Comparison of Anthropometric Indices (Body Mass Index, Waist Circumference, Waist to Hip and Waist-to-Height Ratios) in Predicting the Risk of Hypertension in Women in Bojnurd - 2014

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Abstract

Purpose: The best anthropometric index has not been established to investigate the relationship between hypertension and obesity. Since a similar study was not conducted in Bojnurd, we began to investigate the comparison of anthropometric indices (body mass index, waist circumference, waist to hip and Waist-to-Height ratios) in predicting the risk of hypertension in women.

Materials and Methods: The present cross-sectional study conducted on women referring to Bojnurd health centers. We used multi-stage sampling methods from health centers of Bojnurd in five geographic regions of North, South, East, West and Center. Then we choose one center randomly from each region. We randomly selected participants from the centers. For analyzing the data, we used t-test, chi-square, logistic regression and the ROC curve in SPSS19 software.

Results: The prevalence of hypertension was 53.4% (CI = 46.8–60). All four anthropometric indicators were used as a screening tool for predicting hypertension diagnosis, but body mass index (BMI) had a higher sub-curved surface than other anthropometric indices (AUC = 0.717). The cut-off point of BMI for predicting the risk of hypertension was 25.6.

Conclusions: This study suggested BMI as anthropometric indicators to evaluate the risk of hypertension. Since a significant percentage of people are unaware of the existence of hypertension and, continuing education is needed to encourage people to pay more attention to this problem.

Keywords: Hypertension; Body mass index; Waist to hip ratio; Waist circumference; Waist to height ratio

Introduction

Urbanization, industrialization and population growth led to increasing in the prevalence of chronic diseases throughout the world. Obesity as a risk factor for non-communicable diseases is one of the most important public health problems in worldwide [1]. Obesity refers to abnormal accumulation of fat in the body tissue [2]. The prevalence of obesity is increasing and obese people are prone to chronic diseases such as type 2 diabetes, hypertension, cardiovascular disease, and some cancers [3]. Due to its economic burden, choosing the best measure to monitor the complications of obesity in the population is very important. Body mass index (BMI) is the most commonly used index for assessing obesity. It has been recently suggested other anthropometric indices such as waist circumference (WC), Waist to Hip ratio (WHR) and Waist-to-Height ratios (WHtR) [4,5]. The waist circumference gives us information on how the body's fat is distributed, indicating abdominal obesity [6]. Some acquired Factors, including obesity, are effective in hypertension. The prevalence of hypertension in obese people is higher than normal people [5] and it is varies from country to country, from 10% to over 60% in different countries [7]. 13% of global deaths have been attributed to hypertension. It causes one in eight deaths in the world [8]. It is the most important health issue in developed and developing countries [9]. The prevalence of hypertension in the 25–64 year Iranian population was 22.1% in 2015 [10]. The risk of developing hypertension in individuals with abnormal BMI is more, while central obesity with waist circumference and waist to hip ratio are better predictor for hypertension [5]. North Khorasan Province has been ranked first in terms of age-related hypertension in women. The prevalence of hypertension in women of North Khorasan province is 42.7% [11,12]. So using simple and inexpensive methods to diagnose especially the fat distribution in the body, help us to identify people at high risk for chronic diseases such as hypertension. By decreasing the prevalence of obesity, through prevention and education, we will see a significant reduction in the prevalence of hypertension. Since a similar study was not conducted in Bojnurd, this study was done to determine the best anthropometric index and determine the optimal cutoff point for each of these indicators to predict the risk of hypertension.

Materials & Methods

The present study was a cross-sectional study and the statistical population was women referring to health centers in Bojnurd. We used cross-sectional sample size formula based on the prevalence of hypertension 30%, accuracy of 0.06 and confidence level of 95% to estimate sample size. Finally, we examined 230 people. We used multi-stage sampling methods from health centers of Bojnurd in five geographic regions of North, South, East, West and Center. Then we choose one center randomly from each region. We randomly selected participants from the centers. Then, we conducted the coordination (on a telephone) for them who were willing to participate in the study after explaining purpose of the study for them and getting consent, then we measured anthropometric...
The criteria for entry were all women (married) referred to health centers, in which they had willing to participate in the study. An excluded criterion was: not having a history of exercise and exercise therapy to control or reduce weight gain. After obtaining satisfaction, the questions were asked by the trained person using a questionnaire and an interview. We measured hypertension, with pressure gauge. People with systolic blood pressure ≥ 140 mm Hg or diastolic blood pressure ≥ 90, consider as people with hypertension based on the definition of hypertension published by the Seventh Joint National Committee on Prevention. The weight of the subjects was measured using an Omron digital scale manufactured in Japan. Also, a meter was used to measure the height of people in cm. The BMI was obtained as weight (in kg) divided by the square of height (in m2). The hip circumference was also measured, similar to the WC, at the widest part of the buttocks, and then WHR calculated by divided the waist circumference to the hip circumference in cm. The waist circumference was also divided by the height to obtain WHtR. To analyze the data, we used t-test, logistic regression model, the ROC curve and area under curve (AUC), Youden Index (J), the maximum potential effectiveness of a biomarker, to measure the power of each anthropometric index in predicting the risk of hypertension in SPSS19 software by using 95% confidence interval level.

Results

In this cross-sectional study, 230 women were enrolled in the study. The mean age of women who participate in the study was 41.1 ± 15.2 years, with an average pregnancy rate of 3 ± 0.14. The prevalence of hypertension was 53.4% (CI = 46.8–60) Demographic characteristics of the study show in table 1.

The mean anthropometric indices of (BMI, WC, WHR, and WHtR) were higher in subjects with hypertension than those without hypertension (p < 0.001). There was a significant difference in physical activity between the two groups (p = 0.02). The odds ratio of hypertension obtained from anthropometric indices before and after adaptation for age variables, Occupation, level of education, number of pregnancies, physical activity show in table 2.

In the first model, from four anthropometric indices, BMI, WHR had a significant relationship with the risk of hypertension. After entering the confounding variables, BMI, WC, WHR showed a significant relationship, so that the risk of hypertension in people with BMI ≥ 25.6 was greater than the risk of hypertension in people with BMI < 25.6. In order to compare predictive power of anthropometric indices, for the risk of hypertension we used ROC curve and the sub-curved surface (AUC) (Figure 1).

To determine the risk of hypertension, the best cut-off point for anthropometric indices shows in table 3. Which were considered as ideal points for optimizing the indicators accuracy. The best cut-off point for BMI was (25.65 kg/m²). Also, the cut-off point of WHR was (0.52) but the cut-off point of WHR (0.94). The cut-off point of WC was (101); Although WC had a lower surface area under the ROC curve than other anthropometric indices.

For comparison in pairs between BMI vs WC, P-value was 0.0012 but surface area under the ROC curve was higher in BMI like BMI vs WHR: 0.015, BMI vs WHtR: 0.0057. For comparison in pairs between WC vs WHR, p-value was 0.12, WC vs WHtR: 0.2 and WHR vs WHtR: 0.38; which means WC, WHR and WHtR had similar predictive power in the risk of hypertension.

Discussion

In this study, all four anthropometric indicators were significantly different between two groups; with and without hypertension [13], but BMI had a higher AUC than other anthropometric indices like study conducted by Fuchs [14]. However, in a study that conducted in Spanish the AUC for BMI was significantly higher than the AUCs for WC and WHtR like this study [15]. Some study shows WHR is better predictor for hypertension which was contradicted with this study [16].

Waist to the hips indices were a good predictor for the risk of hypertension in some study that was contradicted with this study [17]. But such studies had shown that Waist circumference is most closely correlated with changes in blood pressure [18,19]. In this study, results showed that BMI, WC, and WHtR had a significant relationship with the risk of hypertension after controlling for confounders such as age, occupation, level of education, number of pregnancies and physical activity. Also, by analyzing ROC curves, it showed that BMI is the best prediction for the risk of hypertension compared to other anthropometric indicators. WHR, WC, WHtR also showed similar predictive power. In cross-sectional study that conducted by Liu the AUC values did not differ between BMI, WC and WHtR for prediction of hypertension that was different with this study [20].

In a meta-analysis study in the world that compared WC, WHR, and BMI indices, WHR was the best indicator for measuring obesity [21]. In the study conducted by Zabetian in Tehran [22], the cut-off point for waist circumference was 94.5 as predictor for risk of cardiovascular disease. Also, according to the National Committee of Obstetrics (WC ≥ 90) had suggested for obesity, which was different with this study. This committee recommends waist circumference ≥ 95 cm for appropriate medical interventions. Our estimate is also up to 101. The cut-off point for BMI, WHR, and WHtR were 25.6, 0.52 and 0.94 in this study, respectively. Each population, depending on race and ethnicity, has a different cut-off point for anthropometric indices related to the risk of developing diseases such as blood pressure. Different cut-off point estimated for anthropometric indices. These differences may be due to differences in lifestyle due to the dietary habits and physical activity of the population under study as well as the differences in the study outcomes found in the prediction models. Cutting points that show the highest probability of predicting the risk of hypertension based on sensitivity and specificity were similar to recommended values [13,23]. WC does not consider the person's height in the risk assessment, it was not significantly good predictor for hypertension; Therefore, it can be said that because WHtR index considers the height of people in measuring body mass, in contrast to WC, is more sensitive than other anthropometric indices in identifying patients with hypertension. In this study the prevalence of hypertension in this study was 53.4%. In comparison with other parts of the country, the prevalence rate of hypertension was 23.7% in Tehran [24] and 27.3% in Isfahan [25]. There is a significant difference in the prevalence of hypertension in different parts of the world. In the United States, 20.5% [26], in Canada 21.6% [27]. The prevalence of hypertension in the study conducted by Rezende was 22% [13]. Several studies had reported increasing incidence of hypertension especially in women in developing countries, including Iran. In this study, abdominal obesity was one of the factors that influence women's hypertension. Such studies confirm our results [28,29]. In this study, age had a major risk in hypertension. Such studies have reported similar results [24,30]. But Anane’s study did not report a significant relationship between age and hypertension which may be due to differences in the age group of the study [31]. In the present study, there was significant relationship between regular...
Variables | With hypertension | Without hypertension | p - value
--- | --- | --- | ---
N | 123 | 107 | 
Age | 44.1 ± 16.5 | 37.4 ± 12.9 | 0.001
Body mass index (BMI) | 24.3 ± 3.3 | 21.4 ± 2.5 | < 0.001
Waist circumference (WC) | 101.6 ± 9.7 | 92.06 ± 13.1 | < 0.001
Waist to height ratio (WHtR) | 0.6 ± 0.07 | 0.57 ± 0.08 | 0.02
Waist to hip ratio (WHR) | 0.87 ± 0.07 | <0.87 ± 0.07 | < 0.001

<table>
<thead>
<tr>
<th>Frequency</th>
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<tbody>
<tr>
<td>Number of pregnancy</td>
</tr>
<tr>
<td>&lt;= 2</td>
</tr>
</tbody>
</table>
| > 2-5 | 57 (46.3) | 39 (36.4) | 0.018
| > 5 | 20 (16.3) | 9 (8.4) |
| Occupation |
| Housewife | 108 (87.8) | 88 (82.2) |
| Employee | 15 (12.2) | 19 (17.8) | 0.23
| Level of Education |
| Under diploma | 90 (73.2) | 55 (51.4) |
| Diploma | 19 (15.4) | 30 (28) | 0.003
| Academic | 14 (11.4) | 22 (20.6) |
| Regular Exercise |
| Yes | 7 (5.7) | 16 (15) | 0.02

Table 1: Basic characteristics of the population studied. *Significant at 95% confidence level.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Odds Ratio (95% CI)*</th>
<th>p - value</th>
<th>Odds Ratio (95% CI)**</th>
<th>p - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI1</td>
<td>&lt; 23.5</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
| 23.5–25.6 | 1.5 (0.7–3.2) | 0.23 | 1.2 (0.4–3.1) | 0.67
| ≥ 25.6 | 7.6 (3.1–18.2) | < 0.001 | 13.9 (4.5–43.1) | < 0.001
| WC2 | < 97 | 1 | 1 | 
| 97–100 | 1.06 (0.4–2.6) | 0.88 | 0.2 (0.04–1.3) | 0.11
| ≥ 101 | 1.2 (0.7–2.1) | 0.41 | 0.07 (0.01–0.4) | 0.005
| WHR3 | < 0.9 | 1 | 1 | 
| 0.9–0.93 | 1.4 (0.5–3.4) | 0.43 | 1.06 (0.3–3.5) | 0.92
| ≥ 0.94 | 1.9 (1.1–3.6) | 0.02 | 0.7 (0.2–2.2) | 0.6
| WHtR4 | < 0.50 | 1 | 1 | 
| 0.50–0.52 | 1.2 (0.5–2.6) | 0.58 | 3.01 (0.7–12.7) | 0.13
| ≥ 0.52 | 1.6 (0.8–2.9) | 0.11 | 9.2 (1.3–62.6) | 0.02

Table 2: The odds ratio of blood pressure in terms of cut-off points for anthropometric indices. (*Significant at p < 0.05**after adjusting for Confounders. 1BMI: Body mass index; 2WC: waist circumference; 3WHR: Waist to Hip ratio; 4WHtR: Waist-to-Height ratios).

<table>
<thead>
<tr>
<th>Variables</th>
<th>AUC (95% CI)</th>
<th>p - value</th>
<th>Cut-off points</th>
<th>sensitivity</th>
<th>Specificity</th>
<th>Youden's index</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>0.71 (0.65–0.77)</td>
<td>&lt; 0.001</td>
<td>25.65</td>
<td>40.65</td>
<td>100</td>
<td>0.4</td>
</tr>
<tr>
<td>WC</td>
<td>0.56 (0.49–0.62)</td>
<td>0.09</td>
<td>101</td>
<td>36.5</td>
<td>74.7</td>
<td>0.11</td>
</tr>
<tr>
<td>WHR</td>
<td>0.6 (0.53–0.66)</td>
<td>0.004</td>
<td>0.94</td>
<td>26.8</td>
<td>88.7</td>
<td>0.15</td>
</tr>
<tr>
<td>WHtR</td>
<td>0.58 (0.51–0.64)</td>
<td>0.03</td>
<td>0.52</td>
<td>86.1</td>
<td>28.9</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Table 3: Areas under the ROC curve, cut-off points, sensitivity and specificity of anthropometric measurements to predict hypertension.
exercise and hypertension. Some studies reported inconsistent results with our study [32,33]. Maybe few people in the two study groups had reported doing exercise in their leisure time. But such studies showed, by reducing physical activity, the risk of hypertension would increase [31,34]. So people who had not have physical activity in the day are twice more susceptible to had higher blood pressure. The present study shows that the number of pregnancies is one of the factors that increase the blood pressure in women. Such studies have reported similar results [35]. In this study, there was no significant relationship between female occupation and their education level with hypertension. The results of such studies contradicted our study [31,33]. Overall, this study indicated that BMI, WC, WHR and WHtR had affected on blood pressure in women since BMI had better surface area under the ROC curve. Since a significant percentage of people are unaware of the existence of hypertension and controls of this disorder is not appropriate in many people, continuing education is needed to encourage people to pay more attention to this problem. Since obesity and hypertension are important risk factors for cardiovascular disease, the need for nutritional education with a change in attitude is necessary as a result of weight control and fitness.

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Conflict of Interest

All authors declare no conflict of interest.

References

Comparison of Anthropometric Variables in Predicting a 7.6-year Risk of Cardiovascular Disease in Iranian Adult Population. Journal of Isfahan Medical School. 2009;27(100).


