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Research Article

Efficiency of Anthropometric Indices in Predicting Metabolic Syndrome among Adult Population of Ahvaz, Iran

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Abstract

The objective of the present study was to evaluate the efficiency of physical indices of waist circumference, waist-height ratio, and waist to the hip ratio in predicting risk of metabolic syndrome among Ahvazian adults. A cross sectional study was performed using random cluster sampling method on 944 subjects (446 men and 498 women, aged 44.2±14.2 and 40.5±13.5 years respectively) from 55 households per health centre in Ahvaz, Iran. Data were analyzed using statistical program SPSS version 19 and state version 12. The overall prevalence of metabolic syndrome was found to be 21.8% among all the subjects (28.9 % in women and 14% in men). WC cut off points for prediction of metabolic syndrome among Ahvazian men and women were found to be 91.5 and 85.5 cm respectively. The present study demonstrated that WC is a preferred index with highest sensitivity with value of 61.4 and specificity value of 61.1 in predicting MetS and its associated components among men. While WhtR, followed by WC with sensitivity of 67.4 and 65.8 specificity value of 67.1 and 65.5 have more discriminating power for predicting MetS and its associated components among women.

Keywords: Metabolic syndrome (MetS); Waist circumference (WC); Waist-to-height ratio (WhtR); Waist to the hip ratio (WhpR); ROC curve.

Introduction

Metabolic syndrome (MetS) is a cluster of interrelated risk factors of metabolic origin such as obesity, high serum triglyceride (TG), elevated blood pressure (BP), low serum high density lipids (HDL), and high fasting blood sugar (FBS) [1]. These factors are linked to development of atherosclerotic cardiovascular diseases and type 2 diabetes mellitus. Among these factors, obesity is considered as an easily assessable and cost effective criterion for predicting the development of MetS and other cardiovascular risk factors [2].

Obesity is a growing health problem in developed and developing countries. The World Health Organization (WHO) has defined obesity as a disease [3]. Anthropometric indices such as waist circumference (WC), waist-to-height (WhtR), waist-to-hip (WhpR), and body mass index (BMI) are studied as indicators of obesity and ultimately, a way of predicting MetS [4].

The criteria for the diagnosis of MetS have been discussed in recent years. Hypertension, dyslipidemia (high TG or low HDL levels), high fasting glucose, and abdominal obesity are considered as components of MetS [5]. Currently, various definitions for MetS are introduced by the WHO (4), International Diabetes Federation (IDF), and Adult Treatment Panel (ATP III) [6, 7]. The American Heart Association (AHA), and the National Heart, Lung and Blood Institute (NHLBI) [8]. Meanwhile, IDF has introduced a definition for MetS that takes ethnic differences into account which implies that regional and ethnic cut-off values should be used instead of global definitions of obesity [9] (5). Ethnic specific values for WC have been proposed which show variable values, ranging from 80 to 94 cm. the general trend of these values show that females from different ethnic groups were lower than male counterparts (RR)?. ATP III has come in line with IDF for considering WC as a component for inclusion criteria in the definition of MetS. Meanwhile various reports have been

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presented in which several other indicators have been provided for evaluating central obesity [10]. WhtR, and WhpR are instances of such new indicators; and it has been argued that these indicators are more efficient than WC [11].

Iran is a large country covering 1,648,195 km2, with more than 78 million population and more than 12 ethnic groups. Previous studies in Esfhan (Isfahan Cohort Study) have shown that the WC and WHtR were better indictors for predicting MetS in women and WC and BMI for men. The cut-off points for WC in both sexes were almost equal with a value of 90.3 and 90 for men and women respectively. However, the optimal cut-off points for all the three parameters increased with age in both genders [12]. On the other hand, different studies from other areas of the world reported different cut-off points for WC. For example the cut-off point for men in Oman , Iraq and Korea [13-15] were 80, 97and 90 cm, respectively, and 84.5, 99, and 85 cm, respectively, in women. Put together, these data suggest that in order to determine the most approperiate anthropometric index which can most efficiently identify the risk for developing MetS for a given ethnic and racial group in a geographical location is different. On the other hand, no data on these parameters have been found regarding the cut off value among Ahvazian adults, with mainly Arab, Lurs and Fars ethnic background in southwestern Iran. In the present study, therefore, the cut off points of WC, WhtR, and WhpR in our region will be determined; and their efficiency in the diagnosis of MetS among men and women population in this part of Iran will be evaluated.

Subjects and Methods

This cross sectional study is performed through cluster sampling method in 6 health centers in Ahvaz. Fifty five households were randomly selected from each center and each household three persons over 20 years of age were randomly studied. After obtaining informed consent from the participants, they were invited to participate in the study. A questionnaire which asks the participants for their age, sex, their previous history of diabetes (DM), hypertension and hyperlipidemia was handed to them to fill. Fasting blood samples (HDL, TG, FPG which were measured in Diabetes Center Laboratory, Ahvaz, Jundishapur University of Medical Sciences), weight, height, BMI and systolic and diastolic blood pressure (measured after 15 minutes of rest in sitting position). Anthropometric measurements were taken with participants in thin clothing and with no shoes. Weight and height were measured according to the standard method. WC was measured at the mid-point between the lowest rib and the upper lateral border of the right iliac crest and the hip circumference ad the point of maximum hip diameter. Metabolic syndrome was defined by at least three of the following 5 components: (according to the ATPIII criteria, update 2005) (Grundy 12, 13): Waist circumference ≥ 102 cm in men and ≥88 cm in women; TG≥ 150 mg/dl or a history of drug consumption for hyper-triglyceridemia; HDL ≤ 40 mg/dl in men and ≤ 50 mg/dl in women or a history of drug consumption; BP ≥ 130/85 mmHg or a history of anti-hypertensive drug consumption; and FBS ≥ 100 mg/dl, or a history of diabetes mellitus or consumption of anti-diabetes drugs.

Data analysis

Receiver operation characteristic (ROC) curve was used to determine the cut-off points of the indices; ROC curve is drawn using the true positive (sensitivity) against false positive (1-specificity) axis to determine the optimum. ROC analysis is used to evaluate the accuracy of a diagnostic test by summarizing the potential of the test to discriminate between absence and presence of an abnormality (14). Cut -off point for MetS is the highest and the leftmost point of the ROC curve, which is the closest to both maximum sensitivity and maximum specificity values.

The area under the ROC curves (AUC) was used to assess the diagnostic accuracy of each index and is compared across genders. J is the maximum vertical distance or difference between the ROC curve and the diagonal line (reference line). This index ranges between 0 and 1, with values close to 1 indicating that the biomarker's effectiveness is relatively high and values close to 0 indicating limited effectiveness [16]. An AUC of 1 was considered to have perfect discriminatory power, and an AUC of 0.5 indicated the predicting performance of no better than sheer chance. An AUC of 0.6 - 0.7 was considered poor and 0.7 - 08 was considered fair [17].

Results

The participants in the study were 944 individuals (446 men (47.2%) and 498 women (52.8%)]. Table 1 shows anthropometric specifications and laboratory results of the participants. The average age for the men and women participants were 44.2 ±14.2 and 40.5±13.5 years respectively. The prevalence of MetS was found to be 14% among the male participants and 28.9% among the females. There was a significant correlation between prevalence MetS on the one hand, and WhtR (r=045) and WC (r= 0.4) on the other. WhtR was more strongly correlated with the prevalence of MetS than WC in women (Figures 1 and 2).

Table 1:

Parameter	Men (n= 446)	Women (n= 498)
Age	44.2 ± 14.2	40.5 ± 13.5
BMI (kg/m)	26.2 ± 3.9	27.7 ± 5.2
WC (cm)	90.8 ±10.7	85 ± 12.3
WC-height (cm/cm)	0.52 ± 0.06	0.53 ± 0.08
WC/hip (cm/cm)	0.95 ± 0.05	0.88 ± 0.07
FBS (mg/dl)	109 ± 46.5	103.4 ± 40.1
TG (mg/dl)	153 (108-220)	103 (89-182.2)
HDL mg/dl	53.1 ± 11.2	61.1 ± 12.6
Systolic BP mmHg	116.2 ± 20.6	114 ± 21.4
Diastolic BP (mmHg)	72.4 ± 15.2	70.1 ± 15.3

The chi -square test showed a statistically significant difference between AUC of the three measured indices for women (P=0.03) but not for men (P=0.71) (Figure 3 and 4). However, among these three indices in women, no significant differences between WC and WhtR was found , while between WC and WhtR relative to WhpR were significantly different (P<0.0097) respectively Table 2.

The cut-off point of WC using ROC curve was calculated to be 91.5 cm for the male participants and 85.5 for the females.

For the male participants the sensitivity and specificity of WC

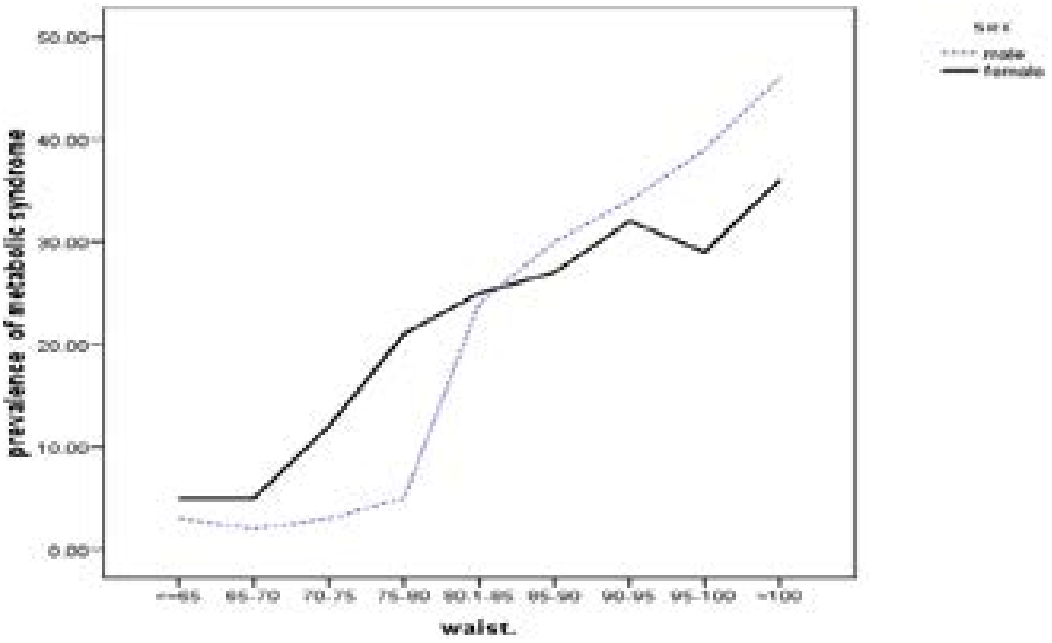

Figure 1: Chart of Prevalence of metabolic syndrome according to Waist and sex.

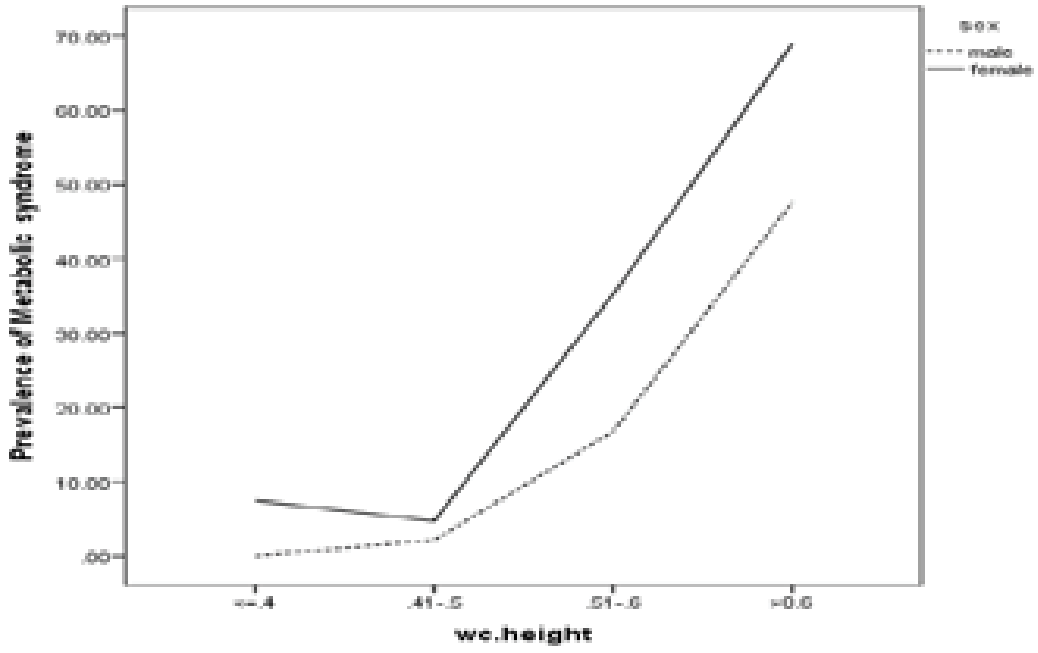

Figure 2: Chart of Prevalence of metabolic syndrome according to Waist to height and sex..

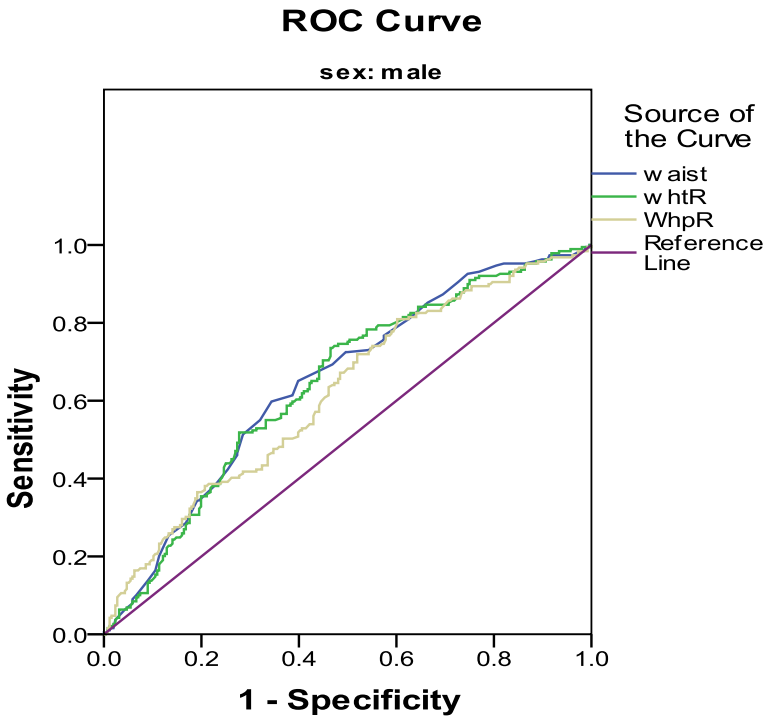

Figure 3: Receiver operation curve (ROC) for MetS against anthropometric indices (Waist Circumference, Waist /Height and Waist/Hip Ratios) for men and women.

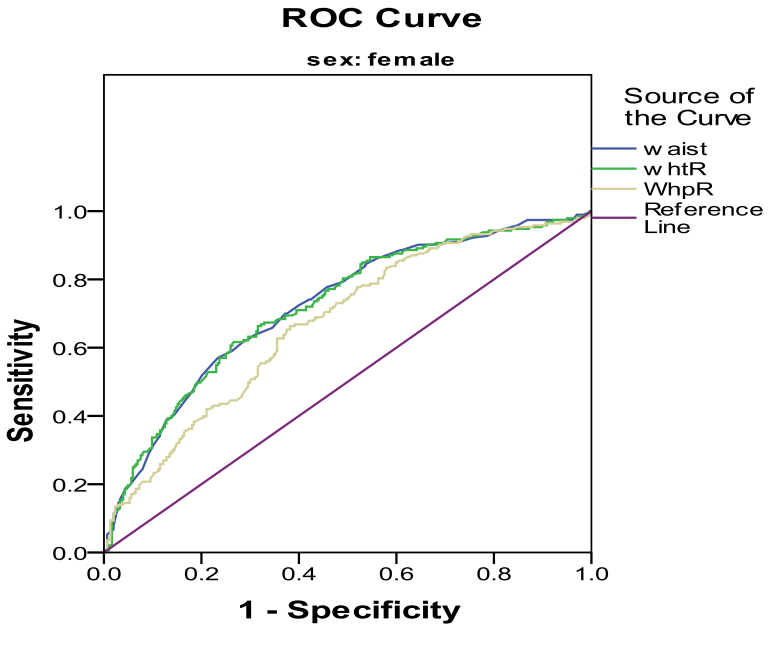

Figure 4: Receiver operation curve (ROC) for MetS against anthropometric indices (Waist Circumference, Waist /Height and Waist/Hip Ratios) for men and women.

Table 2: Area under the curve (AUC), opitimal cutt-off points, and validity parameters of different obesity indices in predicting MetS and different metabolic and cardiovascular paramets in Ahvazian men population (n=446)

Parameter	Obesity Index	Cut of point	AUC (95% C.I.)	Sensitivity	Specificity
TG	WC	90.5	0.67 (0.63 - 0.72)	0.65	0.65
	Whtr	0.54	0.67 (0.62 - 0.72)	0.66	0.66
	Whpr	0.82	0.62 (0.58 - 0.68)	0.63	0.63
B.P.	WC	93.5	0.67 (0.59 - 0.74)	0.65	0.62
	Whtr	0.54	0.71 (0.65 - 0.78)	0.65	0.65
	Whpr	0.91	0.69 (0.62 - 0.77)	0.65	0.64
Low HDL	WC	91.5	0.55 (0.48 - 0.61)	0.55	0.54
	Whtr	0.53	0.52 (0.46 - 0.58)	0.53	0.52
	Whpr	0.89	0.52 (0.46 - 0.58)	0.5	0.51
FBS	WC	91.5	0.58 (0.53 - 0.64)	0.55	0.56
	Whtr	0.53	0.59 (0.53 - 0.64)	0.56	0.55
	Whpr	0.89	0.57 (0.51 - 0.62)	0.56	0.55
METS	WC	91.5	0.65 (0.60-0.70)	0.61	0.61
	Whtr	0.53	0.64 (0.58-0.69)	0.6	0.6
	Whpr	0.89	0.62 (0.57-0.67)	0.57	0.57

cut-off point were found to be 61.1 %. For the female participants the WC sensitivity and specificity were equal with a value of 65.5% and 65.8%. While AUC was found to be poor for men and fair for women Table 3.

The cutoff point of WhtR with ROC curve was found to be 0.53 for males and 0.54 for the females. Sensitivity and specificity cut-off point of WhtR were found to be 60% for men and 67.4% and 67.1% for women. The AUC value was found to be poor for men and fair for women. For men participants, the cut-off point of WhpR was 0.89 with a sensitivity of 57% and a specificity of 56.6%.

Table 3: Area under the curve (AUC), optimal cut-off points, and validity parameters of different obesity indices in predicting MetS and different metabolic and cardiovascular parameters in women population (n=498).

Parameter	Index	Cut of point	AUC (95% C.I.)	Sensitivity Specificity
TG	WC	85.5	0.73 (0.68 - 0.78)	0.67 0.63
	Whtr	0.55	0.72 (0.68 - 0.77)	0.66 0.66
	Whpr	0.82	0.68 (0.63 - 0.73)	0.64 0.63
B.P.	WC	87.5	0.69 (0.63 - 0.75)	0.67 0.63
	Whtr	0.56	0.71 (0.63 - 0.76)	0.66
	Whpr	0.82	0.66 (0.60 - 0.73)	0.61 0.61
Low HDL	WC	84.75	0.55 (0.50 - 0.60)	0.54 0.54
	Whtr	0.53	0.53 (0.48 - 0.58)	0.54 0.53
	Whpr	0.81	0.56 (0.51 - 0.61)	0.55 0.55
FBS	WC	85.5	0.66 (0.61 - 0.71)	
	Whtr	0.54	0.67 (0.61 - 0.72)	0.64 0.63
	Whpr	0.82	0.62 (0.57-0.68)	0.60 0.61
METS	WC	85.5	0.72 (0.68- 0.77)	65.8 65.5
	Whtr	0.54	0.72 (0.67-0.76)	67.4 67.1
	Whpr	0.82	0.67 (62.3-71.9)	63.7 62.8

For the women participants the cut-off point of WhpR was 0.82 with sensitivity and specificity of 63.7% and 62.8% respectively. The AUC for males and females were 62% and 67% respectively (poor for both genders). Among the three indices measured for each of the four mets parameters, WHtR for BP was found to have fair predictability value in both men and Women. Also, WHTR and WC values for TG were found to be fair in women.

Discussion

In this cross-sectional study which was carried out among Ahvazian adult population aged above 20 years, the overall prevalence of MetS was 22.8 and 15.9 % in men and women respectively. In addition, among the anthropometric indices, WC seems to be a better predictor of MetS in men. While WHtR was found to be a more suitable index for discriminating MetS in women. The optimal cut-off value for WC to predict MetS among men and women were 91.5 and 85.5 cm respectively. On the other hand, WHtR and WHpR were 0.53 and 0.54, and 0.81 and 0.816 in men and women respectively.

It is widely accepted that in different population different anthropometric indices are found superior in predicting MetS, cardiovascular and diabetes. A recent cross-sectional survey, carried out among Qatari adult population, found WC at a cut-off value of 99.5 cm in men and 91 cm was the best predictor of MetS [18]. A similar study among Esfahanian adults in Iran [19] also WC was the preferred index in both men and women with a cut-off value of 90 and 90.3 cm respectively. On the other hand, the results from a study carried out on Korean adults [20], WHpR was selected as a better predictor of multiple metabolic risk factors than WC, WHtR and BMI. Furthermore, an INTERHEART study among a large cohort of primary care patients reported WHtR as a better predictor of metabolic risk factors except

hypertension as compared to other obesity indices, while interestingly BMI was found to be the better predictor of hypertension alone as compared to other obesity measurements [21]. Put together, these results support the prevailing notion that the power of predication of each of the obesity indices differ among different ethnic communities and the type of various MetS components risk factor under question.

Previous studies on different ethnic populations have shown that, relative to other obesity indices, BMI has a poor discriminating power for predicting MetS. The underlying reason for this has been attributed to not considering the association between body fat distribution and lean body muscle mass [22]. In the present study, we did not use BMI for prediction of MetS among our subjects. One the other hand, WC has been considered as a better predictor of MetS and cardiovascular risk factors, on the ground that it is strongly associated with increased abdominal fat distribution. However, this view is not universally accepted criterion [23]. It was argued that WC alone can produce an overestimation of risk for MetS in tall subjects and an underestimation in short ones. Therefore, WHtR was proposed as a better predictor for assessment of abdominal obesity [24].

In the present study, among the selected obesity indices, WC at a cut-off point value of 91.5 cm had the highest sensitivity of 61.4 % to predict the development of MetS in men. When we applied the recommended ATPIII criterion of WC cut-off value of 102 cm for men, the sensitivity to discriminate MetS dropped to 20 %. A similar evaluation among Qatari population the sensitivity of WC was found to drop from 81.6 to 75.9 % (18). On the other hand, in our present study, with WC cut-off point value of 88.5 cm for women had the highest sensitivity value of 67.4 in predicting the development of MetS. When similar evaluations on the sensitivity were applied on the basis of ATPIII criteria, the sensitivity was reduced to 62 %. This finding suggests that lower cut-off values for both genders are needed than the recommended ATPIII criteria of 102 and 88 cm for men and women respectively.

Our results also show that after WHtR, WC at a cut-off point of 85.5 cm yields the higher sensitivity value of 65.8% to differentiate MetS in women than those in men (61.4 %). In concordance with this finding the AUC for WC in women and in men were 72.1 (67.6-76.7) and 64.6 (59.9-69.7) respectively. These findings suggest that WC is more efficient in differentiating MetS in women than for men. In addition, WC at a cut-off value with a close range of 90.5 to 91.5 cm not only had the highest sensitivity to predict MetS in men but also was efficient, in discriminating the presence of other associated MetS components including high TG, low HDL, and high FBS. On the other hand, WC in the range of 84.75 to 85.5 cm in women showed a better sensitivity than WHtR for differentiating the presence of high TG and low HDL. However, among both genders, higher WC cut-off values were needed to predict the presence of high blood pressure. The Framingham Heart Study which included 2732 subjects, Preis et al., reported that neck circumference was a better index for assessment of hypertension [25]. In another study conducted by Lee and Kim among Korean men and women, concluded that the best indicators of the risk of hypertension and hypotension may differ and the use of combined indices seems to slightly improve the predictive power for both hypertension and hypotension [26].

Comparison of our sensitivity results for WHtR for men and women with those reported in other parts of Iran and Middle East region showed that the results from the present study come in agreement with a study carried out in Esfahan (12) which showed that WHtR has highest sensitivity for prediction of MetS among women than those for men. In contrast, the results from similar studies from Qatar (18), WHtR values were equally sensitive in both genders and its discriminating power to predict MetS was lower than WC. While another study from Oman, WHtR was superior to discriminate MetS among women than in men (67.2 v 58 % respectively) [27].

The overall findings from this study demonstrated that among Ahvazian adult women population, the two obesity indices WHtR and WC are better indictors of presence of MetS and its components (dyslipidemia and FBS). While in Ahvazian adult men WC followed by WhtR were more appropriate anthropometric indices for predicting MetS and its associate components. Furthermore, similar to other studies from our region (13, 18, 27, 28) .the cut-off point for WC in both genders were found to be lower than the recommended ATPIII criteria.

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