The Appropriate Waist Circumference Cut-off for Iranian Population

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ABSTRACT

Aim: to estimate the prevalence of obesity particularly abdominal obesity among adults aged between 19 to 65 years in five major cities in Iran.

Methods: in this cross-sectional study, the anthropometric measurements including weight, height, body mass index, waist and hip circumferences were performed in 5724 healthy adults, representative sample of Iranian population, in the urban areas of five great cities of Iran. The prevalence of obesity was calculated in each district. ROC curves were used to evaluate an optimal WC cutoff for predicting obesity.

Results: considering BMI categories, 38.5% were overweight and 19.7% were obese. Abdominal obesity by WC criteria was reported in 45.1% and 19.6% of women and men, respectively. The waist circumference cut-off points corresponding to BMI values of $>30$ kg/m$^2$ were 99.5 cm for men and 94.25 cm for women.

Conclusion: the present study provides alarming evidences for health professionals and policy makers about the high prevalence of generalized and abdominal obesity in Iran.

Key words: obesity, abdominal obesity, body mass index (BMI), waist circumference (WC).

INTRODUCTION

Obesity has become an emerging public health concern worldwide. Its prevalence has increased substantially over the past few decades, and this trend is believed to continue in both developed and developing countries if no preventative measures are adopted.1-5

The condition, considered as an undesirable outcome of changing lifestyle and behavior, is associated with numerous medical, psychosocial and economical consequences.1,6,7 It places affected individuals at a higher risk of a variety of disabling and life-threatening chronic conditions, including high blood pressure, menstrual abnormalities, psychosocial disorders, cardiovascular disease, diabetes mellitus, arthritis, gallbladder and other gastrointestinal disease, cancer, respiratory disorders and overall mortality.8-11

Abdominal obesity per se is considered as an independent predictor of cardiovascular disease, morbidity, and subsequent mortality.12

The prevalence of obesity varies substantially from a nation to another, ranging from as low as 5% in countries such as China, Japan, and certain African nations to as high as 75% in urban Samoa.13-15

While the nationwide data on the prevalence of obesity are available for some developing countries, limited studies have been performed in Iran—a country with a great diversity in socio-demographic and lifestyle factors, experiencing a rapid phase of urbanization and industrialization along with certain cultural changes like many other developing countries.1,12,16-23
This article presents the most recent national estimates of the prevalence of obesity in an Iranian population based on the data gathered for Iranian Multi-centric Osteoporosis Studies (IMOS). The objectives of this population-based survey were to estimate the prevalence of obesity particularly abdominal obesity among adults aged between 19 to 65 years in five major cities of the country with the aim of providing baseline data for planning health programs and preventive measures for different geographical areas as well as future examinations of secular trends.

METHODS

Patient Selection

This study is part of a comprehensive survey (IMOS) assessing the prevalence of osteoporosis and related factors among healthy adults (age range: 20 - 70 years), representative sample of Iranian population, in the urban areas of five great cities of Iran (Tehran, Tabriz, Mashad, Shiraz and Booshehr).

Details on the survey design and methods have been reported previously.24 Briefly, the IMOS used a random cluster sampling design to assess bone health in five provincially representative, independent samples of healthy Iranian adults excluding those taking medications that could modify bone metabolism, those with hepatic or renal disorders, metabolic bone disease, hypercortisolism, malabsorption, sterility, oligomenorrhea, type I diabetes, malignancy, and immobility for more than 1 week as well as the pregnant and lactating women. The subjects entered the survey after giving their written consent.

The Research Ethics Committee of the Endocrine and Metabolism Research Center (EMRC) approved the protocol of this study.

The check-up included anthropometric measures. Anthropometric measurements including weight, height, waist and hip circumferences were obtained with light clothing and without shoes by trained technicians following international guidelines.25,26 Each anthropometric measurement was done by a similar instrument, and with the same technique. Quality control for all measurements was monitored regularly.

The height (to the nearest 0.1 cm) and the weight (to the nearest 0.1 kg) were measured using a wall-mounted stadiometer (Seca) and a mobile digital scale (Seca, Hamburg, Germany), respectively. The BMI was calculated as the body weight divided by the height squared (kg/m²). The waist and hip circumference were measured using a non-elastic flexible anthropometric tape (to the nearest 0.1 cm) in the standing position. The tape was applied horizontally midway between the lowest rib margin and the iliac crest for WC and the widest point over the buttocks for HC measurements. The waist to hip ratio (WHR) was calculated as WC was divided by the HC.25,26

The individuals were then categorized according to their baseline BMI values (underweight <18.5, normal weight 18.5-25, overweight 25-29.9, and obese ≥30 kg/m²).25,26 Central obesity was diagnosed on the base of WC with cut-off points of WC >80 cm for women and WC >94 cm for men.25

Statistical Analysis

Data were entered to Microsoft Access Databank, checked, and cleaned before analysis. All statistical analyses were performed with SPSS 13.0 for Windows (SPSS, Chicago, IL) based on a pair-wise approach, and P values lower than 0.05 were considered statistically significant. All analyses were stratified by district. Means ± SD were used to express standard descriptive statistics. Categorical variables were expressed as percentages. ROC curves were used to evaluate an optimal WC cutoff for predicting obesity.

RESULTS

A total of 5724 individuals with the mean age of 42.64 ± 13.85 years were studied; from among them 2396 (43%) were male. The demographic and anthropometric characteristics of the study population based on the five studied districts are presented in Table 1. The population was equally distributed in different age groups. Overall, 21.7%, 21%, 17.6%, 18.9% and 20.9% of the participants were from Tehran, Tabriz, Mashad, Shiraz and Booshehr, respectively.

Except for Shiraz, BMI and HC values were higher in the female population (all P-value <0.001). In Shiraz, however, male population had a reportedly higher BMI values (24.82 ± 4.30 (M) vs. 24.43 ± 4.21 (F), P-value = 0.165). In both genders, the highest and lowest means of BMI were reported in Booshehr and Shiraz, respectively.

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Considering BMI categories, 164 (3.2%) were underweight, 1990 (38.6%) were normal weight, 1986 (38.5%) were overweight, 794 (15.4%) were mildly obese, 179 (3.5%) were moderately obese, and 42 (0.8%) were severely obese. The prevalence rates of
Table 1. The demographic and anthropometric characteristics of the study population (Mean ± SD) based on the five studied districts

<table>
<thead>
<tr>
<th></th>
<th>Mashhad</th>
<th>Tehran</th>
<th>Shiraz</th>
<th>Tabriz</th>
<th>Booshehr</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>Male</td>
<td>43.16 ± 13.93</td>
<td>43.53 ± 4.65</td>
<td>45.89 ± 14.86</td>
<td>40.83 ± 15.06</td>
<td>42.91 ± 14.27</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>41.21 ± 11.06</td>
<td>42.67 ± 12.41</td>
<td>44.44 ± 14.61</td>
<td>40.92 ± 14.81</td>
<td>42.64 ± 12.94</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>Male</td>
<td>73.59 ± 12.21</td>
<td>74.96 ± 12.80</td>
<td>68.81 ± 13.33</td>
<td>74.96 ± 12.59</td>
<td>73.98 ± 12.74</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>66.97 ± 12.61</td>
<td>68.40 ± 13.92</td>
<td>67.18 ± 12.81</td>
<td>68.60 ± 12.61</td>
<td>69.66 ± 12.87</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>Male</td>
<td>169.78 ± 7.82</td>
<td>169.28 ± 7.67</td>
<td>166.56 ± 10.14</td>
<td>173.69 ± 7.08</td>
<td>169.76 ± 7.89</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>156.88 ± 5.78</td>
<td>156.48 ± 6.83</td>
<td>165.82 ± 9.82</td>
<td>158.98 ± 5.83</td>
<td>157.83 ± 6.45</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>Male</td>
<td>25.54 ± 4.04</td>
<td>26.16 ± 4.17</td>
<td>24.82 ± 4.30</td>
<td>24.84 ± 3.84</td>
<td>25.68 ± 4.18</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>27.28 ± 5.12</td>
<td>27.91 ± 5.38</td>
<td>24.43 ± 4.21</td>
<td>27.14 ± 4.82</td>
<td>27.99 ± 5.06</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>Male</td>
<td>91.40 ± 11.59</td>
<td>90.31 ± 12.57</td>
<td>-</td>
<td>92.98 ± 11.81</td>
<td>91.74 ± 10.15</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>86.34 ± 11.92</td>
<td>91.37 ± 13.36</td>
<td>-</td>
<td>92.88 ± 13.83</td>
<td>90.77 ± 11.95</td>
</tr>
<tr>
<td>HC (cm)</td>
<td>Male</td>
<td>101.38 ± 9.20</td>
<td>98.32 ± 11.16</td>
<td>-</td>
<td>104.67 ± 7.78</td>
<td>101.20 ± 7.30</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>105.24 ± 12.26</td>
<td>105.52 ± 9.36</td>
<td>-</td>
<td>107.74 ± 10.29</td>
<td>106.46 ± 12.14</td>
</tr>
<tr>
<td>WHR</td>
<td>Male</td>
<td>0.90 ± 0.07</td>
<td>0.91 ± 0.08</td>
<td>-</td>
<td>0.89 ± 0.07</td>
<td>0.91 ± 0.07</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0.82 ± 0.10</td>
<td>0.87 ± 0.11</td>
<td>-</td>
<td>0.86 ± 0.07</td>
<td>0.85 ± 0.09</td>
</tr>
</tbody>
</table>

Table 2. The BMI categorization based on the five studied districts

<table>
<thead>
<tr>
<th></th>
<th>Tabriz</th>
<th>Mashhad</th>
<th>Shiraz</th>
<th>Booshehr</th>
<th>Tehran</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>37 (3.1)</td>
<td>24 (2.3)</td>
<td>61 (6.2)</td>
<td>27 (2.4)</td>
<td>15 (1.9)</td>
<td>164 (3.2)</td>
</tr>
<tr>
<td>Normal</td>
<td>493 (41.3)</td>
<td>377 (35.6)</td>
<td>489 (50)</td>
<td>377 (33.1)</td>
<td>254 (32.4)</td>
<td>1990 (38.6)</td>
</tr>
<tr>
<td>Overweight</td>
<td>443 (37.1)</td>
<td>417 (39.4)</td>
<td>331 (33.8)</td>
<td>475 (41.7)</td>
<td>320 (40.8)</td>
<td>1986 (38.5)</td>
</tr>
<tr>
<td>Obese</td>
<td>220 (18.4)</td>
<td>240 (22.7)</td>
<td>97 (9.9)</td>
<td>261 (22.9)</td>
<td>196 (25)</td>
<td>1014 (19.7)</td>
</tr>
<tr>
<td>Total</td>
<td>1193</td>
<td>1058</td>
<td>978</td>
<td>1140</td>
<td>785</td>
<td>5154</td>
</tr>
</tbody>
</table>

Table 3. The BMI categorization based on the five studied districts

<table>
<thead>
<tr>
<th>Gender</th>
<th>Total</th>
<th>Underweight</th>
<th>Normal</th>
<th>Overweight</th>
<th>Obese</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2197</td>
<td>80 (3.6)</td>
<td>989 (45)</td>
<td>857 (39)</td>
<td>271 (12.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Female</td>
<td>2809</td>
<td>80 (2.8)</td>
<td>939 (33.4)</td>
<td>1072 (38.2)</td>
<td>718 (25.6)</td>
<td></td>
</tr>
</tbody>
</table>

In both genders, the rates of obesity raised by increasing age. There was a progressive increase in BMI in both men and women up to about 51 and 52 years of age and it declined thereafter, respectively, with women attaining a higher mean BMI (Figure 1).

The prevalence rate of abdominal obesity by WC criteria was 64.7% (women 45.1% and men 19.6%). The rate was higher among female population in all the studied districts (Tehran: 38.8% vs. 81.6%; Tabriz: 48.7% vs. 81.6%; Mashhad: 46% vs. 72.1%; Booshehr: 44.3% vs.84%; all p-values <0.001). There was a linear and strong correlation between WC and BMI values in both men and women (Pearson correlation: M = 0.768 and F: 0.743, both P-value <0.001).

Sensitivities and specificities in men and women by WC to identify those with a BMI >25 kg/m² are shown in Figure 2. A WC cut-off point of 91.5 cm in men was the most sensitive and specific to identify most subjects with a BMI >25 kg/m², whereas in women it was 86.5 cm. The WC cut-off points

Figure 1. The trend of BMI changes by age in different genders

Figure 2. A WC cut-off point of 91.5 cm in men was the most sensitive and specific to identify most subjects with a BMI >25 kg/m², whereas in women it was 86.5 cm. The WC cut-off points
corresponding to BMI values of ≥30 kg/m² were 99.5 cm for men and 94.25 cm for women.

**DISCUSSION**

The prevalence of obesity among children and adults has increased dramatically in both developed and developing countries in the past decades. This extensive increase can be attributed to the rapid economic growth and globalization leading to significant changes in the lifestyle, involving a higher energy and fat consumption and an increasingly sedentary life. There is a considerable variation in the prevalence of obesity in studies from different parts of the world as obesity estimations depend on methodological factors (weights and heights measured rather than obtained by interview, adequate calibrations of instruments, experimental conditions of measurement (minimal clothing, time of the day, menstrual cycle), statistical considerations (sampling procedure, sample size, stratification), the definition of obesity used, the composition of the community examined by age, the effect of confounding variables (social/professional and economic classes, ethnic background, immigration and delay after immigration), behavioral factors (nutritional habits, physical activity, smoking, alcohol consumption, drugs effect), and environmental factors (seasonal effect, living conditions), making comparisons among studies of limited value.

In general, the overall prevalence rate varies from 10 to 20% in men to 15–25% in women. The current prevalence of obesity (BMI ≥30) is 20% to 25% in the United States and 10% to 24% in most countries in Western Europe. In Europe, countries such as France (7%) and the French part of Switzerland (9–11%) are reported to have the lowest obesity prevalence, whereas the highest prevalence rates have been found in Eastern European countries such as Slovenia, Croatia and Greece. In a study of Canadian population, 27% of women and 35% of men were found to have a BMI ≥27 kg m² (34;35). In Brazilian population, the prevalence rate is about 32.8%. In the developing countries, the transition of population from rural to urban areas as well as the considerable changes in lifestyles has similarly resulted in an increasing trend in the obesity rate. One study from Thailand found 28.3% and 6.8% of the country’s population were overweight and obese, respectively. The prevalence of obesity among Turkish women and men was 32.4% and 14.1%, respectively.

As the Middle East has the highest dietary energy surplus among the developing countries, a rapid rise is reported in the obesity rate in this region during the past years. The respective prevalence rates of obesity in adult women and men in a number of Middle East countries, such as Lebanon, Saudi Arabia, and Bahrain, are 18.8% and 14.4%, 26.6% and 17.8%, 47.7% and 21.2%, respectively.

Confirming previous results in Iran, the present cross-sectional study of 5724 adults of 19 to 83 years of age from five main districts of the country showed that overweight and obesity are common in Iran, as 51.3% of men and 63.7% of women had excess body
weight (BMI 25). In contrast, underweight has a low prevalence (3.6% men and 2.8% women present BMI values <18.5).

Table 4 summarizes a few recent national and regional surveys performed on the prevalence of obesity in adults living in different parts of Iran within the last 10 years. The chart exemplifies the diversity of results on obesity prevalence indicating that various factors such as unemployment rate, personal income, diet, physical activity and lifestyle may influence this rate.

Compared with the TGLS study carried out in 2001, this survey revealed a slight 5.6% increase in the prevalence of excess body weight in men but a 3.9% decline in the very prevalence in women. As for obesity prevalence, however, a 2.1% and 4% decline was expressed in relative terms. Both studies reported that the number of obese women is twice that in men.

Corroborating previous studies particularly those in Iran, the present study showed that excess body weight is more prevalent among women. It also reported higher prevalence of central obesity among female population despite the larger waistlines among male population; this finding was in line with previous studies conducted in this field. The higher WC and abdominal obesity prevalence rate in Iranian women compared to that in other countries can be contributed to genetic predisposition of Iranian women, their low levels of physical activity, high fertility rate and diet differences.

Consistent with some previous studies in the region as well as some other developing countries, the current population-based study found obesity tends to increase with age, showing higher estimates up to middle age (51-52 yrs) and a decline thereafter. This trend seems to be somehow variable in different countries and between the genders, maybe because of the genetic and lifestyle differences which exist in diverse ethnicities.

In our study the prevalence rate of central obesity by WC criteria was higher than those reported in previous studies in different parts of Iran. These rates were also much higher than that found in many Arab countries.

The WC cut-off points corresponding to BMI values of 30 kg/m² in both genders were also reported to be higher than those revealed in previous studies conducted not only in Iran but also other countries. The higher cut-off point for WC in our population underlines the heterogeneity in average WC values associated with higher BMI rates in different populations and ethnic groups. These results also reveal that the present WC values recommended by CMAJ for detecting abdominal obesity in Asian population has little value in identifying the high-risk population in Iran.

Using new ethnic-specific criteria based on this study as well as further studies performed on larger sample sizes would provide the authorities with more accurate prevalence of central obesity in the country.

Study Limitations

The cross-sectional nature of the present study has precluded the causal inferences regarding the determination of the prevalence rate of obesity in a group of individuals representativeness of the national population. Participant selection, on the other hand, has reduced the generalizability of the findings. Large prospective studies in various districts are needed to better evaluate the prevalence of obesity in the country.

The second limitation of this study is the potential for bias due to missing values in some of the
anthropometric variables. The large number of participants, however, may have compensated for these potential biases to some extent.

CONCLUSION

The findings of the present study provide alarming evidences for health professionals and policy makers about the high prevalence of generalized and abdominal obesity in Iran despite the raising concerns regarding the obesity problem in the country, adding that our population can expect to see a very high rate of chronic diseases, in the near future.

Preventive and treatment strategies, notably in women, are urgently needed to prevent overweight and obesity and promote weight maintenance and weight loss and address the health burden of obesity.

In view of the fact that unhealthy lifestyle habits, notably, the sedentary lifestyles in our community, are among the major threats contributing to the challenge, more severe efforts and programs should be incorporated with the existing health promotion programs aiming to tackle the possible epidemic of obesity and obesity-related chronic diseases in the near future.23,52

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REFERENCES


