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THREE BODY MASS INDEX CLASSIFICATION COMPARISON IN PREDICTING HYPERTENSION AMONG MIDDLE-AGED INDONESIANS

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ABSTRACT

Cardiovascular disease is one of the severe causes of death in low-middle-income countries. Being overweight and obese relates to a higher risk of hypertension, which further increases the risk of CVD. Therefore, determining body mass index (BMI) cut-off points is essential to provide a new scale for early and accurate screening. This study aimed to compare three classifications of BMI defined by WHO, Indonesia, and Asian criteria in predicting hypertension in middle-aged Indonesians. We used the 2014 Indonesian Family Life Survey data and included a total sample of 9737 respondents aged 40-60-year-old. We compared values (specificity, sensitivity, negative and positive predictive value, false-positive rate, negative and positive likelihood ratio, Youden index, and prevalence) of three BMI criteria (WHO, Indonesian, and Asian) between groups (Group 1: normal BMI vs overweight + obese BMI; group 2: normal + overweight BMI vs obese BMI) to determine the cut-off points of BMI related to hypertension. The hypertension prevalence was significantly higher in women (48.3%) than in men (42.0%). Respondents' BMI was positively associated with hypertension. The Asian BMI classification showed better sensitivity, specificity, PPV, NPV, FPR, LR+, LR-, and Youden index in group 1 than in group 2. Thus, this study proposed a fitted BMI cut-off point for overweight was ≥23 kg/m^2 and for obesity was ≥25 kg/m^2 as the early screening of overweight and obesity related to hypertension among the middle-aged population in Indonesia.

Keywords: BMI classification, hypertension, sensitivity, Youden index, middle-aged Indonesian, Asian

INTRODUCTION

Cardiovascular disease (CVD) is one of the non-communicable diseases and has become the highest cause of death in low- middle-income countries (World Health Organization, 2014; Hussain et al, 2016; Hawkes et al, 2015). The major preventable behavioral risk factors for CVD are an unhealthy diet and obesity, physical inactivity, tobacco use, and heavy alcohol consumption (Denova-Gutierrez et al, 2016; Brown et al, 2015; Rosengren et al, 2015; Mendis et al, 2011; Chobanian et al, 2003). A person who has been diagnosed with or has a history of hypertension, diabetes, and hyperlipidemia has the highest risk of cardiovascular diseases (Bell et al, 2015). On the other hand, in low-middle-income countries, hypertension was the leading cause of death and increased the adult's risk of CVD. The hypertension prevalence among the middle-aged Indonesian population has increased over the past decades (Hussain et al, 2016). By managing the population's body mass index (BMI), it is possible to reduce the occurrence of obesity-related hypertension and indirectly decrease the number of CVD (He et al, 2009).

Further, Indonesia's overweight (men: 22.5%, women: 29.1%) and obesity (men: 8.9%, women: 19.6%) prevalence is remained high (Roemling et al, 2015). Meanwhile, one of the independent risk factors for hypertension is being overweight or obese (He et al, 2009 ; Jiang, 2016). Researchers have used different approaches to determine obesity, such as BMI (He et al, 2015), waist circumference (WC) (Battie et al, 2016), waist-to-hip ratio (WHR), and the waist-to-stature ratio (WSR) (Correa et al, 2016; World Health Organization, 2008; Doll et al, 2002). Furthermore, Ren and colleague investigated the association between obesity measurement and the risk of hypertension using BMI, WC, WHR, or WSR, which resulted in lowering the BMI cut-off point to ≥ 25 kg/m^2 for obesity (Ren et al, 2016). The Asian population tends to have a higher body fat percentage than the Caucasian population at an

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equivalent BMI level may be a possible explanation for setting the lower BMI cut-off point for Asian people (He et al, 2015). Thus, our study aimed to compare three classifications of BMI defined by WHO, Indonesia, and Asian criteria in predicting hypertension in middle-aged Indonesians and used the representative survey data from 13 provinces of the 2014 Indonesia Family Life Survey (IFLS), conducted from September 2014 to August 2015, to plan effective prevention strategies.

METHODS

Study population

In 1993, RAND Corporation initiated the Indonesia Family Life Survey and continued the data collection with four subsequent rounds (Strauss et al, 2016). Our study used a secondary data from the latest wave of the IFLS dataset completed in August 2015. The dataset contain individual, household, and community-level data from a large-scale longitudinal survey using multistage stratified sampling (Frankenberg, 1995). The IFLS data sampling included 13 of 20 provinces that in 1993 represented more than 80% of Indonesia's population (Frankenberg et al, 1995; Frankenberg et al, 2000). Overall, IFLS respondents were 49,139 people (51% women) aged 0 to >80 years and collected from 16,204 households (Figure 1). Our study used the data from 9,737 respondents aged 40-64 years who were not pregnant nor breastfeeding and had completed information on anthropometric and blood pressure measurements.

In the IFLS5 survey, 14,754 respondents aged 40-64 years (Fig 1). We excluded the participants with body height less than 130 cm to minimize the possibility of the human error that led to the outliers in our data.

On the other hand, because of the U shape effect of the BMI relationship with the health status, so we excluded the participants with BMI less than 18.5 kg/m^2 (Allison et al, 1997; Thinggaard et al, 2010; Li et al, 2021). As many as 5,017 respondents (34%) did not have complete information and were excluded from the analysis. Finally, this study included 9,737 (66%) participants, of whom 51.9% were women.

Ethics approval

The Institutional Review Board (IRB) in the RAND (The United States) and Universitas Gadjah Mada (Indonesia) have been successfully reviewed and approved with the number s0064-06-01-CR01 (Strauss et al, 2016; Frankenberg, 1995). The

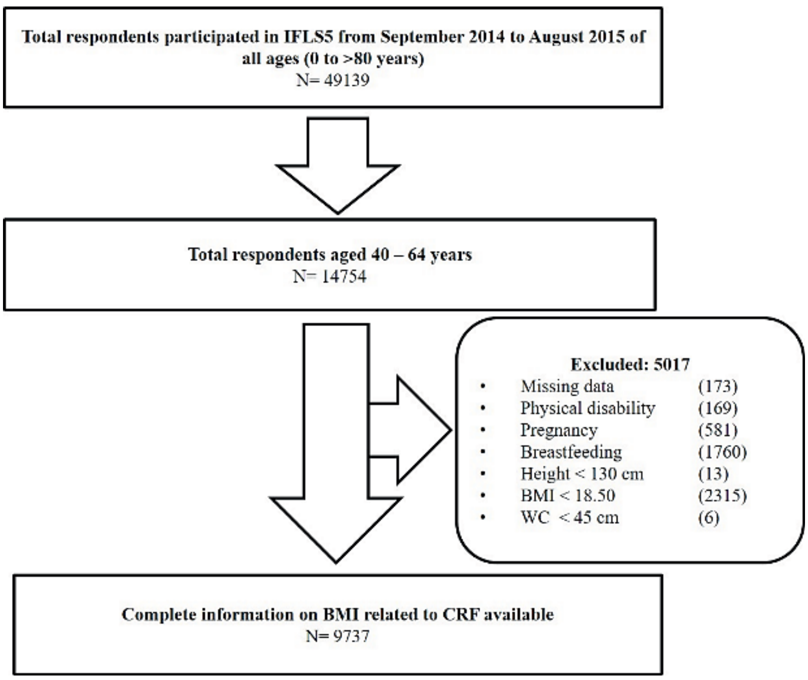

Figure 1. Flowchart of Study Participants

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respondents' data were anonymous and publicly available (Strauss et al, 2004).

Hypertension measurement

The hypertension definition used the systolic and diastolic blood pressure measured by the trained nurse in a seated position at the beginning and twice during the interview sessions or self-reported information on the usage of antihypertension medication or got diagnosis with hypertension by a doctor (Strauss et al, 2016). The hypertension definition from blood pressure measurements was using mean systolic blood pressure (SBP) ≥ 140 mmHg or mean diastolic blood pressure (DBP) ≥ 90 mmHg. Further, the blood pressure is classified into pre-hypertensive if SBP 120–139 or DBP 80–89 mmHg, stage 1 hypertensive if SBP 140-159 mmHg or DBP 90–99 mmHg, and stage 2 hypertensive if SBP ≥ 160 mmHg or DBP ≥ 100 mmHg (Chobanian et al, 2003).

Body mass index measurement

This study used BMI calculation of weight in kilograms divided by height in square meters. Subsequently, the BMI was categorized using three classifications (World Health Organization (WHO) 2000, Indonesia BMI, and Asian BMI). First, the WHO 2000 classify pre-obese if BMI is ≥ 25 kg/m^2 and < 30 kg/m^2, and obese if BMI is ≥ 30 kg/m^2. Second, Indonesian BMI classify overweight if BMI is ≥ 25 kg/m^2 and obese if BMI is ≥ 27 kg/m^2, this cut-off point was used by the Indonesian Ministry of Health. Third, the cut-off points adapted for Asians (overweight if BMI is ≥23 kg/m^2 and obese if BMI is ≥25 kg/m^2) (World Health Organization, 2000; Kementrian Kesehatan RI, 2003). The BMI cut-off point reference in this study was 18.5-24.9 kg/m^2. The 2014 IFLS survey enumerators used Seca plastic height board model 213, the Camry model EB1003 body scale, and a measuring tape for waist or hip circumference measurement (Strauss et al, 2016).

Sociodemographic characteristics

The respondents' sociodemographic information was collected using a questionnaire. The questions included the area of residence (urban or rural), marital status (currently or ever married or unmarried), and the information on the highest attained education level (low level if < 12 years or high level if ≥ 12 years).

Statistical analysis

A total of 9,737 participants aged 40-64 years, who had complete information on blood pressure, anthropometric, waist circumference, and hip circumference (HC) measurements were analyzed. The outcome variables were determined using sensitivity, specificity, and the Youden index to evaluate the fitted cut-off point from three BMI criteria related to hypertension. We presented the continuous data as the mean value (95% confidence interval). Meanwhile, categorical data were presented as number (prevalence). Subjects were grouped based on BMI values into two groups (normal BMI vs overweight + obese BMI) and (normal + overweight BMI vs obese BMI).

Further, data analysis used student t-test and Chi-square test to compare between groups. This study compared prevalence, sensitivity and specificity value, negative predictive value (NPV) and positive predictive value (PPV), false-positive rate (FPR), negative likelihood ratio (LR-) and positive likelihood ratio (LR+), and the Youden index (sensitivity plus specificity-1), of comorbidities in each BMI criteria's group (Jiang et al, 2016; Ren et al, 2016; Bohr et al, 2016). The sensitivity and specificity value should be >50% to determine the reliability of the cutoff point of BMI in the relationship with cardiovascular risk factors (Vasconcelos et al, 2010). On the other hand, the BMI sensitivity value should be higher than its specificity value (Vasconcelos et al, 2010; Parikh, 2008). In addition to the BMI, the highest Youden Index decides the cut-off value supported by the values of FPR, PPV, NPV, LR+, and LR-, specificity, sensitivity, and max value of the Youden index (Jiang et al, 2016; Ren et al, 2016; Bohr et al, 2016). All the analyses in this study used the STATA, Version 12.0 developed by STATA Corp. LP, College Station, TX and the statistically significant p-value was <0.05.

RESULTS AND DISCUSSIONS

Respondents' characteristics

The respondents' mean age was 50 years (Table 1). The majority of the respondents were in the age group of 40-44 years in both groups (Men: 1415 (30.2%), Women: 1365 (27.0%)), respectively (p=0.003). The mean BMI (25.7 (25.6 - 25.8)), SBP (140.0 (139.3 - 140.7)), DBP (84.8 (84.4 - 85.1)), WC (87.1 (86.8 - 87.4)), HC (96.6 (96.3 - 96.8)), and WSR (0.580 (0.578 - 0.582)) were significantly higher in the women than in the men (p<0.001). As many as 1967 (42.0%) men and 2438 (48.3%) women respondents were hypertensive. The most of the respondent were having low education level.

Prevalence of overweight, obesity, and hypertension

This study compared three different BMI criteria and observed that women tended to have higher BMI than men (Table 1). The percentage of the participants with excess weight was significantly higher among women (overweight: 17.9%, obesity: 34.8%) than among men (overweight: 15.0%, obesity: 16.7%).

The mean SBP was significantly higher among women (140.0 mmHg, 95% CI:139.3-140.7) than men (137.5 mmHg, 95% CI: 136.9-138.1). Respondents with a higher BMI were more likely to have a higher probability of hypertension (Table 2). The mean SBP and DBP increased progressively with age in both groups.

Table 2. The Number and Percentage of Participants with Hypertension Classified according to the WHO, Indonesian, and Asian Classifications.

Variable	Normal (n = 5332)		Hypertension (n = 4405)		All (n = 9737)		χ^2	P value‡	PR†
	n	%	n	%	n	%			
BMI (WHO) (kg/m²)									0.005 *
Normal (18.5-24.9)	3385	61.6	2112	38.4	5497	56.5	591.7	< 0.001	Ref.
Overweight (≥25.0)	1947	45.9	2293	54.1	4240	43.6	57.0	< 0.001	1.4
Pre-obese (25.0-29.9)	1562	48.6	1653	51.4	3215	33.0	5.0	0.025	1.3
Obese I (30.0-34.9)	344	39.3	532	60.7	876	9.0	80.2	< 0.001	1.6
Obese II (35.0-39.9)	41	27.5	108	72.5	149	1.5	60.1	< 0.001	1.9
BMI (Indonesian) (kg/m²)									0.014 *
Normal (18.5-25.0)	3427	61.3	2159	38.7	5586	57.4	570.6	< 0.001	Ref.
Overweight (≥25.1-27.0)	833	51.8	775	48.2	1608	16.5	4.2	0.041	1.2
Obese (>27.0)	1072	42.2	1471	57.8	2543	26.1	123.7	< 0.001	1.5
BMI (Asian) (kg/m²)									0.004 *
Normal (18.5-22.9)	2345	64.4	1296	35.6	3641	37.4	603.9	< 0.001	Ref.
Overweight (≥23.0)	2987	49.0	3109	51.0	6096	62.6	4.9	0.027	1.4
Pre-obese (23.0-24.9)	1040	56.0	816	44.0	1856	19.1	53.4	< 0.001	1.2
Obese I (25.0-29.9)	1562	48.6	1653	51.4	3215	33.0	5.0	0.025	1.4
Obese II (≥30.0)	385	37.6	640	62.4	1025	10.5	126.0	< 0.001	1.8
Residence area (%)									
Rural	2189	55.7	1739	44.3	3928	40.3	102.1	< 0.001	
Urban	3143	54.1	2666	45.9	5809	59.7	78.1	< 0.001	
Education level (%)									
High (≥12 years)	1780	58.9	1241	41.1	3021	31.0	191.4	< 0.001	
Low (<12 years)	3552	52.9	3164	47.1	6716	69.0	45.2	< 0.001	
Marital status (%)									
Single	93	50.0	93	50.0	186	2.9	0.0	1.000	
Married/ever married	5239	54.9	4312	45.1	9551	98.1	183.4	< 0.001	

Note: ref., reference. ‡The chi square test was conducted to analyze the difference between hypertension and normal participants at each level of category. †Prevalence Ratio: the prevalence of hypertensive participants and overweight or obese divided by the prevalence of hypertensive participants and normal weight. * The P trend value.

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The hypertensive respondents, 54.1%, 48.2%, and 51.0%, were classified overweight by WHO, Indonesian, and Asian BMI criteria, respectively.

The hypertensive respondents were 60.7% Obese I, 72.5% Obese II by WHO criteria, 57.8% by Indonesian BMI, and 51.4% Obese I, 62.4% Obese II by Asian BMI. Hypertensive respondents with a low education level (47.1%), living in urban residence (45.9%), and were currently married or ever married status (45.1%) significantly differed from the normotensive people ($p<0.001$).

Comparison of three BMI criteria related to hypertension

Table 3 shows the BMI cut-off points to determine hypertension. The sensitivity of WHO and Indonesia (≥25.0 kg/m^2) BMI cutoff point was lower (0.521 in Group 1) than the sensitivity of the Asian BMI cutoff point (≥23.0 kg/m^2) (0.706 in Group 1). In the Asian BMI criteria, Group 1 has a higher sensitivity (0.706) than group 2 (0.521), which indicates a cut-off point ≥23 kg/m^2 by Asian BMI may detect the larger population with overweight that leads to hypertension. Likelihood ratios are related to the amount the researcher can increase or decrease the likelihood of disease (Maxim et al, 2014). The LR+ (1.260) and LR- (0.669) indicated people with BMI ≥23 kg/m^2 were associated with a higher probability of developing hypertension and vice versa. The PPV (51.001) of Asian BMI Group 1 was the lowest among others. However, these measures were not invariant characteristics due to the prevalence of hypertension tested in a large population. Therefore, the highest sensitivity and Youden Index are the key indicators in this study results to determine the optimized BMI cut-off points.

Furthermore, table 3 shows Youden index value of WHO and Indonesia BMI criteria were higher in Group 1 (≥25 kg/m^2) but lower in sensitivity than the Asian BMI criteria (≥23 kg/m^2). Group 2 in all BMI criteria had a lower Youden index and sensitivity value than Group 1. Group 1 (normal BMI vs. overweight + obesity groups) in the Asian BMI performed the best cut-off point with a sensitivity value of 0.706, specificity value of 0.440, and Youden index value of 0.146. Moreover, the Asian BMI cut-off shows that a BMI of ≥23 kg/m^2 signifies an overweight. The BMI cut-off point of ≥23 kg/m^2 can be a suitable value representing a high cardiovascular risk according to the level of SBP and DBP because the BMI cut-off point of ≥25 kg/m^2 had low sensitivity (0.145) but high specificity (0.928), which leads to a high false negatives number interpretation (Parikh et al, 2008; Lalkhen and McCluskey, 2008; Trevethan, 2017; Pugh et al, 2022).

Obesity is a public health problem that depends on the transition from nutrition in the diet and any change in physical activity. BMI is the most common and easy tool to identify obesity (WHO, 2004; Harahap et al, 2005). BMI is a scale used to define overweight and obesity to predict the diseases associated with BMI, especially CVD, which all cause deaths (Malik et al, 2004).

Although the application of BMI became much debate claiming its association with genetics, race, and ethnicity (Bell et al, 2002), BMI has limitations in classifying the adiposity level, which cannot evaluate the difference between body composition and body fatness (Aris et al, 2017; Liu et al, 2011; Stevens et al, 2003). Our study results were consistent with that of Wen and colleagues, conducted in 2009, who reported that

Table 3. Diagnostic Performance of BMI Criteria in Determining the Prevalence of Hypertension

BMI References	Group	Sen	Spec	LR+	LR-	FPR	PPV	NPV	Youden index
WHO	1	0.521	0.635	1.426	0.755	0.365	54.080	61.579	0.155
	2	0.145	0.928	2.012	0.921	0.072	62.439	56.784	0.073
Indonesia	1	0.521	0.635	1.426	0.755	0.365	54.080	61.579	0.155
	2	0.341	0.792	1.638	0.832	0.208	57.498	59.259	0.133
Asians	1*	0.706	0.440	1.260	0.669	0.560	51.001	64.405	0.146
	2	0.521	0.635	1.426	0.755	0.365	54.080	61.579	0.155

Sen, sensitivity; Spec, specificity, LR, likelihood ratio; FPR, false-positive rate; PPV, positive predictive value; NPV, negative predictive value. Group 1 was a comparison between normal weight vs. overweight and obesity; group 2 was a comparison between normal-weight and overweight vs. obese. *The suitable cut-off value of BMI.

the all-cause mortality risk significantly increased in middle-aged Asian participants and showed a higher BMI than Caucasians (Wen et al, 2009). The obesity prevalence among Asian populations that was determined using WHO criteria was < 5% in Indonesia, China, Vietnam, and Taiwan (Wen et al, 2009; Cheung et al, 2014; Nguyen et al, 2009). The Asian BMI cutoff points are lower than the WHO criteria, but lower BMI values showed higher morbidities (Wen et al, 2009). Asians body types re more likely different from the Caucasians, which is the majority sample population for the WHO BMI cutoff values, might be one of the reason that the morbidity between these two races are more likely different as well.

Although the intention of BMI to be accepted globally, the Asian characteristics showed the tendency to have abdominal obesity over non-Asian populations (WHO, 2004; WHO, 2008), and Asian were under-appreciated in the high number of deaths caused by obesity (Decoda et al, 2008). The WHO expert-consultation group has suggested using the country-specific BMI cut-off point for public health action (WHO, 2004). The WHO proposed cutoff points for overweight and obesity are BMI ≥25 kg/m^2 and BMI ≥30 kg/m^2, respectively (WHO, 2000). Meanwhile, in the Asian BMI criteria, the cutoff points for overweight and obesity are BMI ≥23 kg/m^2 and BMI ≥25 kg/m^2, respectively (WHO, 2000). The cut-off for BMI in Indonesia criteria was ≥25 kg/m^2 (overweight) and ≥27 kg/m^2 (obesity) (Kementrian Kesehatan RI, 2003). The lowering of the Indonesian BMI criteria cutoff point for obesity from ≥27 kg/m^2 to ≥25 kg/m^2 and overweight from ≥25 kg/m^2 to ≥23 kg/m^2 is consistent with that of previous studies conducted in Thailand (Angkurawaranon, 2014), Taiwan (Pan et al, 2004), Vietnam (Nguyen et al, 2009; Tuan et al, 2010), and China (Zhang et al, 2016; Zheng et al, 2011). Thus, BMI values of ≥ 25 kg/m^2 and ≥ 23 kg/m^2 may be new cut-off points for obesity and overweight, respectively.

The mean BMI values of men and women in our study were 23.7 and 25.7 kg/m^2, respectively. A BMI of 23.7 kg/m^2 is categorized as "normal to overweight" according to the WHO criteria, and a BMI of 25.7 kg/m^2 as overweight according to both WHO and Indonesia criteria. The obese hypertensive participants were 14.6% categorized by WHO BMI (12.1% level I, 2.5% level II), 33.4% by Indonesian BMI, and 52.0% (37.5% level I, 14.5% level II) by Asian BMI. On the other hand, this study found 49% hypertension in normal weight people as classified by Indonesia BMI.

Hypertension prevalence remained high for the middle age Indonesian population though the obesity cut-off for BMI was lower than the WHO criteria. The comparison of three different BMI criteria in this study showed that the prevalence of hypertension doubled at the ≥25 kg/m^2 BMI cut-off point. Hypertension is the CVD main risk factor (WHO, 2013) which is not quickly fatal. However, less awareness of hypertension leads to CVD, and the screening is to identify people with high risk. A screening test is a performance of medical tests on subjects, without diagnosing the illness, who tested positive and who typically require further evaluation with subsequent diagnostic tests (Maxim et al, 2014). Wald and colleagues reported that a risk factor must be strongly correlated to the disorder to have a meaningful screening test (Wald et al, 1999).

This study aimed to compare prevalence, sensitivity and specificity value, negative and positive predictive value, false-positive rate, negative and positive likelihood ratio, and the Youden index. The prevalence ratio may be the effective way to measure interest in prevalence rather than the incidence, for example, when we are concerned about the public health burden of disease (Pearce et al, 2004).

The sensitivity of the ≥25 kg/m^2 BMI cut-off point proposed for Indonesians was lower than the Asian criteria and was in line with Pan and colleagues (2004) study results as well as Shaikh and colleagues' study results (2016). Former study results suggested lowering the cutoff point following the Asian criteria because the cutoff point associated with the WHO criteria has low sensitivity. Former study results suggested lowering the cutoff point following the Asian criteria because the cut-off point associated with the WHO criteria has low sensitivity to hypertension prevention. The highest sensitivity of the Asian BMI (≥23 kg/m^2) automatically impacts a lower specificity, a lower PPV, and a higher NPV than other criteria, as shown in Table 3. The statistical high sensitivity of the Asian cut-off could be at the "cost" of the low specificity, and inversely (Correa et al, 2016; Pan et al, 2013). However, it is also necessary to consider the actual condition prevalence. Since the confirmatory tests for hypertension disease are not quickly fatal, not painful, and not burdensome, the high specificity is not so critical. The sensitivity and specificity consideration are necessary because we cannot increase both but have to trade off one for another.

In common hypertension cases, even a relatively high sensitivity could still mean missing cases but having a large number of them is a problem. Thus, the ultimate screening process for early detection would be better to avoid false positive cases (Maxim et al, 2014). In other words, the highest sensitivity may give less of a burden on the health resources. Further, people with the high BMI tends to have a high risk of hypertension and dyslipidemia (He et al, 2009; Jiang et al, 2016; Wen et al, 2009).

The low prevalence ratio (< 2) of BMI, as shown in table 2, shows that a test was not well discriminant for hypertension detection. In practice, if the linearity of hypertension and increase of the BMI is evident, screening for hypertension using BMI cannot be such a helpful strategy. However, BMI can be a potential use to screen for the presence of hypertension in middle-aged adults (Cheung et al, 2014). The linearity of the adiposity markers, such as BMI, WC, and WHR, with blood pressure independent of age and fat distribution, is seen in both developed and developing countries (Doll et al, 2002). The usage of BMI alone or with other obesity indices can predict the outcome of cardiovascular and metabolic diseases (Bovet et al, 2012) and is portable, inexpensive, unsophisticated, and particularly helpful in low-resource settings (Bovet et al, 2015).

The Asian population has different body composition and body fat (Aris et al, 2017; Liu et al, 2003; Gallagher et al, 2000), so the WHO BMI classification may not apply to Indonesian populations due to the diversity of race and body shapes between European and Asian (Girrici et al, 1998). Some high- and upper-middle-income countries are currently facing an epidemic of severe obesity (Gearn et al, 2015), while low-middle- and low-income countries appear to have less ability to identify and treat CRFs (Angkurawaranon et al, 2014; Zimmer et al, 2016). Aizawa and Helble (2016) presented empirical evidence that hypertension underdiagnosis was more prevalent among the poor, and health inequality was more pronounced in rural areas (Helble et al, 2016).

Moreover, abdominal obesity, shown by WSR, was higher in women (0.580, 95% CI 0.578-0.581) than in men (0.523, 95% CI 0.521-0.525), as shown in Table 1. The women's waist circumference was above the ethnic or country-specific values recommended by the WHO International Diabetes Federation criteria (WHO, 2014), adapted from the study of Zimmet and Alberti (2006). The BMI, WC, and WSR indicated the relation to abdominal obesity because individuals with excess weight are more likely to develop hypertension (Zhang et al, 2016; WHO, 2013). Adult women aged less than 40 years with large waist circumference and normal BMI had a 1.96 times higher risk than normal BMI and WC women (Zhang et al, 2016). On the other hand, middle-aged women (40–59 years) with a high BMI and normal size of waist circumference performed an independent association with hypertension incidence. Thus, our study results supported the previous studies about BMI and hypertension in terms of lowering cut-off values for Indonesians. The suggestion is to combine the BMI with other adiposity markers, such as waist circumferences, waist-to-stature ratio (Zeng et al, 2014; Zhao et al, 2017), waist-to-hip ratio, or an alternative like body shape index (ABSI) (Dhana et al, 2016; Krakauer et al, 2012) to get more accurate results.

The current study has shown some limitations. Firstly, our sample included only middle-aged adults. However, the sample included only those with complete data on blood pressure and anthropometric measurements (WC and HC). Secondly, the cross-sectional study design did not support the causal relationship between variables. Therefore, the interpretation of the study needs to be careful. The strength of the current study is the representative sample which represents more than 80% of the Indonesian population. This study highlights the prominent issue of reducing CVD numbers in Indonesian adults by setting an early alarm from a public health perspective by lowering a BMI cutoff value to raise awareness of hypertension prevention. Promoting public health awareness and living a healthy way of life needs to be an easy, simple, cheap, and reliable tool to be used by the population. Therefore, the Asian BMI criteria cutoff values can be a suitable early screening in the population, particularly in a poor health resource setting. On the other hand, the WHO and Indonesia BMI criteria suits for diagnosing purposes of hypertension in the clinical setting with modest health resource settings.

CONCLUSIONS

Results of this current study suggested that the BMI criteria according to the Asian classification with BMI ≥23 kg/m^2 as overweight and ≥25 kg/m^2 as obese are the fitted cut-off points for early and accurate screening of apodictic obese people with a high risk of hypertension and may be combined with other adiposity indices to get a better diagnosis. Our study findings support the viewpoint of public health policies that aim at increasing the awareness of the middle-aged population concerning the effect of dietary patterns on BMI.

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