International Journal of Health Science (IJHS)

E-ISSN: 2827-9603
P-ISSN: 2827-9603

Research Article

Anthropometric Index for Predicting Abnormalities of Biomedical Examination in Indonesian Urban Areas

Septiyanti[1]*, Nurpudji A. Taslim[2], Nurhaedar Jafar[3]

[1] Universitas Muslim Indonesia; e-mail : septiyanti.septiyanti@umi.ac.id
[2] Universitas Hasanuddin; e-mail : pudji_taslim@yahoo.com
[3] Universitas Hasanuddin; e-mail : eda.gizi@gmail.com
* Corresponding Author : Septiyanti

Abstract: Obesity is a problem in various parts of the world where its prevalence is increasing rapidly, both in developed and developing countries. It is estimated that there are 1.5 billion people in the world experiencing being overweight and obese. Obesity can occur because there is an imbalance between the energy from the incoming food greater than the energy used by the body. This study is aimed to determine the best anthropometric index to predict abnormalities in biomedical examination (inflammation and lipid profile) in adulthood in urban areas of Indonesia. The study was a cross-sectional study. The data were taken from Health Research (Riskesdas). The population in this study were those age 20-59 years both sexes. The analysis conducted in this study are univariate, bivariate, ROC analysis, and logistic regression analysis. The results indicate that in general obesity and central obesity increases with age, with the highest prevalence was in the 40-59 year age. In adults, cut-off point value based on BMI and waist circumference to predict cardiovascular disease risk in Indonesian society is lower than the WHO recommendation.

Keywords: BMI, cardiovascular disease, cut-off point, obesity, waist circumference

Received: February 28th 2025
Revised: March 15th 2025
Accepted: March 29th 2025
Online Available : March 31th 2025
Curr. Ver.: March 31th 2025

1. Introduction

Obesity is a condition that occurs when the quantity of body fat tissue compared to total body weight is greater than the normal state, or a condition in which excessive body fat accumulates so that a person's body weight is far above normal. Obesity can occur because there is an imbalance between the energy from food that enters greater than the energy used by the body.[1] Obesity is a problem in various parts of the world where its prevalence is increasing rapidly, both in developed and developing countries. It is estimated that there are 1.5 billion people in the world experiencing being overweight and obese. In the United States, 68% of adults suffer from obesity and about 31% of children and adolescents who are obese.[2] According to the latest data, the prevalence of obesity in the UK is showing an increasing trend. In 2022, around 29% of adults in the UK were obese, while 64% were categorized as overweight or obese. Obesity is an increase from previous years; for example, in the 2021-2022 period, 25.9% of adults were obese, up from 25.2% in 2020-2021.[3] The worldwide prevalence of obesity has more than tripled between 1975 and 2022. Obesity is now recognised as one of the most important public health problems facing the world today.[4]

The prevalence of obesity in Indonesia has increased significantly in recent years, becoming a serious concern in the field of public health. Based on the 2023 Indonesian Health Survey (SKI) by the Ministry of Health, around 23.4% of the adult population (aged >18 years) are obese.[5] Data from the Ministry of Health's Nutritional Status Monitoring (PSG) shows that in 2017, around 25.8% of the adult population was classified as obese, a two-fold increase compared to the previous year which was only 10.6%.[6] Obesity causes serious health consequences, because it is a risk factor for degenerative diseases. Excessive fat accumulation in adipose tissue can cause pain and death. Health problems related to obesity include cardiovascular disorders such as hypertension, stroke, and coronary heart disease, as well as conditions related to insulin resistance such as type 2 diabetes mellitus, and some types of cancer.[7] Obesity is also associated with increased inflammation and abnormal body metabolism , thus increasing the risk of insulin resistance, type 2 diabetes mellitus, stroke, and cardiovascular disease.[8]

Obesity measurement indices such as body mass index (BMI), abdominal circumference, waist and hip ratio, and waist and height ratios are useful measurement indicators to provide important information about cardiovascular risk. Obesity is associated with an increased prevalence of hypertension, type 2 diabetes mellitus, and dyslipidemia. Anthropometric indexes to measure obesity include body mass index (BMI), waist circumference, waist and hip circumference ratio, all of which are important anthropometric measures to provide information about the risk of cardiovascular disease.[9] Determining the cut-off point of obese individuals is important to enable effective screening.

The cut-off points of the anthropometric index in Caucasians may not be suitable for Asian race. Goh, et al. (2014) suggests that CVD risk assessment should take ethnic factors into account, and the same obesity measures cannot be applied across all ethnic groups.[10] Some results of previous studies explain that for Asian populations, the prevalence of cardiovascular risk factors increases in BMI, waist circumference, or ratio lower waist-hip circumference compared to WHO recommendations.[11] Therefore, the researcher wanted to analyze the intersection of obesity based on two anthropometric indicators, namely BMI and waist circumference, for the Indonesian people based on Riskesdas biomedical examination data, and compare the two anthropometric indicators with the aim of finding out what anthropometric indicators are appropriate for detecting abnormalities biomedical.

2. Methods

2.1 The type and design of the research

The design of this study was a cross sectional study using data from national basic health research (Riskesdas) in 2007, especially households selected as samples especially households selected as samples of biomedical groups throughout Indonesia. Riskesdas is a cross sectional survey descriptive nature. The Riskesdas design is primarily intended to describe the health problems of the Indonesian population, in a comprehensive, accurate, and interestoriented manner at decision makers at various administrative levels. Various sampling error measures including standard error, relative standard error, confidence interval, design effect, and the number of weighted samples will accompany each variable estimate. In this design, each user of Riskesdas information can obtain a complete and detailed picture of various health problems that are asked, measured, or examined.

2.2 Populations and subjects of the research

The population in this study were all measurement samples biomedical living in census blocks with urban classification, there were 35,285 samples, originating from 272 districts/cities and 540 census blocks. For examination of blood chemistry (total cholesterol, LDL, HDL, Lp (a), ApoB, and hsCRP), 13,134 samples were taken from household members aged 20-59 years. The research sample is a sample taken from a group biomedical that meets the criteria: 1) adult age (20-59 years) which based on examination of blood chemistry; 2) not pregnant; and 3) have data on examination of total cholesterol, HDL, LDL, Lp (a), ApoB, and hsCRP.

2.3 Management of data

Data on Riskesdas from the Department Research and Development Ministry of Health Indonesia in the form of individual data and biomedical data. Furthermore, data management is done by cleaning data. The available data is then checked for the distribution of data per variable by doing descriptive tests for all variables. Age variable is the first variable examined related to the sample criteria. The age criteria in this study were adulthood, namely ages 20- 59 years. The final number of samples after cleaning the data amounted to 13,134 samples. Based on the results of cleaning data, the distribution of age starts from 20 up to 59 years. Furthermore data related to variables bound checked, and data that did not meet the criteria were coded missing. Likewise with other variables, entry errors, answers that do not meet the criteria, or data not available (codes 888 & 999) are considered missing.

2.4 Methods of data analysis

Data is processed using computer assistance and analyzed with the following stages:

(1) Univariate analysis, is a descriptive data analysis for all variable. Variables with continuous / numeric data are averaged values with standard deviations and standard errors, and variables with category data are made percentage and analysis variables (mass index body, waist circumference, CRP, cholesterol, HDL, LDL, small dense LDL, Lp (a), Apo B, and economic status). Univariate analysis was also carried out to see whether the available data could be test (Kolmogorov-Smirnov Test).

(2) Bivariate analysis, made a description by cross tabulation independent variable obesity and obesity central to dependent variable, namely CRP, cholesterol, HDL, LDL, small dense LDL, Lp (a), and Apo B.

(3) Analysis to find the cut-off point Body Mass Index (BMI) of the dependent variable. To obtain optimal sensitivity and specificity using various values of BMI cut-off and waist circumference to predict abnormalities of biomedical examination (inflammation and lipid profile) using ROC analysis (receiver operating characteristic curve).

(4) The significance value is taken at a value of ≤ 0.05.

3. Results and Discussion

Average age and anthropometric index by sex: The results of the average age distribution and anthropometric indicators of respondents based on sex can be seen as follows:

Table 1. Average age distribution and anthropometric indicators based on sex

N	Obesity BMI $(\bar{x} \pm SD)$		Central Obesity $(\bar{x} \pm SD)$	
	Men (8306)	Women (8566)	Men (9157)	Women (8125)
Age	38.26 ± 10.43	37.52 ± 10.36	38.28 ± 10.50	37.46 ± 10.45
BMI	24.28 ± 4.43	24.25 ± 4.40	23.84 ± 4.32	23.98 ± 4.49
Waist circumference	80.93 ± 11.04	80.71 ± 11.38	82.05 ± 10.88	81.13 ± 11.92

Based on table 1. It shows that the average obese male and female respondents were 38.26 years old and 37.52 years old respectively. Based on anthropometric measurements, obese respondents had BMI and waist circumference on average 24.28 and 80.93 in men and 24.25 and 80.71 in women. While for central obesity respondents, the average age was 38.28 years old (male) and 37.46 years old (female). Based on anthropometric measurements, central obesity respondents had BMI and waist circumference 23.84 and 82.05 in men and 23.98 and 81.13 in women.

The prevalence of obesity and central obesity according to biomedical examination: The results of the analysis of the prevalence of obesity and central obesity according to biomedical examination can be seen as fellows:

Table 2. The Prevalence of Obesity and Central Obesity According to Biomedical Examination

Biomedical Examination	BMI: Obese n	%	Non-obese n	%	p	Waist Circumference: Central obesity n	%	Non-central obesity n	%	p
Cholesterol										
Normal	1766	48.7	5189	56.8	0.000	1965	45.6	4990	57.1	0.0
Abnormal	1863	51.3	3948	43.2		2059	51.2	3752	42.9	00
HDL										
Normal	2239	61.0	6059	65.7	0.000	2626	64.5	5627	64.3	0.8
Abnormal	1433	39.0	3162	34.3		1445	35.5	3150	35.7	16
LDL										
Normal	808	22.5	2438	26.9	0.000	889	22.3	2357	27.1	0.0
Abnormal	2791	77.5	6640	73.1		3100	77.7	6331	72.9	00
Small dense LDL										
Normal	3023	84.41	7798	86.5	0.003	3399	85.6	7422	85.9	0.5
Abnormal	560	15.6	11218	13.15		562	14.2	12.16	14.1	68
LP(a)										
Normal	2231	68.5	5571	69.6	0.266	2456	68.4	5328	69.6	0.1
Abnormal	1018	31.5	2437	30.4		1133	31.6	2322	30.4	95
HsCRP										
Low risk	1457	39.0	5191	55.3	0.000	1730	41.8	4918	54.8	0.0
Moderate risk	1132	30.0	2387	28.4		1193	28.8	2326	25.9	00

High risk	1143	30.6	1802	19.2		1213	29.3	1732	19.3

Based on the table above, it is known that the respondents with abnormal cholesterol levels were more in those who were obese and central obesity, with the proportion of 51.3% and 51.2% respectively. The proportion of respondents who were not obese and had abnormal cholesterol levels was 43.2%, while the proportion of respondents who were not obese central and experienced abnormal cholesterol levels was 42.3%. The significance values of both obesity and central obesity are 0,000, which indicates that there are significant differences between those who are obese/central obesity and those with normal BMI/waist circumference on cholesterol testing. Other variables that showed a significant difference between obesity/central obesity and those with normal BMI/waist circumference were LDL, apoB, and HsCRP. While for HDL, small dense LDL, and Lp(a) did not show a meaningful relationship.

Anthropometric Index to Predict Dyslipidemia and Inflammation: Summary of results of sesitivity, specificity, and cut-off BMI and waist circumference for various blood chemistry examinations for adults can be seen as follows:

Table 3. The results of sensitivity, specificity, and cut-off BMI and waist circumference for various blood chemistry examinations for adults

Index	Examination	Cut off	Se	Sp	AUC	p	95% CI	
							Lower	Upper
Men								
BMI	Cholesterol	22.40	51.5	57.6	0.559	0.000	0.544	0.574
	LDL	21.86	53.4	51.2	0.533	0.000	0.516	0.550
	HDL	22.08	54.3	53.3	0.550	0.000	0.535	0.565
	Small dense LDL	22.39	54.6	54.9	0.561	0.000	0.541	0.581
	Lp(a)	22.02	49.6	48.7	0.493	0.450	0.476	0.511
	ApoB	22.41	57.4	55.7	0.588	0.000	0.568	0.608
	HsCRP	22.06	55.0	50.9	0.552	0.000	0.544	0.572
Abdominal Circumference	Cholesterol	75.75	58.5	49.8	0.557	0.000	0.542	0.572
	LDL	75.85	55.5	51.4	0.541	0.000	0.524	0.558
	HDL	75.85	57.8	49.2	0.551	0.000	0.536	0.566
	Small dense LDL	76.38	54.4	52.7	0.547	0.000	0.527	0.567
	Lp(a)	75.65	53.0	46.4	0.493	0.414	0.475	0.510
	ApoB	76.38	58.4	53.3	0.586	0.566	0.566	0.605
	HsCRP	76.75	53.4	53.5	0.544	0.525	0.525	0.563
Women								
BMI	Cholesterol	22.96	54.6	51.9	0.539	0.000	0.526	0.533
	LDL	22.72	54.9	51.4	0.538	0.000	0.522	0.533
	HDL	22.93	54.7	49.9	0.540	0.000	0.526	0.555
	Small dense LDL	23.16	50.8	50.9	0.514	0.156	0.494	0.535
	Lp(a)	22.93	53.2	49.1	0.512	0.126	0.497	0.528
	ApoB	23.35	56.3	54.6	0.571	0.000	0.555	0.587
	HsCRP	23.35	57.4	55.3	0.593	0.000	0.578	0.609
Waist Circumference	Cholesterol	77.35	56.9	50.5	0.543	0.000	0.530	0.577
	LDL	77.35	54.4	51.3	0.538	0.000	0.523	0.544

HDL	78.05	52.9	51.6	0.533	0.000	0.519	0.548
Small dense LDL	77.45	54.8	47.4	0.510	0.326	0.490	0.530
Lp(a)	78.05	50.7	50.2	0.508	0.339	0.492	0.523
ApoB	78.45	57.5	53.2	0.571	0.000	0.555	0.587
HsCRP	78.55	58.3	54.2	0.538	0.000	0.567	0.598

Table 3 provides an overview of the sensitivity summary, specificity, and cut-off of BMI and waist circumference from various blood chemistry examinations using ROC analysis. To detect the cut-off point is determined by looking at the intersection point of the sensitivity and specificity curve. In male adults, the IMT cut-off to predict lipid profile and inflammatory abnormalities also varies, between 21.86 to 22.40 kg/m2 ; similarly in adults women are on BMI 22.72 to 23.35 kg/m2 . Based on measurements of abdominal circumference, the optimal value for predicting dyslipidemia and inflammation in male adults is between 75.85 to 76.75 cm; while for women between 77.35 to 78.55 cm.

4. Discussion

Obese male and female respondents were 38.26 years old and 37.52 years old respectively. Based on anthropometric measurements, obese respondents had BMI and waist circumference on average 24.28 and 80.93 in men and 24.25 and 80.71 in women. While for central obesity respondents, the average age was 38.28 years old (male) and 37.46 years old (female). Based on anthropometric measurements, central obesity respondents had BMI and waist circumference 23.84 and 82.05 in men and 23.98 and 81.13 in women. The percentage of biomedical examination abnormalities is more common in women, except for HDL examination where more men experience low HDL compared to women.

The Khoramipour, et al. (2021) showed that adinopectin production was also related to independent factors, namely body fat distribution. In each body size or distribution of body fat, adiponectin concentrations are greater in women than men.[12] Other studies also show the same thing. Obesity may play a direct role in the elevated hs CRP levels in women, but not men. This is probably due to different body composition or different effects of sex hormones on adipose tissue between men and women.[13]

Based on WHO recommendations for Asians, it was found that the increase in the risk of comorbidity was in the BMI of 23 kg/m2 in both male and female, while the abdominal circumference was 90 cm in men and 80 cm in women. While the WHO recommendations for the Caucasian population are higher, namely BMI 25 kg/m2 for men and women, while the abdominal circumference is 94 cm for men and 80 cm for women.[11]

The definition of a normal BMI cut-off depends on the risk association with BMI-related disorders. Based on the ROC analysis in this study, it was found that the cutoff point to predict the risk of cardiovascular disease varied in each age group and gender. In adulthood, the BMI sensitivity value for female sex is generally higher than that of men, except for the small dense LDL and ApoB variables (Table 3). The value of abdominal circumference sensitivity for male sex is higher, except for the HsCRP variable. The significance values obtained based on ROC analysis for the adult age group were statistically significant, except for the Lp(a) variable, both for men and women, and for the small dense LDL variable in women. Thus, the value of the intersection of variables other than these variables is acceptable.

The IMT cut points obtained for male sex were at 21.86 to 22.49 kg/m2 , while for women it was at 22.72 to 23.35 kg/m2 . The abdominal circumference points obtained for male sex are 75.75 to 76.85 cm, while for women are 77.35 to 78.45 cm. The results obtained in this study are similar to several other studies in Asia. Research by Yu, et al. (2016) concluded that for Chinese residents recommend cutoffs to detect cardiovascular risk lower than WHO criteria.[14]

While research in Malaysia concluded the optimal waist circumference cut-off values for predicting the presence of diabetes mellitus, hypertension, hypercholesterolemia and at least one of the three CV risk factors varied from 81.4 to 85.5 cm for men and 79.8 to 80.7 cm for women.[15]

The study in Iran received a cutoff point for predicting higher risk of cardiovascular disease than other Asian populations. The results obtained by these studies are more directed at the cutoffs recommended for the Caucasian population.[16]

While other studies in Oman and Singapore concluded the same thing as obtained in this study, that the population of Oman and Singapore needed a cutoff point for BMI and abdominal circumference that was lower than those recommended by WHO.[17]

Some researchers have recommended lower abdominal circumference points for Asian populations. The population of Asia and India has relatively greater fat mass than the Caucasian population and the black African population, even though they have the same abdominal circumference. Banerji, et al. reported abdominal fat tissue in the Asian-Indian population identical to the African-American male population, although with the lowest abdominal circumference. Likewise, at the same BMI value, the Asian-Indian population significantly had greater abdominal and visceral fat than the African-American, Latino, and Tionghoa-American population.[18]

Previous research shows that Asian populations have a higher body fat percentage than Western populations for a BMI or waist circumference. Wang et al. reported that at lower BMI, Asians had a higher body fat percentage than white people of the same age and sex. This is in line with the research of Deurenberg et al. who reported that Chinese had 1.9 units of BMI lower than Caucasians in the same percentage of body fat.[17] Similar to BMI, Asian populations were also said to have higher visceral adiposity than Caucasians. A leaner body shape with a relatively short muscle mass and long legs in some Asian populations might be a reason to explain these differences.[11]

Cardiovascular risk seems to be seen in the lower abdominal circumference compared to the Caucasian population. The population of Asia and India significantly experienced lower dyslipidemia in BMI and abdominal circumference compared to the Caucasian population.[11] So it can be concluded that anthropometric cut-off values (BMI and abdominal circumference) to detect the risk of cardiovascular disease for Indonesians are lower than WHO criteria.

5. Conclusions

In general obesity and central obesity increase with age, with the highest prevalence being at the age of 40-59 years, where more women are obese, both obesity and central obesity. Obesity and central obesity is more common in those with high school graduation, and is more common in housewives. The cut-off value based on BMI and waist circumference to predict the risk of cardiovascular disease in Indonesian society is lower than the WHO recommendations.

References

[1] V. Torres-Carot, A. Suárez-González, and C. Lobato-Foulques, "The energy balance hypothesis of obesity: do the laws of thermodynamics explain excessive adiposity?," *Eur. J. Clin. Nutr.*, vol. 76, no. 10, pp. 1374–1379, 2022.

[2] Y. C. Chooi, C. Ding, and F. Magkos, "The epidemiology of obesity," *Metabolism*, vol. 92, pp. 6–10, 2019.

[3] NHS England, "Health Survey for England, 2022 Part 2," 2024. [Online]. Available: https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/2022-part-2/adult-overweight-and-obesity?utm_source=chatgpt.com#summary

[4] D. O'Reilly and N. C. D. R. F. Collaboration, "Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128· 9 million children, adolescents, and adults," *Lancet*, vol. 390, no. 10113, p. 2627, 2017.

[5] Kementerian Kesehatan RI, "Survei Kesehatan Indonesia (SKI)," 2023.

[6] Kementerian Kesehatan RI, "Buku saku pemantauan status gizi," *Buku saku pemantauan status gizi tahun 2017*, pp. 7–11, 2018.

[7] E. Verdú, J. Homs, and P. Boadas-Vaello, "Physiological changes and pathological pain associated with sedentary lifestyle-induced body systems fat accumulation and their modulation by physical exercise," *Int. J. Environ. Res. Public Health*, vol. 18, no. 24, p. 13333, 2021.

[8] T. V Rohm, D. T. Meier, J. M. Olefsky, and M. Y. Donath, "Inflammation in obesity, diabetes, and related disorders," *Immunity*, vol. 55, no. 1, pp. 31–55, 2022.

[9] R. Huxley, S. Mendis, E. Zheleznyakov, S. Reddy, and J. Chan, "Body mass index, waist circumference and waist: hip ratio as predictors of cardiovascular risk—a review of the literature," *Eur. J. Clin. Nutr.*, vol. 64, no. 1, pp. 16–22, 2010.

[10] L. G. H. Goh, S. S. Dhaliwal, T. A. Welborn, A. H. Lee, and P. R. Della, "Ethnicity and the association between anthropometric indices of obesity and cardiovascular risk in women: a cross-sectional study," *BMJ Open*, vol. 4, no. 5, p. e004702, 2014.

[11] S. Haldar, S. C. Chia, and C. J. Henry, "Body composition in Asians and Caucasians: comparative analyses and influences on cardiometabolic outcomes," *Adv. Food Nutr. Res.*, vol. 75, pp. 97–154, 2015.

[12] K. Khoramipour *et al.*, "Adiponectin: structure, physiological functions, role in diseases, and effects of nutrition," *Nutrients*, vol. 13, no. 4, p. 1180, 2021.

[13] X. Bi, Y. T. Loo, S. Ponnalagu, and C. J. Henry, "Obesity is an independent determinant of elevated C-reactive protein in healthy women but not men," *Biomarkers*, vol. 24, no. 1, pp. 64–69, 2019.

[14] J. Yu *et al.*, "Optimal cut-off of obesity indices to predict cardiovascular disease risk factors and metabolic syndrome among adults in Northeast China," *BMC Public Health*, vol. 16, pp. 1–7, 2016.

[15] K. C. Cheong *et al.*, "Optimal waist circumference cut-off values for predicting cardiovascular risk factors in a multi-ethnic Malaysian population," *Obes. Res. Clin. Pract.*, vol. 8, no. 2, pp. e154–e162, 2014.

[16] F. Hadaegh, A. Zabetian, P. Sarbakhsh, D. Khalili, W. P. T. James, and F. Azizi, "Appropriate cutoff values of anthropometric variables to predict cardiovascular outcomes: 7.6 years follow-up in an Iranian population," *Int. J. Obes.*, vol. 33, no. 12, pp. 1437–1445, 2009.

[17] M. Deurenberg-Yap and P. Deurenberg, "Is a re-evaluation of WHO body mass index cut-off values needed? The case of Asians in Singapore," *Nutr. Rev.*, vol. 61, no. suppl_5, pp. S80–S87, 2003.

[18] A. D. Shah *et al.*, "Less favorable body composition and adipokines in South Asians compared with other US ethnic groups: results from the MASALA and MESA studies," *Int. J. Obes.*, vol. 40, no. 4, pp. 639–645, 2016.