Prediction of hypertension by anthropometric parameters in primigravidae

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Abstract

BACKGROUND: The present study was conducted to determine the efficacy of various anthropometric indices in prediction of hypertension risk in primigravidae.

METHODS: In this cross-sectional survey, 183 primigravidae who had referred to health care centers in Rasht (Iran) were recruited at their first antenatal visits. Using standardized methods, the researchers determined the weights, heights, waist to hip ratio (WHR), and waist circumferences (WC) of all women. Body mass index (BMI) was then calculated as weight divided by height squared. Data was analyzed with $SPSS_{17}$. Step-wise linear regression models were fitted for systolic and diastolic blood pressure as dependent variables and BMI, WHR, WC as independent variables.

RESULTS: The mean systolic and diastolic blood pressure were 111.2 mmHg and 73.0 mmHg, respectively. There was a significant positive correlation between obesity indicators and both systolic and diastolic blood pressure. Linear regression models suggested that BMI, WC, and WHR were important indicators of hypertension.

CONCLUSION: WC seemed to have a strong association with the risk of hypertension and preeclampsia.

Keywords: Hypertension, Pregnancy, Waist to Hip Ratio, Body Mass Index, Waist Circumference

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Introduction

The increasing prevalence of obesity worldwide has prompted the World Health Organization (WHO) to designate obesity as one of the most important global health threats. The epidemic is especially pronounced in young people including women of reproductive age. Pre-pregnancy obesity is an independent risk factor for maternal and neonatal morbidity and mortality.[1]

It is well-known that overweight and obesity are increasing worldwide, in all populations, and in all age categories. In recent years, obstetricians have been more frequently confronted with overweight and obese pregnant women. Obesity among American pregnant women ranges from 18.5% to 38.3%, depending on the study design and cut-off points used.[2]

Obesity is known to increase the risk of pregnancy-induced hypertension and preeclampsia. Frederick et al. found that every unit increase in pre-pregnancy body mass index (BMI) resulted in an 8% increase in the risk of pre-eclampsia.[3] Obviously, a significant decrease in risk is also noticed when BMI decreases.[4]

Pregnancy-induced hypertension and preeclampsia affect 10% and 2-8% of pregnancies, respectively.[5] Obesity is a rapidly growing health problem in both developed and developing countries.[6] Obesity has been reported to be associated with preeclampsia and other hypertensive disorders of pregnancy and future cardiovascular diseases.[7]

Anthropometric indices of body fat are widely used to predict increased chronic disease risk at individual and population levels.[8] The efficacy of different anthropometric measurements and indices in predicting obesity-related outcomes has been addressed in several reports.[9] Most previous studies have evaluated the association of different measurements of fat distribution with other risk factors and prevalence of diseases using cross-sectional designs.[10,11]

While BMI is a good indicator for body fatness in adults at the population level, waist circumference (WC)[12] and waist to hip ratio (WHR) provide additional information about central fat distribution.[13] Waist circumference is closely related to BMI but relates better than BMI to health risks because it also contains information about central distribution of

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body fat and is not influenced by height.[14]

Few longitudinal studies have compared the usefulness of anthropometric parameters in predicting hypertension in different populations during pregnancy. Moreover, there is no related data from Iranian people in this regard. Therefore, this study aimed to determine whether anthropometric parameters at the first antenatal visit could predict the risk of pregnancy-induced hypertension.

Materials and Methods

In a cross-sectional survey during 2009-12, 183 normotensive primigravidae with singleton pregnancies were recruited. The subjects had referred to health care centers in Rasht, Iran for their first antenatal visit (6-10 weeks of gestation). Gestational age was estimated from the first day of the mothers' last menstrual period and was confirmed by ultrasound scanning in the late first trimester.

At baseline, complete measurements of demographics, anthropometrics parameters, blood pressure, and other risk factors of hypertension were performed. Incident hypertension was defined as blood pressure equal or higher than 140/90 mmHg. Right-arm blood pressure was measured three times in a seated position by a trained health provider who followed a standardized procedure using a regularly calibrated mercury sphygmomanometers with appropriate-sized cuffs. Systolic blood pressure was measured at the first appearance of a pulse sound (Korotkoff phase 1) and diastolic blood pressure at the disappearance of the pulse sound (Korotkoff phase 5). The three measurements of systolic or diastolic blood pressure were averaged to minimize the effects of measurement error.

Body weight was measured (to the nearest 0.5 kg) with the subject standing motionless on a bathroom weighing scale.[15] Each weighing scale was standardized every day with a weight of 50 kg. Height was measured (to the nearest 0.5 cm) with the subject standing in an erect position against a portable stadiometer. The head was appropriately positioned so that the top of the external auditory meatus was in level with the inferior margin of the bony orbit. BMI was calculated as weight (kg) divided by height squared (m^2). BMI values of 26-29 and greater than 29 kg/m^2 were taken as cut-off for overweight and obesity, respectively.

Waist circumference was measured at the mid-point between the iliac crest and the costal margin in the midauxiliary line. Measurements were performed after exhalation while the subject was in standing position. Hip circumference was measured at the level of greater trochanters with the subject in standing position and keeping the feet together. Two consecutive recordings (to the nearest 0.5 cm) were made for each site using a non-stretch fiberglass measuring tape on a horizontal plane without compression of skin. The mean of the two sets of values was used in analyses.[16] WC and WHR cut-off points for obesity were considered as > 80 and > 0.80, respectively.

Data was analyzed using SPSS for Windows 17.0 (SPSS Inc., Chicago, IL, USA). The population characteristics, anthropometric parameters, and systolic and diastolic blood pressure were shown as mean ± standard deviation (SD). Step-wise linear regression models were fitted for systolic and diastolic blood pressure as dependent variables and BMI, WHR, WC as independent variables. Receiver operating characteristics (ROC) analysis was conducted to identify the cut-off values of anthropometric indices in calculating the risk of hypertension.

The authors had full access to all of data and were responsible for the integrity of data and the accuracy of analyses. Written informed consents were obtained from all participants. We certify that all applicable institutional regulations concerning the ethical use of human volunteers were followed during this research.

Results

Of the total 183 individuals above 18 year of age, 142 individuals were analyzed. The mean systolic and diastolic blood pressure was 111.2 ± 15.3 mmHg and 73.0 ± 12.2 mmHg (Table 1). The prevalence of hypertension was 18%.

Table 1. Baseline characteristics of the study population

Characteristic	Mean ± SD
Age (years)	29.0 ± 8.1
Height (cm)	151.2 ± 6.9
Weight (kg)	50.0 ±11.0
Body mass index (kg/m^2)	22.2 ± 2.71
Waist to hip ratio	0.770 ± 0.107
Waist circumference (cm)	65.4 ± 13.9
Systolic blood pressure (mmHg)	111.2 ± 15.3
Diastolic blood pressure (mmHg)	73.0 ± 12.2

The cut-off values for all anthropometric indices were worked out by ROC analysis to identify the risk of hypertension. The prevalence of overweight and obesity (defined as BMI > 26-29 and > 29 kg/m2) was found to be 9% and 6%, respectively. WC and WHR values higher than the cut-off points were detected in 8% and 28% of the participants, respectively (Table 2). Mean values of BMI, WHR, and WC were significantly higher among hypertensive individuals (Table 3).

In univariate regression analysis, WC, WHR, and BMI were all significantly and positively correlated with hypertension. To assess the relative strength of these associations, we used non-nested regression models. There was no significant difference between WHR and BMI in predicting hypertension. WC was a stronger predictor of hypertension ($P < 0.01$) and preeclampsia ($P < 0.001$) than WHR. In fact, the correlation coefficient for systolic blood pressure was 0.23 with BMI, 0.27 with WC, and 0.23 with WHR. For diastolic blood pressure, the correlation coefficient was 0.11 with BMI, 0.15 with WC, and 0.12 with WHR. WHR was also a stronger predictor of hypertension ($P = 0.03$) and preeclampsia ($P = 0.04$) than BMI. However, the relative strengths of WHR and BMI in predicting hypertension and preeclampsia did not differ significantly ($P > 0.05$). Logistic regression analysis showed that WC was the most important anthropometric factor associated with the risk of hypertensive.

Discussion

BMI, WC, and WHR are known to be important in estimating cardiovascular disease risk factors, particularly due to their positive association with hypertension.[16] Similar to the findings of previous research,[17] mean values of all of these anthropometric parameters in the present study were significantly higher in hypertensive individuals than the normotensive population. We also found significant positive correlations between all of these anthropometric parameters and systolic and diastolic blood pressure. Many investigators have earlier reported the significant positive correlation of BMI with systolic and diastolic blood pressure.[18-20] Dalton et al. found that BMI, WC, and WHR were equally related with hypertension.[21] Lear et al. reported better correlations of BMI and WC with blood pressure than that of WHR.[22] In contrast, Pavey et al. reported WC, and not BMI, to explain obesity-related health risk including hypertension.[23]

In the present study, we detected BMI and WC as the significant predictors of both systolic and diastolic blood pressure. BMI and WHR were also found to have independent associations with systolic/diastolic blood pressure. Chobanian et al. reported that waist to height ratio was a better obesity index than BMI and WHR for predicting hypertension.[9] Similarly, Tesfaye et al. suggested that waist to height ratio may be a better indicator for screening obesity-related cardiovascular disease risk factors including blood pressure than BMI, WC, and WHR.[24] Colin et al. indicated that BMI, WC, and WHR were all positively associated with risk of coronary heart disease in Chinese women.[25]

Table 2. Prevalence of overweight/obesity based on different anthropometric indicators

Anthropometric indicators	n (%)	Sensitivity (95% confidence interval)
BMI (kg/m2)		
< 18.5	56 (40%)	
18.5-25.9	63 (45%)	0.831 (0.809-0.850)
26-29	13 (9%)	
> 29	9 (6%)	
Waist circumference		
< 80	131 (92%)	0.591 (0.571-0.611)
≥ 80	11 (8%)	
Waist hip circumference ratio		
< 0.80	102 (72%)	0.698 (0.645-0.751)
≥ 0.80	40 (28%)	

Table 3. Anthropometric indices in normotensive and hypertensive individuals

Parameter	Normotensive group	Hypertensive group
Body mass index	20.7 ± 3.1	23.1 ± 5.8*
Waist to hip ratio	0.76 ± 0.95	0.80 ± 0.20*
Waist circumference	65.1 ± 11.3	70.1 ± 12.3*

*P < 0.001 compared to the normotensive group

Our findings showed a significant trend of increased prevalence of hypertension with increased BMI, WC, and WHR. However, WC was the best predictor for hypertension among our participants. Visscher et al. reported similar findings.[26] Increased BMI is associated with increased blood pressure. In fact, higher body weight and thus BMI are related with increases in body fluid volume and cardiac output. In addition, peripheral resistance will also increase since hyperinsulinemia, cell membrane alteration, and hyperactivity of the rennin-angiotensin system lead to functional constriction and structural hypertrophy.[27] The positive correlations between WC and WHR and the prevalence of hypertension could be explained by an increase in visceral fat that in turn increases leptin and insulin resistance and worsens lipid profile.[28] Self-measurements of WC and WHR are relatively simple and repeatable. Moreover, measuring techniques in this study have been found to be acceptable in recent epidemiologic studies.[29] Further studies are needed to determine whether WC and WHR are as sensitive as BMI in predicting other pregnancy complications of maternal obesity such as macrosomia, cesarean delivery, and neural tube defects. If the efficacy of WC and WHR is established, they could form the basis of health promotion programs that aim to raise public awareness about the importance of weight reduction for women planning to be pregnant.

Conclusion

In this study, WC was the best predictor of hypertension. BMI and WHR were also good predictors of hypertension. We recommend that not only BMI but also WC should be routinely measured in clinical settings during the first prenatal care.

Conflict of Interests

Authors have no conflict of interests.

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