Int J Physiol Pathophysiol Pharmacol 2014;6(4):216-220
www.ijppp.org /ISSN:1944-8171/IJPPP0001530

Original Article

Waist related anthropometric measures - simple and useful predictors of coronary artery disease in women

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Received July 24, 2014; Accepted October 1, 2014; Epub December 15, 2014; Published December 31, 2014

Abstract: Aim: To compare the waist related anthropometric measures like waist circumference, waist-to-height ratio (WHtR), waist – hip ratio (WHR) and body mass index (BMI) as predictors of coronary artery disease (CAD) in women. Methods: The study included 88 women aged 40-80 years. Waist circumference, hip circumference, height, weight, age, and other covariates were collected by questionnaire. The primary endpoint was incident coronary heart disease that was reported by physician. The data was analyzed statistically using χ^2-test for quantitative data and student t-test. The significance of the results as determined in 95.0% confidence interval. Results: The mean age was 59.07 ± 11.53 in the study group and 54.36 ± 10.84 in the control group. The waist circumference in the study group was higher (95.443 ± 11.187) than the control group (74.886 ± 6.672) ($p < 0.001$). The mean waist to hip ratio (WHR) was 0.96 ± 0.08 in the study group and 0.78 ± 0.06 in the control group ($p < 0.001$). The mean waist to height ratio (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 CAD. The unadjusted AUC (95% Confidence Interval) was 0.008 (0.006-0.095) for WHtR, 0.001 (0.00 0.002) for waist – hip ratio, and 1 (0.323-1.766) for body mass index. Conclusion: Waist related anthropometric measures are important predictors as CAD risk factors among middle-aged and older women, as compared to BMI.

Keywords: Waist cicumference, waist – hip ratio, waist to height ratio, body-mass index, CAD risk factors

Introduction

Vague was the first to observe that women with android obesity had a high prevalence of diabetes and atherosclerosis [1]. Overweight and obesity is one of the leading risk factors for mortality, estimated to account for 23% of the ischaemic heart disease burden [2].

Greater abdominal adiposity is strongly associated with insulin resistance, dyslipidemia, and systematic inflammation, which play essential roles in the pathogenesis of cardiovascular disease (CVD), metabolic syndrome, and certain cancers [3, 4].

Currently used general and central obesity anthropometric measures for assessing adiposity-related risk include: body mass index (BMI; weight in kilograms divided by square of height in meters), waist circumference (WC), hip circumference (HC), waist-to-hip ratio (WHR; ratio of WC to HC), waist-to-height ratio (WHtR; ratio of WC to height).

However, the relative utility of various anthropometric measures in assessing cardiovascular risk remains unclear [5]. Waist circumference (abdominal girth), a measure of both subcutaneous and visceral fat, is easily measured and also correlated with body frame size. WC and WHR have also been identified as independent predictors of CVD risk but not BMI, accounting for conventional risk factors in the Framingham risk score model [6]. Since height is a measure of body frame size, the waist circumference-to-height ratio (WHtR) has been proposed as an alternative to the waist – hip ratio, and has been found to be slightly superior in terms of the prediction of metabolic disturbances among rural Bangladeshi women, Japanese men and women [7, 8].

WHtR has an added advantage over isolated waist circumference 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 and elderly women as a predictor of coronary artery disease (angina pectoris, unstable angina and acute myocardial infarction).

Material and method

Ethics Statement: Ethics approval was obtained from the Institutional Ethic Committee. A written informed consent was acquired from each participant prior to enrollment. This study was conducted on the patients who attended medical outpatient department of Maharishi Markandeshwar Medical College and Hospital, Kumarhatti , Solan, H.P.

Study group included forty four diagnosed patients of coronary artery disease including those of angina pectoris, unstable angina and acute myocardial infarction were examined anthropometrically. Patients with known risk factors like smoking, hypertension and diabetes mellitus were excluded from this study. Body mass index and waist hip ratio and waist height ratio of these patients were calculated along with the variable of the age. This was compared with those of forty four healthy women considered as control group. This study involved age group of 40 yrs and above.

A detailed history was taken to ascertain the presence of coronary artery disease in all cases. Family history and history to rule out smoking, hypertension and diabetes mellitus was also asked.

The clinical examination was done to include general physical examination along with the local examination for cardiovascular system, chest and per abdomen examination to rule out any abnormal finding. Electrocardiography was done for diagnosis of coronary artery disease cases and healthy individuals. Diabetes mellitus was ruled out by blood sugar level.

Anthropometrical examination for height, weight, waist circumference was done 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. Hip circumference was taken in centimeters as circumference of hip at maximum point for buttocks.

Body mass index was calculated as body weight in kg divided by squares of height in meters (kg/m^2). Body mass index range criteria was followed as upto less than 25 kg/m^2 as normal, 25-30 kg/m^2 as overweight and more than 30 kg/m^2 as obese.

B.M.I = weight in kilograms/Square of height in meters.

Waist hip ratio calculated by dividing waist circumference in centimeters by hip circumference in centimeters.

Waist hip ratio = waist circumference in centimeters/hip circumference in centimeters.

In our study, we had followed the criteria of Waist hip ratio more than 0.85 for centrally obese women and < 0.85 for non-obese women.

WHtR was computed as the ratio of waist circumference to height (both in cm). The criterion of abdominal obesity was defined as WHtR $\geq$ 0.55.

Analyses was performed using SAS. The data was analyzed using χ^2-test for quantitative data and student t-test. The significance of the results as determined in 95.0% confidence interval and a value of $P < 0.05$ was considered to be statistically significant.

Results

Study group included forty four diagnosed patients of coronary artery disease including those of angina pectoris, unstable angina and acute myocardial infarction were examined anthropometrically. Patients with known risk factors like smoking, hypertension and diabetes mellitus were excluded from this study. Body mass index and waist hip ratio and waist height ratio of these patients were calculated along with the variable of the age. This was compared with those of forty four healthy women considered as control group. This study involved age group of 40 yrs and above.

The mean age was 59.07 ± 11.53 in the study group and 54.36 ± 10.84 in the control group. The mean weight was more in the study group as compared to control group ($p < 0.05$). The

waist circumference in the study group was higher than the control group ($p < 0.001$). (As shown in the Supplementary Table 1).

Age distribution

Age was taken 40 years and above. Patients were divided into 4 groups i.e. < 50, 51 60, 61 70, and above 70 yrs of age, least number of cases reported above 70 yrs of age. The mean age group of diseased women was 59.07 + 11.53. 34.1% of CAD patients were in the age group of 51-60 yrs of age group as shown in Supplementary Table 2.

The central obesity is an important factor for the cardiovascular disease for which weight consideration is an important part. In our study more obese people lie in the age group of 40-50 (66.364 + 11.32). Cardiovascular risks are increased on advanced age. Here in the age group of 61-70, more people experienced cardiac heart disease in study group than control group ($p < 0.05$ Significant) as shown in the Supplementary Table 3.

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 lie in the study group with the BMI > 25 (61.4%) as shown in the Supplementary Table 4.

The mean waist to hip ratio (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 was 0.010 as shown in the Supplementary Table 5. The percentage of patients with a waist to hip ratio (WHR) of > 0.85 was higher in study group than control group (90.9% vs 9.1%) ($p < 0.001$).

The mean waist to height ratio (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 was 0.024 as shown in the Supplementary Table 6. Here also the percentage of patients with WHtR of > 0.55 were more in the study group than control group (75% vs 6.8%) (Supplementary Table 7).

Discussion

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

Central obesity measures such as WC exhibited higher sensitivity and specificity than BMI. Although BMI was included in the calculation of the CAD risk factor, high area under the ROC curves were reported for WHR and WHtR, thus confirming that anthropometric measure of central obesity independently and significantly predicts CAD risk that is not accounted by the general obesity measure. Hence, BMI alone is insufficient to account for the association between obesity and CAD risk.

Some studies reported that the association between BMI and CAD was similar to measures of central obesity [10, 11]. There are several possible explanations for our study findings that measures of central obesity are better predictors of CAD risk than BMI. Greater central obesity is associated with systemic inflammation which directly contributes to CAD risk [12]. Hence, measures that account for the accumulation of excess abdominal fat would report stronger associations and are desirable for assessing adiposity. The addition of central obesity measures to BMI has also been shown to improve the accuracy of stratifying participants into lower and higher risk categories for mortality [13, 14].

BMI is a flawed measure as it 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 recommended the use of WC in clinical assessment and research studies. In a systematic review and meta-analysis study of Caucasians without CAD, WC was most highly correlated with all CAD risk factors, compared with BMI, WHR, WHtR and body fat percentage, in women [17, 18]. In other studies, waist circumference was also more closely associated with CAD risk factors than other measures of central obesity and BMI in women [19]. The advantages of WC are: it is easy to measure and interpret and it is less prone to measurement and calculation error [18].

The use of WHR is also supported as it is a more specific surrogate for fat distribution. A longitudinal population study on 1462 women

from Sweden reported stronger relations between WHR and CAD endpoints, compared with BMI, waist circumference and hip circumference [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 are: it has low measurement error, high precision and no bias over a wide range of ethnic groups [22].

In contrast, WHtR was most highly correlated with CHD risk in women from England, compared with BMI, waist circumference and WHR in another study [23]. The advantage of WHtR is that the same cut-point could be applied across a wide range of populations. A cut-off 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 waist circumference which requires different cut-offs [24].

Conclusion

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

Disclosure of conflict of interest

None.

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References

[1] Vague J. The degree of masculine differentiation of obesities: a factor determining predisposition to diabetes, atherosclerosis, gout, and uric calculous disease. Am J Clin Nutr 1956; 4: 20-34.

[2] World Health Organization. Obesity and overweight. Secondary obesity and overweight, 2012. Accessed from: accessed on (13/05/2014).

[3] Despres JP. Is visceral obesity the cause of the metabolic syndrome? Ann Med 2006; 38: 52-63.

[4] Calle EE, Kaaks R. Overweight, obesity and cancer: epidemiological evidence and proposed mechanisms. Nat Rev Cancer 2004; 4: 579-591.

[5] Cornier MA, Després JP, Davis N, Grossniklaus DA, Klein S, Lamarche B, Lopez-Jimenez F, Rao G, St-Onge MP, Towfighi A, Poirier P; American Heart Association Obesity Committee of the Council on Nutrition; Physical Activity and Metabolism; Council on Arteriosclerosis; Thrombosis and Vascular Biology; Council on Cardiovascular Disease in the Young; Council on Cardiovascular Radiology and Intervention; Council on Cardiovascular Nursing, Council on Epidemiology and Prevention; Council on the Kidney in Cardiovascular Disease, and Stroke Council. Assessing adiposity: a scientific statement from the American Heart Association. Circulation 2011; 124: 1996-2019.

[6] Dhaliwal SS, Welborn TA. Central obesity and multivariable cardiovascular risk as assessed by the Framingham prediction scores. Am J Cardiol 2009; 103: 1403-7.

[7] Flora MS, Taylor CM, Rahman M. Waist-to-height ratio and socio-demographic characteristics of bangladeshi adults. Ibrahim Med Coll J 2010; 4: 49-58.

[8] Hsieh SD, Yoshinaga H and Muto T. Waist-to-height ratio, a simple and practical index for assessing central fat distribution and metabolic risk in Japanese men and women. Int J Obes Relat Metab Disord 2003; 27: 610-616.

[9] Ashwell M, Hsieh SD. Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. Int J Food Sci Nutr 2005; 56: 303-7.

[10] Taylor AE, Ebrahim S, Ben-Shlomo Y, Martin RM, Whincup PH, Yarnell JW, Wannamethee SG, Lawlor DA. Comparison of the associations of body mass index and measures of central adiposity and fat mass with coronary heart disease, diabetes, and all-cause mortality: a study using data from 4 UK cohorts. Am J Clin Nutr 2010; 91: 547-56.

[11] van Dis I, Kromhout D, Geleijnse JM, Boer JM, Verschuren WM. Body mass index and waist circumference predict both 10-year nonfatal and fatal cardiovascular disease risk: study conducted in 20,000 Dutch men and women aged 20-65 years. Eur J Cardiovasc Prev Rehabil 2009; 16: 729-34.

[12] Berg AH, Scherer PE. Adipose tissue, inflammation, and cardiovascular disease. Circ Res 2005; 96: 939-49.

[13] De Koning L, Merchant AT, Pogue J, Anand SS. Waist circumference and waist-to-hip ratio as predictors of cardiovascular events: meta-regression analysis of prospective studies. Eur Heart J 2007; 28: 850-6.

[14] Dalton M, Cameron AJ, Zimmet PZ, Shaw JE, Jolley D, Dunstan DW, Welborn TA; AusDiab Steering Committee. Waist circumference, waist-hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian adults. J Intern Med 2003; 254: 555-63.

[15] Romero-Corral A, Somers VK, Sierra-Johnson J, Thomas RJ, Collazo-Clavell ML, Korinek J, Allison TG, Batsis JA, Sert-Kuniyoshi FH, Lopez-Jimenez F. Accuracy of body mass index in diagnosing obesity in the adult general population. Int J Obes 2008; 32: 959-66.

[16] Deurenberg P, Yap M, van Staveren WA. Body mass index and percent body fat: a meta-analysis among different ethnic groups. Int J Obes 1998; 22: 1164-71.

[17] Dijk SB, Takken T, Prinsen EC, Wittink H. Different anthropometric adiposity measures and their association with cardiovascular disease risk factors: a meta-analysis. Neth Heart J 2012; 20: 208-18.

[18] Dobbelsteyn CJ, Joffres MR, MacLean DR, Flowerdew G. A comparative evaluation of waist circumference, waist-to-hip ratio and body mass index as indicators of cardiovascular risk factors. The Canadian Heart Health Surveys. Int J Obes (Lond) 2001; 25: 652-61.

[19] Zhu S, Wang Z, Heshka S, Heo M, Faith MS, Heymsfield SB. Waist circumference and obesity-associated risk factors among whites in the third National Health and Nutrition Examination Survey: clinical action thresholds. Am J Clin Nutr 2002; 76: 743.

[20] Lapidus L, Bengtsson C, Larsson B, Pennert K, Rybo E, Sjöström L. Distribution of adipose tissue and risk of cardiovascular disease and death: a 12 year follows up of participants in the population study of women in Gothenburg, Sweden. Br Med J (Clin Res Ed) 1984; 289: 1257-61.

[21] Lu M, Ye W, Adami HO, Weiderpass E. Prospective study of body size and risk for stroke amongst women below age 60. J Intern Med 2006; 260:442-50.

[22] Dhaliwal SS, Welborn TA. Measurement error and ethnic comparisons of measures of abdominal obesity. Prev Med 2009; 49: 148-52.

[23] Ashwell M, Lejeune S. Ratio of waist circumference to height may be better indicator of need for weight management. BMJ 1996; 312: 377.

[24] Browning LM, Hsieh SD, Ashwell M. A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0·5 could be a suitable global boundary value. Nutr Res Rev 2010; 23: 247-69.

Supplementary Table 1. Distribution of various anthropometric Measures among women population (N = 88)

	Study population	Control population	Significance
Anthropometric measures	Mean ± SD	Mean ± SD	
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/Ht^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.

Supplementary Table 2. Age distribution in the study and control population

Age in 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

Supplementary Table 3. Comparison of weight (Kg) between two groups (n = 88)

Age in years	Study Group	Control group	*p*-value
	Weight (Kg)	Weight (Kg)	
≤ 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.

Supplementary Table 4. Comparison of Waist circumference (cm) between two groups (n = 88)

Age in years	Study Group	Control group	*p*-value
	Waist circumference (cm)	Waist circumference (cm)	
≤ 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.

Supplementary Table 5. Comparison of BMI between two groups (n = 88)

BMI	Study Group	Control Group	Odd ratio	95% CI	Chi/t test	*p*-value
< 25	17 (38.6%)	20 (45.5%)	0.756	0.323-1.766	0.420	0.517 ns
≥ 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.

Supplementary Table 6. Comparison of waist to hip ratio (WHR) between two groups (n = 88)

WHR Grade	Study Group	Control Group	Odd ratio	95% CI	Chi/t test	*p*-value
I (< 0.85)	4 (9.1%)	40 (90.9%)	0.010	0.00-0.002	58.909	< 0.001**
II (> 0.85)	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.

Supplementary Table 7. Comparison of waist to height ratio (WHtR) between two groups (n = 88)

WHt R Grade	Study Group	Control Group	Odd ratio	95% CI	Chi/t test	*P* value
< 0.55	11 (25%)	41 (93.2%)	0.024	0.006-0.095	42.308	< 0.001**
≥ 0.55	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.