

Clinical research

Waist circumference cutoff points for predicting metabolic abnormalities in Lebanese adults

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Abstract

Introduction: Central obesity, as measured by waist circumference, performs differently across diverse localities, and there is a need to optimize gender-based cutoff points to specific ethnic and population groups.

Material and methods: A total of 1,528 asymptomatic individuals free from cardiac disease aged 40 years and above and attending 25 primary health care centers distributed over the entire Lebanese territory were recruited for a cardiovascular risk screening service implemented by the Ministry of Public Health in 2012. Using receiver operating characteristics curve analyses, we evaluated different waist circumference cutoff points for the optimal combination of sensitivity and specificity that distinguish men and women with concomitant presence of impaired blood sugar and hypertension.

Results: The optimal waist circumference cutoffs for prediction of the outcome were 98.5 cm in men and 91.5 cm in women, yielding better predictive characteristics than those recommended by the International Diabetes Federation (IDF). Based on the study values, the prevalence rates of central obesity in our sample (36.2% in males and 40.2% in females) were lower than those estimated using the IDF cutoff values (55.2% and 79.7%, respectively).

Conclusions: Findings from this first examination of optimal central obesity cutoff points in Lebanon confirm the need for nation-wide studies with more inclusive cardio-metabolic outcomes for the development of appropriate screening protocols.

Key words: central obesity, waist circumference, Lebanon, cutoff points.

Introduction

Cardiovascular diseases (CVD) are the leading cause of morbidity and mortality worldwide and are a major barrier to sustainable human development [1]. Countries with the greatest number of CVD deaths, after accounting for population size, are found throughout the developing world including the Eastern Mediterranean region [2]. Early detection and timely management of CVD risk factors is the cornerstone in the prevention of CVD and for reducing associated health care costs. Among these risk factors, central or abdominal obesity, as measured by waist circumference, is gaining popularity as a key risk factor for CVD. Waist circumference (WC) is a consistent component of all metabolic syndrome definitions [3, 4] and a significant predictor of obesity-related metabolic factors [5–7].

It is also emerging as a more powerful determinant than body mass index for cardiovascular prognosis in studies conducted worldwide, including developed and developing countries [8].

Measuring WC is a simple procedure limited to the measurement of waistline using an elementary tailor tape and requires minimal training. Also, it entails minimal cost, does not require medical qualification or any kind of calculation or technological infrastructure, and can therefore be used for cardiovascular risk assessment in routine clinical practice or mass screening at any health encounter and at the population level [9, 10].

As with other anthropometric indices, WC measurement performs differently across diverse localities and population groups [11, 12] and cannot be useful as a predictor of cardiovascular risk if not optimized to specific ethnic groups and geographical areas [5]. The International Diabetes Federation (IDF) and the World Health Organization (WHO) recommend the use of ethnic specific cutoffs for WC measurement in metabolic syndrome to define a threshold for central obesity [4, 13]. However, in the absence of enough evidence for the Arab population, the IDF and WHO recommend the use of the European definition of central obesity set at WC \geq 94 cm for men and WC \geq 80 cm for women [3, 13].

Consequently, researchers from the Arab region have been increasingly engaged in studies that aim at defining optimal WC cutoff points appropriate to their populations. In these studies, the cutoff points have varied among men between 80 cm in Oman [14] and 100.5 cm in Egypt [15], and among women between 84.5 cm in Oman [14] and 96.2 cm in Iran and Egypt [15, 16]. While these studies were not always comparable because of the use of different outcome measures against which the WC cutoff points were optimized and owing to the various age groups targeted in the study population, the findings elicited a set of concerns. These revolved around the applicability of the European WC cutoffs to the Arab population considering two arguments: firstly, almost none of the studies obtained WC cutoffs that were comparable to the recommended European ones, and secondly, the cutoff points obtained were varied, suggesting that the region is non-homogeneous with regard to average population values of WC.

Using data from a large database drawn from a cardiovascular risk screening intervention conducted in primary care centers in Lebanon, this study was set with the goal of optimizing the use of WC measurements in screening protocols in the country. It aimed at identifying the optimal WC cutoff points that best discriminate otherwise healthy men and women presenting concomitantly with impaired blood sugar and elevated blood

pressure. Findings from this study are of significance to warrant the assessment of optimal WC cutoff points in nationally representative community-based populations for assessment of cardiovascular risk.

Material and methods

Study subjects

This study is based on secondary analysis of data generated as part of a screening service implemented by the Lebanese Ministry of Public Health in 2012 in 25 primary health care centers distributed over the entire Lebanese territory. The detailed description of the study design, conduct and the preliminary results are reported elsewhere [17]. In brief, the screening served 5,875 beneficiaries and included questions and direct measurements to assess six significant cardiovascular risk factors (random blood sugar (RBS), blood pressure (BP), smoking status, family history of premature CVD, body mass index (BMI), and WC), along with age, sex, education, work status and residence. Fieldwork and assessments were undertaken by 72 trained non-physician health workers working at the respective centers.

The beneficiaries of the program were recruited purposefully with close to two-thirds of them being recruited while attending the health center for services not related to chronic conditions ($n = 3,555$; 60.5%). The remaining subjects underwent the screening protocol in their residence through home visits performed by the health workers. For the parameters included in this study, the protocol was thoroughly identical in both settings. For the objectives of this study, a total of 1,528 records were retained for the analysis. These belonged to individuals fasting for > 8 h, aged 40 years and above, with no prior history of diabetes, hypertension, dyslipidemia or documented CVD, and with no missing data for variables pertinent to the study (fasting blood sugar (FBS) testing, BP, BMI and WC measurements reports).

Variables and measurements

The outcome variable was defined as the concomitant presence of two metabolic abnormalities: impaired sugar metabolism defined as FBS > 110 mg/dl and raised blood pressure defined as BP $> 135/85$ mm Hg. Fasting participants were screened for RBS through a standardized finger glucometer, while blood pressure was measured in the right arm, using a standardized digital sphygmomanometer. WC was measured at the point midway between the lower rib and the iliac crest, using a regular tape. Central obesity was then defined according to the IDF categorization (WC \geq 94 cm in men and \geq 80 cm in women), and

according to the optimal WC cutoffs as obtained from subsequent analysis of the receiver operator characteristic (ROC) curve.

Ethical approval

De-identified clinical data were retrieved from the health information system of the Primary Health Care (PHC) department at the Ministry of Public Health.

Statistical analysis

Continuous variables were reported as means and standard deviations (SD), and comparisons across groups were carried out using the independent samples *t*-test. Categorical variables were summarized using frequencies and proportions and were compared using the χ^2 test. All data were presented for men and women separately. The ROC curve was plotted between the test variable (WC) and the state variable (metabolic outcome) to determine the optimal WC cutoff, which is the point on the ROC curve closest to the upper left corner with optimal sensitivity and specificity. The overall performance of the different measures

of central obesity against metabolic outcome was assessed using the κ statistic, and calculation of sensitivity, specificity and Youden's index were retrieved from simple two-by-two tables between the dichotomized central obesity variables. The software IBM SPSS Statistics v. 20 was used for all analyses, and the level of significance was set at $\alpha < 0.05$.

Results

Sample characteristics

The sample consisted of 536 (35%) men and 992 (65%) women with a similar mean age of around 51 years for both sexes (Table I). The mean WC was 95.1 cm in men and 90.3 cm in women. While mean FBS levels and proportion of impaired blood sugar were comparable in men and women ($p = 0.861$ and $p = 0.850$, respectively), mean systolic (125 mm Hg vs. 121 mm Hg, respectively; $p < 0.001$) and diastolic (78 mm Hg vs. 76 mm Hg, respectively; $p < 0.01$) blood pressure as well as proportion of hypertension (28.9% vs. 22.5%; $p = 0.012$) were significantly higher in men compared to women. Overall, 4.3% had metabolic outcome,

Table I. Baseline study sample characteristics

Parameter	Men (n = 536)		Women (n = 992)		Total (N = 1528)		P-value*
	Mean	SD	Mean	SD	Mean	SD	
Age [years]	51.5	9.5	51.2	9.7	51.3	9.6	0.472
WC [cm]	95.1	11.5	90.3	11.7	-	-	-
FBS [mg/dl]	99.2	19.0	99.0	19.8	99.0	19.5	0.861
SBP [mm Hg]	125.1	14.6	121.4	14.6	122.7	14.7	< 0.001
DBP [mm Hg]	78.0	9.5	75.8	9.9	76.5	9.8	< 0.001
Parameter	n	%	n	%	N	%	P-value*
Impaired blood sugar (FBS > 110 mg/dl)	54	10.1	103	10.4	157	10.3	0.850
Hypertension (BP > 135/85 mm Hg)	155	28.9	223	22.5	378	24.7	0.012
Metabolic outcome (elevated FBS and BP)	24	4.5	41	4.1	65	4.3	0.753

WC – waist circumference, FBS – fasting blood sugar, SBP – systolic blood pressure, DBP – diastolic blood pressure, BP – blood pressure. *P-values obtained using *t*-test and χ^2 test for continuous and categorical variables, respectively.

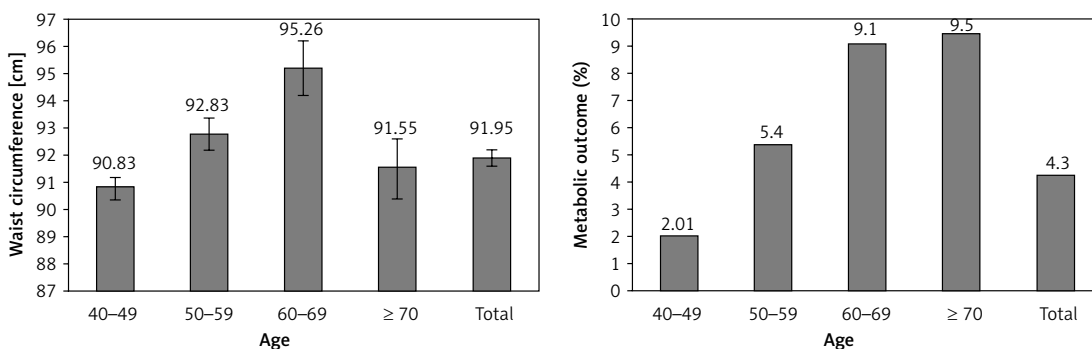


Figure 1. Mean waist circumference and metabolic outcome by age

defined here as elevated FBS and BP. Whereas metabolic outcome increased consistently with age, mean WC value was highest in the age group 60–69 years and decreased thereafter (Figure 1).

ROC curve analysis and predictive characteristics

The ROC curve was plotted to determine the discriminative values of WC that best predicts

metabolic outcome for men and women, separately. The areas under the curve (AUC) showed a fair outcome for both sexes, slightly better for men (AUC = 0.763; 95% CI: 0.670–0.856) than for women (AUC = 0.669; 95% CI: 0.589–0.748) (Figure 2). The closest data point to the upper left corner of the data plot corresponded to the cutoff points 98.5 cm for men and 91.5 cm for women, defining the optimal WC cutoffs of central obesity. These

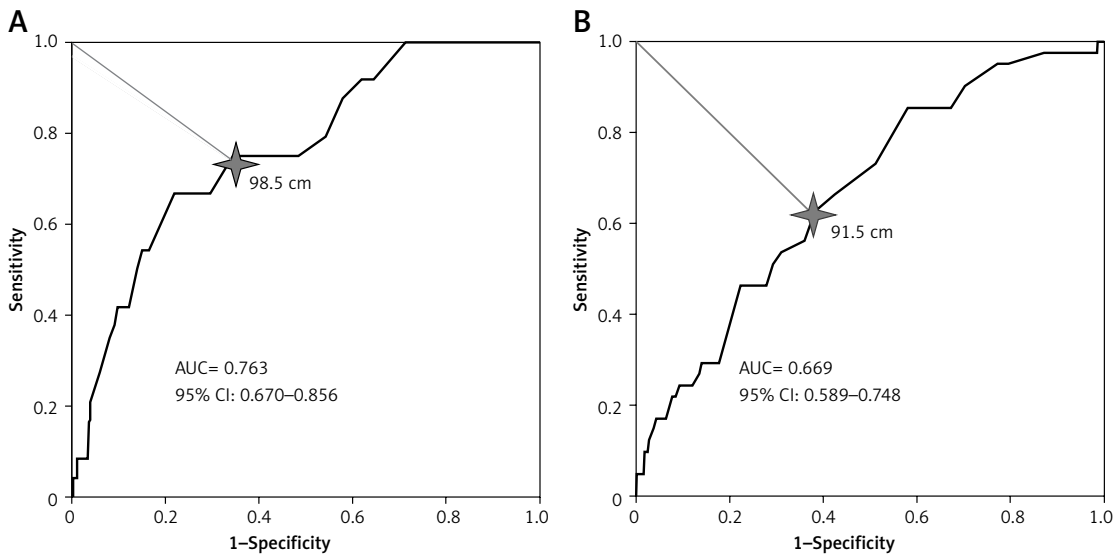


Figure 2. ROC curves testing waist circumference levels against cardiovascular outcome indexed as the detection of concomitant presence of raised FBS and hypertension during screening (A – men, B – women)

AUC – area under the curve; CI – confidence interval.

Table II. Comparative predictive characteristics of central obesity defined by International Diabetes Federation and by new cutoff points as established by study findings, against metabolic outcome

Classification of central obesity	Sample prevalence of central obesity (%)	Predictive characteristics of central obesity against metabolic outcome								
		TP (n)	FN (n)	TN (n)	FP (n)	Sensitivity (%)	Specificity (%)	J	κ	P-value *
Men (n = 536):										
IDF recommended (WC ≥ 94 cm)	55.20	19	5	235	277	79.20	45.90	0.25	0.039	0.01
Study-based recommendation (WC ≥ 99 cm)	36.20	18	6	336	176	75.00	65.60	0.41	0.093	< 0.001
Women (n = 992):										
IDF recommended (WC ≥ 80 cm)	79.70	39	2	199	752	95.10	20.90	0.16	0.016	0.01
Study-based recommendation (WC ≥ 92 cm)	40.20	26	15	578	373	63.40	60.80	0.24	0.047	< 0.001
Men and women (N = 1,528):										
IDF recommended	71.10	58	7	434	1029	89.20	29.70	0.19	0.022	< 0.001
Study-based recommendation	38.80	44	21	914	549	67.70	62.50	0.3	0.062	< 0.001

TP – true positive, FN – false negative, TN – true negative, FP – false positive, J – Youden index. *P-value of the κtest between central obesity classified by IDF and newly defined cutoff points and the outcome variables.

Table III. Waist circumference optimal cutoff points deriving from selected studies conducted in the Eastern Mediterranean Region during the last decade (listed in increasing order of optimal WC cutoff points)

Authors [ref no.]	Year of publication	Location	Sampling	Sample size	CV pathology (state variable)	Optimal WC cutoff points	
						Men	Women
Al-Lawati and Jousilahti [14]	2008	Oman, Nizwa	Community-based	1,421 aged ≥ 20 y	Any 2 of the three disorders (hyperglycemia, hypertension, and dyslipidemia)	80.0	84.5
Khader <i>et al.</i> [22]	2010	Jordan	Community-based	4,590 aged > 18 y	Metabolic abnormalities (hypertension, high triglyceride, low HDL, and high FBS)	88.5/91.8	84.5/88.5
Delavari <i>et al.</i> [23]	2009	Iran, 30 provinces	Community-based	3,024 aged 25–64 y	At least 2 components of MetS	89.0	91.0
Gharipour <i>et al.</i> [24]	2013	Iran, Isfahan, Arak, and Najafabad	Community-based	468 aged ≥ 35 y	MetS	90.3	90.0
Esteghamati <i>et al.</i> [25]	2008	Iran, Tehran	Facility based	2,752 aged 18–80 y	Any 2 components of MetS	91.5	85.5
Al-Rubean <i>et al.</i> [26]	2017	Saudi Arabia, 13 regions	Community-based	12,126 aged ≥ 18 y	MetS	92.0	87.0
Mansour and Al-Jazairi [27]	2007	Iraq, Basrah	Community-based	12,986 aged ≥ 18 y	Diabetes and hypertension	90.0/95.0	91.0/95.0
Ibrahim <i>et al.</i> [28]	2011	Egypt	Community-based	2,313 aged ≥ 25 y	Any cardio-metabolic factor	93.5	91.5/92.5
Nadeem <i>et al.</i> [29]	2013	Pakistan, Rawalpindi	Facility based	209 aged 28–73 y	Insulin resistance	94.37	95.5
Bener <i>et al.</i> [30]	2013	Qatar	Facility based	1,552 aged > 20 y	MetS	99.5	91.0
This study Lebanon	2019	Lebanon	Facility based	1,528 aged ≥ 40 y	Raised FBS and elevated blood pressure	99.0	92.0
Assaad-Khalil <i>et al.</i> [15]	2015	Egypt, Alexandria	Community-based	3,209 age 18–80 y	At least 2 components of MetS	100.5	96.25

cutoff points yielded a sensitivity and a specificity of 75% and 65.6% respectively, in men, and 63.4% and 60.8% respectively, in women (Table II). When these cutoff points were used to define central obesity, the prevalence of central obesity was estimated at 38.8% (36.2% among men and 40.2% among women) and was lower than that estimated based on the IDF criteria (71.1% for the total sample, 55.2% among men and 79.7% among women). Furthermore, Youden index and κ coefficient values were larger and superior when central obesity was defined by the study cutoff points than when they were defined according to the IDF recommendations.

Discussion

Using estimates from a large database generated as part of a screening program implemented in 25 health centers widespread in the entire Lebanese territory, this study proposes new cutoff points for WC for asymptomatic men (98.5 cm) and women (91.5 cm) aged 40 years and over. Compared to those recommended by the IDF for the region, the WC cutoffs identified through this study were higher by 4.5 cm and 11.5 cm, for men and women, respectively, and had better discriminatory power to characterize individuals with metabolic outcome. Moreover, the obtained difference between sexes was narrower than that of the IDF criterion (7 cm as compared to 14 cm, respectively). The WC cutoff points recommended in our study seemed to provide a less inflated estimate of the prevalence of central obesity than that of the IDF and may be more appropriate to use for screening among the Lebanese population for risk of CVD.

Country-specific variations in the optimal cutoff point in the WC have also been seen in studies from the region and outside, such as India [18], South Africa [19], Spain [20], and Turkey [21]. Table III and Figure 3 reproduce data generated from

studies conducted in the Eastern Mediterranean Region during the past decade. These findings show that WC measurement is ethnically and geographically specific and cutoff points cannot be extrapolated from one context to the other. Furthermore, and in contrast to the IDF cut-off points, differentials between men and women appeared to be narrower (range: 0.3–8 cm vs. 14 cm in IDF), with several countries tolerating higher values of normal WC in women.

This study is the first to examine the WC cutoff points within the Lebanese context, yet the findings need to be considered with caution. Firstly, the study subjects included participants attending primary health care centers, and the sample was recruited based on non-probability purposive sampling; hence, the findings may not be representative of the total population. Secondly, data on lipid measurements were not available, thus limiting our choice of the metabolic outcome measure to blood pressure and FBS impairments. The lack of data on the study subjects' lipid profile poses another limitation in this study, and future studies need to examine the prognostic characteristics of central obesity and WC cut-off points in relation to the different components of lipid impairment in the Lebanese population. This is of crucial importance because dyslipidemia is among the significant risk factors for ischemic heart diseases and lipid profile testing is an expensive procedure, which limits its use in population-wide screening. Finally, whilst participants in the study were restricted to individuals aged 40 years and over, representing the age group at highest risk for diabetes and hypertension, younger age groups can present metabolic impairments as well, and would benefit from further optimization studies of WC cutoff points to define their central obesity status.

In conclusion, to date, available evidence on the prevalence of metabolic syndrome in Lebanon has been limited to the use of internationally de-

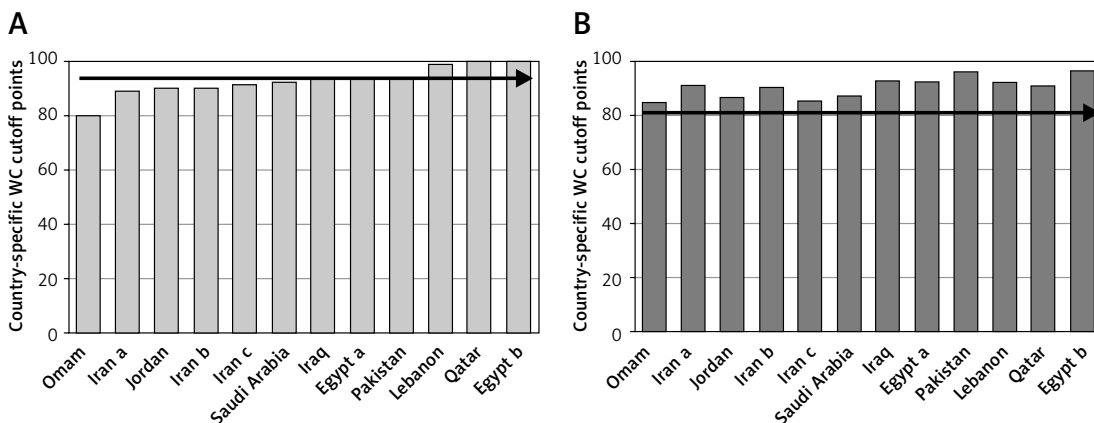


Figure 3. Optimal cutoff points as defined in countries of the region during the last decade (A – men, B – women). The horizontal lines represent the IDF recommended values

defined cutoff criteria for WC (IDF or Adult Treatment Panel (ATP)). Findings from this study show that the IDF default WC cutoff points recommended by WHO for the region may be inappropriate for the Lebanese population. We identified new cutoffs for predisposition to CVD risk indexed as the concomitant presence of raised blood sugar and hypertension in otherwise healthy individuals. Further studies are needed to examine optimal WC cut-off points at the population level and on a nationally representative sample with outcomes that include lipid impairments and enhanced assessment of cardiometabolic risk factors.

Conflict of interest

The authors declare no conflict of interest.

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