Correlation between anthropometric measurements and hypertension in Oman

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Abstract

Introduction: Evidence that hypertension is related to increase in body fat is well established in literature. Evidence gathered from several studies shows that central obesity is a greater risk factor for cardiovascular diseases. Oman has witnessed an epidemiological transition to non-communicable diseases.

Objectives: The objective of the study was to examine the correlation between different anthropometric indicators and hypertension in Omani adults.

Materials and Methods: A total of 500 adults participated in this study after taking informed consent from them. All participants underwent blood pressure and anthropometric measurements using standard procedures. The population study was separated in males and females and the effect of anthropometric measurements was compared for normotensive and hypertensive population. Correlation of anthropometric measurements with mean systolic and diastolic blood pressure was observed.

Results: Mean values of all anthropometric measurements were significantly higher in hypertensive compared to people with normal blood pressure across both the gender. In both males and females; hip circumference, waist circumference, waist height ratio and BMI had significant strong positive correlation with mean systolic blood pressure ($p < 0.01$). Females had significant strong positive correlation of all anthropometric measurements with diastolic blood pressure ($p < 0.01$); hip circumference ($r = 0.310$), waist circumference ($r = 0.283$), body mass index ($r = 0.273$), waist height ratio ($r = 0.260$). However, in males only waist circumference and hip circumference had significant but weak positive correlation with diastolic blood pressure ($p < 0.05$). The AUC for predicting hypertension for all anthropometric indicators was significantly more than 0.7 ($p < 0.01$).

Conclusion: Simple anthropometric measurements like hip circumference, waist circumference and waist height ratio can be used to predict hypertension in both males and females.

Keywords: Hip circumference, AUC, Correlation, Body mass index, Hypertension.

Introduction

The prevalence of obesity has reached epidemic proportions in both industrialized and developing countries; urban and rural communities alike. Evidence that hypertension is related to increases in body fat is well established in literature.[1,2] However, there are controversial opinions on their relationship with the distribution of body fat. To discriminate the amount of body fat and its distribution, anthropometric indicators have proven to be effective, especially in epidemiological studies with larger samples. Evidence gathered from several studies shows that central obesity is a greater risk factor for cardiovascular diseases compared to other types of obesity.[3] While the body mass index predicts the overall fat, waist circumference identifies the fat located in the central region of the body; waist height ratio considers the proportion of central fat by the individual's height. This has led investigators to use various anthropometric measurements such as waist circumference, waist height ratio, hip circumference, total body fat and skin fold thickness to establish which of these variables would show better association with cardiovascular diseases or help predict risk.[4,5] Several epidemiological studies from different populations have reported significant association between different anthropometric indicators and blood pressure levels.[6-10] Among the anthropometric indicators, BMI and waist circumference have been widely used in the detection of cardiovascular risk factors.[11] Currently, some studies especially in Asian populations, have used waist height ratio to predict central fat and associated risk factors.[12]

Oman has witnessed an epidemiological transition to non-communicable diseases possibly due to number of factors including changes in lifestyle together with demographic changes as evident by aging of the population. Non-communicable diseases contributed 42.5% of the outpatient morbidity in 1996 compared to 47.6% in 2015. Cardiovascular diseases are the leading cause of deaths; hypertension, hypercholesterolemia, obesity and diabetes are on the rise. The prevalence of hypertension has increased from 32% in 2000 to 40% in 2008.[13] Overweight and obesity in Oman are present in 30% and 20% adults respectively and is known risk factor for cardiovascular risk. The present study was therefore undertaken with the objective to examine the correlation between different anthropometric indicators and hypertension in Omani adults.

Materials and Methods

A total of 500 adults participated in this study after taking informed consent from them. The participants were visitors attending the polyclinic in South Batinah governorate; research was approved by the Ministry of Health, Oman. All participants underwent blood pressure and anthropometric measurements. After about 10 min of quiet sitting, three readings of blood pressure were taken at intervals of 3 to 5 minutes using mercury sphygmomanometer. The mean blood pressure value was

used for analysis. Based on the WHO and International Society of Hypertension guidelines; a cutoff point of 140/90 mmHg for hypertension was used.[14] Participants with blood pressure value less than or equal to 140/90 mmHg were considered normotensive while those with higher values or who reported to be on new antihypertensive medications were classified as hypertensive. Weight and height were measured with Detecto scale. The body mass index (BMI) was calculated as Weight/Height^2 (kg/m^2)). A non-elastic measuring tape was used to determine waist circumference at the smallest diameter of the waist and hip circumference at the widest diameter of the buttocks.[15] Participants were advised to stand erect with both feet together, arms at the side and not retract abdomen during measurement. All measurements were recorded to the nearest centimeter. Waist height ratio was calculated by dividing waist circumference in centimeter by height in centimeter.

Data was entered and analyzed in SPSS version 22. Mean and standard error was calculated for anthropometric measurements in normotensive and hypertensive population after separating the population into males and females. For comparing means in two groups, independent student's t test was used as the test of significance. Partial correlation coefficients after adjusting for age were calculated to see correlation between anthropometric measurements and mean systolic and diastolic blood pressure values. ROC curve analysis was done to find out the Area under the curve (AUC); in order to see how well the test separates the group being tested into those with and without hypertension. A p value of less than 0.05 was interpreted as a statistically significant test.

Results

Out of 500 participants who were recruited in the study, 147 were females and 353 were males. Mean age of participants was 44 years; females had a significantly higher mean age than males (p<0.01). Mean weight of participants was 71.8kg; males had a significantly higher mean weight than females (p<0.01). Females on the other hand had significantly higher mean waist height ratio than males (p<0.05). Mean systolic blood pressure was 130.9mmHg and was same for both the genders. Mean diastolic blood pressure was 85.5mmHg, mean BMI was 27.1, mean waist circumference was 90.9cm, and mean hip circumference was 105.2cm; however these parameters were not statistically different across both the genders (Table 1).

The differences in anthropometric measurements between normotensive and hypertensive population were explored in Table 2. Mean values of waist circumference and hip circumference were significantly higher in hypertensive compared to people with normal blood pressure across both the gender (p<0.01). Waist height ratio and body mass index was also significantly higher in male hypertensive population (p<0.01) but the difference was not significant for females.

Relationship of anthropometric measurements (BMI, waist circumference, hip circumference, waist height ratio) with both mean systolic blood pressure and mean diastolic blood pressure was explored by partial correlation coefficients controlled for age (Table 3). In both males and females, all the anthropometric measurements had significant strong positive correlation with mean systolic blood pressure (p<0.01). Hip circumference had the strongest correlation, (r = 0.363 in males, r = 0.341 in females). With mean systolic blood pressure, the next strongest correlation was with body mass index in females while in males it was with waist circumference. Females had significant strong positive correlation of all anthropometric measurements with diastolic blood pressure (p<0.01). Hip circumference (r = 0.310) had the strongest correlation followed by waist circumference (r = 0.283) and then body mass index (r =0.273). However, in males only waist circumference and hip circumference had significant but weak positive correlation with diastolic blood pressure (p<0.05); while waist height ratio (r = 0.105) and BMI (r = 0.093) did not have a significant correlation (p>0.05) with diastolic blood pressure.

Receiver operating characteristic curves (ROC) analysis of anthropometric measurements with hypertension is shown in Table 4. Area under the curve (AUC) was used to indicate the degree of accuracy in prediction of hypertension from anthropometric measurements. AUC more than 0.5 indicates positive predictive power of studied variables. All the anthropometric measurements showed significant predictive ability to discriminate hypertensive from normotensive population (p<0.001). Hip circumference had the best predictive ability (AUC = 0.724 in females, AUC = 0.708 in males) followed by waist height ratio and then waist circumference in both males and females (Fig. 1 & 2). BMI had the least AUC. AUC was significantly higher in females than males for all anthropometric measurements.

Table 1: Descriptive characteristics of study population

Variable	Females (Mean ± S.E)	Males (Mean ± S.E)
Age (years)	48.52 ± 1.53	42.36 ± 0.97
Mean SBP (mmHg)	130.89 ± 1.21	130.92 ± 0.70
Mean DBP (mmHg)	84.09 ± 0.82	86.12 ± 0.98
Waist circumference (cm)	90.84 ± 1.81	91.03 ± 0.92
Hip circumference (cm)	106.44 ± 1.94	104.70 ± 1.04
Waist height ratio	0.58 ± 0.01	0.55 ± 0.01
Weight (kg)	67.25 ± 1.24	73.68 ± 0.75
Body mass index (kg/m^2)	27.05 ± 0.47	27.12 ± 0.29

Table 2: Anthropometric indicators of hypertensive vs normotensive study population

| Variable	Females			Males		
	Normotensive (Mean ± S.E)	Hypertensive (Mean ± S.E)	p value	Normotensive (Mean ± S.E)	Hypertensive (Mean ± S.E)	p value
Waist circumference	85.05 ± 1.74	101.12 ± 3.57	0.010	86.51 ± 0.99	97.13 ± 1.57	0.000
Hip circumference	99.38 ± 1.78	118.95 ± 3.82	0.004	98.76 ± 1.09	112.73 ± 1.77	0.000
Waist height ratio	0.54 ±0.01	0.64 ± 0.02	0.218	0.52 ± 0.01	0.59 ± 0.01	0.000
Body mass index	25.74 ± 0.59	29.34 ± 0.66	0.829	26.00 ± 0.31	28.62 ± 0.51	0.002

(Waist circumference and Hip circumference are expressed in cm; BMI in kg/m^2)

Table 3: Partial correlation coefficients between anthropometric indicators and blood pressure controlled for age

Variable	SBP				DBP			
	Females		Males		Females		Males	
	r	p value	r	p value	r	p value	r	p value
Waist circumference	0.275	0.001	0.299	0.000	0.283	0.001	0.123	0.022
Hip circumference	0.363	0.000	0.341	0.000	0.310	0.000	0.137	0.010
Waist height ratio	0.279	0.001	0.276	0.000	0.260	0.002	0.105	.050
Body mass index	0.282	0.001	0.231	0.000	0.273	0.001	0.093	0.082

Table 4: ROC curve analysis of anthropometric indicators and hypertension

Variable	Females			Males		
	AUC	95% CI	p value	AUC	95% CI	p value
Waist circumference	0.705	0.614-0.796	0.000	0.683	0.625-0.741	0.000
Hip circumference	0.724	0.638-0.811	0.000	0.708	0.652-0.764	0.000
Waist height ratio	0.707	0.619-0.794	0.000	0.685	0.625-0.744	0.000
Body mass index	0.703	0.615-0.791	0.000	0.665	0.607-0.724	0.000
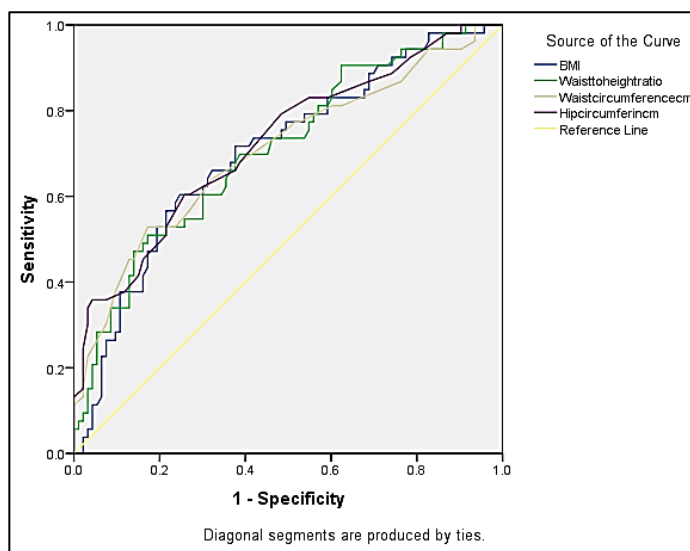
Fig. 1: ROC Curve for females
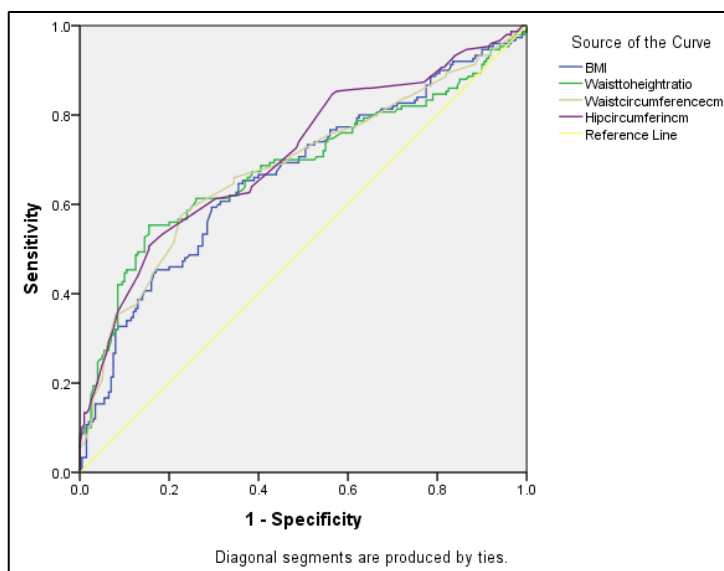
Fig. 2: ROC curve for males

Discussion

It is of utmost importance to determine valid anthropometric measurements that may be useful for predicting obesity related cardiovascular disease risk in adults. The present study showed that all the studied anthropometric indicators had good predictive ability for higher blood pressure (p<0.001) as seen from the area under the ROC curve. However the best predictor was hip circumference followed by waist circumference and then hip circumference in both males and females; BMI had the least AUC. Similar findings were seen in the study by Maken et al who observed that BMI did not show a very good area under the ROC curve; waist height ratio was the best predictor, followed by waist circumference among males; among females, waist height ratio was the best predictor, followed by waist circumference and body mass index.[16] In another study, in males only waist circumference (AUC=0.676) and waist height ratio (AUC=0.658) showed significant ability to discriminate higher blood pressure while in females all four anthropometric indicators (AUC>0.7) were significant.[17] In another study conducted in Oman, the BMI (AUC = 0.766) and waist circumference (AUC = 0.772) predicted prevalent CVD risk factors equally well.[18]

The mean waist circumference of the population was 90.9cm, hip circumference was 105.2cm and body mass index was 27.1cm in the present study which is in accordance with the findings by Riyami et al in Oman survey which showed high mean values of waist circumference and hip circumference.[19] In the present study mean values of all anthropometric measurements were significantly higher in hypertensive males; however in females only waist circumference and hip circumference had statistically significantly higher mean values. Different studies reported increased BMI and waist circumference increased the risk of high systolic and diastolic blood pressure.[20,21] Doll et al found a linear relation between systolic and diastolic blood pressure with BMI, waist hip circumference ratio and waist circumference.[22]

The present study found a significant correlation between all anthropometric indicators and mean systolic and diastolic blood pressure in females and males; except that in males only hip and waist circumference were significantly associated with diastolic blood pressure. Maximum correlation was seen with hip circumference and waist circumference. BMI correlated less with both mean systolic and diastolic blood pressure across both gender even though the mean BMI of hypertensive was higher than normotensive. Janssen et al reported waist circumference and not BMI explains obesity related health risk including hypertension.[23] In contrast to these findings Gus et al reported that body mass index is associated with hypertension in both the genders.[24]

In a South African study, there was significant correlation in females between mean systolic blood pressure and waist circumference (r=0.360), hip circumference (r=0.292); mean diastolic blood pressure and waist circumference (r=0.216); while in males only weak and nonsignificant correlations were noted. Similar to the present study their hypertension status correlated less well with BMI.[17] Choy et al, showed an association between increased waist circumference and raised blood pressure.[25] Dalton et al reported that BMI, waist circumference and waist-hip ratio were equally related with hypertension.[26] Several studies have shown that a larger hip circumference is protective against hypertension and metabolic diseases.[16] Studies have demonstrated that without controlling for BMI or waist circumference, hip circumference was associated with higher blood pressure in females.[17]

Conclusion

Mean values of waist circumference, hip circumference, waist height ratio and BMI were significantly higher in hypertensive compared to people with normal blood pressure across both the gender. There was positive

correlation between all anthropometric indicators and systolic as well as diastolic blood pressure. However the best predictor was hip circumference followed by waist circumference and then hip circumference in both males and females. Higher values of hip and waist circumference being modestly associated with hypertension, highlights the importance of using these simple anthropometric measurements to predict hypertension in both males and females. It also emphasizes the importance of weight reduction as an effective method of preventing and controlling hypertension in Omani adults.

Acknowledgements

Conflict of Interest: Nil.

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