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RESEARCH ARTICLE

WAIST-RELATED ANTHROPOMETRIC MEASURES: SIMPLE AND USEFUL PREDICTORS OF CORONARY HEART DISEASE IN WOMEN

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Background: Waist circumference (WC) (abdominal girth), a measure of both subcutaneous and visceral fats, is easily measured and also correlated with body frame size. Waist circumference (WC) and waist–hip ratio (WHR), but not body mass index (BMI), have also been identified as independent predictors of CVD risk, accounting for conventional risk factors in the Framingham risk score model.
Aims & Objective: To compare waist-related anthropometric measures such as waist circumference, waist–height ratio (WHtR), waist–hip ratio (WHR), and body mass index (BMI) as predictors of coronary heart disease (CHD) in women.
Materials and Methods: This prospective study included 88 women aged 40–80 years. Waist circumference, hip circumference, height, weight, age, and other covariates were collected by a questionnaire. The primary end point was incident CHD that was reported by a physician. χ^2-Test or Student's *t*-test was used for comparison of quantitative data. The significance of the results was determined by 95% CI and a p value <0.05 was considered to be statistically significant.
Results: The mean age of the women was 59.07 ± 11.53 in the study group and 54.36 ± 10.84 in the control group. The waist circumference of the women in the study group was higher (95.443 ± 11.187) than that of the control group (74.886 ± 6.672) ($p < 0.001$). The mean WHR was 0.96 ± 0.08 in the study group and 0.78 ± 0.06 in the control group ($p < 0.001$). The mean WHtR was 0.62 ± 0.07 in the study group and 0.48 ± 0.04 in the control group ($p < 0.001$). Waist-derived measures were superior to BMI in predicting CHD. The unadjusted area under the ROC curve was 0.008 (95% confidence interval (CI) 0.006–0.095) for WHtR, 0.001 (95% CI 0.00–0.002) for WHR, and 1 (95% CI 0.323–1.766) for BMI.
Conclusion: Waist-related anthropometric measures are important predictors of CVD risk among middle-aged and older women, as compared to BMI.

INTRODUCTION

Vague[1] was the first author to observe that women with android obesity had a high prevalence of diabetes and atherosclerosis. Overweight and obesity are the leading risk factors for mortality, estimated to account for 23% of the ischemic heart disease burden.[2] Greater abdominal adiposity is strongly associated with insulin resistance, dyslipidemia, and systematic inflammation, which play essential role in the pathogenesis of cardiovascular disease (CVD), metabolic syndrome, and certain type of cancers.[3,4]

Currently used general and central obesity anthropometric measures for assessing adiposity-related risk include body mass index [BMI; weight (kg) divided by square of height (m)], waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), and waist–height ratio (WHtR).

However, the relative utility of various anthropometric measures in assessing cardiovascular risk remains unclear.[5] WC (abdominal girth), a measure of both subcutaneous and visceral fats, is easily measured and also correlated with body frame size. WC and WHR, but not BMI, have also been identified as independent predictors of CVD risk, accounting for conventional risk factors in the Framingham risk score model.[6] Since height is a measure of body frame size, the WHtR has been proposed as an alternative to the WHR and has been found to be slightly superior in terms of the prediction of metabolic disturbances among rural Bangladeshi women.[7]

Among Japanese men and women,[8] WHtR has an added advantage over isolated WC measurement because its adjustment for height allows establishment of a single, population-wide cutoff point that remains applicable regardless of gender, age, and ethnicity.[9]

This study was designed to evaluate and compare these anthropometric measures in a population of middle-aged and elderly women as a predictor of coronary heart disease (CHD; angina pectoris, unstable angina, and acute myocardial infarction).

MATERIALS AND METHODS

For this study, ethics approval was obtained from the relevant institutional ethics committee. A written informed consent was acquired from each participant before enrollment.

This study was conducted on the patients who attended medical outpatient department of Maharishi Markandeshwar Medical College and Hospital, Kumarhatti, Solan, Himachal Pradesh, India.

Study group included 44 patients with diagnosed coronary artery disease, including those with angina pectoris, unstable angina, and acute myocardial infarction, who were examined anthropometrically. Patients with known risk factors such as smoking, hypertension, and diabetes mellitus were excluded from this study. BMI, WHR, and WHtR of these patients were calculated along with age as a variable. These data were compared with those of 44 healthy women (control group). This study involved women aged 40 years and over.

A detailed history was taken to ascertain the presence of coronary artery disease in all cases. Information regarding family history and medical history was also obtained to rule out smoking, hypertension, and diabetes mellitus.

The clinical examination carried out included general physical examination along with local examination for cardiovascular system, chest, and abdomen to rule out any abnormal finding. Electrocardiography was carried out to diagnose coronary artery disease cases and healthy individuals. Diabetes mellitus was ruled out by assessing blood sugar levels.

Anthropometrical examinations for height, weight, and WC were carried out for both coronary artery disease cases and healthy women. Weight was taken without shoes; it was in kilograms. Height was measured in standing position without shoes. Waist was measured at narrowest point between lower rib and iliac crest. It was measured in centimeters. HC was taken in centimeters at the point yielding the maximum circumference around the buttocks.

BMI range criteria were ≤25 kg/m^2 as normal, 25–30 kg/m^2 as overweight, and >30 kg/m^2 as obese. BMI was calculated as follows:
BMI = Weight (kg)/ Height (m^2)

WHR was calculated as follows:
WHR = Waist circumference (cm)/Hip circumference (cm)

In our study, we considered women with a WHR > 0.85 as centrally obese and those with WHR < 0.85 as nonobese. WHtR was computed as the ratio of waist circumference to height (both in cm). Abdominal obesity was defined as WHtR ≥0.55.

Analyses were performed using SAS software. χ^2-Test or Student's *t*-test was used for comparing quantitative data. The significance of the results was determined by 95% CI and a p value <0.05 was considered to be statistically significant.

RESULTS

Study group included 44 patients diagnosed with coronary artery disease, including those with angina pectoris, unstable angina, and acute myocardial infarction, who were examined anthropometrically. Patients with known risk factors such as smoking, hypertension, and diabetes mellitus were excluded from this study. BMI, WHR, and WHtR of these patients were calculated along with age as a variable. These data were compared with those of 44 healthy women (control group). This study involved women aged 40 years and over.

The mean age of the women was 59.07 ± 11.53 in the study group and 54.36 ± 10.84 in the control group. The mean weight was found to be more in the study group when compared that of the control group (p < 0.05). The WC in the study group was higher than that of the control group (p < 0.001) (Table 1).

Age Distribution

Female patients with age 40 years and over were included in the study. They were divided into four age groups (≤50, 51–60, 61–70, and >70 years), least number of cases were reported in the women aged 70 years or older. The mean age the study group was 59.07±11.53 years. Among patients with CAD, 34.1% were in the age group of 51–60 years, as shown in Table 2.

Table 1: Distribution of Various Anthropometric Measures Among Women Population (*n* = 88)

Character	Study Population (Mean ± SD)	Control Population (Mean ± SD)	Significance
Age (years)	59.07 ± 11.53	54.36 ± 10.84	0.052
Weight (kg)	63.614 ± 11.477	58.057 ± 8.140	0.0104 *
Height (cm)	1.539 ± 0.05593	1.536 ± 0.05205	0.7982
Waist circumference (cm)	95.443 ± 11.187	74.886 ± 6.672	<0.0001**
Hip circumference (cm)	99.284 ±9.653	96.068 ± 7.125	0.0789
BMI (kg/m^2)	26.75 ± 4.22	24.72 ± 3.61	0.017*
Waist–hip ratio	0.96 ± 0.08	0.78 ± 0.06	<0.001**
Waist–height ratio	0.62 ± 0.07	0.48 ± 0.04	<0.001**

** Significant; ** Highly significant*

Table 2: Age distribution in the study and control population

Age (years)	Study Group	Control Group	*p*-Value
≤50	11 (25%)	18 (40.9%)	0.333
51–60	15 (34.1%)	15 (34.1%)	
61–70	12 (27.3%)	7 (15.9%)	
>70	6 (13.6%)	4 (9.1%)	
≤50	11 (25%)	18 (40.9%)	0.112
>50	33 (75%)	26 (59.1%)	
Mean ± SD	59.07 ± 11.53	54.36 ± 10.84	0.052

Table 3: Comparison of weight (kg) between groups (*n* = 88)

Age (years)	Weight (kg)		*p*-Value
	Study Group	Control Group	
≤50	66.364 ± 11.325	58.944 ± 8.242	0.0512
51–60	64.867 ± 13.271	61.308 ± 6.933	0.3932
61–70	60.833 ± 9.759	49.857 ± 7.883	0.0218*
>70	57.167 ± 11.444	58.000 ± 6.377	0.8990

** Significant*

Table 4: Comparison of waist circumference (cm) between two groups (*n* = 88)

Age (years)	Waist Circumference (cm)		*p*-Value
	Study Group	Control Group	
≤50	98.136 ± 9.225	73.389 ± 6.213	<0.0001***
51–60	97.600 ± 10.343	76.385 ± 8.170	<0.0001***
61–70	94.417 ± 12.413	73.714 ± 5.823	<0.0001***
>70	85.833 ± 10.778	77.750 ± 3.403	0.1913

**** Extremely significant*

Table 5: Comparison of BMI between two groups (*n* = 88)

BMI	Study Group	Control Group	OR	95% CI	χ^2-/*t*-test	*p*-Value
<25	17 (38.6%)	20 (45.5%)	0.756	0.323–1.766	0.420	0.517
≥25	27 (61.4%)	24 (54.5%)				
Mean ± SD	26.75 ± 4.22	24.72 ± 3.61			2.424	0.017*
Range	17.80–35.49	17.60–33.33				

** p < 0.05; significant*

Table 6: Comparison of Waist–Hip Ratio (WHR) between two groups (*n* = 88)

BMI	Study Group	Control Group	OR	95% CI	χ^2-/*t*-test	*p*-Value
<25	4 (9.1%)	40 (90.9%)	0.010	0.00–0.002	58.909	<0.001*
≥25	40 (90.9%)	4 (9.1%)				
Mean ± SD	0.96 ± 0.08	0.78 ± 0.06			11.857	<0.001*
Range	0.78–1.12	0.66–0.91				

*** Highly significant*

The central obesity is an important factor for CVD, which depends on weight measurement. In our study, more obese people were in the age group of 40–50 (66.364 ± 11.32). Cardiovascular risk increases as the age advances. In this study, more people had CHD in the age group of 61–70 than control group ($p < 0.05$, significant), as shown in Table 3.

Table 7: Comparison of Waist–Height Ratio (WHtR) between two groups (*n* = 88)

BMI	Study Group	Control Group	OR	95% CI	χ^2-/*t*-test	*p*-Value
<25	11 (25%)	41 (93.2%)	0.024	0.006–0.095	42.308	<0.001*
≥25	33 (75%)	3 (6.8%)				
Mean ± SD	0.62 ± 0.07	0.48 ± 0.04			10.551	<0.001*
Range	0.45–0.72	0.39–0.57				

*** Highly significant*

Waist circumference was found to be higher for all age groups in the study group than in the control group, as shown in Table 4 ($p < 0.0001$).

The mean BMI was 26.75 ± 4.22 in the study group with the mean range of 17.80–35.49 and 24.72 ± 3.61 in the control group with the mean range of 17.60–33.33 ($p < 0.05$, significant). More patients were in the study group with BMI ≥25 (61.4%), as shown in Table 5.

The mean WHR was 0.96 ± 0.08 in the study group and 0.78 ± 0.06 in the control group with the mean range of 0.66–0.9 ($p < 0.001$, highly significant). The odd ratio is 0.010, as shown in Table 6. The percentage of patients with a WHR of >0.85 was higher in study group than in control group (90.9% vs 9.1%) ($p < 0.001$).

The mean WHtR was 0.62 ± 0.07 in the study group and 0.48 ± 0.04 in the control group ($p < 0.001$, highly significant). The odd ratio is 0.024, as shown in Table 7. Here also the percentage of patients with WHtR of ≥0.55 is higher in the study group in than control group (75% vs 6.8%).

DISCUSSION

In this study, anthropometric measurements of central obesity (WC, WHR, and WHtR) were found to be strongly associated with conventional CVD risk factors or measures of general obesity, such as BMI, in a sample of female subjects.

Central obesity measures such as WC show higher sensitivity and specificity than BMI. Although BMI was included in the calculation of the CVD risk factor, high area under the ROC curves was reported for WHR and

WHtR, confirming that anthropometric measure of central obesity independently and significantly predicts CVD risk that is not accounted for by the general obesity measure. Hence, BMI alone is insufficient to account for the association between obesity and CVD risk.

Some studies have reported that the association between BMI and CVD was similar to measures of central obesity.[10,11] There are several possible explanations that support our study findings confirming that measures of central obesity are better predictors of CVD risk than BMI. Greater central obesity is associated with systemic inflammation that directly contributes to CVD risk.[12] Hence, measures that account for the accumulation of excess abdominal fat would report stronger associations and are desirable for assessing adiposity. In addition to central obesity measures, BMI has also been shown to improve the accuracy of stratifying participants into categories for lower and higher risk for mortality.[13,14] BMI does not correctly identify individuals with excess body fat due to its inability to differentiate fat and fat-free mass, and it does not account for the effect of age and ethnicity on body fat distribution.[15,16]

Some studies have recommended the use of WC measurement in clinical assessment. In a systematic review and meta-analysis study of Caucasians without CVD, WC was found to be highly correlated with all CVD risk factors, compared with BMI, WHR, WHtR, and body fat percentage in women.[17,18] In other studies, WC was also found to be more closely associated with CVD risk factors than other measures of central obesity and BMI in women.[19] The use of WC is advantageous as it is easy to measure and interpret, and it is less prone to measurement and calculation errors.[18]

The use of WHR is also supported by the fact that it is a more specific surrogate for fat distribution. A longitudinal population study on 1462 women from Sweden reported stronger relations between WHR and CVD end points, compared with BMI, WC, and HC.[20] Elevated WHR was also independently associated with a higher CVD risk in the Nurses' Health Study and in the Swedish Women's Lifestyle and Health Cohort Study.[21] The advantages of WHR include low measurement error, high precision, and no bias over a wide range of ethnic groups.[22]

In contrast, WHtR was highly correlated with CHD risk in women from England, compared with BMI, WC, and WHR in another study.[23] The advantage of WHtR is that the same cutpoint could be applied across a wide range of populations. A cutoff value of 0.5 indicates increased risk for men and women and people of different ethnic groups, and this value may also be used in children and adults, unlike WC that requires different cutoffs.[24]

CONCLUSION

Central obesity is more strongly associated with CVD risk than general obesity. The deposition of adipose tissue is associated with systemic inflammation, which has a direct effect on CVD risk. When used alone, BMI is inadequate for identifying individuals at increased risk of CVD as it does not differentiate between fat and fat-free mass. However, anthropometric measurements of central obesity have higher sensitivity and specificity. These measures are also more sensitive to lifestyle-related modifications and should be incorporated into the assessment of CVD risk factors, particularly when assessing the risk in women and the elderly. Treatment of well-established CVD risk factors coupled with reducing overweight and obesity through lifestyle-related modifications is advisable in the primary prevention of CVD. It is equally important to maintain a healthy weight and to prevent central or abdominal obesity concurrently.

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