Obesity and abdominal obesity; an alarming challenge for cardio-metabolic risk in Turkish adults

Türk erişkinlerinde kardiyometabolik risk için alarm; obezite ve abdominal obezite

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ABSTRACT

Objective: To assess the prevalence of obesity and abdominal obesity in Turkish adults.

Methods: This is a nationally representative cross-sectional study. From both urban and rural areas of seven geographical regions of Turkey 2110 men and 2154 women with a mean age of 40.9±14.9 years (range 20-90) were included in this study. Demographic, anthropometric data were collected and biochemical analyses of blood lipids and glucose levels were performed in all participants. Statistical analyses were performed using Chi-square, unpaired t and two-way ANOVA tests. Stepwise logistic regression analysis was applied for the study of association of obesity with cardiometabolic risk factors.

Results: The prevalence of the overweight was 36.0% (41.5% in men and 30.6% in women) and the prevalence of obesity was 30.4% (20.6% in men and 39.9% in women). The prevalence of obesity was similar in rural and urban areas. The prevalence of abdominal obesity and metabolic syndrome were 36.2% and 40.9 % according to American Heart, Lung, and Blood Institute criteria and 58.7% and 42.6% according to International Diabetes Federation criteria, respectively. Abdominal obesity and metabolic syndrome were significantly more prevalent among women. After adjusting for age, sex and other cardiometabolic risk factors, abdominal obesity was significantly associated with increases in body mass index (odds ratio [OR] per 5 kg/m^2 increase 1.61, 95% CI 1.52-1.69) and triglycerides (OR per 10 unit increase 1.02, 95% CI 1.01-1.02) and negatively associated with total cholesterol (OR 0.95, 95% CI 0.94-0.96), high-density lipoprotein cholesterol (OR 0.96, 95% CI 0.93-0.99), systolic blood pressure (OR 0.95, 95% CI 0.92-0.98) and diastolic blood pressure (OR 0.94, 95% CI 0.90-0.99).

Conclusion: Obesity and abdominal obesity are major problems for Turkish adults, especially for Turkish women. Our finding is alarming for cardio-metabolic complications and underscores the need for population-based strategies to modify lifestyle related risk factors.

(Anadolu Kardiyol Derg 2008; 8: 401-6)

Key words: Metabolic syndrome, obesity, abdominal obesity, cardiometabolic risk, logistic regression analysis

ÖZET

Amaç: Türk yetişkinlerinde farklı tanımlamalara göre obezite ve abdominal obezite prevalanslarını ve bunların kardiyometabolik risk faktörleri ile olan ilişkilerinin araştırılması.

Yöntemler: Bu enine-kesitsel ulusal çalışmaya Türkiye'nin yedi farklı coğrafi bölgesindeki kırsal ve kentsel alanlardan yaş ortalaması 40.9±14.9 (20-90, yıl) olan 2110 erkek (1374'ü kentsel, 736 kırsal) ve 2154 kadın (1426'sı kentsel, 728'i kırsal) alındı. Tüm katılımcılarda demografik, antropometrik veriler toplandı ve kan lipitleri ile glükoz seviyeleri ölçüldü. İstatistiksel analiz Ki-kare, eşleştirilmemiş t ve iki-yönlü ANOVA testleri ile yapıldı. Obezite ve kardiyometabolik risk faktörleri arasında ilişki adımsal lojistik regresyon analiz ile araştırıldı.

Bulgular: Obezite prevalansı %30.4 (erkeklerde %20.6, kadınlarda %39.9), kilolu prevalansı %36.0 idi (erkeklerde %41.5, kadınlarda %30.6). Obezite prevalansı kırsal (%30.3) ve kentsel (%30.4) alanlarda benzerdi. Abdominal obezite prevalansı ve metabolik sendrom prevalansı; Amerikan Ulusal Kalp, Akciğer ve Kan Enstitüsü kriterlerine göre sırasıyla %36.2 ve %40.9, Uluslararası Diyabet Federasyonu kriterlerine göre sırasıyla %58.7 ve %42.6 idi. Abdominal obezite ve metabolik sendrom prevalansı kadınlarda daha yüksekti. Yaşa, cinsiyete ve diğer kar-

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diyometabolik risk faktörlerine göre düzeltildiğinde; abdominal obezite vücut kitle indeksi (her 5 kg/m^2 artışta göreli risk [GR] 1.61, %95 GA 1.52-1.69) ve trigliserid (her 10 unite artışta GR 1.02, %95 GA 1.01-1.02) artışıyla anlamlı şekilde ilişkili, total kolesterol (GR 0.95, %95 GA 0.94-0.96), yüksek-yoğunluklu lipoprotein kolesterol (GR 0.96, %95GA 0.93-0.99), sistolik kan basıncı (GR 0.95, %95GA 0.92-0.98) ve diyastolik kan basıncı (GR 0.94, %95GA 0.90-0.99) ile negatif ilişkili bulunmuştur.

Sonuç: Türkiye'de yetişkinler için özellikle de kadınlar için obezite ve abdominal obezite önemli bir sorun haline gelmiştir. Bulgularımız kardiyometabolik komplikasyonların ve yaşam tarzı ile ilintili risk faktörlerinin azaltılması için toplumsal stratejilerin geliştirilmesi hususunda uyarıcı olmuştur. *(Anadolu Kardiyol Derg 2008; 8: 401-6)*

Anahtar kelimeler: Metabolik sendrom, obezite, abdominal obezite, kardiyometabolik risk, lojistik regresyon analiz

Introduction

The metabolic syndrome has become one of the major public-health challenges worldwide (1). The increase in prevalence of the metabolic syndrome is driven largely by the epidemic of obesity throughout the world (1). The global increase in obesity and metabolic syndrome has been shown to result in a dramatic increase of type 2 diabetes and is expected to lead to an increase in cardiovascular disease as well (2). There is an urgent need for strategies to prevent the emerging global epidemic. Combating metabolic syndrome requires knowledge of the incidence, prevalence, and rates of transition between stages of the condition as well as relationships between obesity and cardiometabolic risk factors. Recently, in a cross-sectional study, we reported the prevalence of metabolic syndrome in Turkey, which was one of the highest in the world (3). Based on the same study data, we aimed to examine the prevalence of obesity and abdominal obesity, according to different definitions, and their relations with cardiometabolic risk factors in Turkish population.

Methods

The study protocol of this nationally representative cross-sectional survey was published previously (3). Briefly, sample size calculation was based on the assumption - from results of previous trials of metabolic syndrome (MS) - that the rural/urban frequency of MS in Turkey is 24 and 32%, and men/women frequency is 20 and 34%. The sample size was selected to achieve 80% power to detect a difference in the prevalence of MS between the rural/urban and between men/women at a 5% alpha level. A total of 3600 subjects was calculated as necessary to provide the study with 80% power to detect a difference between rural/urban or men/women with a type I error of 5%. In order to account for possible dropouts, a sample equivalent to ~125% of the required sample size was invited. A total of 4264 subjects aged >20 years from both urban and rural areas of seven geographical regions in Turkey who approved to participate were included in this study. The study protocol was approved by the Ministry of Health of Turkey.

Fasting blood samples early in the morning after an overnight fast (12h) were drawn for biochemical analyses, and were analyzed immediately. Total plasma cholesterol, triglyceride (TG), high-density lipoprotein cholesterol (HDL-C) and glucose levels were measured using Vitros multianalyzer and respective reagents (Ortho-Clinical Diagnostics Inc., Rochester, NY, USA). Low-density lipoprotein cholesterol (LDL-C) was calculated with Friedewald formula. If serum TG exceeded 400 mg/dL LDL-C was not calculated.

To measure the waist circumference, a measuring tape was placed in a horizontal plane around the abdomen at the level of iliac crest. Before reading the tape measure, the tape was snuggled but it did not compress the skin and was parallel to the floor. Measurement was made at the end of a normal expiration. Body weight and height were measured by a trained survey team, while subjects were wearing light clothing without shoes. Body mass index (BMI) was calculated with the formula; weight (kg) / height (m)^2. Subjects with a BMI of <25 kg/m^2 were classified as normal, BMI of 25-29.9 kg/m^2 were classified as overweight, and BMI of ≥ 30 kg/m^2 were classified as obese (4).

Two different criteria were used to determine abdominal obesity. According to the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) criteria, abdominal obesity was defined as waist circumference of >102 cm in men and >88 cm in women (5). According to the International Diabetes Federation (IDF) criteria, abdominal obesity was defined as waist circumference of ≥94 cm in men and ≥80 cm in women (6).

Metabolic syndrome was defined as the presence of 3 or more of the following 5 parameters (AHA/NHLBI definition) (5): HDL-C <40 mg/dL in men and <50 mg/dL in women or drug treatment for reduced HDL-C; TG ≥150 mg/dL or drug treatment for elevated TG; fasting glucose ≥100 mg/dL or drug treatment for elevated glucose; resting blood pressure ≥30/85 mm Hg or antihypertensive drug treatment; and waist circumference >102 cm in men, >88 cm in women.

Statistical analysis

Statistical analyses were performed using SPSS software (version 11.0, Chicago, IL, USA). Chi-square test was used for comparison of frequency distribution of categorical variables. Unpaired Student t test was used for comparison of continuous variables. Age and sex adjusted changes in BMI were compared using two-way ANOVA test, with Tukey test as posthoc analysis. Age and sex-adjusted univariate logistic regression and multiple stepwise binary logistic regression were used to examine the association between abdominal obesity cardio-metabolic risk factors. Level of statistical significance was accepted as 0.05.

Results

This study included the subjects aged >20 years. Of the 4264 subjects included in the survey, five subjects were excluded because the HDL-C, TG or blood glucose levels were not specified in the records; the remaining 4259 subjects were included in the analysis. The final study population was 2108 men (1372 in urban and 736 in rural locations) and 2151 women (1423 in urban and 728 in rural locations) with a mean age of 40.9±14.9 years (range 20-90).

Table 1 shows mean BMI by sex and age groups. Mean BMI was significantly higher in women (28.8±6.3 kg/m^2) than in men (26.6±4.7 kg/m^2, p<0.001) and increased steadily with age (p<0.05). Highest BMI was found in the 60-69 age group in men and 50-59 age group in women. Body mass index decreased slightly in individuals above the age of 70.

Of the study population, 1.4% was identified as underweight, 32.3% as normal, 36% as overweight and finally 30.4% as obese. The prevalence of overweight was higher among men (41.5% in men and 30.6% in women, p<0.001) whereas the prevalence of obesity was higher among women (39.9% in women and 20.6% in men, p<0.001). The prevalence of obesity was similar for rural (30.3%) and urban (30.4%) populations, and increased with age in both men (from 6.5% in subjects aged 20-29 years to 34.6% in those aged 60-69 years) and women (from 10.9% in subjects aged 20-29 years to 66.8% in those aged 50-59 years) (Fig. 1).

Abdominal obesity

Mean waist circumference of the entire study population was 90.9±13.6 cm (91.7±12.2 cm in men, 90.1±14.8 cm in women, p<0.001). Based on ATP III criteria, the overall prevalence of abdominal obesity was 36.2% and was significantly higher among women (54.8%) than in men (17.2%, p<0.001). Based on IDF definition for Europeans (≥94 cm for men, ≥80 cm for women) the overall prevalence of abdominal obesity was 58.7% (73.8% for women and 43.2% for men, p<0.001). The prevalence of abdominal obesity increased with age in both men and women until age 70 (Fig. 2).

The prevalence of abdominal obesity was similar in urban (35.5%), and rural (37.5%) locations. It was the highest in the Black Sea region (40.2%), followed by the Marmara (37.7%), Aegean (36.6%), East Anatolia (35.4%), Central Anatolia (35.3%), Mediterranean (34.2%), and Southeastern Anatolia (31.9%) regions. Interregional differences were not statistically significant.

The characteristics of subjects with or without abdominal obesity are shown in Table 2. Age, female sex, blood pressure, total plasma cholesterol, TG, LDL-C, HDL-C and fasting plasma glucose levels were higher in abdominally obese subjects than in those without abdominal obesity. When the levels of HDL-C were compared between women and men, mean HDL-C levels of women (with or without abdominal obesity) were found to be higher than those of men. Smoking ratios of abdominally obese subjects were found to be lower than in those without abdominal obesity. Smoking ratios of women (with or without abdominal obesity) were lower than those of men.

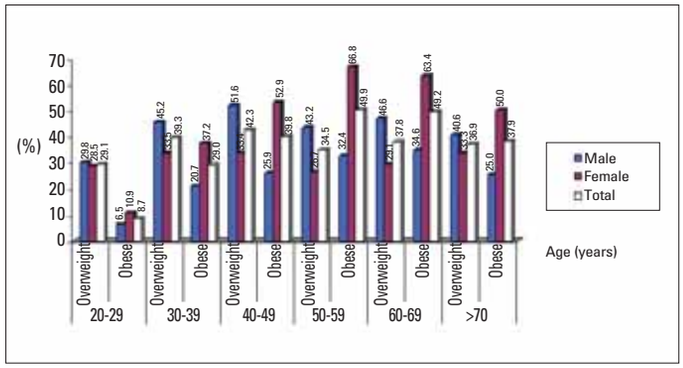

Figure 1. The prevalence of overweight and obesity in different age categories

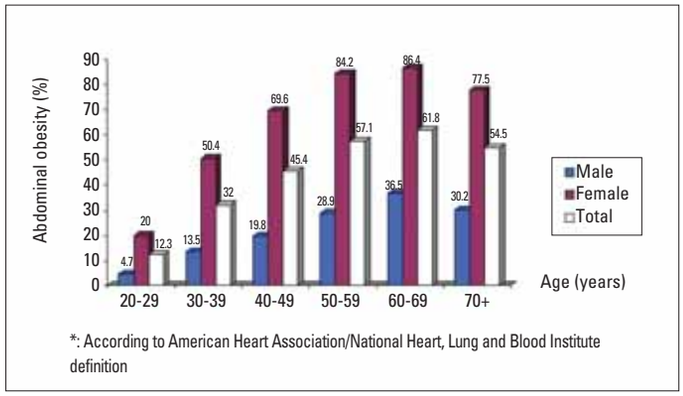

Figure 2. The prevalence of abdominal obesity in different age categories

Table 1. Mean BMI values according to sex and age groups

	Male		Female	
Age, years	n	BMI, kg/m^2	n	BMI, kg/m^2
20-29	618	24.1±3.8 [23.71-24.51]	614	24.5±5.0 [24.07-24.86]
30-39	527	26.7±4.4 [26.28-27.13]	532	28.6±5.9 [28.21-29.06]
40-49	374	28.1±4.9 [27.55-28.56]	395	30.9±5.6 [30.38-31.36]
50-59	287	28.3±4.7 [27.68-28.84]**	298	32.6±5.7 [32.00-33.14]**
60-69	208	28.6±4.5 [27.95-29.30]	213	32.2±5.4 [31.48-32.82]
70+	96	27.0±4.6 [26.04-28.04]	102	30.1±5.5 [29.08-31.02]
Total	2110	26.6±4.7 [26.39-26.80]	2154	28.8±6.3 [28.55-29.08]*

Data are represented as mean±SD (95% CI) values
Two-way ANOVA test
(F=3.47 p=0.004 for age groups in total; F=97.31 p<0.001 for sex in total; F=1.75 p=0.12 for age*sex)
Tukey post hoc test
*-p<0.001 for differences between male and female
**-p<0.05 for intragroup differences in age groups
BMI-body mass index

Table 2. The characteristics of subjects with or without abdominally obesity

Parameters	Abdominally obese	Abdominally not obese	p*
	(n=1540)	(n=2719)	
Age, years	48.08±13.71	36.82±14.02	<0.001
Male,%	23.48	64.22	<0.001
Current smoking,%	16.8	39.5	<0.001
Male	34	48.3	
Female	11.5	23.7	
Systolic BP, mmHg	136.57±22.12	122.99±16.55	<0.001
Diastolic BP, mmHg	87.90±14.05	80.07±11.77	<0.001
Total cholesterol, mg/dL	188.24±40.62	170.04±40.17	<0.001
Triglycerides, mg/dL	161.32±82.21	126.18±77.10	<0.001
HDL-C, mg/dL	50.57±17.28	48.36±16.33	<0.001
Male	45.91±16.76	46.34±16.58	
Female	52.0±17.19	51.98±15.23	
LDL-C, mg/dL	105.52±37.45	96.41±36.59	<0.001
FPG, mg/dL	116.17±45.68	104.14±37.00	<0.001

Data are represented as percentages and Mean±SD
*Chi-square test and unpaired Student t test
BP - blood pressure, HDL-C - high-density lipoprotein-cholesterol, LDL-C – low-density lipoprotein-cholesterol, FPG - fasting plasma glucose

We then examined the relationship between BMI categories and abdominal obesity and cardiometabolic risk factors. The frequency of abdominal obesity (according to AHA/NHLBI) was 3.6% in subjects with a BMI <25 kg/m^2, 28% with a BMI 25-29,9 kg/m^2, 81.9% with a BMI ≥30 kg/m^2 (p<0.0001, Fig. 3). In abdominally obese subjects with BMI ≥30 kg/m^2; high blood pressure, hypertriglyceridemia and hyperglycemia were significantly more frequent than abdominally obese subjects with BMI < 30 kg/m^2 (Table 3).

In age and sex adjusted univariate analyses, all of the cardiometabolic risk factors were significantly associated with abdominal obesity (Table 4, first column). In multiple analyses, the association with fasting plasma glucose was no longer significant, and the positive associations with total cholesterol, HDL-C, systolic and diastolic blood pressure changed direction, indicating that the association of these risk factors with abdominal obesity was in part mediated with BMI. After adjusting for age, sex and other cardiometabolic risk factors, abdominal obesity was significantly associated with increases in BMI (odds ratio [OR] per 5 kg/m^2 increase 1.61, 95% CI 1.52-1.69) and triglycerides (OR per 10 unit increase 1.02, 95% CI 1.01-1.02) and negatively associated with total cholesterol (OR 0.95, 95% CI 0.94-0.96), HDL-C (OR 0.96, 95% CI 0.93-0.99), systolic blood pressure (OR 0.95, 95% CI 0.92-0.98) and diastolic blood pressure (OR 0.94, 95% CI 0.90-0.99).

Finally, we also examined the prevalence of metabolic syndrome in Turkish adults according to new definitions. According to AHA/NHLBI and IDF definitions, the overall prevalence of metabolic syndrome was 40.9% (male 42.0%, female 58.0%, p<0.001) and 42.6% (male 33.9%, female 51.1%, p<0.001), respectively.

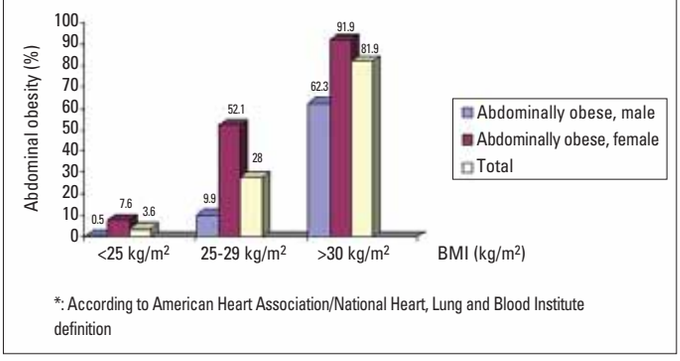

Figure 3. The prevalence of abdominal obesity in non-obese overweight and obese subjects
BMI – body mass index

Discussion

Our findings indicate that two out of three Turkish adults above the age 20 are either overweight or obese and more than one out of three are abdominally obese based on AHA/NHLBI criteria. The results are comparable with the United States 1999-2002 National Health and Nutrition Estimates Survey results for adult population (BMI of 25 or higher 65.1%, obesity 30.4%) (7). Although it is difficult to provide a single prevalence estimate for the continent of Europe, in general terms, the prevalence of overweight has been reported as 28.4-39.6% (30.7-57% for men and 23.3-56% for women) while the prevalence of obesity is 11.3-24.2% (9.3-24.75 for men, 8.7-35% for women) (8). Among Turkish adults, the prevalence of being overweight is similar to that of Europe whereas the prevalence of obesity among women is higher than European average.

Table 3. Metabolic syndrome indicators in abdominally obese patients who are obese and who are not obese

Metabolic syndrome parameters	Abdominally obese*		p*
	BMI ≥30 kg/m^2	BMI <30 kg/m^2	
Waist circumference, cm	105.6±9.9	98.2±6.9	<0.001
High blood pressure (≥130 and/or ≥85 mmHg), %	75.7	62.0	<0.001
Low HDL-C, %	49.3	46.2	NS
Triglycerides ≥150 mg/dL, %	52.7	41.3	<0.001
FPG ≥100 mg/dL, %	41.3	29.7	<0.001

*:American Heart Association/National Heart, Lung, and Blood Institute definition.
Data are represented as percentages and Mean±SD
*-Chi-square test and unpaired Student t test
BMI - body mass index, HDL-C - high density lipoprotein-cholesterol, FPG - fasting plasma glucose, NS- non significant

Table 4. Association between abdominal obesity and cardiometabolic risk factors

	Age and sex-adjusted univariate odds ratios (95% CI)*	Multivariate odds ratios (95% CI)*	p
Body mass index	1.15 (1.14-1.16)	1.61 (1.52-1.69)	<0.001
Fasting plasma glucose	1.07 (1.06-1.07)	1.00 (0.99-1.01)	NS
Triglycerides	1.05 (1.04-1.05)	1.02 (1.01-1.02)	<0.001
Total Cholesterol	1.04 (1.03-1.04)	0.95 (0.94-0.96)	<0.001
High density lipoprotein-cholesterol	1.14 (1.13-1.15)	0.96 (0.93-0.99)	0.01
Systolic blood pressure	1.06 (1.05-1.06)	0.95 (0.92-0.98)	<0.001
Diastolic blood pressure	1.09 (1.08-1.09)	0.94 (0.90-0.99)	0.03

* Odds ratios correspond to per 10 unit increase in cardiometabolic risk factors, except for body mass index which corresponds to per 5 kg/m^2 increase
Logistic Regression (Enter method) analysis was used.
Model $\chi 2$=1946.49 P<0.001 Correct percentage=%82.3
In age and sex adjusted analysis: independent variables - body mass index, fasting plasma glucose, total cholesterol, HDL-C, TG, systolic and diastolic blood pressure; dependent variable - abdominal obesity present (waist circumference for male >102 cm, for female >88 cm) vs absent (1 / 0)
CI - confidence interval, NS - nonsignificant

Historical data on BMI for Turkish adult population is available through the Turkish Adults Hearth Disease and Risk Factors Study (TEKHARF) (9, 10). In 1990, mean BMI was 24.4 kg/m^2 for men and 26.4 kg/m^2 for women. The prevalence of obesity was 9.0% for men and 24.0% for women (9, 10). As comparable cohorts, we can say that during the 15 years since 1990, BMI increased to 26.6 kg/m^2 for men and to 28.8 kg/m^2 for women (increases of 2.2 kg/m^2 in men and 2.4 kg/m^2 in women on average), meanwhile the prevalence of obesity reached 20.6% in men and 39.9% in women. This increase in obesity prevalence is consistent with the 10-year follow-up data obtained from TEKHARF study. About 25.2% of all women and 44.2% of all men over 30 years of age were found to be obese in TEKHARF in 2001 (11). These findings demonstrate that the prevalence of obesity almost doubled, and as observed in whole world, especially in developing countries, it is increasing due to environmental factors such as life-style of people and is becoming a major public health problem in Turkey.

Furthermore, obesity is much more common among women than in men. The highest prevalence for both sexes is observed during the third decade and the prevalence further increases with a peak at fifth to sixth decades. The obesity pattern is similar in all geographical regions, and in both rural and urban locations. We expected in this study that there would be difference, in terms of obesity, between urban and rural areas due to the fact that obesity is closely related to the increasing urbanization. Contrary, the study did not support our expectations. This result led us to conclude that there is insignificant relation in rural-urban differentiation in terms of life-style. This is possibly caused by the fact that in the areas regarded as rural; people use technological utilizations, thus spending less energy than expected. The eating habits prove also slight difference when compared to that of urban areas.

Similar to the data on obesity, abdominal obesity was also more common among women. The prevalence of abdominal obesity among men increased steadily with increasing age, whereas among women, the prevalence was 20% in the second decade, doubled more than two fold to 50% in the third decade and remained as high as 86% during the sixth decade. Intraabdominal fat increases with age in both overweight and normal weight individuals independent of changes in total body fat (12). Premenopausal women can accumulate more body fat than men of the same age before reaching the same amount of visceral adipose tissue found in men, and estrogen deficiency (at menopause) is associated with a preferential increase in

visceral fat (13, 14). In our study, abdominal obesity being an indicator of visceral fat accumulation was higher for women in all age groups than in men. The fact that abdominal obesity is more commonly observed in women had no parallel relationship to the other areas in the world. We think that difference could be a topic, which requires further investigation.

The percentage of abdominal obesity in both men and women was lower than those reported for the U.S. adults (42.4% for male, 61.3% for female) (15). Subjects with abdominal obesity had significantly higher blood pressure, total cholesterol, TG, LDL-C, HDL-C and blood glucose levels, whereas they had lower smoking ratios. Since higher HDL-C levels and low smoking ratio are generally encountered among female population, the higher mean HDL-C levels and the lower ratio of smoking in abdominally-obese group can be explained with the higher female/male ratio in this group.

There was inverse association between abdominal obesity and total cholesterol and systolic and diastolic blood pressure in our study. Since accompanying health problems are more commonly seen in subjects with abdominal obesity, hospital visits, usage of anti-hypertensive and lipid-lowering drugs are also more commonly observed in those subjects. For this reason, a pseudo inverse relation could be concluded among abdominal obesity, total cholesterol level and blood pressure.

Regional body fat distribution has an important influence on metabolic risk factors, and even normal weight individuals with increased amounts of abdominal adipose tissue can be metabolically obese, with insulin resistance and dyslipidemia (16, 17). In our study, we found a considerably high prevalence of abdominal obesity and metabolic syndrome in overweight subjects.

Study limitations

This study has some potential limitations. First, in a cross sectional survey, the causal role of abdominal obesity for cardio-metabolic risk cannot be assessed. Second, the lack of C- reactive protein, adipocytokines, plasminogen activator inhibitor-1 and insulin sensitivity measurements limits the power of the study for cardiometabolic risk evaluation.

Conclusion

Obesity and abdominal obesity are major and growing problems for Turkish adults, especially for Turkish women. According to the IDF criteria for Europeans, more than two thirds of Turkish women over 20 years of age are abdominally obese. This finding is alarming for metabolic syndrome and cardio-metabolic complications, and strategies to modify unhealthy lifestyle of the population should be developed and applied as soon as possible.

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