21.4	128.8 ± 20.9	0.0001
DBP (mmHg)	79.1 ± 12.2	89.3 ± 14.1	81.8 ± 13.5	0.0001
FBG (mg/dl)[b]	83.3 ± 14.7	104.2 ± 46.7	89.0 ± 28.8	0.0001
Total-C (mg/dl)	183.5 ± 40.8	207.6 ± 44.9	190.0 ± 43.3	0.0001
Triglycerides(mg/dl)	109.7 ± 73.7	212.3 ± 132.6	137.3 ± 103.8	0.0001
HDL-C (mg/dl)	52.6 ± 11.3	43.8 ± 9.4	50.3 ± 11.5	0.0001
LDL-C (mg/dl)	121.8 ± 36.9	142.8 ± 39.9	127.5 ± 38.8	0.0001
Men				
Age (years)	36.7 ± 13.2	49.5 ± 13.9	40.7 ± 14.7	0.0001
BMI (kg/m^2)	27.0 ± 5.6	32.9 ± 5.4	28.8 ± 6.1	0.0001
Waist girth (cm)	86.5 ± 13.9	102.8 ± 10.7	91.6 ± 15.0	0.0001
Hip girth (cm)	104.3 ± 11.9	115.2 ± 11.4	107.7 ± 12.8	0.0001
Waist–hip ratio	0.83 ± 0.63	0.89 ± 0.19	0.85 ± 0.77	0.0001
SBP (mmHg)	123.2 ± 19.7	142.5 ± 22.8	129.3 ± 22.6	0.0001
DBP (mmHg)	78.6 ± 12.8	90.0 ± 14.8	82.2 ± 14.5	0.0001
FBG (mg/dl)	82.8 ± 10.1	102.5 ± 45.1	89.0 ± 28.1	0.0001
Total-C (mg/dl)	181.6 ± 37.7	210.5 ± 46.0	190.7 ± 42.6	0.0001
Triglycerides(mg/dl)	92.4 ± 50.3	195.7 ± 123.5	124.7 ± 93.8	0.0001
HDL-C (mg/dl)	57.8 ± 10.3	47.1 ± 9.2	54.4 ± 11.2	0.0001
LDL-C (mg/dl)	117.2 ± 34.1	145.2 ± 40.0	125.9 ± 38.3	0.0001
Women				
Age (years)	38.6 ± 14.1	47.7 ± 13.3	40.6 ± 14.4	0.0001
BMI (kg/m^2)	25.7 ± 3.5	29.7 ± 3.8	26.5 ± 3.9	0.0001
Waist girth (cm)	90.2 ± 10.6	103.7 ± 10.1	93.2 ± 11.9	0.0001
Hip girth (cm)	101.2 ± 8.3	108.0 ± 7.9	102.7 ± 8.7	0.0001
Waist–hip ratio	0.89 ± 0.85	0.96 ± 0.23	0.90 ± 0.28	0.0001
SBP (mmHg)	125.3 ± 17.6	139.3 ± 18.7	128.4 ± 18.8	0.0001
DBP (mmHg)	79.6 ± 11.6	88.0 ± 12.6	81.4 ± 12.3	0.0001
FBG (mg/dl)	83.9 ± 18.2	107.1 ± 49.3	88.9 ± 29.7	0.0001
Total-C (mg/dl)	185.5 ± 43.7	202.8 ± 42.7	189.3 ± 44.0	0.0001
Triglycerides(mg/dl)	127.5 ± 88.3	240.4 ± 142.6	152.1 ± 112.6	0.0001
HDL-C (mg/dl)	47.3 ± 9.5	38.2 ± 6.8	45.3 ± 9.8	0.0001
LDL-C (mg/dl)	126.7 ± 38.9	138.6 ± 39.4	129.3 ± 39.3	0.0001

[a] Variance analysis

[b] FBG, fasting serum glucose

graduated from universities or colleges. As education level increases the prevalence of MetS was decreased.

As for occupation, association with MetS was showed in subjects ($P < 0.0001$). The prevalence of MetS is highest in the groups of housewife and agricultural worker and lowest in unemployed group.

We found a significant association between MetS and marital status ($P < 0.0001$). The prevalence of MetS was highest in widows and widowers and lowest in unmarried people.

We observed an association between cigarette use and the prevalence of MetS ($P < 0.0001$). Especially, there was a significant correlation among non-smoking, cessation of cigarette smoking, and the prevalence of MetS. Interestingly, there was an inverse association between alcohol consumption and prevalence of MetS ($P < 0.01$).

Table 2 Prevalence of MetS in the female subjects (χ^2: 435.66, $P < 0.0001$) and male subjects (χ^2: 169.81, $P < 0.0001$) by age group (χ^2: 588.22, $P < 0.0001$)

Age group	No MetS		MetS		Total	
	n	(%)	*n*	(%)	*n*	(%)
Women						
20–29	647	92.6	52	7.4	699	26.9
30–39	501	75.3	164	24.7	665	25.6
40–49	369	62.6	220	37.4	589	22.6
50–59	138	46.6	158	53.4	296	11.4
60–69	74	36.1	131	63.9	205	7.9
≥70	58	39.5	89	60.5	147	5.7
Total	1,787	68.7	814	31.3	2,601	100
Men						
20–29	566	93.2	41	6.8	607	27.5
30–39	447	82.5	95	17.5	542	24.5
40–49	366	71.8	144	28.2	510	23.1
50–59	185	65.4	98	34.6	283	12.8
60–69	96	60.0	64	40.0	160	7.2
≥70	68	64.2	38	35.8	106	4.8
Total	1,728	78.3	480	21.7	2,208	100
All						
20–29	1,213	92.9	93	7.1	1,306	27.2
30–39	948	78.8	259	21.5	1,207	25.1
40–49	735	66.9	364	33.1	1,099	22.9
50–59	323	55.8	256	44.2	579	12.0
60–69	170	46.6	195	53.4	365	7.6
≥70	126	49.8	127	50.2	253	5.3
Total	3,515	73.1	1,294	26.9	4,809	100

Prevalence of MetS was highest in non-drinkers and ex-drinkers (former drinkers) and lowest in the drinker people.

We observed an inverse association between physical activity and prevalence of MetS ($P < 0.0001$). The prevalence of MetS increased with decreased physical activity.

There was a significant association household income and prevalence of MetS ($P < 0.01$). Prevalence of MetS was decreased, as income level increases.

No significant association was found between the MetS and the family history of obesity, hypertension, hyperlipidemia, diabetes, or CVDs.

Among women, a lineer association was observed between the parity (the number of births) and the prevalence of MetS ($P < 0.0001$, Table 4). The prevalence was increased with the parity.

The prevalence of components of MetS in all subjects was shown in Table 5. Hypertension was the most common metabolic abnormality (57.4%) in both sexes. Hypertension followed by abdominal obesity (40.9%), low HDL-C (31.8%), hypertriglyceridemia (30.7%), and high FBG (9.2%). Except for hypertriglyceridemia, all abnormalities were more common in women than in men.

Among participants with the MetS (data not shown in the table), hypertension was the most common abnormality (91.9%), followed by abdominal obesity (83.3%), hypertriglyceridemia (74%), low HDL-C (68.6%), and high FBG (28.6%).

The number of the components of the MetS in the study population by sex is given in Table 6. Most of subjects in the study population had one component of the MetS (26.9%), 25.1% had two, 16.6% had three, 8.4% had four, and 1.9% had five components.

As a result of multivariate (linear logistic) analysis, ORs for each of the demographic factors, socioeconomic factors, lifestyle factors, and family history of selected medical conditions are presented in Table 7. In this analysis, the most important differences were seen for age, education level, occupation, marital status, physical activity, family history of selected medical conditions, and parity.

Discussion

This paper reports one of the largest population-based studies of MetS ever conducted, in which the prevalence of MetS and associated risk factors were analyzed for the first time in Trabzon Region. The prevalence of MetS in previous studies has differed because of differences and populations studied [5, 11, 14, 22–29]. The prevalence in the worldwide adult populations according to the ATP III definition criteria varies from 8.1 [15] to 41.1% [16]. From Turkey, Onat et al. [20], in a study performed in 1997–1998 (Turkish Adult Risk Factor Study), reported that prevalence of MetS in a Turkish adult population of 786 inhabitants was 32.8 % (38.6 for women and 27% for men) at basal examination. Four years later, in year 2000–2001, at the final cross-sectional evaluation, during which a total of 2,296 participants (1,166 women) were examined. The prevalence of MetS was 38.7% (45.1 for women and 32.2% for men). In another study, Ozsahin et al. [21] found that the prevalence of MetS in a Turkish adult population of 1,637 inhabitants was 33.4% (39.1 for women and 23.7% for men) in Adana, a southern province of Turkey.

In the present study, the prevalence of MetS was found to be 26.9% by using the NCEP ATP III diagnostic criteria. The prevalence was comparable, moderately high by international standards. Compared with other surveys in the European, Mediterranean, and Middle and Far East regions which used ATP III diagnostic criteria, prevalence of MetS in Trabzon Region is higher in Italy [30], France [15], Philippinnes [27], Korea [29, 31], China [23], and Vietnam [24], but it is lower in India [16, 28] and Iran [25], and

Table 3 Prevalence of MetS in adult Turkish subjects by occupation, level of education, marital status, cigarette smoking, alcohol consumption, degree of physical activity, household income and family history of obesity, diabetes, and hypertension

	No MetS		MetS		Total	
	n	(%)	*n*	(%)	*n*	(%)
Level of education (χ^2: 348.67, $P < 0.0001$)						
Illiterate	376	49.7	381	50.3	757	15.7
Primary	1,262	70.3	532	29.7	1,794	37.3
Secondary	396	76.7	120	23.3	516	10.7
High school	911	84.1	172	15.9	1,083	22.5
University	570	86.5	89	13.5	659	13.7
Total	3,515	73.1	1,294	26.9	4,809	100
Occupation (χ^2: 142.26, $P < 0.0001$)						
Worker	873	80.8	208	19.2	1081	22.5
Agriculturel worker	61	74.4	21	25.6	82	1.7
Tradesman	439	76.3	136	23.7	575	11.96
Unemployed	120	89.6	14	10.4	134	2.8
Housewife	1391	64.9	751	35.1	2142	44.5
Official	631	79.4	164	20.6	795	16.5
Total	3,515	73.1	1294	26.9	4809	100
Marital status (χ^2: 287.93, $P < 0.0001$)						
Unmarried	773	93.6	53	6.4	826	17.2
Married	2631	70.4	1,106	29.6	3,737	77.7
Widowed	111	45.1	135	54.9	246	5.1
Total	3,515	73.1	1,294	26.9	4,809	100
Cigarette use (χ^2: 41.68, $P < 0.0001$)						
Smoker	1,131	79.4	293	20.6	1,424	29.6
Women	361	78.6	98	21.4	459	17.6
Men	770	79.8	195	20.2	965	43.7
Nonsmoker	2,013	70.2	854	29.8	2,867	59.6
Women	1,354	66.5	682	33.5	2,036	78.3
Men	659	79.3	172	20.7	831	37.6
Former smoker	371	71.6	147	28.4	518	10.8
Women	72	67.9	34	32.1	106	4.1
Men	299	72.6	113	27.4	412	18.7
Alcohol consumption (χ^2: 12.92, $P = 0.002$)						
Drinker	289	81.0	68	19.0	357	7.4
Women	25	89.3	3	10.7	28	1.1
Men	264	80.2	65	19.8	329	14.9
Non-drinker	3,115	72.6	1,177	27.4	4,292	89.3
Women	1,759	68.5	809	31.5	2,568	98.7
Men	1,356	78.7	368	21.3	1,724	78.1
Former drinker	111	69.4	49	30.6	160	3.3
Women	3	60.0	2	40.0	5	0.2
Men	108	69.7	47	30.3	155	7.0
Physical activity (χ^2: 51.93, $P < 0.0001$)						
Never	1,480	70.0	634	30.0	2,114	44.0
Mild	1,440	72.5	545	27.5	1,985	41.3
Moderate-heavy	595	83.8	115	16.2	710	14.8
Household income (US $/month) ($\chi^2$: 11.33, $P < 0.01$)						
1–250	476	70.4	200	29.6	676	14.1

Table 3 continued

	No MetS		MetS		Total	
	n	(%)	*n*	(%)	*n*	(%)
250–500	1,724	71.8	678	28.2	2,402	49.9
500–750	997	75.8	318	24.2	1,315	27.3
>750	318	76.4	98	23.6	416	8.7
Family history of diabetes, hypertension, obesity, and CHD[a] ($P = 0.548$)						
No	975	73.7	344	26.3	1,309	27.2
Yes	2,550	72.9	950	27.1	3,500	72.8
Total	3,515	73.1	1,294	26.9	4,809	100

[a] CHD, coronary heart disease

Table 4 The prevalence of MetS in females by parity ($\chi^2 = 325.84$, $P < 0.0001$)

Number of births	No MetS		MetS		Total	
	n	(%)	*n*	(%)	*n*	(%)
Unmarried	331	95.7	15	4.3	346	13.3
Nulliparous	134	70.9	55	29.1	189	7.3
1	209	82.9	43	17.1	252	9.7
2	420	77.8	120	22.2	540	20.8
3	301	61.8	186	38.2	487	18.7
4	181	59.7	122	40.3	303	11.6
>5	211	43.6	273	56.4	484	18.6
Total	1,787	68.7	814	31.3	2,601	100

similar to the prevalence in the USA [23], Mexico populations [32], and Greece [26]. An important finding of our study is the higher prevalence of MetS among women compared with that of among men (31.3 vs. 21.7%). These results were similar to previous studies in Turkey [20, 21]. In the literature, in most of studies, MetS is more prevalent among women than among men [14, 16, 23, 25, 28, 30, 31], although the prevalence is more prevalent among men than among women in rare studies [15, 33]. In the USA, the prevalence of the MetS was similar among men and women [14]. The variation may be explained by differential distribution in risk factors (e.g., genetic predisposition, dietary factors, lack of physical activity) between women and men across populations. Also, in this study, the greatest difference observed between the two genders was the prevalence of abdominal obesity (21.2% in men vs. 57.6% in women). Therefore, this difference between genders might be due to a higher prevalence of abdominal obesity in women compared with men [23].

Lack of employment outside the home may contribute to the higher frequency of obesity and MetS [17, 21] among Turkish women. Our country has witnessed dramatic changes in lifestyle in the past two decades. Electricity and tapwater entered almost every house. Modern transportation (buses, cars, and airplanes) became available on a large scale and agriculture became largely mechanized. These changes were accompanied by an abundance of food. Also, physical activity is restricted to housework, and women have no tradition for sporting activities.

Age is strongly associated with MetS. In many studies, it was reported that prevalence of MetS increased with age [14, 15, 21, 24, 29, 30, 32]. In our study, prevalence increased dramatically with age in both genders, from about 7% among people in their 20s to over 50% among people older than 60 years. The highest prevalence of MetS was in the 60–69-year-old age group for women (63.9%) and men (40%). The increasing trend may be attributed to a similar age-related trend in each of the components of MetS. The positive association between ageing and hypertension, diabetes, and obesity was illustrated in a Turkish adult population [17–19]. Moreover, women are prone to weight gain during menapouse. The loss of the menstrual cycle affects calorie intake and slightly lowers metabolic consumption, although most weight gain has been attributed to a reduction in physical activity [34]. Gender differences in the prevalence of the MetS after age 50 may be related to the higher prevalence of obesity (general and abdominal) and prominent weight gain associated with ageing in women compared with men in Trabzon [17].

In our study, MetS had a strong inverse association with the level of education. The results are in line with previous studies [35, 36]. Low education was a risk indicator for features of the MetS in the present study. It per se will not cause diabetes, but may influence the attitude toward lifestyle changes and possibly contributes to obesity and MetS [17, 35]. Many studies have reported that low socioeconomic status is associated with a higher mortality rate from CVD [37]. In the present study, OR for the MetS was significantly increased in the housewives performing domestic duties. Son et al. [24] reported that MetS showed a positive association with sedantary occupation (homemakers and retired workers) in southern Vietnam. Park

Table 5 The prevalence of components of MetS in all subjects by gender and age group

	n	High FPG		High triglycerides		Low HDL-C		Abdominal obesity		Hypertension	
		n	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Women											
20–29	699	14	2.0	65	9.3	169	24.2	151	21.6	190	27.2
30–39	665	31	4.7	155	23.3	247	37.1	357	53.7	311	46.8
40–49	589	45	7.6	170	28.9	215	36.5	434	73.7	410	69.6
50–59	296	52	17.6	119	40.2	104	35.1	254	85.8	257	86.8
60–69	205	55	26.8	102	49.8	88	42.9	182	88.8	193	94.1
≥70	147	47	32.0	67	45.6	51	34.7	119	81.0	139	94.6
Total	2,601	244	9.4	678	26.1	874	33.6	1,497	57.6	1,500	57.7
Men											
20–29	607	11	1.8	118	19.4	149	24.5	31	5.1	234	38.6
30–39	542	27	5.0	219	40.4	168	31.0	88	16.2	260	48.0
40–49	510	60	11.8	251	49.2	172	33.7	142	27.8	312	61.2
50–59	283	42	14.8	122	43.1	91	32.2	88	31.1	221	78.1
60–69	160	35	21.9	62	38.8	43	26.9	80	50.0	144	90.0
≥70	106	25	23.6	28	26.4	34	32.1	39	36.8	89	84.0
Total	2,208	200	9.1	800	36.2	657	29.8	468	21.2	1,260	57.1
All											
20–29	1,306	25	1.9	183	14.0	318	24.3	182	13.9	424	32.5
30–39	1,207	58	4.8	374	31.0	415	34.4	445	36.9	571	47.3
40–49	1,099	105	9.6	421	38.3	387	35.2	576	52.4	722	65.7
50–59	579	94	16.2	241	41.6	195	33.7	342	59.1	478	82.6
60–69	365	90	24.7	164	44.9	131	35.9	262	71.8	337	92.3
≥70	253	72	28.5	95	37.5	85	33.6	158	62.5	228	90.1
Total	4,809	444	9.2	1478	30.7	1,531	31.8	1,965	40.9	2,760	57.4

Table 6 The number of the components of the MetS in the studied participants by gender and residential places

The number of the components of the MetS	0		1		2		3		4		5	
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Women	530	20.4	564	21.7	693	26.6	479	18.4	269	10.3	66	2.5
Men	484	21.9	730	33.1	514	23.3	320	14.5	133	6.0	27	1.2
Total	1,014	21.1	1,294	26.9	1,207	25.1	799	16.6	402	8.4	93	1.9
Work place												
Trabzon	368	18.8	551	28.2	486	24.9	338	17.3	171	8.7	41	2.1
Akcaabat	131	22.9	136	23.8	133	23.3	98	17.1	59	10.3	15	2.6
Duzkoy	41	32.3	33	26.0	24	18.9	15	11.8	13	10.2	1	0.8
Arakli	84	21.2	98	24.7	107	27.0	74	18.7	23	5.8	10	2.5
Surmene	61	20.3	54	17.9	101	33.6	52	17.3	26	8.6	7	2.3
Of	75	19.4	107	27.6	104	26.9	60	15.5	35	9.0	6	1.6
Caykara	27	25.7	24	22.9	26	24.8	17	16.2	10	9.5	1	1.0
Vakfikebir	144	24.9	174	30.1	131	22.7	86	14.9	37	6.4	6	1.0
Macka	48	22.4	60	28.0	48	22.4	38	17.8	17	7.9	3	1.4
Yomra	35	20.1	57	32.8	47	27.0	21	12.1	11	6.3	3	1.7

Table 7 Odds ratios for MetS for demographic, socioeconomic, lifestyle factors, and family history of selected medical conditions (logistic regression analysis)

Parameter	Odds ratio	95% convidence interval	*P*
Age groups			
20–29	1		
30–39	2.48	1.88–3.27	0.0001
40–49	4.14	3.13–5.48	0.0001
50–59	6.29	4.61–8.58	0.0001
60–69	8.31	5.86–11.78	0.0001
≥70	6.75	4.55–10.01	0.0001
Sex			
Female	1		
Male	1.06	0.79–1.43	0.6804
Level of education			
Illiterate	1		
Primary	0.79	0.64–0.97	0.0259
Secondary	0.74	0.54–0.99	0.0458
High school	0.59	0.44–0.79	0.0005
University	0.49	0.34–0.73	0.0004
Occupation			
Worker	1		
Agricultural worker	0.74	0.43–1.29	0.2891
Tradesman	1.24	0.95–1.62	0.1121
Unemployed	0.70	0.38–1.29	0.2567
Housewife	1.56	1.13–2.16	0.0066
Official	1.24	0.93–1.65	0.1401
Household income (US $/month)			
1–250	1		
250–500	1.12	0.90–1.38	0.3106
500–750	1.19	0.94–1.53	0.1417
>750	1.35	0.96–1.89	0.0791
Marital status			
Unmarried	1		
Married	1.73	1.23–2.42	0.0015
Widowed	2.32	1.49–3.62	0.0002
Cigarette use			
Smoker	1		
Nonsmoker	1.15	0.96–1.37	0.1420
Former smoker	1.03	0.79–1.32	0.8441
Alcohol consumption			
Drinker	1		
Nondrinker	0.96	0.71–1.31	0.8180
Former drinker	1.16	0.73–1.83	0.5384
Physical activity			
Never	1		
Mild	0.98	0.84–1.14	0.7579
Moderate-heavy	0.75	0.59–0.96	0.0237
Family history of selected medical conditions			
No	1		
Yes	1.24	1.05–1.45	0.0097

Table 7 continued

Parameter	Odds ratio	95% convidence interval	*P*
Unmarried	1		
Nulliparous	0.72	0.48–1.08	0.115
Parity (for women only)			
1	0.56	0.36–0.86	0.008
2	0.61	0.44–0.84	0.003
3	0.925	0.69–1.25	0.610
≥4	0.79	0.57–1.08	0.142

et al. [31] have found that the OR for the MetS among Korean adults was significantly increased in the unemployed. In our study, prevalence of the MetS was the lowest in the unemployed group. This result may be explained the fact that mean age of unemployed group is lower (32.93 ± 13.2 years) than those of other occupational groups. Our results are in consistent with the results for Vietnamese adults [24].

To the best of our knowledge, the association between MetS and reproductive history in women has not been studied in world yet. In our study, the prevalence of MetS increased with parity. In women we would have to consider various pregnancy-related circumstances, as BMI has been shown to increase with number of pregnancies [38]. In logistic regression analysis, interestingly the risk of MetS significantly decreased in women with one or two parities than that of unmarried women. According to the results of Chi-square test, MetS prevalence of nulliparous women was higher (29.1%) than unmarried (4.3%) and had one (17.1%) or two (22.2%) parities. Therefore, we may suppose to married women that they have to at least one or two child.

Park et al. [31] reported that there was no significant association found between the MetS syndrome and the household income. In the present study, household income was inversely related to the prevalence of MetS. This may indicate that reducing income in our country may be a potential contributor to the high rates of MetS. However, the OR for MetS by linear logistic analysis did not change with household income in subjects. This results is concordant with the results of previous studies [24, 31].

Current smoking is a significant independent risk factor for the MetS in both women and men [7, 31, 39, 40]. In other studies, the significant association between MetS and smoking has not been observed [24, 28, 30]. Smoking is known to impair insulin action and may lead to insulin resistance [41]. Smokers have been shown to be hyperinsulinemic and dyslipidemic compared with a matched-group of non-smokers [42]. Cigarette smoking may also cause high blood pressure by increasing sympathetic activity, and it may elevate triglyceride levels [43]. The clustering of metabolic abnormalities associated with insulin resistance has been shown to be sixfold higher in smokers than in non-smokers [40]. However, this releationship has not been clarified, and reports on this issue are also scarce. In the present study, we found the association of smoking with MetS (Table 3). But, the risk of MetS did not increase in logistic regression analysis.

In our study, we observed an association between MetS and alcohol consumption in both men and women in accordance with previous cross-sectional studies [8, 31, 35, 39]. However, this association was lost in logistic regression analysis. In the literature, few studies have examined the association between the alcohol consumption and the MetS as defined by the NCEP [8, 39]. Park et al. [31] reported that there was no association of alcohol consumption with MetS. Lidfeldt et al. [35] showed that low and moderate alcohol comsumptions were associated with a lower risk of MetS. Since our study did not distinguish between the types of alcohol consumption and the MetS, the prevalence should be interpreted cautiously. It should be pointed out that number of alcohol drinkers is highly low (<10%) in the present study. Thus, in the logistic regression analysis there was no association found between MetS and alcohol consumption.

In most of studies, there is an inverse relationship between physical activity and MetS [31, 39]. From the early 1980s, several observational studies suggested that morbidity and mortality caused by atherosclerotic disease were inversely related to the individuals' physical activity status [44, 45], whereas even a single session of moderate-to long-duration exercise can reduce blood pressure and glucose and triglyceride leves and can increase HDL-C levels [45]. Lidfeldt et al. [35] reported that significant association was not found between the MetS and the physical activity. Moderate exercise is beneficial to promote weight loss in obese individuals and favorably modifies components of the MetS [31]. The lack of regular exercise by the majority of the Turkish population was seen in other Turkish community surveys. Our findings confirmed the literature. The present study revealed that moderate physical activity is associated with a considerable reduction of the odds of having the MetS.

The OR for the MetS was significantly increased in subjects with a family history of obesity, diabetes, hypertension, and atherosclerotic heart disease compared with those without a family history. Family history of components of the MetS was found to be a significant independent risk factor for the MetS (Table 7).

As previously mentioned, MetS was a cluster of several components. In our study, the most common metabolic abnormality among all subjects was arterial hypertension (57.4%), followed by abdominal obesity (40.9%) and low HDL-C level (31.8%) (Table 5). The presence of high FBG level in MetS is lowest (9.2%). Also, among participants with MetS, hypertension was the most common abnormality (91.9%), followed by abdominal obesity (83.3%), and hypertriglyceridemia (74%). High prevalence of abdominal obesity has been previously reported from the USA by Ford et al. [14], from Vietnam by Son et al. [24], and from Greece by Athyros et al. [26]. In Asian countries (Iran and India), low HDL-C is the most prevalent abnormality among subjects with MetS [16, 24].

In a previous study performed by us from 2001 to 2002, we reported that the prevalences of obesity and arterial hypertension in adult population ($n = 5{,}016$) in the Trabzon city were 23.5 (29.4 for women and 16.5% for men) and 34%, respectively [17]. (That study was actually about the prevalence of obesity and associated risk factors.) Several findings indicated that about half of the patients with hypertension may have insulin resistance and hyperinsulinemia. A meta-analytic review demonstrated a significant correlation between fasting serum insulin level and blood pressure, further supporting the role of hyperinsulinemia in the pathogenesis of essential hypertension [46].

The prevention and control of obesity play a central role in the prevention of the MetS. The risk of developing abnormal glucose metabolism, hypertension, and dyslipidemia is markedly higher among obese subjects compared with subjects with normal weight [47]. In contrast, weight reduction through dietary modification and regular physical exercise are shown to be effective in improving insulin sensitivity [48], correcting metabolic abnormalities, and reducing blood pressure in obese subjects [47].

In conclusion, the present study, which firstly examines the clustering of various risk factors showed that the prevalence of MetS as defined by ATP III criteria, is high in the Turkish adult subjects living in Trabzon. Subjects living in Trabzon may have a tendency toward MetS. A high prevalence of the MS in Trabzon may lead to an increase in diabetes and CVD. Economic development and consequential changes in lifestyle and diet might explain this high prevalence. MetS is a major public health problem in Trabzon. Prevention of the modifiable risk factors such as obesity, physical inactivity, and hypertension should be the key strategy for avoiding morbidity and mortality. There is need for effective public health program and urgent precautions for the control of MetS. These precautions include serious education, providing a well-balanced diet and increasing physical activity.

Acknowledgments This study was supported by a research grant from the Karadeniz Technical University (Project No. 2003.114.003.5).

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