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Original Article

Predicting hypertension using waist circumference in obese Indonesian adolescents

Elvietha Allamanda, Endy P. Prawirohartono, Nenny Sri Mulyani

Abstract

Background Increasing prevalence of pediatric obesity and hypertension demonstrate the urgent need for early intervention. Waist circumference (WC) provides a measurement of central obesity, which has been specifically associated with cardiovascular risk factor including hypertension.

Objectives This study aims to identify the optimal cut-off point of WC in predicting hypertension in obese adolescents.

Methods We randomly recruited 115 adolescents aged 12–17 years from schools in Yogyakarta, Indonesia. We measured height, weight, WC and blood pressure in 109 subjects. Optimum WC cut-offs to predict hypertension were determined using receiver-operating characteristic (ROC).

Results The optimum WC cut off point to predict any hypertension in adolescents was at the 88.95 cm with 97.8% sensitivity and 47.3% specificity. Age-specific cut-off points for subjects < 15 year old was 90.1 cm with 91.7% sensitivity and 58%specificity, and for subjects ≥ 15 year old was 103.5 cm with 75% sensitivity and 88% specificity.

Conclusions Waist circumference can be used to predict hypertension in obese adolescents with fair sensitivity and specificity. Waist circumference values associated with hypertension in adolescents vary with age and ethnicity. **[Paediatr Indones. 2010;50:300-4]**.

Keywords*: waist circumference, hypertension, adolescent, obesity.*

The prevalence of obesity in Indonesian children has been climbing globally.[1,2] Hypertension is one of the most prominent effects of obesity on the cardiovascular system. The prevalence of hypertension in children and adolescents in the United States in 2003 ranged from 1% to 5%; this figure continues to rise along with the prevalence of obesity.[3] Recent studies in children and adults have showed that waist circumference is a more powerful risk factor for cardiovascular disorders than body mass index (BMI).[3,4] The increasing prevalence of obesity and hypertension indicates the need for a waist circumference cut-off point for children and adolescents for purposes of early intervention.

The International Diabetes Foundation has published race-specific waist circumference cut-off points in adults. Reference waist circumference percentiles for children and adolescents are also being developed in several countries including the United States, Australia, the Netherlands, Canada, United Kingdom, Spain, and China.[5-11] In Indonesia, a waist circumference cut-off point beyond which the risk

From the Department of Child Health, Medical School, Gadjah Mada University, Sardjito Hospital, Yogyakarta, Indonesia.

Reprint request to: Elvietha Allamanda, MD, Departement of Child Health, Medical School, Gadjah Mada University, Dr. Sardjito Hospital, Jln.Kesehatan no.1, Sekip Utara, Yogyakarta 55281, Indonesia.Tel 62-274-587333 ext.232.Fax.62-274-583745. Email:dr.epi_beumaputra@yahoo.com

of obesity-related disease, such as hypertension, is increased, has not been determined in adolescents. This study aims to determine such a cut-off point in obese adolescents.

Methods

We conducted a cross-sectional study in Yogyakarta, Indonesia. Subjects were 115 high school students aged 12-18 years with obesity. Further inclusion criteria were parental informed consent, not consuming steroids or sympathomimetic agents, and absence of family history of hypertension. Subjects who suffered from heart disease, renal disease, neurological disorders, or endocrine disorders were excluded from this study.

Obesity was defined as BMI at or above 95th percentile on CDC-NCHS 2000 growth charts. Waist circumference was measured using a tape wrapped around the halfway point between iliac crest and costal angle. Measurements were taken three times at the end of normal expiration by one examiner and average calculated.[12] Hypertension was defined as systolic or diastolic blood pressure (BP) above 95th percentile based on age, sex and body height according to 2004 NHBPEP Working Group on High Blood Pressure in Children and Adolescents blood pressure chart.[13]

We calculated the sensitivity, specificity, and accuracy of each waist circumference cut-off point. We used receiver-operator characteristics (ROC) curve to assess the diagnostic ability of various waist circumference cut-off points to predict hypertension.

Results

This study was conducted in March through April 2010. We obtained 109 subjects, consisting of 69 (63.3%) boys and 40 (35.7%) girls. Subject characteristics are shown in **Table 1**.

The optimum waist circumference cut-off point to predict hypertension was determined using the ROC curve in **Figure 1**. The optimum waist circumference cut-off point to predict systolic hypertension was 90.1 cm, with a sensitivity of 93.3%, specificity of 51.1%, and accuracy of 0.728 (95% CI 0.60;0.85, p=0.005). The optimum cut-off point to predict diastolic

Table 1. Characteristic of study subjects

Characteristic	Mean	Standard Deviation
Age (year)	14,1	1,39
Waist circumference (cm)	92,53	9,81
Blood pressure (mmHg)		
Systolic	117,4	8,25
Diastolic	73,94	5,62
Waist circumference (cm) based on:		
Sex		
male	94,16	10,62
female	89,71	7,53
Blood pressure group		
Hypertension	98,60	10,25
No Hypertension	91,48	9,39
Systolic BP (mmHg) based on:		
Blood pressure group		
Hypertension	135,1	3,55
No Hypertension	114,59	4,33
Waist circumference		
≥ p75 - < p95	113,32	5,15
≥ p95	120,99	9,66
Diastolic BP (mmHg) based on:		
Blood pressure group		
Hypertension	86,26	1,86
No Hypertension	72,43	3,79
Waist circumference		
≥ p75 - < p95	72,01	4,47
≥ p95	76,22	6,25

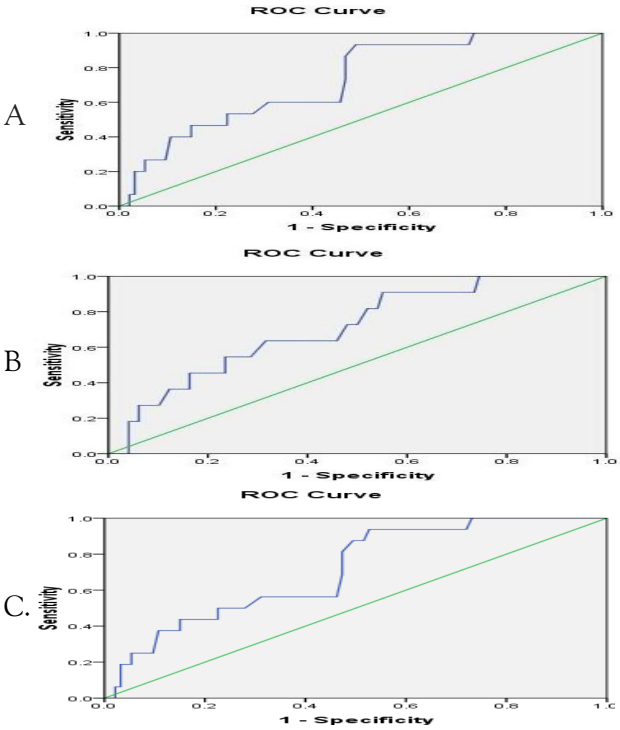

Figure 1. ROC curve for adolescent waist circumference cut-off points to predict: A. systolic hypertension; B. diastolic hypertension, and C. any hypertension

hypertension circumference cutwas 88.95 cm with 90.9%, with a sensitivity of 46.9%, specificity of 46.9%, and accuracy of 0.707 (95% CI 0.56;0.85, p=0.025). The optimum waist circumference cut-off point for any hypertension in adolescents was 88.95 cm, with a sensitivity of 93.8%, specificity of 47.3%, and accuracy of 0.711 (95% CI 0.59;0.83, p=0.007).

We also performed separate ROC curve analyses for subjects aged ≥15 years and <15 years. We found different optimum cut-off points for the respective age groups (**Figures 2** and **3**).

Figure 2 shows ROC curves for waist circumference cut-off points in children aged ≥15 years. As a predictor of systolic hypertension, a cut-off point of 104.85 cm yielded 67% sensitivity and 92% specificity, a cut-off point of 103.5 cm yielded 100% sensitivity and 88% specificity, and a cut-off point of 102.4 cm yielded 100% sensitivity and 84% specificity, with an accuracy of 0.91 (p=0.02, 95%CI 0.80;1.02).

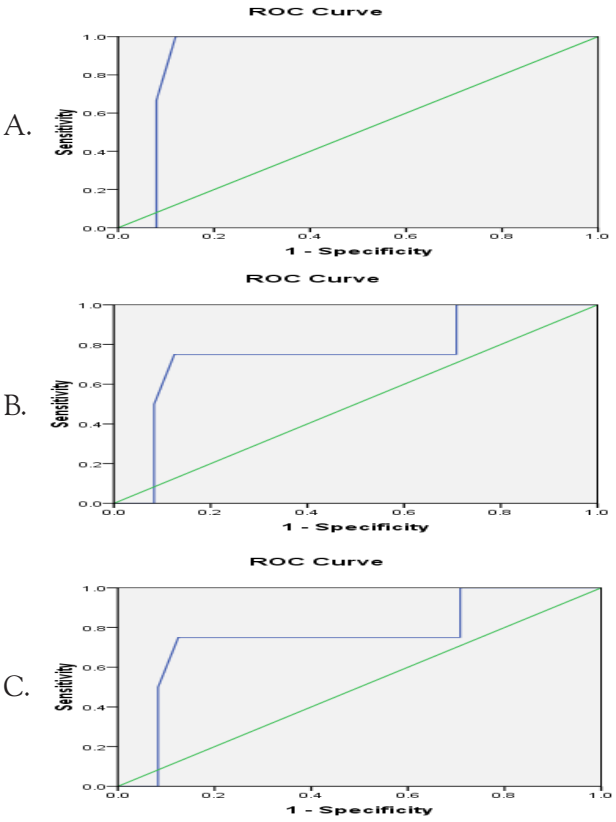

Figure 2. ROC curve for waist circumference cut-off points in children ≥15 years to predict: A. systolic hypertension; B. diastolic hypertension, and C. any hypertension

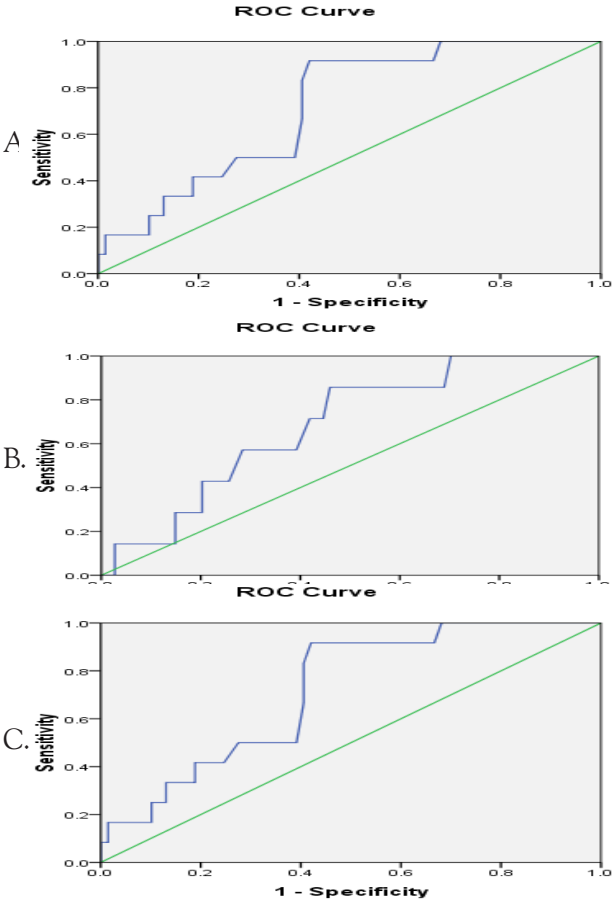

Figure 3. ROC curve for waist circumference cut-off points in children <15 years to predict: A. systolic hypertension; B. diastolic hypertension, and C. any hypertension

Diastolic hypertension could be predicted by a cut-off point of of 103.5 cm with a sensitivity of 75%, specificity of 88% and accuracy of 0.75 (p=0.108, 95%CI 0.47;1.4). The cut-off point to predict any hypertension was 103.5 cm with a sensitivity of 75%, specificity of 88%, and accuracy of 0.72 (95%CI 0.59;0.85, p=0.17).

ROC curves for waist circumference cut-off points in children aged <15 years are shown in **Figure 3**. In adolescents aged <15 years, the waist circumference cut-off point to predict systolic hypertension was 90.1 cm with a sensitivity of 92%, specificity 58%, and accuracy of 0.72 (p=0.017, 95%CI 0.60;0.85). Diastolic hypertension can be predicted by a waist circumference cut-off point of 90.1 cm with a sensitivity of 86%, specificity of 54%, and accuracy of 0.69 (95%CI 0.52;0.86, p=0.107).

The waist circumference cut-off point to predict any hypertension was 90.1 cm with a sensitivity of 91.7%, specificity of 58%, and accuracy of 0.72 (p=0.017, 95%CI 0.59;0.85).

Discussion

Males have higher average waist circumference than females (94.16 cm vs. 89.71 cm). This is consistent with the theory that fat tends to accumulate centrally in men, whereas in women it accumulates in peripheral areas such as thighs, hips, and breasts.[14] Hypertensive subjects had higher average waist circumference than non-hypertensive ones (98.60 cm vs. 91.48 cm). This concurs with surveys by McCarthy et al, which have reported that hypertension is proportionate to waist circumference.[9]

Using a waist circumference cut-off point of 90.1 cm, we obtained an accuracy of 0.728 to predict systolic hypertension. We find the accuracy values of the optimum waist circumference cut-off points to predict systolic, diastolic, and any hypertension quite good. Good accuracy was also found after classification by age, particularly in the >15 years age group.

Our optimum waist circumference cut-off points are higher than those reported by Wildman et al (2004),[15] The World Health Organization (2000),[12] Yan (2008),[11] and Sung (2006). These studies were done in Chinese school-age children. The difference in cut-off points may arise due to differences in the sensitivity and specificity of each study. In adults, Wildman (2004) obtained a cut-off point of 80 cm with sensitivity of only 20.3% and specificity 77.9%.[15] In a similar study on 18-year-old Asians, the cut-off point obtained was 80 cm for women and 90 cm for men, with sensitivity and specificity of 86.1 and 13.9, respectively. Yan (2008), who studied children 7-18 years old, obtained a cut-off point of 85 cm with sensitivity of 74.7% and specificity of 77.95%.[11]

We conclude that the optimum waist circumference cut-off points to predict systolic, diastolic, and any hypertension in adolescents are 90.1, 88.95, and 88.95 cm, respectively. For adolescents >15 years of age, the waist circumference cut-off points are 104.85 cm (sensitivity 67%, specificity 92%) and 103.5 cm (sensitivity 100% and specificity 88%) to predict systolic hypertension, and 103.5 centimeters for adolescents ≥15 years to predict diastolic hypertension. In adolescents aged <15 years, the waist circumference cut-off point to predict systolic and diastolic hypertension was 90.1 cm. Comparing our results to that of others, it appears that cut-off waist circumference values associated with hypertension vary with age groups and ethnicity.

Authors' contributions

EA has been involved in drafting the manuscript and revising it critically for content.

EPP, NSM have made substantial contributions to the conception and design of the study as well as data collection, analysis, and interpretation.

All authors have given final approval of the version to be published.

Conflicts of interest

The author(s) declare that they have no competing interests.

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