

# Comparison of obesity indexes BMI, WHR and WC in association with Hypertension: results from a Blood Pressure Status Survey in Iran

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## ABSTRACT

**Background:** This study was done to identify prevalence of obesity by three indexes body mass index (BMI), waist hip ratio (WHR), and waist circumference (WC) in Yazd- Iran adult population and comprise them in association with hypertension prevalence. **Methods:** The study used a cross-sectional survey of 18 years of age and older urban population. In cluster sampling method, 1130 persons were selected. In-home interview and examination were used. **Results:** The prevalence of overweight and obesity by BMI were 36.1% and 26.1% respectively. The prevalence of central obesity was 57.9% by WHR and was 42.8% by WC. Odd ratios for WHR and WC with hypertension were slightly lower than BMI (2.39, 2.66 and 2.86 respectively). But odd ratio for WC in women was strongly higher than BMI and WHR (5.39 confronting 3.99 and 3.05). **Conclusion:** We have identified high prevalence of obesity in Yazd adult population. This is an important health issue and indicates an urgent need for prevention and control of it. The results suggest that the association of obesity by WC with hypertension is stronger than other indexes in women and by BMI with hypertension is slightly stronger than other indexes in men. Based on this result, the health professionals can assign obese people and in second level identify risk of hypertension with measuring of waist circumference.

**Keywords:** Body mass index, Hypertension, Obesity, Prevalence, Waist circumference, Waist hip ratio.

## INTRODUCTION

Over 1.5 billion people worldwide are overweight or obese.<sup>1</sup> In both developed and developing countries, the prevalence of obesity has reached epidemic levels<sup>2-4</sup> because two-thirds of the adult populations are overweight<sup>3</sup>. The prevalence of obesity and associated cardiometabolic risk factors such as hypertension is increasing significantly for all demographic groups.<sup>5</sup>

Obesity cause major risk factors for hypertension.<sup>1,6-9</sup> Obese

patients are prone to arterial hypertension, require more antihypertensive medication, and have an increased risk of treatment resistant.<sup>10</sup>

Worldwide prevalence estimated for hypertension may be as much as 1 billion individuals,<sup>11</sup> and it has an increasing trend in developing countries.<sup>12</sup>

The prevalence of hypertension increases with increasing body mass index (BMI).<sup>13</sup> Obesity can be considered a secondary cause of hypertension.<sup>14</sup> Hypertension is approximately twice prevalent in the obese than in the non obese.<sup>8</sup> Weight gain is associated with increases in arterial pressure<sup>15</sup> and both of them, are high risk factors for subsequent cardiovascular and renal complications.<sup>3</sup>

It has been estimated that 60-70% of hypertension in

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adults is attributable to adiposity.<sup>8</sup> Abdominal adiposity is a growing clinical and public health problem.<sup>16</sup> Obesity, in particular abdominal adiposity, is associated with increased risk of cardiovascular disease.<sup>16-19</sup> Abdominal obesity has been identified as the second strongest risk factor for myocardial infarction.<sup>20</sup> Compared with BMI, anthropometric measures of abdominal obesity [e.g. waist circumference (WC), waist-to-hip ratio (WHR)] appear to be more strongly associated with metabolic risk factors, incident of cardiovascular events, and death.<sup>17</sup>

This study was done to identify prevalence of obesity by three indexes of determining obesity (BMI, WHR, and WC) and compare them in association with hypertension prevalence in Yazd- Iran adult population. Yazd is an industrial city in the centre of Iran with hot and dry climate.

## MATERIALS AND METHODS

The study used a cross-sectional survey of 18 years of age and older urban population of Yazd.

**Sample and data collection:** In cluster sampling method, 1130 persons (456 men and 674 women) were selected. The sample was down from 60 randomly selected clusters. Within each cluster, the adults age 18 years and over who were usual residents was invited to attend the survey. Only one person within the household was asked to participate in the interview. When an individual was selected for the interview, his/her participation was voluntary. Except above criteria, there weren't any other criteria for subject selection. In-home interview and examination were used. The survey team was consisted of well-trained nursing students. A team of two surveyors visited each home and interviewed the volunteer subject.

**Measurements:** Blood pressure (BP) readings were taken using mercury manometer and stethoscope in brachial artery in sitting position. First, BP measured in two arms. If the difference was lower than 15 mmHg in systolic BP,

one arm which was in higher pressure used for second and third time's measurements with at least 2 min intervals. Data presented here are the average of three measurements on either arm.

Measurements of waist and hip circumferences were done based on the World Health Organization (WHO) protocol. The measurement of waist circumference was done at the approximate midpoint between the lowest rib and the top of the iliac crest. The hip circumference measurement was taken around the widest portion of the buttocks. The subjects stand with arms at the sides and feet positioned close together. A plastic stretch-resistant measuring tape was used parallel to the floor at the level at which the measurement is made.<sup>21</sup>

**Data classification:** Hypertension was defined as a systolic BP $\geq$ 140 mmHg or diastolic BP $\geq$ 90 mmHg according to the seventh report of the joint national committee on prevention, detection, evaluation and treatment of high blood pressure.<sup>11</sup> All patients with positive response to the question "Do you currently use drugs for treatment of high blood pressure?" also was defined as hypertensive patients. Classification of BP was defined as normal (systolic BP $<$ 120 mmHg and diastolic BP $<$ 80 mmHg), pre hypertension (120-139 mmHg for systolic BP or 80-89 mmHg for diastolic BP), stage I hypertension (140-159 mmHg for systolic BP or 90-99 mmHg for diastolic BP) and stage II hypertension (systolic BP $\geq$ 160 mmHg or diastolic BP $\geq$ 100 mmHg).<sup>11</sup>

General obesity identified based on BMI. Weight and height were measured, and BMI was calculated. BMI was calculated as weight in kilograms divided by the square of height in meters. The population divided in four groups by BMI: thin (BMI $<$ 18.5), normal (BMI=18.5-24.9), overweight (BMI=25-29.9) and obese (BMI $\geq$ 30).

Central obesity was determined based on WHR and WC. WHR $\geq$ 0.9 in men and WHR $\geq$ 0.85 in women and WC $>$ 102 cm in men and WC $>$ 88 in women were cut-off points for

**Table 1: Mean  $\pm$  SD<sup>a</sup> of age, blood pressure and obesity indexes in population**

	Men (n=456)	Women (n=673)	95%CI <sup>b</sup>	p value*
Age	41.50 $\pm$ 16.93	41.93 $\pm$ 15.88	-2.37 – 1.51	0.663
SBP <sup>c</sup>	132.17 $\pm$ 18.16	129.24 $\pm$ 21.91	0.49 – 5.37	0.018
DBP <sup>d</sup>	85.01 $\pm$ 11.20	83.08 $\pm$ 12.34	0.52 – 3.35	0.007
BMI <sup>e</sup>	25.62 $\pm$ 4.49	27.67 $\pm$ 5.25	-2.64 – -1.45	0.000
WHR <sup>f</sup>	0.91 $\pm$ 0.08	0.86 $\pm$ 0.08	0.04 – 0.06	0.000
WC <sup>g</sup>	91.67 $\pm$ 12.75	90.50 $\pm$ 13.66	0.42 – 2.75	0.150

<sup>a</sup>standard deviation; <sup>b</sup>confidence interval; <sup>c</sup>systolic blood pressure; <sup>d</sup>diastolic blood pressure; <sup>e</sup>body mass index; <sup>f</sup>waist hip ratio; <sup>g</sup>waist circumference. \*(Independent-samples T Test)

**Table 2: Prevalence of hypertension, general and central obesity**

	Men [N (%)]	Women [N (%)]	All [N (%)]	P value*
<b>Blood Pressure</b>				0.000
<b>Normal</b>	60 (13.2)	177 (26.3)	237 (21.0)	
<b>Pre HTN<sup>a</sup></b>	206 (45.2)	256 (38.0)	462 (40.9)	
<b>Stage I HTN</b>	124 (27.2)	138 (20.5)	262 (23.2)	
<b>Stage II HTN</b>	66 (14.5)	102 (15.2)	168 (14.9)	
<b>BMI<sup>b</sup></b>				0.000
<b>Thin</b>	19 (4.2)	20 (3.0)	39 (3.5)	
<b>Normal</b>	189 (41.8)	194 (29.2)	383 (34.3)	
<b>Overweight</b>	168 (37.2)	253 (35.3)	403 (36.1)	
<b>Obese</b>	76 (16.8)	216 (32.5)	292 (26.1)	
<b>WHR<sup>c</sup></b>				0.775
<b>Normal</b>	188 (41.6)	284 (42.5)	472 (42.1)	
<b>Obese</b>	264 (58.4)	385 (57.5)	649 (57.9)	
<b>WC<sup>d</sup></b>				0.000
<b>Normal</b>	362 (79.9)	280 (41.9)	642 (57.2)	
<b>Obese</b>	91 (20.1)	389 (58.1)	480 (42.8)	

<sup>a</sup>Hypertension; <sup>b</sup>body mass index; <sup>c</sup>waist hip ratio; <sup>d</sup>waist circumference. \*Pearson chi-square test.

obesity determining.<sup>21</sup>

## RESULTS

The mean age of the men (41.5±16.9) was not significant different from the mean age of the women (41.9±15.9) (P=0.663).

The mean of systolic BP was 132.17 ± 18.16 and 129.24 ± 21.9 mmHg in men and women, respectively (P=0.018). The equivalent values were 85.01 ± 11.20 and 83.08 ± 12.34 mmHg for diastolic BP (P=0.007) (Table 1).

The mean ± SD of BMI, WHR and WC in men and women were respectively 25.62 ± 4.49 and 27.67 ± 5.25 (P=0.000), 0.91 ± 0.08 and 0.86 ± 0.08 (P=0.000), 91.67 ± 12.75 and 90.50 ± 13.66 (P=0.150) (Table 1).

The overall prevalence of hypertension in this study was 38.1% (41.7% in men and 35.7% in women, P=0.000) (Table 2).

The prevalence of general overweight and obesity by BMI were 36.1% and 26.1% respectively. Obesity status was significantly higher in women (P=0.000). The prevalence of central obesity in this population was 57.9% by WHR [58.4% in men and 57.5% in women (P=0.775)] and was 42.8% by WC [20.1% in men and 58.1% in women (P=0.000)] (Table 2).

Prevalence of hypertension in population by obesity status has shown in table 3. The prevalence of hypertension in overweight and obese population by BMI was 38.7% and 52.4% respectively. Results for obese population by WHR

and WC were 46.5% and 51.3% respectively (Table 3).

Table 4 shows multivariate logistic regression analysis for association of obesity with prevalence of hypertension. By BMI, overweight and obese population has Odds ratios [(95%CI) – P value] 1.64 [(1.21-2.22) - 0.001] and 2.86 [(2.07-3.95) - 0.000] respectively, when reference category was normal population. The Odds ratio of hypertension in obese population by WHR and WC were 2.39 [(1.85-3.09) - 0.000] and 2.66 [(2.07-3.41) - 0.000] respectively.

## DISCUSSION

The first important finding of our study was that the overall prevalence of hypertension, estimated to be 38.1%, higher than many countries<sup>22-27</sup> and higher than hypertension prevalence in developing countries reported in a systematically review from 35 countries.<sup>12</sup> Compared with rest of the world, the mean systolic BP, diastolic BP and prevalence of hypertension in this population is higher than Canada and United States (127 mmHg, 77 mmHg and 28%) but lower than of European countries (136 mmHg, 83 mmHg and 44%).<sup>28</sup> The result obtained in the present study is very close to the result of Yazd Province Urban and Rural Health and Disease Project was done in 2001, which reported the prevalence in urban population as 37.3%.<sup>29</sup>

In a study conducted in 2002 in Tehran (capital of Iran), the prevalence rate of hypertension in 20-69 years has been reported 22%.<sup>30</sup> Also, a prevalence of 21% in 19-70 years was reported in the Isfahan urban population (a city near the Yazd).<sup>31</sup> The younger age range in these studies and hypertension definition as ≥160/95 in second study could be effective in this difference.

**Table 3: Prevalence of Hypertension by obesity status in men and women**

	Men [N (%)]	Women [N (%)]	All [N (%)]	P value*	
				by Sex	by Obesity
<b>BMI<sup>a</sup></b>				0.003	0.000
<b>Thin</b>	4 (21.1)	3 (15.0)	7 (17.9)		
<b>Normal</b>	68 (36.0)	40(20.6)	108 (28.1)		
<b>Overweight</b>	73 (43.5)	83 (35.3)	156 (38.7)		
<b>Obese</b>	44 (57.9)	109 (50.5)	153 (52.4)		
<b>WHR<sup>b</sup></b>				0.005	0.000
<b>Normal</b>	64(34.0)	62 (21.8)	126 (26.7)		
<b>Obese</b>	125 (47.3)	177 (46.0)	302 (46.5)		
<b>WC<sup>c</sup></b>				0.002	0.000
<b>Normal</b>	138 (38.1)	44 (15.7)	182 (28.3)		
<b>Obese</b>	51 (56.0)	195 (50.1)	246 (51.3)		

<sup>a</sup>body mass index; <sup>b</sup>waist hip ratio; <sup>c</sup>waist circumference. \*Pearson chi-square test

**Table 4: Multivariate logistic regression analysis for association of obesity indexes with hypertension. [Odds ratio (95%CI<sup>a</sup>) – P value]**

	Men	Women	All
<b>BMI<sup>b</sup></b>			
<b>Overweight</b>	1.36 (0.88-2.09) - 0.158	2.15 (1.38-3.35) - 0.001	1.64 (1.21-2.22) - 0.001
<b>Obese</b>	2.47 (1.43-4.27) - 0.001	3.99 ( 2.57-6.21) - 0.000	2.86 (2.07-3.95) - 0.000
<b>WHR<sup>c</sup></b>			
<b>Obese</b>	1.74 (1.18-2.56) - 0.005	3.05 (2.16-4.31) - 0.000	2.39 (1.85-3.09) - 0.000
<b>WC<sup>d</sup></b>			
<b>Obese</b>	2.07 (1.30-3.30) - 0.002	5.39 (3.70-7.87) - 0.000	2.66 (2.07-3.41) - 0.000

<sup>a</sup>confidence interval; <sup>b</sup>body mass index; <sup>c</sup>waist hip ratio; <sup>d</sup>waist circumference

Prevalence of hypertension in men was higher than women (41.7% and 35.7% respectively). In above systematically review, also was shown higher prevalence of hypertension in men, both in developed and developing countries.<sup>12</sup>

The prevalence of obesity, both general and central, in this population was high (Table 2).

The mean of BMI and WC have reported by A National Profile of Noncommunicable Disease Risk Factors in the I.R. of IRAN in 15-64 years population, 24 and 84.3 in men and 25.5 and 86.1 in women.<sup>32</sup> These values are lower than our results (Table 1). This project was done in both areas, urban and rural, and also in a younger age range.

The values of prevalence of two kinds obesity which were obtained in present study, is also higher than eastern Asian populations<sup>13,33-35</sup> and seven geographical regions of Turkey<sup>19</sup> and a little lower than reported values from Mediterranean region of Turkey.<sup>36</sup> Mean of BMI and WC of this population that is shown in table I, are lower than results of Middle East region from International Day for the Evaluation of Abdominal Obesity (IDEA) study in 63 countries.<sup>16</sup>

Results of this study showed that the prevalence of hypertension in general overweighs was 38.7% and in general obese population was 52.4%. Results for

obese population by WHR and WC were 46.5% and 51.3% respectively (Table 3). Hypertension prevalence was significantly higher in both general and central obese population. The association between obesity and hypertension has been well documented in most racial, ethnic and socioeconomic groups.<sup>37</sup>

Results confirm a strong association between obesity by BMI, WHR and WC with hypertension prevalence in adult Yazd population (Table 4). Obese population (BMI $\geq$ 30) are about 3 times as likely to suffer from hypertension as normal population. Obesity and hypertension are high risk factors for subsequent cardiovascular and renal complications.<sup>3</sup> The association between these two coronary vascular disease risk factors has well shown in numerous studies from the entire world<sup>13,18,38-42</sup> Seventh report of the joint national committee on prevention, detection, evaluation and treatment of high blood pressure has shown the relative 10-years risk for hypertension and stroke over the next decade among men initially free of disease stratified by baseline BMI is 1.3 for overweighs and 2.1 - 2.5 for obese men.<sup>11</sup>

Odd ratios for WHR and WC were slightly lower than BMI (2.39, 2.66 and 2.86 respectively). But odd ratio for WC in women was strongly higher than BMI and WHR

(5.39 confronting 3.99 and 3.05). Waist circumference may be a better indicator for the prediction of obesity-related cardiovascular risk factors in women compared to BMI and WHR. The results of this study show that BMI may be a good indicator for the prediction hypertension in men. But it seems that the best choice in women is WC.

Clearly, it is not appropriate to use a single universal cut-off level to define obesity for all populations given the potential ethnic variation in body build and composition, as well as variation in the health risk associated with obesity among populations.<sup>2</sup> Numerous Studies were done about this issue in Asian populations. These studies suggest WC cut off point values of 80 – 92 cm for men and <80 cm for women.<sup>2,35,43</sup>

Used cut of points in this study were according to recommendations of World Health Organization,<sup>21</sup> but it seems that a lower cut off point especially in men could efficiently discriminate both obesity and hypertension among this population. Further studies can be done to understand the optimal obesity indexes cut off points in this general population.

## CONCLUSION

In conclusion we have identified high prevalence of hypertension and obesity in Yazd adult population. This is an important public health issue and indicates an urgent need for prevention and control of hypertension and obesity.

Furthermore in this study we found significant association between both general and abdominal obesity with hypertension. The results suggest that the association of obesity by WC with hypertension is stronger than BMI and WHR in women. Association of obesity by BMI is a little stronger than WC in men.

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Based on this result, the nurses can assign obese people and in second level identify risk of hypertension with measuring of abdominal obesity through measuring of waist circumference. Obtaining of waist circumference alone is easier and more reliable than measuring of weight, height and hip circumference. This result is particularly usable in the cases that required instruments are not available and also in screening studies.

## CONFLICTS OF INTEREST

There are no conflicts of interest.

## ABBREVIATION

BMI : Body Mass Index

BP : Blood Pressure

WC : Waist Circumference

WHR : Waist Hip Ratio

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