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RESEARCH STUDY
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Body Mass Index as Hypertension Predictor: Comparison between World Health Organization and Asia-Pacific Standard

Indeks Massa Tubuh sebagai Prediktor Hipertensi: Perbandingan Standar World Health Organization *dan Asia-Pasifik*

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ABSTRACT

Background: BMI is associated with increase in blood pressure. Asia-Pacific BMI recommendation has lower cut-off for overweight and obesity categories than WHO standard.
Objectives: To analyze sensitivity of BMI based on WHO and Asia-Pacific recommendation for predicting hypertension.
Methods: This study was diagnostic research. Population of this study was women employees in a Garment company in Semarang Regency aged 19-54 years. Total sample was 180 taken using simple random sampling technique. Sensitivity of BMI was analyzed using ROC.
Results: Prevalence of overnutrition based on WHO criteria is 30.6% and 87.8% based on Asia-Pacific criteria. Sample with hypertension are 85% and not hypertension 15%. BMI is very good on predicting hypertension with AUC 95.5%. WHO and Asia-Pacific BMI recommendation are associated with blood pressure (p<0.001, r=0.278, 0.450 respectively). Asia-Pacific BMI recommendation has better sensitivity than WHO recommendation (Se=95.4%, Se=35.9%).
Conclusions: Asia-Pacific BMI recommendation is more suitable for predicting hypertension in adult women in Indonesia.

INTRODUCTION

Hypertension is one of the main factors of heart disease, chronic kidney disease, coronary heart disease, and stroke[1]. Hypertension is closely related to cardiovascular disease. Every 10 mmHg increase in systolic blood pressure increases the risk of atherosclerosis by 53%[2]. Elevates blood pressure in childhood and adolescence is correlated with high blood pressure in adulthood. High blood pressure in young age is related with cardiovascular disease and risk factor of death in adulthood[3].

Hypertension is a global health problem. The average of blood pressure tends to decrease generally due to the use of hypertension medication, but the prevalence of hypertension tends to increase. Around 1.28 billion people in the world 30-79 years of aged suffer from hypertension, of which two-thirds live in low-middle income countries. 46% adults with hypertension are unaware with their condition[4,5]. The prevalence of hypertension is increase based on basic health survey in Indonesia. In 2013 the prevalence was 25.8% become 34.11% in 2018[6,7]. The risk factors of the increasing

prevalence of hypertension are age, food consumption, inactive physical activity, and obesity[4]. Obesity one of the main predictors of noncommunicable diseases including hypertension. BMI has been widely associated with blood pressure and hypertension.

BMI was correlated with blood pressure (p<0.001) even after correction of age factor. The greater BMI the risk of increasing blood pressure also increase[8]. In the population that does not consume hypertension medication, every increase in BMI by 1 kg/m^2 increases the blood pressure by 0.8-1.7 mmHg[9]. The weaker correlation is found between BMI and blood pressure probably due to the increasing blood pressure medication consumption recently[10]. BMI which has strong correlation with blood pressure can be used as predictor of hypertension as disease prevention to decrease hypertension prevalence.

BMI is simple anthropometry index and globally use for obesity screening. There was Asia-Pacific recommendation of BMI beside international recommendation from WHO. Asia-Pacific population showed higher body fat percentages with the same BMI

compare with Europe population. In BMI 22.3 kg/m^2, Higher body fat percentages was found in Asia-India population than Europe population (9.1% dan 21.2%)[11]. Ethnicity influences the body fat distribution and cardiometabolic diseases. Asian have higher body fat percentages in the same BMI than Caucasians and have higher risk of cardiometabolic diseases[12]. Study in China was found lower cut-off of BMI for obesity screening than WHO recommendation. Optimal cut-off of BMI was found 23.53 kg/m^2 in male and 23.41 kg/m^2 in female[13].

Comparison study of three standards of BMI has been done in Indonesian middle adult aged (40-64 years of aged). BMI was found having positive correlation with hypertension. The prevalence was higher in female (48.3%) than male (42%). The recommendation for overweight and obesity cut-off related to hypertension for Indonesian middle adult aged was ≥23 kg/m^2 for overweight and ≥25 kg/m^2 for obesity[14]. Cut-off difference of BMI might cause the differences of interpretation measurement result and screening.

BMI is one of adult nutrition status indicators. Garment X Company located in semarang Regency is hiring female adult workers in sewing department. Lifestyle characteristics between workers are similar, namely unbalanced diet, frequent consumption of fried foods, and inactive physical activity. Most of the activities in the company is done in sitting position. Fifty workers in Garment X Company was observed. It was found that the prevalence of overweight was higher while using Asia-Pacific recommendation compare to WHO recommendation. The incidence of hypertension while using WHO recommendation was 18 (36%) workers and 14 (28%) workers while using Asia-Pacific recommendation. Based on the preliminary study data, it needs a re-examination in BMI classification. Study about the relevancy of BMI classification based on WHO recommendation for Indonesian need to be done. The appropriate BMI classification is important for nutritional screening which beneficial for early detection of overweight and obesity as one of indicators of hypertension. This study examined the difference of sensitivity of BMI based on WHO recommendation and Asia-Pacific recommendation as hypertension indicator. The study results can be used for BMI classification recommendation for Indonesian related to hypertension.

METHODS

This study was a diagnostic study with descriptive observational design and cross-sectional approach. The study conducted in July 2023 in Garment X Company Semarang Regency. The population was female workers in sewing department in Garment X Company Semarang Regency consisted 400 workers. The age of the population in research location are in the adult range and have similar characteristic form ethnicity, food pattern, physical activity, and lifestyle. It was one of the things that underlies the choice of the research location. The sample was 180 female workers which was taken by simple random technique. The minimum sample size was counted by diagnostic research formula. Sample selection by random sampling was using the company data of human resources department. The sample criteria were 1) 19-54 years of aged, 2) can be measured in standing position, 3) was not disability person, 4) have underweight nutritional status, 5) was not pregnant, 6) was not in breastfeeding period, 7) was not using hypertension medication.

BMI classification based on WHO recommendation is normal (18.5-24.9 kg/m^2) and overnutrition (≥25 kg/m^2). BMI classification based on Asia-Pacific recommendation is normal (18.5-22.9 kg/m^2) and overnutrition (≥23 kg/m^2). Overnutrition nutritional status in sample characteristics and correlation test was explained into two categories overweight and obesity. respectively, WHO and Asia-Pacific BMI recommendation for overweight is 25.0-29.9 kg/m^2 and 23-27.4 kg/m^2, ≥30 kg/m^2 dan ≥27.5kg/m^2 for obesity[15]. Blood pressure was classified not hypertension/normal (systolic blood pressure = <140 mmHg) and hypertension (systolic blood pressure = ≥140 mmHg)[16]. The instruments in this study were digital weight scale, stadiometer, and digital tensimeter. The measurement was done by following the standard measurement for each variable. Correlation between BMI and hypertension was analyed by using Kendall-tau test (α=0.05). BMI sensitivity was analyzed using ROC.

RESULTS AND DISCUSSION

The sample of this study was adult female workers in Garment X Company In Semarang Regency 19-54 years of aged. Most of the samples were 30-54 years of aged. Blood pressure is influenced by age. As it increase, there will be a decrease in arterial flexibility, hormonal changes, and kidney agung which can affect blood pressure. The BMI cut-off of overnutrition in Asia-Pacific recommendation was lower than WHO, so the prevalence of overweight and obesity is higher in Asia-Pacific recommendation. Most of the samples in this study also had hypertension (85%).

If a cross tabulation was carried out between BMI and hypertension, it was found that both the WHO and Asia-Pacific classification had positive correlation with hypertension. Asia-Pacific classification had stronger correlation than WHO classification. A study in the age group ≥60 in Aceh found that BMI was positively correlated to both systolic ($r=0.302$, $p=0.007$) and diastolic blood pressure ($r=0.315$, $p=0.005$)[17]. Research over 15 years (2003-2017) in Korea on 19 year old men found that the coefficient correlation between BMI and hypertension increases every year[18]. An increase of 5 kg/m^2 of BMI in Bangladesh, Nepal, and India increase the risk of hypertension by 1.79 times. The correlation between BMI and hypertension is very strong even when using the South Asian threshold which is lower than WHO threshold[19].

Table 1. Frequency Distribution of Female Workers in Sewing Department of Garment X Company Semarang Regency Central Java Characteristics

Characteristics	n	%
Age		
19-29 years	36	20
30-54 years	144	80
BMI WHO[a]		
Normal (18.5-24.9 kg/m^2)	125	69.4
Overweight (25.0-29.9 kg/m^2)	52	28.9
Obesity (≥30 kg/m^2)	3	1.7
BMI Asia-Pacific		
Normal (18.5-22.9 kg/m^2)	22	12.2
Overweight (23.0-27.4 kg/m^2)	130	72.2
Obesity (≥27.5 kg/m^2)	28	15.6
Hypertension status		
Not hypertension/Normal	27	15
Hypertension	153	85

[a]BMI WHO: Body Mass Index World Health Organization

Table 2. Correlation between BMI and Hypertension on Female Workers in Sewing Department of Garment X Company Semarang Regency Central Java

Nutritional Status	Hypertension Incidence				r	p
	Hypertension		Not Hypertension			
	n	%	n	%		
BMI WHO[a]						
Normal (18.5-24.9 kg/m^2)	98	54.4	27	15		
Overweight (25.0-29.9 kg/m^2)	52	29	0	0	0.278	<0.001*
Obesity (≥30 kg/m^2)	3	1.6	0	0		
BMI Asia-Pacific						
Normal (18.5-22.9 kg/m^2)	7	4	15	8.3		
Overweight (23.0- 27.4 kg/m^2)	118	65.5	12	6.7	0.450	<0.001*
Obesity (≥27.5 kg/m^2)	28	15.5	0	0		

[a]BMI WHO: Body Mass Index World Health Organization
*Kendall-tau test

AUC score of BMI in hypertension prediction is 95.5% which mean BMI is very good in hypertension prediction. The studi in Korean middle adult aged was found similar result. AUC score of BMI in hypertension prediction was 84.5%. The result showed that BMI was good in predicting hypertension[20]. Prediction model of hypertension incidence with inclose age, sex, HDL (High Density Lipoprotein) cholesterol, systolic blood pressure, and BMI showed AUC score 82.3%. BMI showed better capacity in predicting hypertension than Body Adiposity Index (BAI), Body Roundness Index (BRI), and Visceral Adiposity Index (VAI). BMI still become the best index and the simplest in predicting hypertension incidence even after follow-up for 10 years in samples[21].

Table 3. Sensitivity and Specivicity BMI in Predicting Hypertension on Female Workers in Sewing Department of Garment X Company Semarang Regency Central Java

Nutritional Status	Hypertension Incidence				Se	Sp
	Hypertension		Not Hypertension			
	n	%	n	%		
BMI WHO[a]						
Overnutrition (≥25.0 kg/m^2)	55	30.5	0	0	0.359	1.000
Normal (18.5-24.9 kg/m^2)	98	54.5	27	15		
BMI Asia-Pacific						
Overnutrition (≥23.0 kg/m^2)	146	81	12	6.7	0.954	0.556
Normal (18.5-22.9 kg/m^2)	7	4	15	8.3		

[a]BMI WHO: Body Mass Index World Health Organization

Table 3 showed that sensitivity score of BMI using Asia-Pacific classification is higher (95.4%) than BMI WHO classification (35.9%). It can be concluded that BMI using Asia-Pacific classification is better than WHO classification in predicting people with disease based on screening results. Lower cut-off (23 kg/m^2) of BMI was showed higher sensitivity (67%) than using 25 kg/m^2 (55%) as a cut-off[22]. Similar results was found in prediction of diabetes in Asian Americans. Lower cut-off of BMI was more sensitive than cut-off using WHO classification for overnutrition[23].

This study was showed that BMI Asia-Pacific classification is more appropriate than WHO classification for female workers in Garment X Company in Semarang Regency Central Java. BMI Asia-Pacific classification is considered more appropriate due to the sensitivity score was higher in predicting diseases related to obesity. Asian have smaller frame size of the body with higher risk of metabolism[23].

Using the appropriate classification will affect the screening accuracy results. BMI is one of the methods to assess the body weight and its correlation with health problem risks. BMI has some advantages in the screening process. The advantages are easy in measurements, cheap, the respondent's refusal rate is low, and already has health risk classification based on huge population data. BMI not only for body weight classification but also for monitoring the changes both in individual level and population from time to time. The weakness of BMI is can not distinguish fat mass and fat free mass. It can lead to misclassification of nutritional status. In adult, BMI can be misclassified as normal when there was an increase of fat mass and a decrease of fat free mass. In athlete the misclassification can be happened when there was an increase in muscle mass relatively to fat mass. This condition can be categorized as overweight or obesity according to BMI[24].

Choosing the appropriate classification of BMI can assist in obesity prevention and control. It can decrease hypertension risk indirectly. Classification of BMI from WHO is not adequate to describe overweight and obesity in all population. Higher body fat percentages was found having correlation with lower BMI in Asian. Higher BMI was found in people living in Pacific area due to have higher muscle mass and lower fat mass. The weakness of BMI in describing fat mass can cause misclassification in some ethnic when using WHO recommendation[25]. Choosing appropriate classification of BMI will assist the screening process of health problem. BMI is a simple method so can be conducted easily in the community and in health institutions for health program policy.

In this study, the samples are female from Java tribe. Indonesia has ethnic diversity. The future research needs to consider to conduct research that examine the sensitivity of BMI Asia-Pacific for Indonesian. Ethnic difference can affect anthropometry profile. A study was found difference anthropometry profile in black female, American-Indian, and Asian female. Black female had the highest BMI, waist circumference, fat mass, and leg fat mass, but lowest fat mass-leg ratio. American-Indian women had highest waist-hip ratio, body fat percentages, trunk fat mass, and trunk-leg fat mass ratio. Asian female had lowest BMI, waist circumference, body fat percentages, trunk fat mass, and leg fat mass but lowest in leg fat mass, but the ratio of trunk-leg fat mass was higher than black female[26]. The ethnic diversity can affect the frame size that might affecting on BMI classification.

CONCLUSIONS

BMI Asia-Pacific have higher sensitivity in predicting hypertension than BMI WHO classification. Lower cut-off of BMI need to be considered for classifying overnutrition in Indonesian population. Future research

on sensitivity test of BMI Asia-Pacific classification at various age, genders, and ethnicities need to be done so that it can represent all ethnicities in Indonesia.

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