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Research Article

Identifying the Optimal Waist Circumference Cut-off Point of Metabolic Syndrome among Apparently Healthy Syrian Adults

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Abstract

Background: Central obesity, which is mainly measured by waist circumference (WC), is regarded as the most important component of metabolic syndrome (MetS). WC is thus used as a predictor for MetS. Since WC varies among race, the aim of this study was to identify the optimal WC cut-off point in the Syrian population as a predictive tool for MetS, based on the International Diabetes Federation criteria.

Methods: A convenient sample of 1550 healthy subjects aged 18-82 years participated in this study, 61% of whom were females. ROC curve analysis was performed to identify the optimal WC cut-off point.

Results: The identified WC cut-off point was 95 cm for males and 86.5 cm for females. Using the traditional cut-off according to the International Diabetes Federation criteria, 28.5% of the participants had MetS; with males having a higher MetS prevalence (37.2%) compared to females (22.2%). In contrast, MS prevalence decreased using the identified cut-off, where it became 25% in the total sample, 35.9% in males and 18.9% in females.

Conclusion: WC was found to be a good predictor for MetS, and the WC cut-off for predicting MetS in Syrian adults was different than the one used according to the International Diabetes Federation criteria. Consequently, there should be a study conducted at a national level in order to adopt the WC cut-off point for the screening of MetS.

Keywords: *Waist Circumference; Cutoff Point; Metabolic Syndrome; Receiver Operator Characteristic Curve*

Introduction

Metabolic Syndrome (MetS), which was called „Syndrome X" by Reaven in 1988 [1] and „the Deadly Quarter" by Kaplan in 1989 [2], is defined as a combination of components that ultimately lead to its emergence. These components include central obesity, hypertension, dyslipidemia and insulin resistance [3,4].

The importance of MetS lies in its association with type 2 diabetes and cardiovascular diseases, where it was shown that the mortality risk of patients with the latter diseases is twice as much for those with MetS than those without it [5,6].

There has been ongoing debate and lack of consensus regarding the definition of MetS (Table 1), depending on the components chosen by different organizations and associations including the National Cholesterol Education Program-Third Adult Treatment Panel (NCEP:ATPIII), the World Health Organization (WHO) and the International Diabetes Federation (IDF). The American Association for

Clinical Endocrinology (AACE) and the European Group for the Study of Insulin Resistance (EGIR) also use slightly different definitions but are less commonly used than those in table 1.

WHO	NCEP:ATP III	IDF
Presence of insulin resistance or glucose ≥ 6.1 mmol/L (110 mg/dl), 2h glucose > 7.8 mmol (140 mg/dl) (required) along with any two or more of the following	Presence of any three or more of the following	Central obesity (waist circumference ≥ 94cm for Europid men and ≥ 80cm for Europid women, with ethnicity specific values for other groups) along with any two of the following
1-HDL cholesterol < 0.9 mmol/L (35 mg/dl) in men, < 1.0 mmol/L (40 mg/dl) in women	1-Blood ≥ 5.6 mmol/L (100 mg/dl) or drug treatment for elevated blood glucose	1-Blood glucose ≥.6 mmol/L (100 mg/dl) or diagnosed diabetes
2-Blood triglycerides ≥ 1.7 mmol/L (150 mg/dl)	2-HDL cholesterol < 1.0 mmol/L (40 mg/dl) in men, < 1.3 mmol/L (50 mg/dl) in women or drug treatment for low HDL-C	2-HDL cholesterol < 1.0 mmol/L (40 mg/dl) in men, < 1.3 mmol/L (50 mg/dl) in women or drug treatment for low HDL-C
3- Waist/hip ratio > 0.9 (men) or > 0.85 (women) or BMI > 30 kg/m^2	3-Blood triglycerides ≥ 1.7 mmol/L (150 mg/dl) or drug treatment for elevated triglycerides	3-Blood triglycerides ≥ 1.7 mmol/L (150 mg/dl) or drug treatment for elevated triglycerides
4- Blood pressure ≥ 140/90 mmHg	4-Waist > 102 cm (men) or > 88 cm (women)	4-Blood pressure ≥130/85 mmHg or drug treatment for hypertension
	5-Blood pressure ≥ 130/85 mmHg or drug treatment for hypertension	

Table 1: *Definitions of MetS according to: the World Health Organization (WHO), the National Cholesterol Education Program-Third Adult Treatment Panel (NCEP:ATPIII), and the International Diabetes Federation (IDF).*

Regardless of the definitions, it is agreed that fat distribution is the most important risk factor for MS [7-9]. The most efficient way to measure the latter is by waist circumference (WC), which in turn can be used as a predictor for MetS [10,11].

Since central obesity is gender, ethnic and race specific [12], different WC cut-offs are needed for the diagnosis of MetS [13-15].

In the Middle East and North Africa (MENA) region, there has only been one nationwide study to identify the optimal WC cut-off in Iran [16] and only two on Arabs specifically [17,18], with the three studies having different WC cut-offs.

Hence, the aim of this study is to identify the optimal WC cut-off needed to diagnose MetS among Syrian adults.

Methods

Study design

The present study used secondary de-identified data, collected as part of a cross-sectional survey conducted in Damascus, Syria between 2010 and 2015 on participants recruited from Al Assad University Hospital. The study was approved by the Damascus University Review Board (DURB).

Study population and sampling

Participants were recruited using a flyer advertising for the study at the Department of Internal Medicine. The participants who self-selected themselves into the study included hospital staff or their relatives and medical school students. Initially, 1577 volunteered to participate in the study. A series of laboratory measurements and tests were used to exclude participants who were suffering from any acute or chronic illness, impaired renal or liver function, intestinal malabsorption. Pregnant and lactating women were also excluded. The final sample comprised of 1550 "healthy" participants, including 602 males and 948 females aged 18 - 82 years.

Data collection

A written informed consent was obtained from participants. Medical doctors in their final year of specializing in Endocrinology were responsible for collecting data from the participants, including conducting the face-to-face interviews, performing the clinical examination and collecting morning fasting blood samples. All tests were performed in Al-Assad University Hospital clinical laboratory and analyzed immediately after collection by the same team of laboratory technicians. The same procedures were followed throughout the study period, using kits provided by the same manufacturer.

Measures

High density lipoprotein (HDL), Triglycerides (TG), Glucose (Glu), Creatinine (Cr), and Alanine transaminase (ALT) were measured by standard colorimetric methods using Roche Hitachi 912 autoanalyzer (Roche Diagnostics, Mannheim, Germany).

Anthropometric measurements were performed using the same standardized techniques and calibrated digital scale (Seca, Germany). Body mass index (BMI) was calculated for all subjects wearing light clothing and no shoes, as weight in kilograms (kg) divided by squared height in meters (m).

Metabolic syndrome was defined based on the International Diabetes Federation as having central obesity along with two of the following: TG level: ≥ 150 mg/dL (1.7 mmol/L); reduced HDL cholesterol: < 40 mg/dL (1.0 mmol/L) in males and < 50 mg/dL (1.3 mmol/L) in females; blood pressure: systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg; raised fasting plasma glucose (FPG) ≥ 100 mg/dL (5.6 mmol/L) [19].

Statistical analyses

Data was analyzed using Stata Software (version 13). Descriptive statistics was reported as mean ± SD for continuous variables. For categorical variables, results were reported as frequencies and valid percentages.

Receiver Operating Characteristics (ROC) curve analysis was performed to determine the optimal WC cut-off point that detects at least two other MS components, using Index of Union method (IU) [20].

Results

Characteristics and distribution of metabolic syndrome components among the study population

The total sample comprised 1550 participants, 61% of which were females. The mean age of the study population was 36.58 ± 11.09 years, with no significant difference between gender.

When looking at age as a categorical variable, the difference between gender became significant (p-value < 0.001). The age group with the highest prevalence in the study sample was those between the ages of 25 and 34 years of age (31.6%), followed by those between the ages of 35 and 44 years of age (26.3%). Mean WC was 88.91 ± 14.06 cm, and differed statistically between gender, where it was higher among males 95.49 ± 12.27 compared to females 84.72 ± 13.52, (p-value < 0.001).

As for non-adipose components of metabolic syndrome, they all differed statistically between gender and were found to be higher in males compared to females. The components with the highest prevalence were low HDL levels (38.2%) and high SBP (28.1%), respectively (Table 2).

Optimal WC cut-off point for detecting at least 2 other MetS components

From the ROC curve analysis, the optimal cut-off point among men was 95 cm, with a 79.12%sensitivity and 62.92% specificity (Area Under the Curve (AUC) = 0.74, 95% Confidence Interval (CI) = 0.70 - 0.78) (Figure 1).

Characteristics	All (n: 1550)	Males (n: 602)	Females (n: 948)	P-value
Age (years)	36.58 ± 11.99	36.21 ± 11.38	36.81 ± 12.36	0.331
Age Group(years)				
18 - 24	249 (16)	74 (12.3)	175 (18.5)	< 0.001
25 - 34	490 (31.6)	227 (37.7)	263 (27.7)	
35 - 44	407 (26.3)	162 (26.9)	245 (25.8)	
45 - 54	280 (18.1)	92 (15.3)	188 (19.8)	
55 - 64	86 (5.5)	32 (5.3)	54 (5.7)	
65 and above	38 (2.5)	15 (2.5)	23 (2.4)	
BMI (kg/m^2)	27.39 ± 5.55	27.87 ± 4.74	27.09 ± 5.99	< 0.001
WC (cm)	88.91 ± 14.06	95.49 ± 12.27	84.72 ± 13.52	< 0.001
Glucose(mg/dl)	87.30 ± 18.65	89.77 ± 18.77	85.73 ± 18.41	<0.001
HDL (mg/dl)	50.30 ± 13.74	42.91 ± 10.76	55.00 ± 13.37	< 0.001
TG (mg/dl)	123.96 ± 81.79	147.79 ± 96.84	108.77 ± 66.28	< 0.001
SBP	118.21 ± 14.65	122.08 ± 13.50	115.75 ± 14.83	< 0.001
DBP	73.67 ± 10.48	76.05 ± 9.78	72.15 ± 10.63	< 0.001
Prevalence of MetS Components	**All n (%)**	**Males n (%)**	**Females n (%)**	**P-value**
High FPG (≥ 100 mg/dL)	229 (14.8)	118 (19.6)	111 (11.7)	<0.001
High TG (≥150 mg/dL)	422 (27.3)	242 (40.2)	180 (19.0)	< 0.001
Low HDL (M: < 40 mg/dL; F: < 50 mg/dL)	588 (38.2)	256 (42.8)	332 (35.3)	< 0.001
High SBP (≥ 130 mmHg)	436 (28.1)	217 (36.0)	219 (23.1)	< 0.001
High DBP (≥ 85 mmHg)	212 (13.7)	108 (17.9)	104 (11.0)	< 0.001

Table 2: *Distribution of MetS components among the study population and prevalence of MetS components. BMI: Body Mass Index; WC: Waist Circumference; HDL: High Density Lipoprotein; TG: Triglycerides; FPG: Fasting Plasma Glucose; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.*

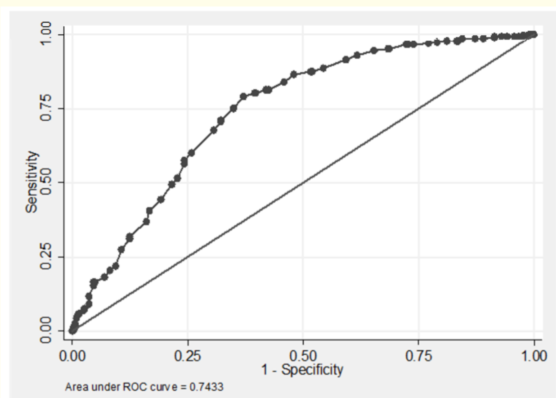

Figure 1: *ROC curve for WC as a MetS predictor among males (presence of at least two MetS risk factors, as defined by the International Diabetes Federation).*

Among females, the optimal WC cut-off point was 86.5 cm, with a 76.82% sensitivity and 73.43% specificity (AUC = 0.79, 95%CI

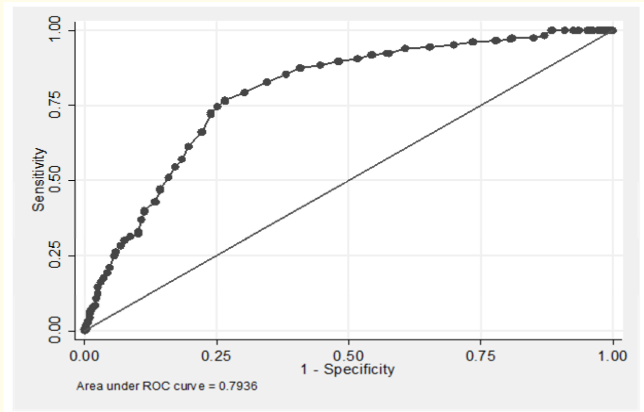

Figure 2: *ROC curve for WC as a MetS predictor in females (presence of at least two MetS risk factors, as defined by the International Diabetes Federation).*

= 0.76 - 0.72) (Figure 2).

Prevalence of MetS in the study population

Using the IDF criteria for defining MetS, the prevalence of the latter was 28% in the total sample, with males having a higher prevalence (37.2%) compared to females (22.2%) when the traditional WC cut-off was used (WC ≥ 94 cm for Europid men and ≥ 80cm for Europid

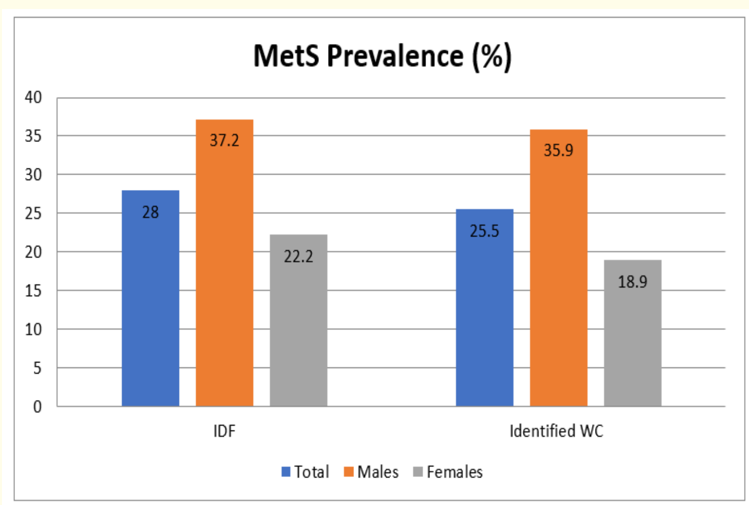

Figure 3: *MetS Prevalence using IDF WC cut-off and the Identified WC cut-off.*

women). In contrast, the MetS prevalence dropped to 25.5% in the total sample, with 35.9% among males and 18.9% among females after using the identified WC cut-off (WC ≥ 95 cm for men and ≥ 86.5 cm for women) (Figure 3).

Discussion and Conclusion

The results of this study show that the optimal WC cut-off point for detecting at least two other MetS components, as per the IDF definition [19], was 95 cm for men and 86.5 cm for women. These cut-offs are different from the ones set by the IDF. Accordingly, MetS prevalence differed. When the traditional WC cut-off set by the IDF was used, MetS prevalence was 28% in the total sample; 37.2% in males and 22.2% in females. This prevalence dropped when the identified WC cut-off was used, where it became 25.5% in the total sample; 35.9% in males and 18.9% in females. In both cut-offs, MetS prevalence was higher in males compared to females.

In a study conducted in Iraq, the WC cut-off point was found to be 97 cm for males and 99 cm for females [17], which is different than the cut-offs identified in this study. In another study conducted in Iran, the cut-offs were also different, where it was 89 cm for males and 91 cm for females [16]. The same discordance was observed in a study conducted in Tunisia, where the identified waist circumference was 85 cm for both males and females [18]. In the first two studies [16,17], the WC cut-off for females was bigger than that for males, which is in discordance with our findings since the identified WC cut-off was bigger for males than for females.

Regarding MetS prevalence, it was higher in males than in females using both the traditional and identified WC cut-offs. These results were different from findings of other studies conducted in the region, where females had higher MetS prevalence than males [16,17,21-23].

Limitations of this study include the convenient sampling method, which affects the generalizability of this study's results.

Still, Al-Assad hospital is a big public hospital where Syrians from different areas and cities go to. Also, the ROC curve analysis gave significant and strong results, as both the sensitivity and specificity were high in both genders, as well as the AUC. Worthy to mention were the strict inclusion criteria to ensure participants were healthy. In addition, this is, to the best of our knowledge, one of the few studies among Arab countries and also in the MENA region to try to identify the optimal WC cut-off points.

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