A Body Shape Index versus Traditional Anthropometric Parameters to Identify Subclinical Atherosclerosis in Perimenopausal/Menopausal Women

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Background: *The body mass index (BMI), waist circumference (WC) and waist-hip ratio (WHR) are well-used anthropometric predictors for cardiovascular diseases (CVD), but their validity is regularly questioned. Recently, A body shape index (ABSI) was introduced as an alternative anthropometric index that may better reflect health status.*
Objective: *To assess the ability of ABSI to identify a marker of early atherosclerosis using carotid intima media thickness (CIMT) and determine whether it is superior to traditional anthropometrics: BMI, WC, and WHR.*
Material and Method: *This is a cross-sectional study of 114 participants, aged 40 to 80 years, recruited from the cardiovascular clinic and menopausal clinic between February 2015 and January 2016. CIMTs were measured using B-mode ultrasonography. The novel ABSI, both ABSI [American (A) and Asian or Indonesia formula (I)] and traditional anthropometric parameters (BMI, WC, and WHR) were measured. Total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were assessed in the entire population.*
Results: *There was 114 participants with mean age of 53.75±9.92 years and mean CIMT of 0.70±0.15 mm. The prevalence of abnormal CIMT was 22.3%. ABSI (A), ABSI (I), and BMI were significantly different between normal and atherosclerotic CIMT ≥0.9 mm (p<0.001). Both ABSI (A) and ABSI (I) were correlated with atherosclerosis (r = 0.211, p = 0.024), (r = 0.188, p = 0.046) but there was no correlation with mean CIMT. The anthropometric parameters WC and WHR were correlated with mean CIMT, however they had no correlation with atherosclerosis. Only the traditional anthropometrics BMI was not correlated with CIMT or atherosclerosis.*
Conclusion: *ABSI (A) and ABSI (I) could predict the presence of early atherosclerosis but have no correlation with mean CIMT, as opposed to the anthropometric indices WC and WHR.*

Keywords: *A body shape index, Carotid intima media thickness, Subclinical atherosclerosis, Perimenopausal women, Menopausal women*

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Overweight and obesity person are associated with an increased risk of cardiovascular diseases (CVD) and premature death(1-10). Therefore, early detection of overweight or obesity is considered necessary to prevent CVD(11). The body mass index (BMI) and waist circumference (WC) are currently recommended by several guidelines to classify overweight and obesity(12). However, previous studies also demonstrated that the discriminative capacity of BMI is not optimal, as this calculation cannot distinguish between adipose tissue and lean body mass(13-15). This has led to the idea that combining traditional anthropometric measures for better body index could be utilized, which takes body shape into account(16-18). Recently, the new body index 'A Body Shape Index' (ABSI), which is based on WC (m), BMI (kg/m^2), and height (m) has been introduced which relates to a greater fraction of abdominal adipose tissue. It appears to be a significant risk factor for premature death(19), predicts the onset of diabetes mellitus(20) and could be used to evaluate the physical health status of adolescents(21). However, it is unknown whether ABSI can predict the presence of early markers of atherosclerosis before the development of overt

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cardiovascular diseases in perimenopausal and menopausal women.

Therefore, the aim of this study was to assess the capacity of the novel index ABSI to identify atherosclerosis and CVD risk factors in perimenopausal/menopausal women and to determine whether this ABSI is superior to the traditional anthropometric BMI, WC, and waist-hip ratio (WHR) parameters.

Material and Method

Study population

The study included 130 perimenopausal/menopausal participants without history of hormonal replacement therapy, aged from 40 to 80 years who underwent carotid intima media thickness (CIMT) measurements in the cardiovascular clinic and menopausal clinic between February 2015 and January 2016. Sixteen participants were excluded for morbid obesity BMI $\geq$30 kg/m^2. For the assessment of CIMT values, we selected our sample by excluding participants with any of the following: morbid obesity, overt CVD or cardiovascular equivalence conditions, a history of stroke including cerebral infarction or transient ischemic attack, myocardial infarction, heart failure or end stage renal disease.

Study protocol

The participants' medical history, alcohol intake, and smoking habits were ascertained by a questionnaire. Alcohol intake and smoking habits were classified as current habitual use or not. Height and weight were measured, and BMI was calculated as weight (kg) divided by the square of height (m^2) as an index of obesity. WC was measured at the level of the umbilicus in the standing position and WHR was calculated as WC divide by hip circumference (HC).

The ABSI was based on height (m), BMI (kg/m^2), and WC (m) and calculated using the following formula.

For American populations, use of the scaling exponents (or exponents in short) 2/3 and 1/2 in the denominator makes ABSI uncorrelated to BMI, weight, and height and no difference in the formula between male and female genders. This follows the same logic that the use of the exponent in the denominator of BMI makes BMI uncorrelated to height.

ABSI (A) base on American population sample they studied[22]

$$\text{ABSI (A)} = \frac{\text{WC}}{\text{BMI}^{2/3}/\text{Height}^{1/2}}$$

For Asian populations (Indonesia), the formula in the female gender is different from American by the regression coefficients 0.608 and 20.947, which were rounded to 3/5 and -1. Then weight was replaced by (height^2 x BMI) and the expression re-arranged to the equation:

ABSI (I) base on Asian population (female) sample they studied[23]

$$\text{ABSI (I)} = \frac{\text{WC}}{\text{BMI}^{3/5}/\text{Height}^{1/5}}$$

Laboratory measurement

All participants underwent a complete cardiovascular evaluation after eight hours of fasting, including: 1) a medical history for acute myocardial infarction, congestive heart failure, previous stroke, end stage renal disease, hypertension, diabetes mellitus, dyslipidemia or smoking; 2) an anthropometric analysis including weight, height, WC and HC; 3) blood pressure measurement; 4) serum glucose levels; 5) plasma lipid profile including total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) level. All blood chemistry analyses were performed at the central laboratory of Suranaree University of Technology Hospital.

Definition of terms

Perimenopausal/menopausal women

Participants were also asked about their menstrual bleeding patterns in the 12 months prior to recruitment. Perimenopausal status was defined as age $\geq$40 years with menstrual period irregularity in the past 12 months. Menopausal status was defined as those with no menstrual period within the last 12 months.

Carotid intima media thickness measurement

The measurement was carried out according to a validated procedure, using high resolution B-mode ultrasonography with a phased array transducer (PLT-704SBT 7.5 MHz, Toshiba). The far wall of the common carotid artery, carotid bulb and internal carotid artery was imaged using the automated edge of the lumen intima and the media-adventitia interface at the far wall for CIMT. According to the joint European Society of Hypertension (ESH)/European Society of Cardiology (ESC) guidelines, we considered normal values as <0.9 mm and abnormal CIMT as $\geq$0.9 mm marker of atherosclerosis.

Statistical analysis

Baseline characteristics were analyzed using descriptive techniques. Data for continuous variables were presented as the mean ± standard deviation (SD) and proportions were presented as frequencies and percentages. Categorical data were reported in proportions and differences tested by Pearson's Chi-squared test. The correlation between CIMT and ABSI was assessed by Pearson's correlation. Test for significance was done using student's t-test and analysis of variance (ANOVA) where applicable. The *p*-values less than or equal to 0.05 were considered as statistical significant.

Ethics statement

All participants signed informed consent forms for participation in this study. This study was reviewed and approved by Ethic committee, institutional review board of Suranaree University of Technology code EC-58-05.

Results

The study population consisted of 114 participants, mean age 53.75±9.92 years, mean CIMT 0.70±0.15 mm (min 0.45 mm and max 1.14 mm), mean ABSI (A) 0.0054±0.0016, mean ABSI (I) 0.0010±0.0005. Diabetes mellitus, hypertension and hyper-cholesterolemia were reported at 5.4%, 24.6%, and 47% of the study population, respectively (Table 1).

Both ABSI (A) and ABSI (I) were different between normal CIMT and abnormal CIMT ≥ 0.9 mm (p = 0.001) (Table 2) and correlated with atherosclerosis (r = 0.211, p = 0.024), (r = 0.188, p = 0.046), but there was no correlation with mean CIMT. The WC and WHR anthropometric parameters were correlated with mean CIMT but they had no correlation with atherosclerosis. Only the traditional anthropometrics BMI was not correlated with CIMT and atherosclerosis (Table 3).

Table 1. Baseline characteristics of the participants

Characteristics	Mean ± SD
Age (years)	53.75±9.92
Weight (kg)	60.41±11.77
Height (cm)	155.48±5.99
Body mass index (kg/m^2)	24.89±4.23
Waist circumference (cm)	83.00±3.88
Systolic blood pressure (mmHg)	125.88±16.76
Diastolic blood pressure (mmHg)	69.22±9.85
Fasting plasma glucose (mg/dL)	101.00±20.91
Total cholesterol (mg/dL)	221.24±44.92
Triglyceride (mg/dL)	123.26±62.25
High-density lipoprotein cholesterol (mg/dL)	58.58±17.32
Low-density lipoprotein cholesterol (mg/dL)	134.25±40.76
Carotid intima media thickness (mm)	0.70±0.15

Discussion

The study demonstrated that the atherosclerosis marker CIMT ≥0.9 mm significantly correlated with ABSI (A) (r = 0.211, p = 0.024) and ABSI (I) (r = 0.188, p = 0.046), respectively. ABSI (A) and ABSI (I) can be used for differentiating between two groups of normal and abnormal CIMT (p<0.001). The mean CIMT is correlated with the anthropometric parameters of central obesity WC and WHR but not correlated with the generalized obesity marker BMI. In contrast to our hypothesis, neither ABSI (A) nor ABSI (I) are superior measures compared to WC and WHR for determining the mean CIMT.

Our findings indicate that the novel index ABSI (A) and ABSI (I) are not suitable for identifying mean CIMT but ABSI can be used to distinguish between individuals with and without early atherosclerosis compared with anthropometric parameters of obesity BMI, WC, and WHR. Thus, ABSI is a suitable measurement to predict early subclinical atherosclerosis (CIMT ≥0.9 mm).

A possible explanation for the contrasting findings between our data and Krakauer NY et al[19], is the endpoint variable, early atherosclerosis marker by using CIMT versus premature death in the previous study. Alternatively, participant characteristics may explain the dissimilarities between our study and the previous study. Our study perimenopausal and menopausal population has approximately ABSI (A) values of 0.0054±0.0016 m11/6·kg-2/3 vs. 0.081±0.0053 m11/6·kg-2/3 but surprisingly our study population had a lower average BMI (24.89 kg/m^2 vs. 25.6 kg/m^2) and lower average WC (females: 83 cm vs. 88 cm). The explanation why ABSI is not similar is that our study population comprising Thai participants was shorter compared to the American study population of Krakauer NY et al. The estimated average body height was 1.70 meters in the study of Krakauer NY et al, whereas our study population had an average body height of 1.50 meters. This suggests that body height might confound the capacity of ABSI to identify CIMT in our study population. Future studies should further investigate

Table 2. A Body Shape Index, anthropometrics index for classifying subclinical atherosclerosis association with carotid intima media thickness (CIMT) $\geq$0.9 mm and normal CIMT

Anthropometrics indices	Mean Difference	Std. Error Difference	*p*-value	95% CI	
				Lower	Upper
A Body Shape Index (American formula)	0.0017	0.0005	0.001*	0.0026	0.0007
A Body Shape Index (Indonesian formula)	0.0005	0.0002	0.001*	0.0008	0.0002
Body mass index (kg/m^2)	2.79	1.27	0.030*	0.2753	5.3111
Waist circumference (cm)	0.48	1.18	0.687	1.8577	2.8107
Hip circumference (cm)	1.54	1.05	0.146	0.5441	3.6295
Waist-hip ratio	0.02	0.018	0.220	0.0576	0.0134

* Statistical significant $p<0.05$, 95% CI = 95% confidence interval

Table 3. Correlation between carotid intima media thickness in perimenopausal/menopausal women according to A Body Shape Index (ABSI) and anthropometrics indices

Parameters		BMI	WC	HC	WHR	ABSI (A)	ABSI (I)
Mean CIMT	r	0.032	0.205*	0.079	0.251**	0.181	0.152
	p-value	0.739	0.020	0.375	0.007	0.055	0.105
Atherosclerosis (CIMT $\geq$0.9 mm)	r	0.121	0.055	0.010	0.097	0.211*	0.188*
	p-value	0.198	0.533	0.909	0.304	0.024	0.046

* Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).
CIMT = Carotid intima media thickness, BMI = Body mass index, WC = Waist circumference, HC = Hip circumference, WHR = Waist-hip ratio, ABSI (A) = A Body Shape Index of American, ABSI (I) = A Body Shape Index of Indonesia or Asia

the limits of ABSI and especially study the impact of body height on the calculation of ABSI.

Our study compared ABSI against BMI and WC for predicting early atherosclerosis in perimenopausal/menopausal women. This could have led to an underestimation of our results. Therefore, the capacity of BMI and WC to identify CIMT could somewhat be higher. Finally, one might argue that the cross-sectional nature of our study is suboptimal to study the predictive capacity of anthropometric characteristics. In future studies, the longitudinal relation between ABSI and CVD incidence in perimenopausal/menopausal women should be studied.

Conclusion

In the current study, we demonstrated that the early atherosclerosis marker, CIMT $\geq$0.9 mm is correlated with ABSI (A) and ABSI (I) in the perimenopausal/menopausal population but not correlated with anthropometric parameters WC and WHR. Nonetheless, only WC and WHR, but not ABSI, could significantly determine the mean CIMT. The capacity of ABSI (A) and ABSI (I) gives an adequate impression of early atherosclerosis to predict further cardiovascular health status.

What is already known on this topic?

The present study is not the first report of ABSI (A), ABSI (I) and CIMT values in an Asian population but previous studies cannot be directly applied to the perimenopausal/menopausal specific subgroup in Thailand because of differences in ethnic groups and environmental factors which likely CIMT in our study.

What this study adds?

ABSI, in our study, is shown to be correlated with an early atherosclerosis marker CIMT measurement in individual specific perimenopausal/menopausal participants from the Thai population that is thicker than in those studies of other Asian populations. The capacity of ABSI and traditional anthropometric parameters in determining early atherosclerosis was assessed using mean CIMT and subclinical atherosclerosis, CIMT $\geq$0.9 mm.

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Potential conflicts of interest

None.

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ดัชนีรูปร่างกับค่าสัดส่วนร่างกายแบบดั้งเดิมในการวินิจฉัยภาวะหลอดเลือดแดงตีบแบบไม่แสดงอาการในสตรีวัยใกล้หมดประจำเดือน/วัยหมดประจำเดือน

พรทิพย์ นิ่มขุนทด, ปัทมา ทองดี

ภูมิหลัง: *ดัชนีมวลกาย เส้นรอบเอว และสัดส่วนรอบเอวต่อรอบสะโพกใช้ทำนายโรคหัวใจและหลอดเลือดได้เป็นอย่างดี แต่มักมีข้อสงสัยความถูกต้องของการใช้เป็นประจำ ปัจจุบันพบว่าได้มีการนำดัชนีรูปร่างมาใช้เป็นดัชนีสัดส่วนของร่างกายอาจสะท้อนให้เห็นทางเลือกในการบอกสภาวะทางสุขภาพที่ดีกว่าสัดส่วนของร่างกายแบบดั้งเดิม*

วัตถุประสงค์: *เพื่อประเมินความสามารถของดัชนีรูปร่างในการวินิจฉัยภาวะหลอดเลือดแดงตีบแบบไม่มีอาการ จากการวัดความหนาของไขมันที่หลอดเลือดแดงคอคาร์โรติดหรือก้อนไขมัน โดยประเมินว่าค่าดัชนีรูปร่าง มีความแม่นยำกว่าสัดส่วนของร่างกายแบบดั้งเดิม ค่าดัชนีมวลกาย รอบเอว และสัดส่วนรอบเอวต่อรอบสะโพกหรือไม่*

วัสดุและวิธีการ: *การศึกษาแบบตัดขวาง มีผู้เข้าร่วมการศึกษา 114 คน อายุ 40-80 ปี ในคลินิกโรคหัวใจและหลอดเลือด และคลินิกวัยหมดประจำเดือน ตั้งแต่เดือนกุมภาพันธ์ พ.ศ. 2558 ถึง เดือนมกราคม พ.ศ. 2559 มีการวัดความหนาของไขมันชั้นในของหลอดเลือดแดงแดงคอคาร์โรติดโดยใช้เครื่องตรวจคลื่นเสียงความถี่สูง วัดดัชนีรูปร่างและสัดส่วนของร่างกายแบบดั้งเดิม ดัชนีมวลกาย สัดส่วนรอบเอวต่อรอบสะโพก ทุกคนที่เข้าร่วมการศึกษาได้รับการประเมินค่าไขมันในเลือด ได้แก่ โคเลสเตอรอล ไตรกรีเซอไรด์ เอชดีแอล และแอลดีแอล*

ผลการศึกษา: *กลุ่มประชากร 114 คน มีอายุเฉลี่ย 53.75±9.92 ปี ค่าเฉลี่ยของความหนาของไขมันชั้นในของหลอดเลือดแดงคอคาร์โรติด 0.71±0.15 มิลลิเมตร ความชุกของความผิดปกติของไขมันเกาะหลอดเลือดแดงคอคาร์โรติด 22.3% ดัชนีรูปร่างทั้งแบบอเมริกันกับแบบเอเชีย รวมทั้งค่าดัชนีมวลกายสามารถช่วยแยกแยะภาวะไขมันเกาะหลอดเลือดแดงคอคาร์โรติดผิดปกติที่ทำให้การเกิดหลอดเลือดแดงตีบแบบไม่แสดงอาการและกลุ่มปกติได้ (p = 0.001) ความสัมพันธ์ของความหนาของไขมันเกาะหลอดเลือดแดงคอคาร์โรติดกับดัชนีรูปร่างโดยค่าอ้างอิงจากประชากรอเมริกัน (r = 0.211, p = 0.024) และค่าในประเทศแถบเอเชีย (r = 0.188, p = 0.046) แต่ไม่สัมพันธ์กับค่าเฉลี่ยของความหนาของไขมันชั้นในของหลอดเลือดแดงคอคาร์โรติด ค่ารอบเอวและสัดส่วนรอบเอวต่อรอบสะโพกมีความสัมพันธ์กับค่าเฉลี่ยของความหนาของไขมันชั้นในของหลอดเลือดแดงคอคาร์โรติด แต่ไม่สัมพันธ์กับภาวะหลอดเลือดแดงตีบ ส่วนค่าดัชนีมวลกายไม่มีความสัมพันธ์กับทั้งความหนาของไขมันชั้นในของหลอดเลือดแดงคอคาร์โรติดและภาวะหลอดเลือดแดงตีบ*

สรุป: *ดัชนีรูปร่างทั้งแบบประชากรอเมริกันและค่าในประเทศแถบเอเชีย สามารถใช้เป็นตัวบ่งชี้การเกิดหลอดเลือดตีบ ระยะเริ่มต้นแบบไม่แสดงอาการได้ แต่ไม่มีความสัมพันธ์กับความหนาของไขมันชั้นในของหลอดเลือดแดงคอคาร์โรติด ซึ่งตรงข้ามกับค่ารอบเอวและสัดส่วนรอบเอวต่อรอบสะโพก*