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Correlational study on Obesity Indicators and Blood Pressure in Productive Age Group

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Abstract

Background: Hypertension causes various health problems worldwide, including in Indonesia. High blood pressure that occurs in productive age and unmanaged properly can increase various risks of disease which amya lead to health burden nationally and globally. . Currently, the lifestyle of the productive age group contributes to obesity and hypertension, amplifying the risk factors for increased Cardiovascular Disease (CVD).
Objective: This study aimed to analyze the relationship between obesity indicators and blood pressure in the productive age group.
Methods: A survey was conducted at a total of 150 respondents aged 25-64 years who had jobs, had no impaired physical mobility, and had no pregnancy. . Measurements included Systolic and Diastolic Blood Pressure, Body Mass Index (BMI), waist circumference, Waist to Height Ratio (WHtR), and Waist to Hip Ratio (WHR). The data was analyzed using the Pearson correlation test.
Results: The majority of the respondents were male, aged 30-39 and 40-49 years, normal range of BMI and waist circumference, but WHR and WHtR on high risk. More than half of the total respondents in the productive age group had blood pressure in the normal range. There was a strongest positive correlation between waist circumference with SBP and BMI with DBP.
Conclusion: Individuals in the productive age group with higher waist circumference and BMI are more prone to elevated blood pressure. Regular health screening and lifestyle change intervention are crucial to prevent hypertension in the productive age group.

Keywords: adults; anthropometry; blood pressure; hypertension; obesity

INTRODUCTION

The prevalence of hypertension causes various health problems and has become a challenge worldwide. Around 1.28 billion people worldwide between the ages of 30 to 79 are estimated to suffer from hypertension (WHO, 2023). In Japan, in 2017, as many as 26.3 million people aged 20–64 years experienced hypertension, which caused a burden on the country's economy and was exacerbated by the minimum number of workers of productive age (Asakura et al., 2021). In Indonesia, hypertension is also become a major health problem. Based on diagnosis in the population aged more than 18 years, hypertension in Indonesia affects 8.36%, and around 38.73% belong to the productive age group (Ministry of Health RI, 2019).

Hypertension can be experienced by anyone regardless of age, gender, and social status. For the trend in India, the incidence rate of hypertension has seen a significant rise over the past eight years, particularly among older age groups (Longkumer et al., 2023). In Indonesia itself, based on the diagnosis of hypertension, the majority are female and live in urban areas (Ministry of Health RI, 2019).

Hypertension often causes no symptoms; around 46% of people with hypertension are not aware of an increase in blood pressure (WHO, 2023). This can cause delays in management and hypertension not being treated properly, causing various health problems, complications, and even death. Data

reveals that only around 42% of people with hypertension are diagnosed and treated, and only 21% can be controlled (WHO, 2023).

High blood pressure that is not managed properly can cause damage to artery walls and reduce blood flow and oxygen to the heart. If increased blood pressure persists for a long time from young to old age, this can affect health and productivity in the future. The productive age group is the main actor in Indonesia's development (BPS, 2022). Hypertension in productive age can affect national development and the country's economy. Various studies indicate that hypertension reduces employee productivity and lowers the country's gross domestic product (Asakura et al., 2021; Fuge et al., 2022; Hird et al., 2019).

Hypertension that occurs at a young age can also increase the risk of early death and result in organ damage (Hinton et al., 2020; Hird et al., 2019). Various Cardiovascular Diseases (CVD) can occur due to hypertension, such as heart attacks and heart failure, which is a complication of hypertension that causes most deaths. Hypertension in productive age will be exacerbated by low awareness, treatment and control of hypertension, thereby elevating morbidity and mortality rates from non-communicable diseases in the future (Faisal et al., 2022).

At present, there are many possible factors related to hypertension among a productive age group, such as a sedentary lifestyle, inadequacy of physical activity, unhealthy diet, obesity, and others. Aside from overconsumption of sugar and salt, obesity and inadequacy of physical activity are risk factors that are thought to be very influential. Nowadays, hypertension among young age is common; 1 in 8 adults aged 20-40 years have hypertension, and it is estimated to increase along with changes in unhealthy lifestyles (Hinton et al., 2020). The rising rate of CVD among young adults in the last 20 years has been accompanied by unhealthy lifestyle habits, overweight and obesity, as well as other risk factors for CVD (Gooding et al., 2020).

Various study results have demonstrated that high blood pressure and the incidence of hypertension are related to obesity. Overweight and obese also increase the risk of cardiovascular disease in comparison to those who maintain a metabolically healthy, normal weight (Opio et al., 2020). Primary hypertension is one of the conditions that 65–78% happen because of obesity (Shariq & Mckenzie, 2020). A recent study mentions that there is a correlation between hypertension and obesity ($p = 0.03$) (Debora et al., 2023).

Anthropometric measurements, including Body Mass Index (BMI), waist circumference, Waist-to-Height Ratio (WHtR), and Waist-to-Hip Ratio (WHR), are markers of obesity that can be a signal of some conditions, such as hypertension, CVD, and Cardio-Metabolic Risk (CMR) (Moosaie et al., 2021; Nevill et al., 2022; Zhang et al., 2022). In productive age, various risks of disease are often ignored, even though it is necessary to know the indicators of obesity as early detection of increased blood pressure, which is a risk factor for CVD and CMR. Noteworthy, the conceptual model of obesity transition suggests that understanding the current stage of the obesity transition in the specific population could help effective public health intervention to prevent obesity (Jaacks et al., 2019). Moreover, the observed pattern of obesity progression in Indonesia during stage 2 indicates an increasing prevalence among adults and a narrowing gender gap (Jaacks et al., 2019). However, some previous studies have been observed and focused on a single obesity measure, such as BMI or High Waist Circumference, without directly comparing other potentially significant indicators within the working age group population (Cheng et al., 2022; Khalid et al., 2020; Sun et al., 2022).

Therefore, this study aims to fill the gaps in the existing studies by examining the correlation between various indicators of obesity (BMI, waist circumference, WHR, WHtR) and blood pressure in the productive age group.

METHOD

This study adopted cross-sectional design with 150 respondents selected through convenience sampling. The number of samples was determined using G*Power software with a correlation parameter of 0.3, alpha 0.05, and power 0.95. The inclusion criteria were aged 25-64 years and working in a university in Tangerang. The exclusion criteria were individuals who experienced physical mobility problems and were pregnant. This study has gone through an ethical test from the Ethics Committee

of Syarif Hidayatullah University with number Un.01/F.10/KP.01.1/KE.SP/06.08.070/2023.

Respondents involved in the study have received an explanation of the procedures to be carried out and have the right to decide whether to be involved in the study or not. Respondents who were unwilling to be involved in the study or withdraw would be invited to do so without any sanctions. Measurements taken included BMI, Systolic and Diastolic Blood Pressure, waist circumference, WHR, and WHtR. Tools for measuring blood pressure were an Omron HEM-7143T1 digital blood pressure monitor; waist-hip circumference and body height were assessed with a tape measure, while body weight was gauged using a digital scale. Normality test employed Kolmogorov–Smirnov and obtained normal data distribution results. Following that, bivariate data analysis was carried out through the Pearson test using computerization.

RESULTS

This study involved 150 respondents from the productive age group. The characteristics of the respondents are explained in the following table:

Table 1. Distribution of characteristics, obesity Indicators, and blood pressure of respondents (n=150)

Characteristics	Frequency	
Sex		
Female	68	45.33%
Male	82	54.67%
Age		
25-29	15	10%
30-39	58	38.67%
40-49	58	38.67%
50-59	15	10%
60-64	4	2.67%
Body Mass Index		
13.79 – 25.99 kg/m^2	80	53.33%
26.00 – 29.99 kg/m^2	48	32%
30.00 – 35.58 kg/m^2	22	14.66%
Women waist circumference		
≤88 cm	47	31.33%
>88 cm	21	14%
Men waist circumference		
≤102 cm	75	50%
>102 cm	7	4.67%
Women WHR		
<0.85 cm	22	14.67%
≥0.85 cm	46	30.67%
Men WHR		
<0.90 cm	24	16%
≥0.90 cm	58	38.67%
WHtR		
<0.50	40	26.67%
≥0.50	110	73.33%
Blood pressure		
<130/85 mmHg	87	57.99%
130-139/85-89 mmHg	30	20%
140-159/90-99 mmHg	27	17.99%
160-179/100-109 mmHg	4	2.67%
≥180/≥110 mmHg	2	1.33%

Table 1 shows that males (54.67%) aged 30-39 and 40-49 years (38.67%; 38.67%) became the majority characteristic of respondents. The majority of respondents had an ideal BMI of 13.79–25.99 kg/m^2 (53.33%), and a low-risk waist circumference was observed for both women ≤88 cm (31.33%) and men ≤102 cm (50%). Meanwhile, the WHR and WHtR values for women (≥0.85 cm; ≥0.50) and men (≥0.90 cm; ≥0.50) were at high risk (30.67%; 38.67%; 73.33%). More than half (57.99%) of respondents in the productive age group had blood pressure in the normal range (<130/85 mmHg).

Table 2. Pearson Correlation Coefficient of Obesity Indicators with Blood Pressure (n=150)

Blood pressure	BMI	Waist circumference	WHR	WHtR
Systolic	0.313**	0.316**	0.274**	0.232**
Diastolic	0.206*	0.173*	0.088	0.163*

**Significant at p-value <0.05*
***Significant at p-value <0.01*

Table 2 reveals a relationship between all the obesity indicators with Systolic Blood Pressure (SBP) (p<0.01). Meanwhile, there was a correlation between waist circumference, BMI, and WHtR with Diastolic Blood Pressure (DBP) (p<0.05), but there was no relationship with WHR (p>0.05). The correlation test results were strongest for waist circumference with SBP (r=0.316) and BMI with DBP (r=0.206).

DISCUSSION

This study was to analyze the correlation between obesity indicators and blood pressure in the productive age group. Most of the participants in this study were males aged between 30-39 years and 40-49 years. There are significant differences in clinical characteristics and the epidemiology of hypertension between men and women related to certain types of hypertension (Song et al., 2019). The majority of women experience hypertension at an older age than men, and sharper increases in blood pressure begin as early as the third decade and continue throughout women's life (Ghazi & Bello, 2022; Ji et al., 2020). Alongside SBP, both Pulse Pressure (PP) and Mean Arterial Pressure (MAP) experienced a steady rise prior to menopause, followed by a marked acceleration in the year following menopause (Samargandy et al., 2022). Reaching 50 years old, DBP generally rises because of heightened arteriolar resistance (Singh et al., 2023). Nevertheless, the majority of men in this study were more likely to experience hypertension as they got older due to low levels of estrogen in their bodies compared to women before menopause.

Results of this study indicate that more than half of the total respondents had blood pressure in the normal range (<130/85 mmHg). This could be because the majority of respondents had a fairly healthy lifestyle, such as physical activity and not smoking. Most respondents also were in middle adulthood where the body is still able to carry out various mechanisms for controlling blood pressure physiologically. Under normal conditions, when there is a disturbance in homeostasis due to an increase in blood pressure, the *Atrial Natriuretic Peptide* (ANP) produced by heart muscle cells of the right atrium's wall and has a hypotensive effect and is crucial in returning blood pressure to normal (Tokudome & Otani, 2022).

Along with time, increases in blood pressure may occur due to changes in the arteries. The lumen of arterial blood vessels in old age tends to experience narrowing and hardening of the blood vessel walls through the process of forming atherosclerosis (Singh et al., 2023). In other words, even though respondents had normal blood pressure, there is a possibility that they will move to higher blood pressure as they get older. Therefore, preventing age-related increases in blood pressure can mitigate most of the vascular consequences typically caused by aging.

This study uncovered that the majority of obesity indicators, including BMI and waist circumference, were within the normal range, but WHR and WHtR fell into the high-risk category. Obesity indicators, such as waist circumference, WHR, and WHtR, were measured by assessing abdominal circumference, as obesity was evaluated based on the amount of fat in the abdomen. In general, white adipose tissue is

divided into two categories, namely Subcutaneous Adipose Tissue (SAT) in the gluteus femoral and abdominal areas, whereas Visceral Adipose Tissue (VAT) in the omentum and mesenteric or intra-abdominal fat and fat surrounding the heart (Santillana et al., 2023).

Accumulating fat in the abdominal area gradually leads to obesity over time. Low-grade inflammation in the body was associated with obesity and also any conditions such as macrophage infiltration and adipocyte dysfunction (Kojta et al., 2020). Adipose dysfunction plays an important role in causing cardiometabolic alterations, and these are characterized by decreased adiponectin levels, hyperleptinemia, increased macrophage infiltration and free fatty acid levels (Santillana et al., 2023). Therefore, indicators of obesity that involve measuring abdominal circumference are often associated with increased blood pressure. However, not everyone with excess adiposity develops comorbidities (Santillana et al., 2023).

Obesity-induced hypertension occurs through complex mechanisms in the body, involving excessive activation of the sympathetic nervous system. These mechanisms also stimulate the system called Renin-Angiotensin-Aldosterone (RAA), fat-derived cytokines changes, insulin resistance, and kidneys' structural and functional changes (Shariq & Mckenzie, 2020). These conditions cause inflammation in the body, which can be characterized by an increase in C-Reactive Protein (CRP). A previous study showed that serum High Sensitivity C-Reactive Protein (hs-CRP) levels were positively correlated with waist circumference but not with WHR (Syifarahmi et al., 2021).

This study, based on bivariate analysis, demonstrated a relationship between BMI to SBP and DBP ($p<0.01$; $r=0.313$; $p<0.05$; $r=0.206$). This study aligns with previous, showing that BMI was related to SBP and significantly associated with an increased hypertension incidence (Moosaie et al., 2021). This study indicates that the majority of respondents were male. In men, BMI is an indicator of obesity (AUC = 0.603 (0.52; 0.69), which is the best predictor of hypertension in older men (Modjadji et al., 2022). Obesity can generally be assessed by comparing body weight and height in square meters. The comparison in this way was measured without considering the fat distribution in the waist and hips.

The correlation also can be seen between waist circumference against blood pressure, both SBP and DBP ($p<0.01$; $p<0.05$). The waist circumference correlation test was stronger against SBP ($r=0.316$). This corroborates with the previous study that shows a correlation between waist circumference and blood pressure (Wang et al., 2020). Obesity indicators by measuring waist circumference are commonly used because adiposity collects in the abdomen. However, it is slightly different from the previous study, which showed a significant positive correlation between abdominal circumference and SBP but a negative relationship with DBP (Asnaniar & Munir, 2021; Pramaningtyas et al., 2021).

The study's findings indicate a correlation between WHR and SBP but not such a relationship with DBP. Other studies in hypertensive patients showed a relationship between blood pressure and WHR ($p=0.03$; OR=10.23) and a stronger correlation for both SBP and DBP (test power = 0.526) (Andriyani et al., 2022; Yuriah et al., 2019). WHR also has a significant correlation and has been proven to be the main predictor of high risk of CVD ($p<0.001$; $r=0.385$) (Azahar et al., 2022; Hastuti et al., 2022). Another study comparing BMI discloses that WHR becomes the second-best indicator behind waist circumference in patients with DM and hypertension (Khanna et al., 2022).

Different from WHR, WHtR correlated with SBP and DBP ($p<0.01$, $r=0.232$; $p<0.05$, $r=0.163$). This is consistent with earlier research that demonstrated that higher WHtR values are associated with arterial stiffness, increased blood pressure, and systemic vascular resistance (Taurio et al., 2023). Previous studies have shown that WHtR is the best alternative anthropometric measurement compared to waist circumference and BMI in predicting hypertension in adult men and women (Fajria et al., 2021). Another study also exposes that WHtR can predict the incidence of CVD better in hypertensive people than other obesity indices such as BMI, waist circumference, and WHR (Zhang et al., 2022). Apart from patients with type 2 diabetes, hypertension can be predicted more accurately by

calculating WHtR compared to WHR and BMI (Moosaie et al., 2021). However, in older women, hypertension can be predicted better by measuring waist circumference (AUC = 0.640 (0.56; 0.72) and WHtR (AUC = 0.605 (0.52; 0.69) than BMI and WHR (Modjadji et al., 2022).

People with the same waist circumference but different heights also have varying body fat percentages (Moosaie et al., 2021). Therefore, the WHtR measurement is more sensitive in describing fat deposits in the body because it compares the waist circumference with relatively constant body height. Calculation of WHtR as a predictor also does not require certain characteristic limitations and tends to refer to stable height (Fajria et al., 2021). The WHtR value limit can also be simplified and memorable, and waist circumference is recommended to be less than half of body height (NICE, 2023). Women are especially encouraged to maintain ideal WHtR from an early age (Wu et al., 2022).

Nevertheless, there is no single anthropometric waist circumference index that is consistently superior in predicting the four risk factors for cardiometabolic syndrome (Nevill et al., 2022), as well as other obesity indicators when predicting blood pressure. Differences in research results may be caused by the diversity of respondent characteristics in various studies. In conclusion, early detection of hypertension by measuring obesity indicators, such as BMI, waist circumference, WHR, and WHtR, can be recommended. Individuals within the productive age group need to monitor and be aware of abnormal obesity indicators in calculating the risk of CVD and increased blood pressure.

This study had several limitations, including the procedure. There is a possibility of inaccurate waist and hip measurement procedures. It is because respondents wore clothing of different thicknesses when measuring waist and hip circumferences. Besides that, this study did not assess other factors that possibly contribute to blood pressure, such as stress level and sleep disorder.

CONCLUSION

A total of 150 respondents participated in the study, most of whom were men aged 30-39 and 40-49 years who had blood pressure in the normal range. Indicators of obesity in productive age were based on BMI and waist circumference; the majority of those were in the ideal range and low risk. Meanwhile, the majority of WHR and WHtR of productive age were at high risk. The correlation test results were stronger for waist circumference with SBP ($p<0.01$, $r=0.316$) and BMI with DBP ($p<0.05$, $r=0.206$). As such, the productive age group is advised to regularly measure, monitor, and manage obesity indicators and blood pressure to prevent the emergence of risk factors for CVD. Future research should consider wearing the same clothes and examine factors that affect blood pressure before measurement.

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