

## COMPARATIVE ANALYSIS OF ANTHROPOMETRIC INDEXES TO PREDICT HYPERTENSION RISK IN EMPLOYEES CIMAHY CITY

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### ABSTRACT

**Background:** Anthropometric indicator such as Body Mass Index (BMI), Waist Circumference (WC) and Waist to Height Ratio (WHtR) can be used to predict the risk of hypertension. This study aims to compare anthropometry in predicting the risk of hypertension in employees in Cimahi City.

**Methods:** The design study was cross-sectional with diagnostic test. This study used secondary data of Non-Communicable Diseases (NCD) screening 827 employees with age  $\geq 15$  years. The ROC (receiver operating characteristic) curves were analyzed to identify the optimal cut-off points and to compare the capacity of anthropometric indexes for prediction hypertension by gender using Stata.13 software.

**Result:** The hypertension cases in men 65.32% was higher than women 34.68%. The Area under the Curve (AUC) of WC 0.70 (95%CI=0.66-0.74) was more than WHtR 0.66 (95%CI=0.62-0.70) and BMI 0.64 (95%CI=0.60-0.69). Based on gender, the highest AUC of men was WC 0.69 (95%CI=0.64-0.75) and the highest AUC of women was WC and WHtR 0.67 (95%CI=0.60-0.74). The optimal cut-off points in predicting hypertension were BMI 25.89 (Sn=67.05%, Sp=57.95%), WC 90 cm (Sn=76.30%, Sp=54.74%) and WHtR 0.56 (Sn=68.79%, Sp=59.02%).

**Conclusion:** Based on the result, waist circumference can be used as an anthropometric index indicator better than WHtR and BMI in predicting hypertension risk in employees Cimahi City.

**Keywords:** Hypertension, obesity, diagnostic test

## ANALISIS KOMPARATIF INDEKS ANTROPOMETRI UNTUK MEMPREDIKSI RISIKO HIPERTENSI PADA PEGAWAI DI KOTA CIMAHY

### ABSTRAK

**Latar Belakang:** Indeks antropometri seperti Indeks Massa Tubuh (IMT), Lingkar Pinggang (LP) dan Rasio Lingkar Pinggang Tinggi Badan (RLPTB) dapat memprediksi risiko hipertensi pada seseorang. Penelitian ini bertujuan membandingkan indeks antropometri untuk memprediksi risiko hipertensi pada pegawai di Kota Cimahi.

**Metode:** Desain studi Cross Sectional dengan pendekatan Uji Diagnostik. Penelitian ini menggunakan data sekunder hasil skrining Penyakit Tidak Menular (PTM) pada pegawai yang berumur  $\geq 15$  tahun yaitu 827 orang. Analisis Receiver Operating Characteristic (ROC) untuk mendapatkan cut-off point yang optimal dan membandingkan kemampuan indeks antropometri dalam memprediksi risiko hipertensi berdasarkan jenis kelamin dengan menggunakan software Stata.13.

**Hasil Penelitian:** Hipertensi lebih banyak laki-laki 65.32% dibandingkan perempuan 34.68%. Analisis kurva ROC didapatkan nilai AUC LP 0.70 (95%CI=0.66-0.74) lebih tinggi dibandingkan dengan RLPTB 0.66 (95%CI=0.62-0.70) dan IMT 0.64 (95%CI=0.60-0.69). Berdasarkan jenis kelamin, nilai AUC paling tinggi pada laki-laki yaitu LP 0.69 (95%CI=0.64-0.75) sedangkan pada perempuan nilai AUC paling tinggi pada LP dan RLPTB yaitu 0.67 (95%CI=0.60-0.74). Cut off point yang optimal pada masing-masing indeks antropometri dalam memprediksi hipertensi yaitu IMT 25.89 (Sn=67.05%, Sp=57.95%), LP 90 cm (Sn=76.30%, Sp=54.74%) dan RLPTB 0.56 (Sn=68.79%, Sp=59.02%).

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**Kesimpulan:** Berdasarkan dari hasil penelitian, lingkaran pinggang dapat digunakan sebagai indikator indeks antropometri yang lebih unggul dari pada RLPTB dan IMT dalam memprediksi risiko hipertensi pada pegawai di Kota Cimahi.

**Kata Kunci:** Hipertensi, obesitas, uji diagnostik

## INTRODUCTION

Hypertension is one of the death causes in the world with an estimated 9.4 million die every year with complication heart disease 45% and stroke 51%.<sup>1</sup> The prevalence of hypertension in Indonesia was 25.8% (2013) and through increased become 34.1% (2018).<sup>2,3</sup> The trend of obesity based on Body Mass Index (BMI) was also increase 10.5% (2007), 14.8% (2013) and 21.8% (2018). Central obesity based on waist circumference measurements in 2007 (18.8%) increased in 2018 (31.0%).<sup>2</sup> Hypertension is strongly associated with the increase of overweight or obesity<sup>4,5,6,7,8,9</sup> and usually used as a standard indicator to predict the risk of hypertension.<sup>10,11</sup>

Body Mass Index, Waist circumference, and Waist to Height Ratio (WHtR) are an anthropometric index which usually used to measure adiposity of fat in the body.<sup>12</sup> The anthropometric index can also be used to predict the risk of hypertension for someone with a certain cut-off point.<sup>13</sup>

Generally, World Health Organization (WHO) recommended that BMI cut-off points are classified on three levels, normal (18.5–24.9 kg/m<sup>2</sup>), overweight (25.0–29.9 kg/m<sup>2</sup>) and obesity ( $\geq 30.0$  kg/m<sup>2</sup>). However, in 2004, the expert's consultation of WHO redefined BMI cut-off points is only overweight (23 kg/m<sup>2</sup>) and obesity (27.5 kg/m<sup>2</sup>) for Asian populations.<sup>13</sup> The studies from several countries in Asia also found different cut-off points, such as China (23.5 kg/m<sup>2</sup>), Vietnam (20.5 kg/m<sup>2</sup>), Egypt (27 kg/m<sup>2</sup>) and Korea (22.7–23.3 kg/m<sup>2</sup>).<sup>14,15,16</sup> The Ministry of Health Indonesia apply a cut-off point ( $\geq 27$  kg/m<sup>2</sup>) lower than the WHO standard for the indicator of obesity.<sup>17</sup>

Waist circumference (WC) is alternative clinical method that relevant use to assess adiposity. BMI provides a marker of overall adiposity whereas WC provides a surrogate marker of abdominal adiposity and is the best association to visceral fat mass. Higher levels of WC are strongly associated with risk factors for and incidence of cardiometabolic disease.<sup>18</sup> Cut-off points for a waist circumference of Southeast Asians, Japan, and China are 90 cm for men and 80 cm for women, lower than Europeans (men = 94 cm and women = 80 cm).<sup>15</sup> Indonesia has been using standard cut-off point for waist circumference 90 cm for men and 80 cm for women.<sup>3</sup>

Although BMI and WC are widely used in clinical practice and have been applied in several studies, there are still some limitations with these indicators. The use of the BMI does not reflect differences in body composition according to gender, age, and ethnicity. The main limitation of the WC is that the use of this measure in isolation may underestimate or overestimate the health risks for tall and short individuals with similar WCs. Several authors have proposed the use of waist to height ratio (WHtR) as a better indicator of abdominal obesity. This measure corrects the WC according to the individual's height and offers a strong correlation with cardiometabolic disease.<sup>19</sup>

Several studies published the important to reclassify the anthropometric index cut-off point in Asian population require BMI and WC lower than the general population in the world.<sup>15</sup> Determining the obesity cut-off point is essential to prevent and reduce the risk of

cardiovascular disease which complication due to hypertension. Based on the problems, this study aims to compare the anthropometric index between BMI, WC, and WHtR in predicting the risk of hypertension in employees in Cimahi City.

## METHODS

The design study was cross-sectional with the diagnostic test approach. The cross-sectional study is a measurement between exposure and outcome at one time simultaneously. Diagnostic tests in this study are used to validity screening the population with anthropometric index approach to predict the risk of hypertension. The diagnostic test has the purpose of assessing the validity and reliability of a test in detecting the possibility of an illness earlier (early detection). Validity includes sensitivity and specificity. The sensitivity and specificity indicated the best cut-off points for the hypertension risk. Sensitivity was defined as the ratio of correctly identified hypertensive individuals, and specificity was defined as the ratio of correctly identified normotensive individuals.

Hypertension is a clinical condition characterized by Systolic blood pressure more or equal to 140 mmHg and or Diastolic blood pressure more or equal to 90 mmHg.<sup>11,20</sup> The anthropometric index approach used the Body Mass Index (BMI), Waist Circumference (WC) and Waist to Height Ratio (WHtR). BMI is the result of the calculation between bodyweight (kg) divided by height ( $m^2$ ). WC is measurements from the midpoint between the lowest rib point and the arch endpoint of the groin/ pelvis then horizontally circling the waist and abdomen back towards the midpoint at the beginning of measurement.<sup>21</sup> WHtR is a calculation of waist circumference divided by height.

This study used secondary data of Posbindu PTM (screening of Non-Communicable Disease) for employees in the Cimahi City in March 2018. The samples are employees who participated in screening examination with data eligible to be analyzed with a total of samples 827 people.

Data were analyzed using software Stata13 (Stata Corporation, College Station, TX, the USA with serial number: 501306208483). Data were analyzed by univariate and bivariate analysis. Diagnostic tests using the Receiver Operating Characteristic (ROC) curve analysis to identify the best cut-off points of specificity and sensitivity, then evaluate and compare the predictive capacity of the anthropometric indicators for the hypertension outcome by age group in men and women ( $< 40$  years and  $\geq 40$  years).

The areas under ROC curves provided the overall probability of the anthropometric indicator correctly classifying the presence or absence of illness. A larger area under the ROC curve indicated a higher predictive power of the indicator. The AUC value is between 0.5 – 1; the test is useful if  $AUC \geq 0.7$ . The selected cut-off points had the greatest concomitant sensitivity and specificity. The significance level adopted for all analyses was 5% with a confidence interval of 95%.

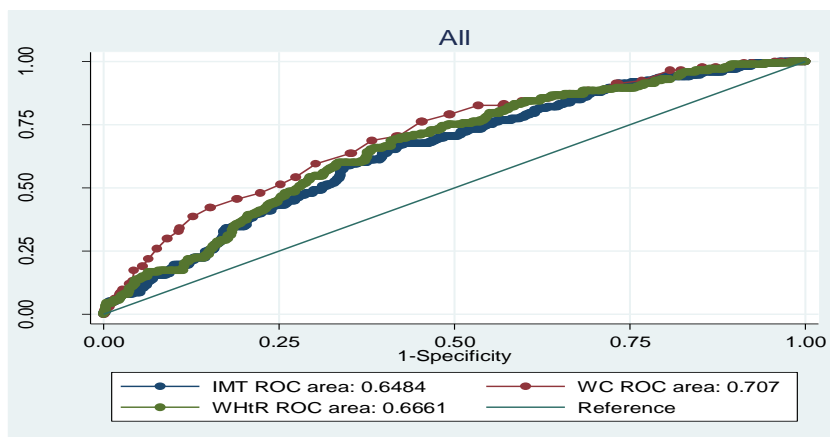
## RESULTS

Table.1 showed that hypertension was higher in male 113 people (65.32%) than female 60 people (34.68%). The mean age of hypertension employees was  $46.86 \pm 9.02$  years, higher than employees with normotensive  $39.53 \pm 10.22$  years. BMI in employees with hypertension mean  $27.75 \pm 5.41$  higher than the BMI of employees with normotensive  $25.40 \pm 4.42$ .

**Table.1**  
**Characteristics Subject of Study**

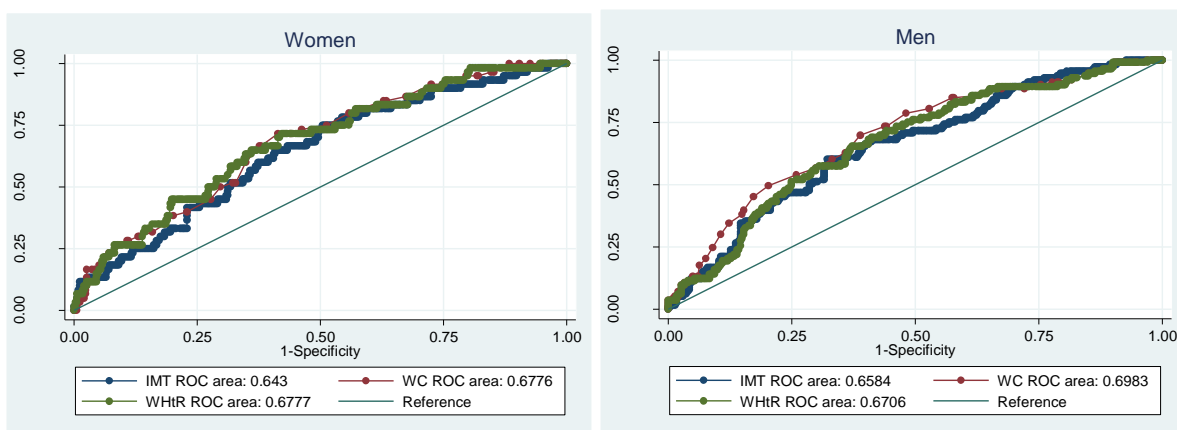
Variable	Over all (n=827)		Hypertensive (n=173)		Normotensive (n=654)	
	n	%	n	%	n	%
<b>Gender</b>						
Men	414	50.06	113	65.32	301	46.02
Women	413	49.94	60	34.68	353	53.98
<b>Age</b>	41.07 ± 10.41		46.86 ± 9.02		39.53 ± 10.22	
<b>BMI</b>	25.90 ± 4.74		27.75 ± 5.41		25.40 ± 4.42	
<b>WC</b>						
Men	92.99 ± 10.50		98.03 ± 9.59		91.10 ± 10.21	
Women	86.92 ± 10.50		92.75 ± 10.43		85.93 ± 10.21	
<b>WHtR</b>	0.56 ± 0.068		0.59 ± 0.068		0.55 ± 0.065	

The mean waist circumference in male hypertension was  $98.03 \pm 9.59$  cm higher than the waist circumference of male normotensive  $91.10 \pm 10.21$  cm. The mean waist circumference in female hypertension higher than female normotensive. The waist to height ratio in employees with hypertension was higher than normotensive.



**Graph.1**  
**Receiver Operating Characteristic (ROC) Curve between BMI, WC, and WHtR in Prediction of Hypertension**

Based on graph.1 results of ROC curve analysis showed that the area under the curve (AUC) of WC was 0.70 (95% CI = 0.66-0.74) higher than WHtR 0.66 (95% CI = 0.62-0.70) and BMI 0.64 (95% CI = 0.60-0.69).



**Graph.2**  
**Receiver Operating Characteristic (ROC) Curve between BMI, WC and WHtR in Prediction Hypertension by Gender.**

Based on graph.2 results of ROC curve analysis by gender obtained the highest AUC WC value for men 0.69 (95% CI = 0.64-0.75) whereas for women the AUC value highest in WC and WHtR 0.67 (95% CI = 0.60-0.74).

**Table.2**  
**Area Under the Curve (AUC) between BMI, WC and WHtR Prediction Hypertension in Age Groups by Gender.**

Age Groups	Total	AUC (95% CI)		
		BMI	WC	WHtR
<b>Men</b>				
< 40	171	0.68 (0.58-0.78)	0.68 (0.57-0.80)	0.66 (0.55-0.78)
≥ 40	243	0.65 (0.57-0.72)	0.69 (0.63-0.76)	0.65 (0.58-0.72)
Total	414	0.65 (0.60-0.71)	0.69 (0.64-0.75)	0.67 (0.61-0.72)
<b>Women</b>				
< 40	224	0.64 (0.48-0.81)	0.66 (0.48-0.84)	0.64 (0.47-0.81)
≥ 40	189	0.60 (0.51-0.69)	0.63 (0.55-0.72)	0.63 (0.54-0.72)
Total	413	0.64 (0.56-0.71)	0.67 (0.60-0.74)	0.67 (0.60-0.74)
<b>Total</b>	<b>827</b>	<b>0.64 (0.60-0.69)</b>	<b>0.70 (0.66-0.74)</b>	<b>0.66 (0.62-0.70)</b>

Table.2 showed that the results of the ROC curves analyzed by age group of each gender. The highest AUC value for men age <40 years 0.68 (95% CI = 0.57-0.80) in BMI and WC, whereas for men age ≥ 40 years the highest AUC that is WC 0.69 (95% CI = 0.63-0.76). For women age <40 years, the highest AUC value was WC 0.66 (95% CI = 0.48-0.84) and for women age ≥ 40 years the highest AUC value that is WC and WHtR 0.63 (95% CI = 0.54-0.72).

**Table.4**  
**Results Measurement Cut-Off Points of Anthropometric Indexes Based on Age Groups in Men and Women**

Age Groups	N	BMI			WC			WHtR		
		Cut-off	Sensitivity %	Specificity %	Cut-off	Sensitivity %	Specificity %	Cut-off	Sensitivity %	Specificity %
<b>Men</b>										
<40	171	26.17	71.43	65.73	94	71.43	61.54	0.57	60.71	73.43
≥ 40	243	26.64	57.65	66.46	94	69.41	60.76	0.56	70.59	56.33
Total	414	26.64	60.18	67.77	94	69.91	61.13	0.57	65.49	62.79
<b>Women</b>										
<40	224	27.42	58.33	70.75	91	58.33	72.64	0.59	50.00	73.58
≥ 40	189	26.15	66.67	54.61	88	75.00	52.48	0.56	70.00	50.35
Total	413	26.43	60.00	62.61	88	71.67	58.64	0.56	71.67	57.79
<b>Total</b>	<b>827</b>	<b>25.89</b>	<b>67.05</b>	<b>57.95</b>	<b>90</b>	<b>76.30</b>	<b>54.74</b>	<b>0.56</b>	<b>68.79</b>	<b>59.02</b>

Table.4 showed the best cut-off point for each anthropometric index in predicting hypertension were BMI=25.89 kg/m<sup>2</sup> with sensitivity 67.05% and specificity 57.95%, WC=90 cm with sensitivity 76.30% and specificity 54.74% and WHtR=0.56 with sensitivity 68.79% and specificity 59.02%. Based on gender were no differences anthropometric index cut-off point among men and women except waist circumference. Measurement cut-off point waist circumference were men 94 cm (sensitivity 69.91%; specificity 61.13%) and women WC=88 cm (sensitivity 71.67%; specificity 58.64%).

## DISCUSSION

The results showed that the prevalence of hypertension among men was higher than women. This study is in line with research conducted in Iran and Egypt.<sup>22,23,24</sup> Hypertension in men caused by some factors like work, smoking, drinking alcohol and consumption of unhealthy foods.<sup>25</sup> The increase of age makes blood pressure increased too because the arterial wall in the elderly will experience thickening which results in the accumulation of collagen in the muscle layer so that the blood vessels will gradually narrow and become stiff.<sup>1,19</sup>

Index anthropometrics among BMI, WC, and WHtR can predict and distinguish the risk of hypertension, dyslipidemia, and diabetes. Body fat variations are influenced by various factors such as gender, age, ethnicity and

reproductive status.<sup>21</sup> WC was better predicting the risk of hypertension with the AUC value of 0.70 (95% CI = 0.66-0.74) compared to BMI and WHtR. Similar result with study was found in Brazil,<sup>19</sup> and Egypt<sup>16</sup> also shows that WC is slightly better than BMI.<sup>26</sup>

Based on gender the anthropometric index with the highest AUC value in men were WC 0.69 (0.64-0.75) linear with the study conducted in Brazil with the AUC value 0.59 (95% CI = 0.49-0.68), while in the female anthropometric index the best in predicting hypertension that is WC and WHtR with AUC value 0.67 (95% CI = 0.60-0.74). Our findings are consistent with other research in Brazil where the WHtR AUC value was 0.69 (95% CI = 0.63-0.75).<sup>19</sup> Based on the age group between men and women were not significant difference of value among BMI, WC, and WHtR in

predicting hypertension where similar result with study was conducted in Chinese people.<sup>27</sup>

Based on recommendations in general WC cut-off points were for men 94 cm and women 80 cm, while those for Southeast Asia, China, and Japan cut-off points WC for men 90 cm and women 80 cm.<sup>21</sup> The results showed that the cut-off point for WC in men was 94 cm, and women were 88 cm. The results of the study that were not too different were found in South Africa<sup>28</sup> in men who got a cut-off point of 95.25 cm WC and 89.45 cm for women. The WC cut-off point is still among the results of the study<sup>18</sup> for the Southeast Asian population which found that in men between 93.3 cm to 105.2 cm and women between 77.4 cm to 95.8 cm.

The cut-off BMI in this study found no differences between men and women. The Study in Nigeria found the same result where no differences BMI cut-off point between men and women.<sup>29</sup> Cut-off point BMI on men in Southern Asia is 26.5- 30.4 kg/m<sup>2</sup> and women 24.9-33.3 kg/m<sup>2</sup>.<sup>18</sup> The mean BMI of Chinese, Indonesian and Vietnamese women were 23.1, 22.4 and 20.4, and the mean BMI of Chinese, Indonesian and Vietnamese men were 23.1, 21.2 and 20.2 respectively.<sup>14</sup>

WHtR is an alternative anthropometric index in central obesity in addition to the use of WC. The studies in Taiwan,<sup>30</sup> Jordanian<sup>31</sup> and Korea,<sup>15</sup> WHtR showed better results to identify

the risk of hypertension with cut-off point 0.50. This study was found that the cut-off point of the WHtR 0.56. Linear with the study was found in adult Egyptians with cut-off points 0.57 in men and 0.56 in women.<sup>22</sup>

The three anthropometric indexes above with the right cut-off point can be used to detect various risk factors for metabolic diseases.<sup>27,32</sup> From some studies of the ability of the anthropometric index to predict the risk of hypertension, the AUC values were ranged from 0.51 to 0.83.<sup>12,15,19,22,29,30,31</sup>

## CONCLUSION

Waist circumference is the most superior anthropometric index compared to WHtR and BMI in predicting the risk of hypertension in employees Cimahi City. The results of the study can be used as a recommendation and strategy of a public health program to classify anthropometric index. Therefore can help prevent and control the obesity epidemic and warning about increasing of risk hypertension and other comorbidities associated with metabolic syndrome.

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