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Original Article

Waist Circumference Limits for the Diagnosis of Metabolic Syndrome in Turkish Society

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ABSTRACT

Objective: Metabolic syndrome is a worldwide health problem. The International Diabetes Federation (IDF) recommends a population- and country-specific definition of cutoff points of waist circumference for the diagnosis of abdominal obesity. The purpose of this study was to determine the waist circumference cutoff values of the Turkish population.

Methods: The study was conducted on a total of 1379 subjects (767 females and 612 males) who were admitted to the study hospital's central laboratory for a routine check-up and blood tests and accepted to participate in this study. The participants were evaluated for the presence of the IDF criteria (other than waist circumference) for the diagnosis of metabolic syndrome.

Results: To determine the cutoff values of waist circumference for predicting ≥2 risk factors defined by the IDF, a receiver operating characteristic (ROC) curve was plotted for each sex separately. The area under the ROC curve for men and women was 0.69 and 0.75, respectively. The cutoff values of waist circumference for predicting the presence of multiple risk factors (with at least 80% sensitivity) for men and women were 94 cm and 96 cm, respectively.

Conclusion: For Turkey, it is more rational to use the waist circumference cutoff points identified in this study (i.e., 94 cm for men and 96 cm for women) than to use the IDF's cutoff points recommended for the European subjects for the diagnosis of metabolic syndrome.

INTRODUCTION

Metabolic syndrome is a fatal endocrinopathy with high cardiovascular mortality and morbidity that begins with insulin resistance and involves systemic disorders such as abdominal obesity, glucose intolerance or diabetes mellitus, dyslipidemia, hypertension, and coronary artery disease. Factors that form metabolic syndrome cause endothelial dysfunction, leading to the development of atherosclerotic vascular diseases.[1–3]

Body mass index (BMI) and waist circumference measurement are used as indicators of obesity. Waist circumference measurement better indicates the risk of obesity-related metabolic syndrome compared with BMI.[4] It has been shown that people with increased abdominal fat without obesity develop a high cardiovascular disease with similar endothelial dysfunction.[5,6]

The International Diabetes Federation (IDF) recommends a community and country-specific definition of waist circumference cut points for the diagnosis of central obesity. The IDF recommends using waist circumference cut points (≥80 cm for females and ≥94 cm for males) set for the European community until new data are available from the Middle East and Mediterranean countries for the diagnosis of abdominal obesity.[7]

This study aimed to determine the waist circumference cut points to be used in the diagnosis of metabolic syndrome in Turkish society by using the metabolic syndrome diagnostic criteria determined by the IDF.

MATERIALS AND METHODS

A total of 1379 volunteers over the age of 18 years who applied to the hospital for routine general control between

July 2010 and October 2010 were included in the study.

Being inadequate to give written consent, presence of pregnancy, previous abdominal surgery (abdominoplasty and liposuction procedures), presence of acid for any reason, liver failure, renal failure, heart failure, chronic obstructive pulmonary disease, and presence of hypothyroidism were the exclusion criteria from the study. The sample size was calculated according to the data of the Istanbul City Directorate of Population Registry and Citizenship at the start date of the study.

The waist circumference was measured with an inflexible tape measure from the midpoint of the distance between the arcus costarum and the anterior superior of the spina iliaca in the upright position in the mild expiratory after measuring the height and weight of the participants whose sociodemographic characteristics were taken.

Blood pressure measurement was performed by resting for at least 5 min. Glucose, total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides, and thyroid function tests (TSH, FT4, and FT3) of the patients were examined.

The diagnosis of metabolic syndrome was made by considering criteria other than waist circumference, which is one of the diagnostic criteria of IDF metabolic syndrome in our study. The receiver operating characteristic (ROC) curve was drawn for the waist circumference of patients diagnosed with metabolic syndrome, and the waist circumference cut point was determined for diagnosis accordingly.

SPSS 16.0 statistical package software was used for statistical analysis. Descriptive statistical methods (mean and standard error) and two-mean t-test, Pearson's square, Fisher's square, ROC curve, and Paired sample t-test were used to evaluate the data. Descriptive statistical methods, mean and standard error, and minimum and maximum were used to evaluate the data. $p<0.05$ was considered significant.

RESULTS

A total of 1379 volunteers, 612 males and 767 females, were included in the study. The mean age of all participants was 47 years. The mean height was 162.3 cm, the mean weight was 77.9 kg, the mean BMI was 29.2 kg/m^2, and the mean waist circumference was 97.5 cm. BMI, being an indicator of obesity, was found to be higher because the mean height of the females was relatively shorter even though their mean weight was low. In addition, the waist circumference was found to be high in both genders, and values as high as in males were observed in females too.

The sociodemographic and anthropometric measurements are summarized in Table 1.

Hypertension was detected in 31.54% of the participants in physical examinations and tests. Hypertension was detected in 31.37% of males and 31.68% of females. Diabetes diagnosis was made in 49.74% of all participants. This rate was 52.94% in males and 47.19% in females. Hyperlipidemia was detected in 75.27% of all participants. Of the total patients, 72.38% of males and 77.57% of females had hyperlipidemia. Hypertension was seen at the same rate in both sexes, whereas diabetes was more prominent in males and dyslipidemia in females in general. The study and metabolic data of the participants are summarized in Table 2.

A total of 654 volunteers, 294 of whom were males and 360 of whom were females, were diagnosed with metabolic syndrome according to the IDF criteria. Fasting blood glucose ≥100 mg/dL or using antidiabetic medication was called criterion 1. Criterion 1 was present in 52.94% of males and 47.19% of females participating in the study.

Systolic blood pressure ≥130 mmHg and/or diastolic blood pressure ≥85 mmHg or using antihypertensive medication was referred to as criterion 2; 31.37% of males and 31.68% of females met criterion 2. Fasting triglyceride level ≥150 mg/dL or lipid-lowering medication was called criterion 3, and it was present in 33.16% of males and 28.03% of females participating in the study. Low HDL cholesterol level (<40 mg/dL in males, <50 mg/dL in females) or drug use for low HDL cholesterol was called criterion 4. It was present in 35.94% of males and 49.54% of females participating in the study. When these four criteria were examined collectively, ≥2 risk factors were found in 48.03% of males and 46.93% of females.

The mean waist circumference values of 1379 volunteers participating in our study were 98.14±0.48 cm in males and 97.22±0.53 cm in females (Table 3).

A ROC curve containing at least two criteria was drawn, except waist circumference, which is one of the metabolic syndrome diagnostic criteria defined by the IDF to determine waist circumference cut points (Fig. 1). The optimal waist circumference cut point was taken according to the maximum value of Youden's index (sensitivity + specificity − 1). The area under the curve (AUC) was 0.69 in males

Table 1. Sociodemographic and anthropometric measurements of the participants

	All subjects	Males	Females	p
Average age	47 (19–97)	49 (19–90)	46 (20–97)	0.012
Average height (cm)	162.3 (140–190)	169.8 (150–190)	158.3 (140–177)	0.07
Average weight (kg)	77.9 (39–142)	81.5 (47–140)	75.2 (39–142)	0.047
Body mass index (kg/m^2)	29.2 (24.1–34.3)	28.2 (24.1–32.3)	30.1 (25.9–34.3)	0.03
Waist circumference (cm)	97.5 (49–191)	98.14 (59–191)	97.22 (49–191)	0.14

Table 2. Study and metabolic data of the participants

	All subjects	Males	Females
Normotensive/hypertensive	944/435	420/192	524/243
Non-diabetic/diabetic	693/686	288/324	405/362
Normolipidemia/dyslipidemia	341/1038	169/443	172/595
Glucose (mg/dL)	112	118	109
Serum LDL (mg/dL)	123	123	123
Serum triglyceride (mg/dL)	151	173	134
Serum HDL (mg/dL)	47	43	50

LDL: Low-density lipoprotein; HDL: High-density lipoprotein.

and 0.75 in females. The optimal waist circumference cut point (maximum sensitivity + specificity) was 101 cm in males and 96 cm in females. The sensitivity and specificity of the optimal waist circumference cut points were 54% and 73% in males and 80% and 61% in females, respectively. This cut point (101 cm) cannot be used as a screening test in males due to low sensitivity despite high specificity, whereas the waist circumference cut point can be used with 80% sensitivity as the first screening in females in the diagnosis of metabolic syndrome. Values of 80% sensitivity and 44% specificity were taken in the ROC curve as waist circumference cut point in males, and 94 cm value was deemed appropriate for this reason (Fig. 1).

DISCUSSION

Metabolic syndrome is defined as a series of interrelated factors that directly increase the risk of coronary artery diseases, cardiovascular atherosclerotic diseases, and diabetes mellitus type 2. Its main elements are impaired glucose homeostasis, insulin resistance, abdominal obe-

Table 3. Comparison of the characteristics of the volunteers participating in the study

	Male (n=612)	Female (n=767)	Total (n=1379)
Age (years)	49.53±0.59	46.26±0.51	47.71±0.55
Average waist circumference (cm)	98.14±0.48	97.22±0.53	97.62±0.50
International Diabetes Federation criteria 1*, n (%)	324 (52.94)	362 (47.19)	686 (49.74)
International Diabetes Federation criteria 2†, n (%)	192 (31.37)	243 (31.68)	435 (31.54)
International Diabetes Federation criteria 3‡, n (%)	203 (33.16)	215 (28.03)	418 (30.31)
International Diabetes Federation criteria 4§, n (%)	220 (35.94)	380 (49.54)	600 (43.50)
≥2 risk factors	294 (48.03)	360 (46.93)	654 (47.42)

*Fasting blood glucose ≥100 mg/dL (or if taking antidiabetic medication).
†High blood pressure (systolic ≥130 mmHg and/or diastolic ≥85 mmHg) or use of antihypertensive medication.
‡Fasting triglyceride level ≥150 mg/dL (or if taking lipid-lowering medication).
§Low HDL cholesterol level (<40 mg/dL in males and <50 mg/dL in females) or drug use for low HDL cholesterol.

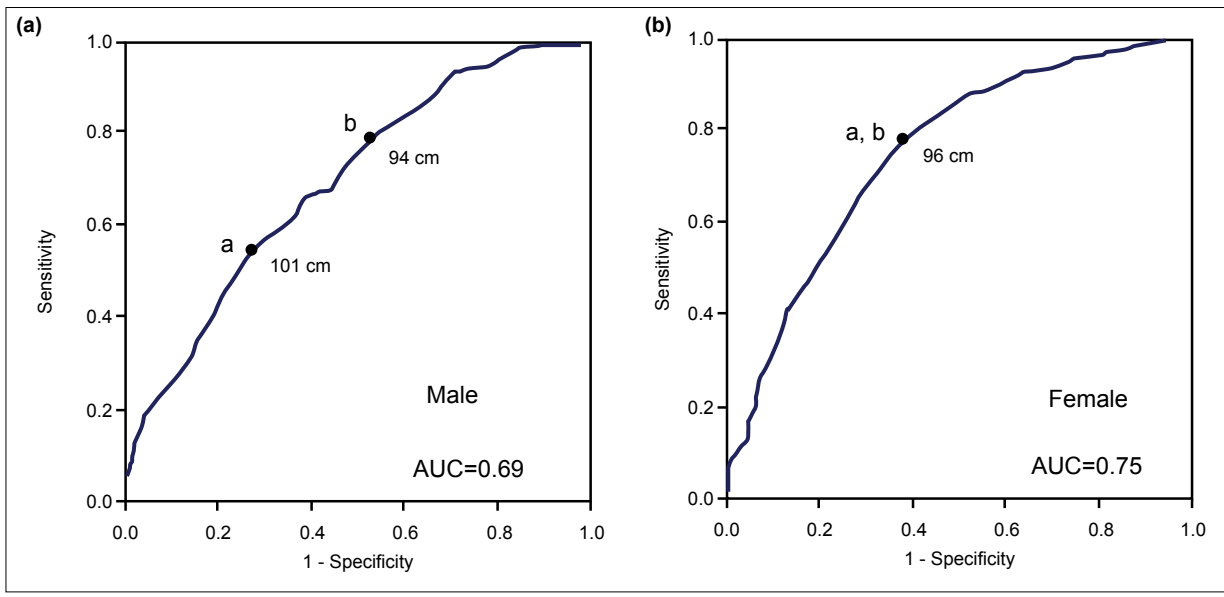

Figure 1. Waist circumference ROC curves, including ≥2 risk factors other than waist circumference in the diagnosis of metabolic syndrome by the International Diabetes Federation (IDF) in males and females. **(a)** Waist circumference cut points that give maximum sensitivity and specificity in the presence of more than 2 risk factors. **(b)** Waist circumference cut points providing at least 80% sensitivity in the presence of more than 2 risk factors. AUC: Area under the curve.

sity, dyslipidemia, metabolic syndrome with high arterial blood pressure, and its increasing prevalence.[8] The IDF demonstrated abdominal obesity as a prerequisite for the diagnosis of metabolic syndrome and adopted waist circumference measurement as a simple screening tool for determining abdominal obesity.[7] The importance of waist circumference measurement was also emphasized by the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI).[9] However, there are no data that can be accepted as the standard on which the authority on waist circumference has reached an agreement. The proposed data are contradictory, and varying measures are given from country to country and even from society to society.

The IDF stated that the waist circumference cut point should be 94 cm for males and 80 cm for females in Europe, whereas AHA/NHLBI proposed cut points of 102 cm and 88 cm, respectively.[9,10] Today, the two most widely used definitions for metabolic syndrome are those of the National Cholesterol Education Program/Adult Treatment Panel III (NCEP/ATP III) and IDF. These definitions are specifically focused on the waist circumference indicative of central obesity.[10,11] A waist-to-hip ratio other than waist circumference has been defined in determining cardiovascular risk. The waist–hip ratio was not considered superior to waist circumference measurement in many studies because it did not reflect the actual risk in people with generalized obesity even though it prevented the BMI from demonstrating cardiovascular risk.[12–14] Waist circumference was found to be the best predictor in the study investigating abdominal obesity in Turkish society.[15]

According to the data from the Turkish Metabolic Syndrome Society, the prevalence of metabolic syndrome in Turkish males and females is 34.5% and 41.8%, respectively. It is better understood how serious and critical the problem is given the population of Turkey (74 816 000) and population density (97.2 km^2) in 2012.[16,17]

NCEP, a study investigating the diagnosis of metabolic syndrome using the criteria of the Expert Panel on the Diagnosis, Evaluation, and Treatment of High Blood Cholesterol Level in Adults (ATP III)[11] (the waist circumference was 102 cm in males and 88 cm in females) found the overall prevalence to be 33.9% (1442 out of 4529 patients). It was found to be 39.6% among females and 28% among males. One of the reasons for the high prevalence in females was the low waist circumference cut point of 88 cm.[18]

The prevalence of diabetes was found to be 7.2% in the most comprehensive diabetes prevalence study (TURDEP I) conducted in Turkey, which examined 24 788 people aged ≥20 years with 55% of them females. The prevalence of hypertension and obesity was 29% and 22%, respectively. Both hypertension and obesity rates were found to be higher in females compared with males. This was explained by low physical activity in females. A total of 26 023 people, 16 696 males and 9327 females, participated, and the prevalence of obesity was found to be high in females in the TURDEP II study.[19] The most important reason for the high prevalence of obesity and metabolic syndrome in females compared with males is the female waist circumference cut point, which is considered 88 cm in TURDEP I and II studies.

They defined waist circumference cut points of 95 cm for males and 88 cm for females as a predictor of high cardiometabolic risk in the Turkish society in the Turkish Adult Risk Factor Study. The waist circumference cut point defined for males in this study is similar to ours even though the metabolic syndrome diagnostic criteria of IDF were not used and diabetic patients were excluded from the study. However, the value determined for females is lower than our value (94 cm vs 95 cm for males and 96 cm vs 88 cm for females).[20]

Waist circumference cut points were defined as 93 cm in males and 83 cm in females to predict insulin resistance in a study examining waist circumference cut points to predict insulin resistance in 1039 Turkish citizens (592 females and 447 males). They excluded diabetic and hypertensive patients taking medication (as required by the study design) from the study although they used the IDF criteria for the diagnosis of metabolic syndrome.[13] The above-mentioned points may be the reason why waist circumference cut points are different from our values.

The cutoff was 90 cm for males and 86 cm for females in the study to determine the waist circumference cut point to determine the cardiovascular risk associated with metabolic syndrome in 3387 people in Venezuela.[21]

The cutoff value of 99.5 cm waist circumference in males and 91 cm in females was found to be the best predictor of metabolic syndrome in a study conducted on 1552 people in the Qatar society. The cutoff determined for males was higher compared with our study, and the results of females were lower.[22]

The cutoff value of waist circumference was found to be 90.3 cm for females and 90 cm for males in a study conducted among the Iranian adult population.[23]

The waist circumference cutoff value for metabolic syndrome was 97 cm for males and 99 cm for females in another study conducted in Basra, Iraq.[24] The cutoff value of the waist circumference of females was higher compared with that of males in both studies, as in our study.

Visceral adipose tissue was measured by computed tomography for the diagnosis of metabolic syndrome, and the waist circumference was determined to be 85 cm in males and 90 cm in females with a visceral adipose tissue of 100 cm^2 in a study conducted in Japan.[25]

Waist circumference cut points (>102 cm for males and >88 cm for females) specified by NCEP/ATP III have been shown not to be suitable for the diagnosis of abdominal obesity in Asian societies in a study conducted in Japan.[26] Our study data also support this. However, some researchers from Middle Eastern countries (such as Jordan[27]) still use these cut points in their studies. These

waist circumference cut points were used in many studies in Turkey (including TURDEP I and TURDEP II).

Another reason why the waist circumference value of Turkish females is higher compared with females in Europe is the high fertility rate in Turkey.[28] The fertility rate in Turkey was 4.3 in 1978 and decreased in 2008. The total fertility rate in Turkey is 2.15 according to 2008 data, whereas the European countries, such as France, England, Ireland, and some other northern countries, with the highest fertility can provide 1.8–2.0 births per female. The fertility rate is between 1.1 and 1.5 in countries such as Germany, Austria, Italy, Spain, and Switzerland. The mean age of female volunteers in our study was 46.26 years, and the waist circumference rate was high as the fertility rate was higher compared with Europe.[29]

The waist circumference cut point in males is consistent with the default values of the IDF for Mediterranean countries in our study. However, the value (80 cm) that the IDF recommends for females is not appropriate for our society. According to our results, the sensitivity and specificity of this cut point are 97% and 19%, respectively. This syndrome is not intended for use as a screening test.[14] This high waist circumference cut point defined for females in our study may be racially specific, or the consumption of foods containing excessive carbohydrates such as bread and rice may depend on a number of reasons, such as Turkish females being less accustomed to exercise programs, abdominoplasty, and liposuction methods compared with females in developed countries. This may also explain the higher waist circumference cut points in females compared with males in neighboring countries such as Iran and Iraq.[23,24,30]

CONCLUSION

The IDF demonstrated abdominal obesity as a prerequisite for the diagnosis of metabolic syndrome and adopted waist circumference measurement as a simple screening tool. The IDF also recommends defining cut points of waist circumference specific to society and country for the diagnosis of abdominal obesity. In conclusion, we think that using cut points of waist circumference defined in many studies in Turkey, including our study, will give more accurate results instead of waist circumference limit values defined by the IDF for the definition and diagnosis of abdominal obesity in Turkey until new data or guidelines emerge.

Ethics Committee Approval

This study approved by the İstanbul University İstanbul Faculty of Medicine Clinical Research Ethics Committee (Date: 09.07.2010, Decision No: 389).

Informed Consent

Prospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: Y.İ., G.Z.Ö., D.Ş.; Design: Y.İ., G.Z.Ö., D.Ş.; Supervision: Y.İ., G.Z.Ö., D.Ş.; Fundings: Y.İ., G.Z.Ö., F.K., D.Ş.; Data: Y.İ., G.Z.Ö., F.K.; Analysis: Y.İ., G.Z.Ö., D.Ş.; Literature search: Y.İ., G.Z.Ö., F.K., D.Ş.; Writing: Y.İ., G.Z.Ö., F.K., D.Ş.; Critical revision: Y.İ., G.Z.Ö., F.K., D.Ş.

Conflict of Interest

None declared.

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Türk Toplumunda Metabolik Sendrom Tanısı İçin Bel Çevresi Sınırları

Amaç: Metabolik sendrom, dünya çapında bir sağlık sorunudur. Uluslararası Diyabet Federasyonu (IDF) abdominal obezite tanısı için bel çevresi sınırlarının toplum ve ülkeye özgü tanımını önerir. Bu çalışmada, Türk nüfusunun bel çevresi eşik değerlerinin belirlenmesi amaçlanmıştır.

Gereç ve Yöntem: Çalışma rutin check-up ve kan testleri için hastanenin merkez laboratuara başvuran ve çalışmaya katılmayı kabul eden 1379 gönüllü (767 kadın ve 612 erkek) ile yapılmıştır. Katılımcıların metabolik sendrom tanısı IDF kriterleri varlığı (bel çevresi hariç) açısından değerlendirildi.

Bulgular: Metabolik sendrom tanısı için IDF tarafından tanımlanan ≥2 risk faktörleri olan hastaların bel çevresi sınır değerleri belirlemek için, cinsiyet ayırıma göre ROC eğrisi çizilmiştir. Erkek ve kadın için ROC eğrisi altında kalan alan sırasıyla 0.69 ve 0.75 idi. Kadınlar ve erkekler için çoklu risk faktörleri varlığında (en az %80 duyarlılık ile) tahmin etmek için bel çevresi eşik değerler sırasıyla 94 cm ve 96 cm idi.

Sonuç: Türkiye için, metabolik sendrom tanı kriteri olarak IDF'in Avrupa toplumu için önerdiği bel çevresi sınırı yerine, bu çalışmada elde edilen bel çevresi sınırlarını (yani, erkekler için 94 cm, kadınlarda 96 cm) kullanmak daha gerçekçi olacaktır.

Anahtar Sözcükler: Bel çevresi; diyabet; hipertansiyon; metabolik sendrom; Türkiye.