WAIST/HEIGHT RATIO AND TRADITIONAL ANTHROPOMETRY FOR SCREENING EARLY ATHEROSCLEROSIS IN PREMENOPAUSAL/MENOPAUSAL WOMEN

Pattama Tongdee[1,*], Natthaphon Annanon[2], Pattra Wattanapan[3], Ryan A. Loyd[4], Porntip Nimkuntod[2]

[1] School of Obstetrics and Gynecology, Institute of Medicine, Suranaree University of Technology, Nakhon Ratchasima, 30000, Thailand; [2] School of Internal Medicine, Institute of Medicine, Suranaree University of Technology, Nakhon Ratchasima, 30000, Thailand; [3] School of Rehabilitation Medicine, Institute of Medicine, Suranaree University of Technology, Nakhon Ratchasima, 30000, Thailand; [4] School of Family and Community Medicine, Institute of Medicine, Suranaree University of Technology, Nakhon Ratchasima, 30000, Thailand

ABSTRACT:

Background: The premenopausal and menopausal phases are biological processes in women with a decline in estrogen and contribute to the changes of increased abdominal fat deposition. The clinical implications to global cardiometabolic risk have been extensively reviewed but few studies have reported the relationship between different bedside anthropometric obesity indices and subclinical vascular disease, an early marker of cardiac atherosclerosis. Measurement of the carotid intima media thickness (CIMT) is relatively simple, noninvasive test for risk stratification to determine who may require more aggressive therapy. The objective of this study was to assess the usefulness of both the new waist to height ratio (WHtR) and traditional anthropometric measurements as predictors of carotid intima media thickness and carotid plaque, which are markers of atherosclerosis.

Methods: One hundred and fourteen premenopausal and menopausal women without cardiovascular events who had never smoked participated. The traditional anthropometric measurements, including waist circumference (WC) and waist to hip ratio (WHR), as well as WHtR were assessed. Participants underwent CIMT measurement and carotid plaque identification using duplex ultrasonography.

Results: CIMT was positively correlated with WHtR ($r = 0.240$, $p = 0.010$), WHR ($r = 0.251$, $p = 0.007$) and WC ($r = 0.195$, $p = 0.037$). Carotid plaques 8/114 (7%) were not correlated with WC, WHtR or WHR. The traditional anthropometric parameters of weight, height, hip circumference and body mass index (BMI) were not correlated with CIMT.

Conclusions: The new anthropometric parameter WHtR, an indicator of central obesity, correlates with CIMT, an early marker of atherosclerosis, the same as the traditional parameters WHR and WC. However, WHtR had no correlation with the presence of carotid plaque.

Keywords: Waist/height ratio, Anthropometry, Carotid intima media thickness, Early atherosclerosis, Premenopause, Menopause

DOI: 10.14456/jhr.2016.44 *Received: November 2015; Accepted: February 2016*

INTRODUCTION

The premenopausal and menopausal phases are biological processes in women defined by the cessation of the menstrual cycle with a decline in estrogen usually occurring between the ages of 40 and 60 years. During the menopausal transition the premenopausal and menopausal phases contribute to

[*] *Correspondence to: Pattama Tongdee*
E-mail: pattama_t@sut.ac.th

Cite this article as: Tongdee P, Annanon N, Wattanapan P, Loyd RA, Nimkuntod P. Waist/height ratio and traditional anthropometry for screening early atherosclerosis in premenopausal/menopausal women. J Health Res. 2016; 30(5): 323-8. DOI: 10.14456/jhr.2016.44

the changes of increased abdominal fat deposition through the influence of hormonal alterations, both low estrogen and high androgens. The anthropometric measurements of waist to height ratio (WHtR) and waist to hip ratio (WHR) were used as markers of central obesity.

The clinical implications of central obesity to global cardiometabolic risk have been extensively reviewed but few studies have reported the relationship between different bedside anthropometric obesity indices and subclinical vascular disease, an early marker of cardiac atherosclerosis. Subclinical vascular disease can be non-invasively measured by high resolution B mode ultrasonography of the intima media thickness of the carotid arteries representing hypertrophy of the arterial wall. The first studies utilizing this technique were performed in children and adolescents, mainly in populations with higher cardiovascular risk, and it then became widely used in adults [1, 2]. Previous studies have shown the associations between different indices of adiposity and carotid intima media thickness (CIMT) [3-6]. Carotid intima wall thickening and carotid plaque can reflect the presence of early atherosclerotic vascular change and most importantly is an independent predictor of future cardiovascular events. The CIMT measurement is relatively simple, noninvasive and could be useful for assessment in screening evaluations of centrally obese subjects for risk stratification to determine who may require more aggressive therapy [7].

The Kuopio Ischemic Heart Disease study in middle aged males with a 4 year follow up showed that central obesity was associated with an accelerated increase in the maximum and mean common CIMT, independent of general obesity and other cardiovascular risk factors [8]. Carotid intima wall thickening and carotid plaque can reflect the presence of early atherosclerotic vascular changes at other sites such as the coronary arteries [9, 10], and most importantly is an independent predictor of future cardiovascular events [11]. For this reason it could be useful to include carotid ultrasound assessment in screening evaluations of centrally obese subjects to identify those at especially high cardiovascular risk who may require more aggressive therapy. This study aims to assess the usefulness of both the new WHtR and traditional anthropometric measurements as predictors of CIMT and carotid plaque which are markers of early atherosclerotic vascular change in premenopausal and menopausal women.

METHODS

Populations

Between February 2015 and July 2015, a total of 114 participants were recruited from the cardiovascular clinic and menopausal clinic at Suranaree University of Technology Hospital. The inclusion criteria were premenopausal and menopausal women age 40 to 80 years old who had no personal history of overt cardiovascular disease. Overt cardiovascular disease was defined as unstable angina, non-ST segment elevation myocardial infarction, previous myocardial infarction, ischemic stroke or peripheral artery disease. Informed consent was taken from all the participants or their relatives as appropriate before inclusion in the study.

Sample size was calculated from

$$n = \frac{z_{1-\alpha/2^2}\, p\,(1-p)}{d^2}$$

In this formula, p is the prevalence of asymptomatic atherosclerosis in premenopausal and menopausal women in Suranaree University of Technology Hospital in 2013 (8%), d is the standard error (5%).

Dependent variables included age, menopausal status, lipid profile [Total cholesterol, Triglyceride (TG), High-density lipoprotein cholesterol (HDL-C) and Low-density lipoprotein cholesterol (LDL-C)] and anthropometric parameters [Waist circumference (WC), WHR and WHtR]. Independent variables were atherosclerotic status (CIMT, carotid plaque). This study compared the CIMT between patients with normal and high WHtR.

Anthropometric measurements

Physical examination included height, weight, WC and hip circumference (HC). According to the World Health Organization's protocol WC was measured in the standing position, midway between the lowest rib and the iliac crest at the end of normal expiration. HC was measured around the widest portion of the buttocks. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. WHR was calculated as WC divided by HC in the same units. WHtR was calculated as WC divided by height in the same units. Anthropometric cut-off points for central obesity were WHtR > 0.5 for both genders, WHR > 0.9 in males and WHR > 0.8 in females. Cut-off points for obesity were BMI > 25 kg/m2 for

Table 1 Demographic data of premenopausal and menopausal women

Characteristics	Mean ± SD
Age (years)	52.80 ± 9.85
Systolic blood pressure; SBP (mmHg)	125.19 ± 16.00
Diastolic blood pressure; DBP (mmHg)	69.19 ± 9.73
Weight (kg)	60.67 ± 11.90
Height (cm)	155.59 ± 6.18
Waist circumference; WC (inch)	32.72 ± 3.89
Hip circumference; HC (inch)	38.07 ± 3.57
Body mass index; BMI (kg/m^2)	24.89 ± 4.23
Waist to hip ratio; WHR	0.86 ± 0.06
Waist to height ratio; WHtR	0.53 ± 0.06
FBS (mg/dL)	100.39 ± 19.35
Total cholesterol (mg/dL)	221.18 ± 46.02
Triglyceride; TG (mg/dL)	122.64 ± 64.22
High-density lipoprotein cholesterol; HDL-C (mg/dL)	57.81 ± 13.68
Low-density lipoprotein cholesterol; LDL-C (mg/dL)	135.25 ± 40.22
Carotid intima media thickness; CIMT (mm)	0.71 ± 0.14

both genders, WC > 90 cm in males and WC > 80 cm in females.

Carotid ultrasound

The study participants were positioned supine with slight hyperextension and rotation of the neck in the direction opposite the vascular probe. A linear multiple frequency transducer (5-7 MHz) attached to a high resolution B mode ultrasound system was used by a cardiologist to acquire images. The cardiologist was blind to the clinical data of the subjects. The carotid vascular transducer was manipulated so that the lumen diameter was maximized in the longitudinal plane. Automated measurements of CIMT were performed at 3 sites on each side of the neck: the common carotid artery, the carotid bulb and the internal carotid artery and the mean of all these CIMT values was calculated for each side of the neck. CIMT was measured during the end of diastole as the distance from the leading edge of the first echogenic line to that of the second echogenic line. The greater of the averaged CIMTs from both sides of the neck was used for the study. Carotid plaques in any of the carotid segments were measured. The presence of plaque was defined as wall thickness that was increased focally > 1.1 mm compared with the CIMT on either side of the focal area.

Laboratory examination

Following a 12 hours overnight fast, fasting blood samples were drawn from the antecubital vein of each participant for determination of the fasting blood sugar (FBS) and lipid profile (Total cholesterol, TG, HDL-C and LDL-C,). They were then transferred on ice to the central laboratory for analysis. All blood analysis was performed at the central laboratory of Suranaree University of Technology Hospital.

Statistical analysis

The results are presented as a mean ± SD (standard deviation) and as a percentage. The correlations between anthropometric parameters and demographic and clinical characteristics were evaluated by Pearson correlation. The dependent t-test was used to compare continuous variables. A *p-value* < 0.05 was chosen to represent statistical significance. All of the analysis was done using a computer program.

Ethical consideration

This project has been reviewed and approved by the Ethics Committee for Research Involving Human Subjects, Suranaree University of Technology. The project code EC-58-05 that approval date on 18 February 2015.

RESULTS

Table 1, the mean CIMT in this study was 0.71 mm. There was a significant correlation between WHtR and CIMT ($p < 0.05$).

In the study of premenopausal and menopausal women the average anthropometric parameters for central obesity (WHtR, WHR) and dyslipidemia (Elevated total cholesterol, TG, LDL-C and low HDL-C) were all elevated. The average mean CIMT of all the participants in our study was 0.71 mm (min 0.46 mm and max 1.22 mm).

Table 2 Correlation between anthropometric parameters and CIMT and carotid plaque.

Anthropometric parameters	CIMT		Carotid plaque	
	Correlation (r)	*p-value*	Correlation (r)	*p-value*
Weight	- 0.039	0.677	- 0.234	0.012**
Height	- 0.113	0.232	- 0.171	0.068
Waist circumference; WC	0.195	0.037**	- 0.051	0.590
Hip circumference; HC	0.074	0.435	- 0.160	0.090
Body mass index; BMI	- 0.032	0.739	- 0.202	0.031**
Waist to hip ratio; WHR	0.251	0.007*	0.132	0.162
Waist to height ratio; WHtR	0.240	0.010*	0.006	0.949

* statistical significance *p-value* $\leq$ 0.01; ** statistical significance *p-value* $\leq$ 0.05

Both central anthropometric parameters WHtR and WHR were positively correlated with CIMT but not correlated with carotid plaque. The anthropometric parameter of general obesity, the BMI, was not positively correlated with CIMT. BMI and weight were negatively correlated with the presence of carotid plaque, Table 2.

DISCUSSION

In our study, the early atherosclerosis marker CIMT was significantly associated with the anthropometric parameters WHtR, WHR and WC ($p < 0.05$) but was not associated with the traditional anthropometric parameter of BMI. The new anthropometric parameter of WHtR was not positively correlated with the presence of carotid plaque, nor were the other traditional parameters of central obesity WHR and WC. The results of the present anthropometric WHtR, WHR, WC indices showed weak to good predictability for increased CIMT whereas BMI and weight showed negative correlation with the presence of carotid plaque. The study had a low incidence of carotid plaque (only 7%). A meta-analysis in several ethnic groups has showed the superiority of WHtR over the traditional anthropometric factors WC and BMI for detecting cardiometabolic risk factors [12]. In Asian population, the WHR and WHtR anthropometric parameters may be better predictor of cardiovascular risk factors than BMI. The WHtR cut-off value to predict cardiometabolic diseases such as diabetes mellitus, hypertension, and dyslipidemia was 0.47-0.51 or higher should be incorporated into the identification of metabolic syndrome risk in postmenopausal women [13-16]. In a health survey from the Thai Epidemiologic Stroke (TES) Study, WC was significantly ($p < 0.001$) better than BMI in predicting at least one cardiovascular risk factor [17]. WHtR, WHR and WC all indicate central obesity or abdominal fat deposition as compared with BMI which reflects generalized obesity [18]. WC with different heights are unlikely to have the same cardiometabolic risk. WHtR above 0.5 in adult also significantly predicts both early vascular and metabolic changes for diabetes, cardiovascular disease, hypertension, lipid and metabolic outcomes but children and adolescents WHtR above 0.44 (a cut-off less than in adults) [19, 20]. Studies have shown high metabolic and inflammatory activity of the visceral fat depots within the abdominal cavity [21] in comparison to subcutaneous depots in other parts of the body such as the gluteal region [22]. Previous studies have demonstrated the relationship between obesity and carotid atherosclerosis [23-26]. WHtR has been found to be slightly superior in terms of the prediction of metabolic disturbances in Asian populations with high cardiovascular risk factors [27-29] and also predicted coronary artery disease [30, 31]. This study was similar to a previous study from China where WHtR was associated with CIMT, independent of BMI and conventional cardiovascular diseases risk factors in middle age people > 40 years old [32]. Different from Asians and other ethnic groups, Caucasians have not been found to have epidemiologically significant differences in predicting coronary heart diseases between WHtR, WHR and WC. It is possible that the differences in the predictive power of WHR between populations may in part be explained by variation in the angle between the sacrum (and pelvis) and the lumbar spine. An earlier study found that women reliably reported WC, but underestimated HC by an average of 1.4 cm (0.54 inchs) [33]. In fact a larger WC and a smaller HC showed the greatest progression of carotid atherosclerosis during a 12 years period in elderly women [34]. Numerous obesity-related anthropometric parameters are used for evaluating the associations between obesity and subclinical atherosclerosis. The new anthropometric parameter WHtR has been

proposed as an alternative to the WHR for predicted early atherosclerosis CIMT. In generally middle-aged and elderly population, both of WHR and WHtR appear to be better predictors of early atherosclerosis than BMI [32, 35] but only WHtR significantly predicted all cardiometabolic risk factors after 5 years [36].

Our study in a Thai population of premenopausal and menopausal women found a correlation between central obesity as measured by the new anthropometric parameter WHtR and CIMT. Other parameters of central obesity such as WHR and WC also correlated with CIMT. These findings about the use of the simple and accurate anthropometric parameter WHtR to screen for early atherosclerosis can be applied in future preventive strategies against cardiovascular disease.

CONCLUSION

This study provides evidence that in the premenopausal and menopausal female population without overt cardiovascular disease the new anthropometric parameter for central obesity WHtR is useful as a marker for predicting the presence of elevated CIMT, an early marker of atherosclerosis, the same as the traditional parameters WHR and WC.

CONFLICTS OF INTEREST

The authors have no financial conflicts of interest.

SOURCE OF FUNDING

Grants from Suranaree University of Technology.

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