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COMPARISON OF THE ANTHROPOMETRIC INDICES TO IDENTIFY PREHYPERTENSION AMONG MALE MEDICAL STUDENTS

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ABSTRACT

The state of prehypertension that is often neglected in young adults is not inferior to hypertension in contributing to a higher risk of cardiovascular diseases. Several simple anthropometric indices may be used as prehypertension prognostic tools, including Body Mass Index (BMI), Body Shape Index (ABSI), Waist Circumference (WC), Weight to Height Ratio (WHtr), and Body Roundness Index (BRI). This study aimed to compare several anthropometric examinations for detecting prehypertension in male medical students. The cross-sectional study design was conducted on 107 male medical students. Direct measurements of the respondents were carried out with blood pressure data collection and anthropometric examination. The area under the receiver-operating characteristic curve (AROC) analysis with a 95% confidence interval (CI) was used to assess all anthropometric measures' discriminatory power to assess the risk of prehypertension in the participants. Participants with prehypertension were relatively older and had less active physical activity than normotensive (p<0.05). The mean BMI, BRI, WC, and WHtR were significantly higher in the prehypertensive group than in the normotensive group. However, ABSI was not showing any relationship with blood pressure. The process with 95% CI of blood pressure classification related to anthropometric measures indicates that BMI showed the highest AROC values for the prehypertensive state (AROC: 0.73, 95% CI: 0.63–0.82), and WC had the lowest AROCs (AROC: 0.63, 95% CI: 0.52–0.63). BMI, BRI, WC, and WHtr may be applied as prognostic assessments for prehypertension states in young adult males.

Keywords: *anthropometric indices, body mass index, body roundness, prehypertension.*

ABSTRAK

Keadaan prehipertensi yang sering terabaikan pada dewasa muda, padahal kondisi ini tidak inferior dari hipertensi dalam kontribusi penigkatan risiko penyakit kardiovaskular. Beberapa indeks antropometri sederhana dapat digunakan sebagai instrumen prognostik prehipertensi, antara lain *Body Mass Index* (BMI), *Body Shape Index* (ABSI), *Waist Circumference* (WC), *Weight to Height Ratio* (WHtr), dan *Body Roundness Index* (BRI). Penelitian ini bertujuan untuk membandingkan beberapa pemeriksaan antropometri untuk mendeteksi prehipertensi pada mahasiswa kedokteran laki-laki. Desain studi potong lintang dilakukan pada 107 mahasiswa kedokteran laki-laki. Pengukuran langsung terhadap responden dilakukan dengan pendataan tekanan darah dan pemeriksaan antropometri. *The area under the receiver-operating characteristic curve* (AROC) dengan interval kepercayaan 95% digunakan untuk menilai kekuatan diskriminatif semua ukuran antropometrik dan risiko prehipertensi pada partisipan. Partisipan dengan prehipertensi relatif lebih tua dan memiliki aktivitas fisik yang kurang aktif dibandingkan dengan normotensif (p<0,05). Rerata BMI, BRI, WC, dan WHtR secara signifikan lebih tinggi pada kelompok prehipertensi daripada normotensif. Namun, ABSI tidak menunjukkan hubungan apapun dengan level tekanan darah. BMI menunjukkan nilai AROC tertinggi untuk keadaan prehipertensi (AROC: 0,73, 95% CI: 0,63-0,82), dan WC memiliki AROC terendah (AROC: 0,63, 95% CI: 0,52-0,63). IMT, BRI, WC, dan WHtr dapat digunakan sebagai penilaian prognostik untuk status prehipertensi pada pria dewasa muda.

Kata kunci: indeks antropometri, indeks massa tubuh, *body roundness*, prehipertensi

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Introduction

While another study focused on hypertension prediction in a relatively older population, less attention is given to the younger population, such as college students. The prevalence of prehypertension globally was estimated at25-50%[1],whereas prehypertension in young adults reached 48.4% in Indonesia.[2] The state of prehypertension is not inferior to hypertension in contributing to a higher risk of cardiovascular diseases (CVD). Prehypertension has been reported to be associated with various cardiovascular changes, such as damaged cardiac structure, impaired renal and vascular function, and decreased nitric-oxide-dependent vasodilation.[3–5] Preventing the occurrence of cardiovascular disease is a global priority, and the earlier prevention strategies are implemented, the greater the health impact is expected.[6]

The term "prehypertension" was first introduced in the Seventh Joint National Committee on Prevention, Detection, Evaluation, and Treatment of Hypertension (JNC-7). Prehypertension is not classified as a disease but indicates that someone is at high risk for developing hypertension. Prehypertension occurs when systolic blood pressure is more than 120, but less than 140 mmHg or diastolic blood pressure is more than 80 but less than 90 mmHg.[7] The prehypertension category hopes to prevent the development of hypertension, especially in young adults such as college students, because of their notoriously unfavorable lifestyle.[8,9]

Evidence suggests that obesity is related to prehypertension etiology, a state of excess adipose tissue in the body.[10,11] Obesity's prevalence in people aged 18 years old and above in Indonesia has increased by 11.3% in one decade (2007-2018).[2] The increase could lead to a higher presence of prehypertension, hypertension, and increased cardiovascular risk. Body mass index (BMI) is the simplest anthropometric examination, comparing weight to height in squared meters; however, BMI cannot describe a person's body composition, for example, visceral fat in the abdomen that was causing insulin resistance and developing risk of degenerative diseases, such as prehypertension.[11,12] Early identification of risk factors for hypertension, measured by an anthropometric index, can be improved in a relatively easy and cost-effective manner in the local settings; thus, interventions can be carried out effectively to reduce the disease burden.

There have been developments in other anthropometric measurements that involve examining visceral fat, such as waist circumference (WC), waist-to-height ratio (WHtR), A Body Shape Index (ABSI) by combining body weight, height and waist circumference, and Body Roundness Index (BRI), seeing the correlation to the incidence of prehypertension.[11] Some studies suggested that two or more indices, for example, BMI and WC in elderly men and women in Xinzheng city;[13]; meanwhile, BMI, WC, and WHtR in Brazilian men and women,[14] were the best predictors, but in an adolescent with normal BMI, WC is highly correlated with higher blood

pressure.[15] Due to many demographic and ethnic factors, the best predictor is likely to differ according to specific demographics and characteristics, and is the main reason for this study. The study aimed to compare several anthropometric indexes with the area under the receiver-operating characteristic curve (AROC), which has rarely been conducted in Indonesia, indicating the best predictors of prehypertension in undergraduate male medical students in North Jakarta, Indonesia. Moreover, this study only examines male students to avoid hormonal effects on women that correlate with hypertension.

Methods

A cross-sectional study design was applied to active undergraduate male students majoring in the school of medicine (total population of 387). Previous primary hypertension diagnosed by a physician was the exclusion criteria. According to minimal sampling calculation for the survey study employing an α of 5%, a margin of error of 10%, prevalence of prehypertension in university students (40%)[16] and considering a 10% non-response rate, a total of 107 male students were included and agreed to participate in the study and given written consent.

The physical examination, including blood pressure and anthropometric measurements, and face-to-face interviews were conducted in a quiet room during the day. A nutrition specialist carried out the physical examination (blood pressure examination and anthropometric). A brief interview was conducted using self-construct demographic and lifestyle questions to collect demographic information and lifestyle habit (smoking, alcohol consumption, and physical activity). Blood pressure while sitting was measured after 5 minutes of rest using a calibrated sphygmomanometer at the beginning of the interview and was measured for the second time at the end. Mean blood pressure resulting from the two measurements were used in the study analysis. Anthropometric measurements were carried out on participants wearing thin clothes without shoes. Portable digital scales were used to measure body weight (Tanita, registered). The participant's height was measured to be close to 0.5 cm, using a stadiometer mounted on the wall. Waist circumference (WC) was measured using a meter scale above the iliac crest and at the bound of the lowest rib at minimum respiration.

The incidence of prehypertension in college students was defined as systolic blood pressure (SBP) >120 mm Hg or diastolic blood pressure (DBP) >80 mm Hg. The lifestyle habit was categorized as 'yes' or 'no' for alcohol consumption and smoking. Physical activity was categorized as low for having less than 3 times a week of physical exercises, moderate for 3-5 times a week of physical exercises, and more than 5 times a week of physical exercises for high. The BMI was calculated by weight (kg) divided by height squared (m) and categorized according to the BMI Asia Pacific guideline (WHO 2014). The waist-to-height ratio (WHtR) was calculated based on measured waist circumference (cm) and height (cm). BRI was calculated based on height and WC,

using the formula presented by Thomas et al.[17] and ABSI was calculated using the formula developed by Krakauer and Krakauer.[18]

The statistical analysis was performed using STATA 15 (STATA, corp). The continuous variables are presented by the mean and standard deviation. Meanwhile, the frequency and the relative proportion were presented in categorical variables. Prehypertension and normotension's general characteristics were compared using student t-test for continuous variables and Chi-squared test for categorical variables. The AROC analysis with a 95% confidence interval (CI) was used to assess all discriminatory power of anthropometric measures to assess the risk of prehypertension in the participants. The ROC analysis was performed for more than one ROC, as suggested by the algorithm proposed by Hanley and McNeil to reduce the collinearity effect. The institutional ethical commission board has approved all the research procedures with an ethical clearance number #10/12/KEP-FKUAJ/2018.

Results

A total of 107 male students aged 19-23 years participated in the study. All participants denied smoking and drinking alchohol; Hence we removed the variables from the analysis. Table 1 shows the clinical characteristics of the study population according to normal and prehypertension criteria. Participants with prehypertension were relatively older and had low physical activity than normotensive ones (p<0.05). The mean BMI, BRI, WC, and WHtR were significantly higher in the prehypertensive group than normotensive. However, ABSI was not showing any relationship with blood pressure.

Table 1. Respondent Characteristics by Blood Pressure Group

Characteristics	Blood Pressure Group		P-value
	Normotension	Prehypertension	
Age, years	19.70±0.85	20.20±1.02	0.007*
Physical activity			
Low	28 (55%)	40 (71.4%)	0.032*
Intermediate	18 (35.3%)	14 (25%)	
High	5 (9.7%)	2 (3.6%)	
Blood Pressure			
Sistole, mmHg	110.11±5.16	124.80±4.82	0.000*
Diastole, mmHg	69.94±5.77	78.57±6.51	0.000*
Anthropomethric measures			
Height, m	1.71±0.04	1.70±0.05	0.192
Weight, kg	68.27±10.24	76.21±13.07	0.001*
BMI, kg/m^2	23.09±2.97	26.26±4.49	0.000*
WC,m	0.84±0.08	0.90±0.10	0.008*
ABSI	0.02±0.03	0.04±0.03	0.134
BRI	2.63±0.78	3.10±1.07	0.030*
WHtR	0.49±0.05	0.52±0.06	0.020*

*Significant value

Table 2 and Figure 1 show the area under the ROC curve (AROCs) with 95% confidence intervals of blood pressure classification related to anthropometric measures. The analysis was

conducted within the same sample. BMI showed the highest AROC values for the prehypertensive state (AROC: 0.73, 95% CI: 0.63–0.82), and WC had the lowest AROCs (AROC: 0.63, 95% CI: 0.52–0.63). Meanwhile, ABSI did not indicate a significant result.

Table 2. The Area Under The Curve of Anthropometric Indexes

Index	AUC	95% CI		p-value
		Lower	Upper	
BMI	0.726	0.630	0.822	0.000
WHtR	0.658	0.554	0.762	0.003
BRI	0.644	0.540	0.749	0.007
WC	0.628	0.523	0.734	0.017
ABSI	0.584	0.474	0.694	0.133

The overall model quality from comparative analysis of the AUC shows that BMI, WHR, BRI, and WC is a good models to detect prehypertension in this study population (Figure 1). The figure indicates that BMI has the highest AUC and WC has the lowest AUC, while ABSI suggests a poor model.

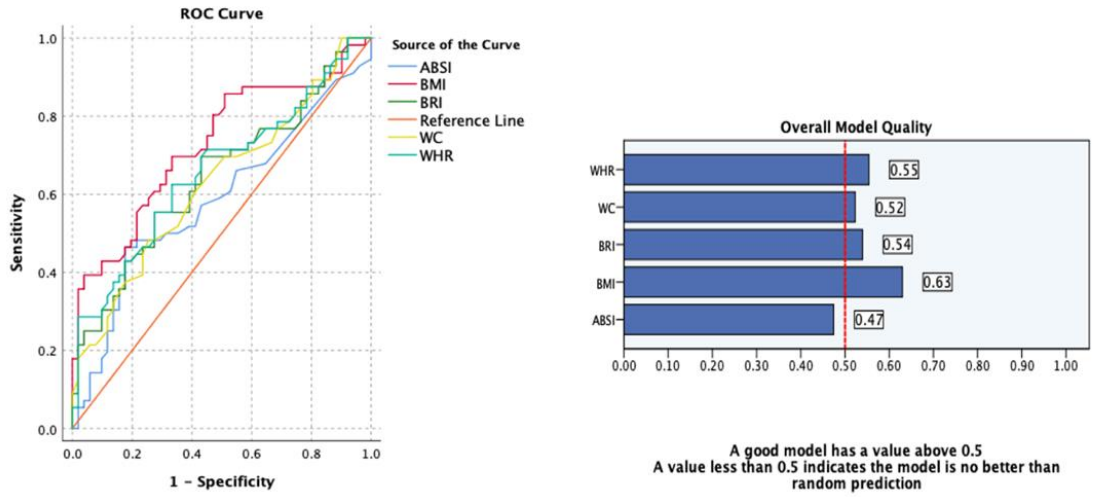

Figure 1.The ROC curve analysis of anthropometric Indexes and the overall model quality

Discussion

Our study compared the correlation of five anthropometric indexes (ABSI, BMI, BRI, WC, and WHtR) with prehypertension in male medical students in Jakarta, Indonesia. The results suggested that four out of five indexes appropriately identify the presence of prehypertension AROC >0.5 and OR >1 ($P < 0.05$). Meanwhile, ABSI did not show any significance to prehypertension status. Chang et al.[19], in their study, stated that a low correlation, although

significant, between ABSI and hypertension happened due to the objective of the index made originally for predicting mortality hazards in a longitudinal study. Thus, maybe it could not be appropriate in a cross-sectional study limitation. BMI showed the expected positive association with BP in a Portuguese adolescent study, but the ABSI showed a negative association with BP. Furthermore, ABSI did not represent an improvement in assessing the association of abdominal obesity with the risk of four obesity-related cancers.[20] According to Christakoudi and colleagues, ABSI was explicitly designed to be independent of BMI. ABSI and BMI are based on allometric principles and play a complementary role in risk stratification for all causes of death.[21] Nevertheless, the results of several studies were inconsistent regarding the usefulness of ABSI in determining the risk of hypertension and cardiovascular disease. Several studies have shown that ABSI is not correlated with an increased risk of cardiovascular disease and metabolic syndrome.[22–24] This explains the weak correlation between the two and other anthropometric indices associated with abdominal obesity.

There was well-established evidence that obesity was closely associated with an increased risk of hypertension.[25,26] This study consistently showed that BMI was superior to any other indexes predicting prehypertension in male college students. The result was interesting due to some contradictions with a few previous studies. Chang et al. claimed that the BRI is superior to any other indexes, showing potential use as an alternative obesity measure in the assessment of hypertension; however, while the analysis breakdown referred to the gender, BRI is the upper hand in women over men (0.68 vs. 0.65, respectively).[27] Another argument made was the average age of the participant. While our study participants were relatively younger, the predictor might differ. Mamdouh et al. suggested that BMI significantly correlated with prehypertension and hypertension in adults in Dubai.[28] Another study from Moinuddin on adult males showed that age and BMI were significantly associated with prehypertension in the 20-40 years age group.[11] Nevertheless, perhaps, research conducted by Bhavani et al. is the most appropriate comparison to this study. Examining the predictor for prehypertension in medical students in India, she indicates that BMI is the best predictor for male students.[29] The relationship between BMI and the risk of hypertension has yet to be fully understood. Some studies of adolescents in Asia have consistently shown a significant association between BMI and blood pressure.[24,30] Normal-weight adolescents in one center in China had an increased risk of hypertension using age-, sex-, and height-adjusted BMI Z-scores.[30] The results of these studies support the association between hypertension and excess fat, but the relationship to body fat distribution remains controversial.

WHtR, BRI, and WC also showed significant AUC, with the lowest belonging to WC. The results were somewhat different in several previous studies. Some of the earlier studies mentioned could have been attributed to differences in the populations' characteristics. Racial/ethnic, gender, and age variations in anthropometry are well established.[31] Study reported that the percentage of

body fat in Asians, measured by dual-energy X-ray absorptiometry, is more significant than in African Americans and whites with a similar BMI.[32] Variations in the leptin level (the gene's product primarily responsible for obesity) across different ethnic groups and races are also well established. Human body composition results from complex multifactorial interactions between lifestyle, culture, and environmental and genetic differences, varies from place to place, and impacts studies in different populations.[32,33]

We acknowledge some limitations in the study. First, the study's cross-sectional nature precludes a conclusion about a cause-effect relationship. A longitudinal study is required; secondly, our study population is limited to a single center that might not represent general college or medical students in Indonesia. Lastly, due to time limitations during the data collection and follow-up survey had a meager response rate, we could not avoid the confounding factor of dietary habits.

Conclusion

In conclusion, BMI strongly predicts prehypertension in young adult males compared to other anthropometric indices. As an alternative, BRI, WHtr, and WC are also good prehypertension screening tools for this population. However, ABSI does not have any association with blood pressure. Future studies of large, diverse populations are required to validate the clinical application of this study's results.

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Conflict of Interest

We have no conflict of interest to disclose.

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