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Abdominal Circumference as a Predictor of Blood Pressure Increase in Menopausal Women in the Mengwi District

Kadek Ayu Rosita Dewi[1*], I Made Niko Winaya[2], Ni Wayan Tianing[3], Anak Agung Eka Septian Utama[4]

[1]Bachelor and Profession of Physiotherapy Study Program, Faculty of Medicine, Udayana University, Denpasar, Bali
[2,3,4]Department of Physiotherapy, Faculty of Medicine, Udayana University, Denpasar, Bali
*Corresponding author: ayurositaaa20@gmail.com

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ABSTRACT

Introduction: Abdominal circumference serves as an indicator in determining central obesity criteria. In the Asia-Pacific region, the central obesity criteria are abdominal circumference ≥90 cm for men and ≥80 cm for women. Menopausal women experience decreased estrogen levels associated with the loss of subcutaneous fat and increased abdominal fat. When there is excessive fat distribution in the central body, there is a possibility of decreased adiponectin levels as an anti-atherogenic factor, leading to increased blood pressure. This study aims to determine the relationship between abdominal circumference and blood pressure increase in menopausal women in the Mengwi District.
Method: A cross-sectional study was conducted on a population of menopausal women aged 45-55 years using a consecutive sampling technique. Subjects were selected according to inclusion, exclusion, and dropout criteria until the total number of subjects reached 85 individuals. Data analysis was performed using the Spearman rho test to determine the relationship between variables and the correlation strength.
Results: Based on the data analysis, there was a significant relationship between abdominal circumference and blood pressure, as evidenced by a p-value of 0.018 ($p<0.05$) and a weak positive correlation coefficient (0.255).
Conclusion: Abdominal circumference is associated with increased blood pressure in menopausal women with a weak correlation level.

Keywords: abdominal circumference, blood pressure, women, menopause

INTRODUCTION

Menopause is a physiological period experienced by women through a series of processes involving the cessation of reproductive functions such as menstrual cycles and the transition from the reproductive phase to the non-reproductive phase.[1] During menopause, there is a decrease in estrogen hormone levels in women, which can affect various physical and psychological conditions.[2] The levels of sex hormones in the body affect body fat distribution and adipocyte differentiation. The distribution of abdominal fat differs between women of reproductive age and menopausal women. The decrease in estrogen levels in menopausal women is associated with the loss of subcutaneous fat and an increase in abdominal fat. Estrogen hormone and estrogen receptors play crucial roles in regulating glucose and lipid metabolism. Disruption in the signalling of glucose and lipid metabolism can lead to the development of metabolic syndrome and higher cardiovascular risk in women. The loss of estrogen hormone indicates the onset of cardiovascular diseases, such as increased blood pressure during the menopausal period.[3] The occurrence of high blood pressure in Rejomulyo Village, Madiun, reaches 28.7%, with women in menopause comprising 87% of the cases.[4] Additionally, based on cohort findings in 2014 in Bogor, the prevalence of menopausal women experiencing high blood pressure was 48.9%.[5]

Blood pressure is the pressure exerted on the walls of blood vessels by the blood flow and can be influenced by blood volume.[6] High blood pressure or hypertension is a condition where the pressure on the walls of the arteries is too high.[7] In Indonesia, the incidence of hypertension reaches 34.1% in the population aged ≥ 18 years, with a higher number of cases in women at 36.9% compared to men at 31.3% in 2018.[8] The increase in blood pressure becomes increasingly dangerous as it can lead to heart failure, stroke, and kidney disease at high rates, thus posing a high risk of death due to hypertension. Many factors, including abdominal circumference, can cause high blood pressure.

The function of abdominal circumference is an indicator of central obesity criteria.[9] In the Asia-Pacific region, the criteria for central obesity are an abdominal circumference ≥90 cm for men and ≥80 cm for women. Abdominal circumference measurement measures the waist diameter horizontally at the midpoint between the iliac crest and the lower costal bone.[10] Central obesity is defined as a condition where fat accumulates in the abdominal area or intra-abdominal fat.[11] According to the Riskesdas data for Bali Province in 2018, Badung Regency has the highest prevalence of central obesity cases, reaching 41.52%. Female residents more commonly experience this at 49.3% compared to males at 24.8%.[12] The increase in abdominal circumference tends to start appearing in the age group of 35-44 years and continues until 45-54 years old.[13]

Women have more fat reserves than men, especially in the abdominal area. After experiencing menopause, women have high levels of triglycerides, abdominal fat, and total cholesterol, leading to increased fat distribution in the central body.[14] When the abdominal circumference exceeds the standard criteria, indicating excess fat in the abdomen, there is a decrease in adiponectin levels as an anti-atherogenic factor, leading to increased blood pressure.[15] A study by Herinasari in 2022 with female subjects aged 35-54 demonstrated a weak positive correlation and a significant relationship between abdominal circumference and blood pressure. This explains that an increase in blood pressure values accompanies an increase in waist circumference.[16] There is a difference between previous studies and this research. In previous studies, blood pressure was classified into two categories: standard and hypertension, while this research uses a classification of blood pressure into four categories: standard, pre-hypertension, hypertension stage I, and hypertension stage II, which are associated with waist circumference categories.

Based on the background above, the researchers aim to demonstrate the relationship between waist circumference and increased blood pressure in menopausal women so that the public understands the importance of maintaining a controlled waist circumference to avoid the risk of high blood pressure. According to the Riskesdas data for Bali Province, Badung Regency has the highest prevalence of central obesity cases, predominantly experienced by women. Additionally, based on the visitation data at Puskesmas Mengwi II, patients with high blood pressure ranked first among the seven most common diseases throughout 2020. This indicates that high blood pressure remains a significant issue and severely impacts health. Therefore, the researchers are interested in conducting research in the Mengwi District. This study hypothesises a relationship between waist circumference and increased blood pressure, where a larger waist circumference is associated with higher blood pressure.

METHOD

The design used in this study is an observational analytical study with a cross-sectional approach. The independent variables in this study are waist circumference and the dependent variable is blood pressure. These variables were observed once at the same time without any follow-up. The research was conducted from August to December 2023 through door-to-door visits in the Mengwi District, Badung Regency. The sampling technique used was consecutive sampling. The sample size was 85 individuals, determined using the Lemeshow formula. Bias control was conducted by controlling age, gender, and selection based on the established inclusion and exclusion criteria. The inclusion criteria in this study were women aged 45-55 years, not menstruating for at least 12 months, and willing to participate voluntarily by signing an informed consent form. The exclusion criteria were having blood pressure ≤90/60 mmHg, inability to stand, or lower limb disability.

The research procedure began by explaining the purpose and procedures of the study. Then, the participants filled out informed consent forms. Subsequently, interviews covered identity, last menstrual history, and hypotension history. This was followed by blood pressure measurement and waist circumference measurement. The measurement tools used were a waist ruler to measure waist circumference, interpreted as <80 cm for the normal category and ≥80 cm for the central obesity category. An aneroid sphygmomanometer was used to measure blood pressure, classified as usual <120/80 mmHg, pre-hypertension 120/80 - 139/89 mmHg, stage one hypertension 140/90 - 159/99 mmHg, and stage two hypertension ≥160/100 mmHg.

The collected data will be processed through univariate and bivariate analysis. Age variable will be tested univariately to determine frequency distribution, mean value, and standard deviation. Waist circumference and blood pressure variables will be tested univariately to determine frequency distribution and cross-tabulation data. The bivariate analysis used was the non-parametric Spearman rho test to determine the relationship between waist circumference and blood pressure. This research has obtained ethical clearance from the Research Ethics Commission Unit of the Faculty of Medicine, Udayana University, with ethical clearance number 1125/UN14.2.2.VII.14/LT/2023.

RESULT

The subjects of this study are menopausal women in the Mengwi district who have met the inclusion and exclusion criteria. The stages of subject identification in this study can be seen in Figure 1.

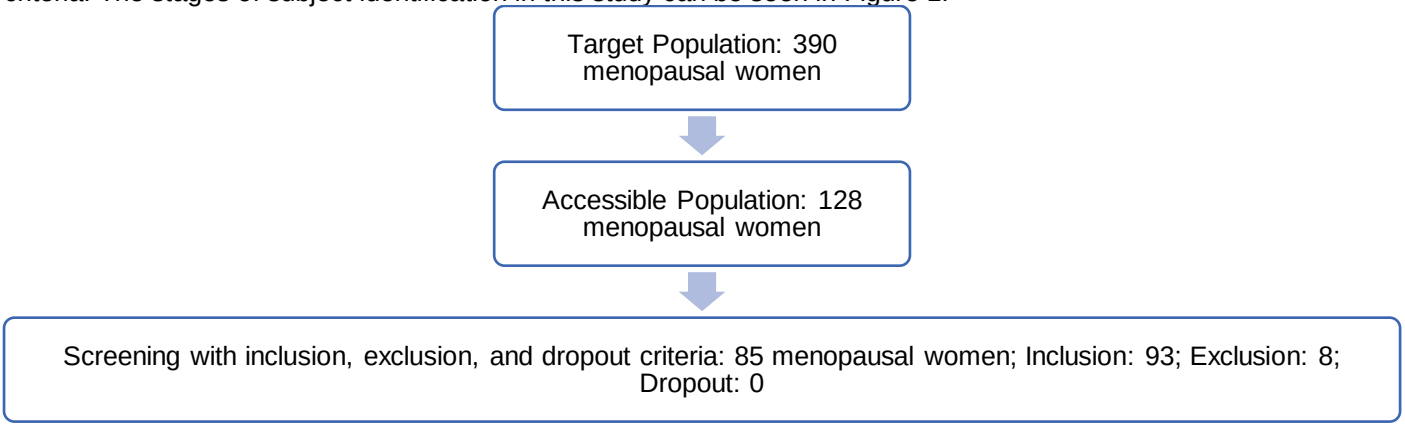

Figure 1. Subject Identification Stage

Based on Figure 1, the number of research subjects is 85 individuals. This number fulfils the calculated subject requirement using the Lemeshow formula. The characteristics of research subjects based on age, waist circumference, and blood pressure can be seen in the Tabel 1.

Table 1. Frequency Distribution of Subject Characteristics based on Age

Age	Frequency	Percentage (%)
45	1	1.2
46	2	2.4
47	7	8.2
48	1	1.2
49	11	12.9
50	11	12.9
51	11	12.9
52	10	11.8
53	13	15.3
54	10	11.8
55	8	9.4
Total	**85**	**100**

Table 2. Mean and Standard Deviation Values based on Age

Variable	Value
Usia (rerata±SD)	51.21±2.351

Based on Table 1, the subjects obtained are from the entire age range of the inclusion criteria, which is 45 to 55 years old. The highest number of samples is for the age of 53, with 13 individuals (15.3%). Table 2 shows that the mean age of the subjects in this study is 51.21, with a standard deviation of 2.351.

Table 3. Frequency Distribution of Subject Characteristics based on Waist Circumference

Waist Circumference	Frequency	Percentage (%)
Normal	19	22.4
Central Obesity	66	77.6
Total	**85**	**100**

Table 3 shows that out of 85 women, most respondents have an abnormal waist circumference or central obesity, with 66 individuals (77.6%). In contrast, 19 individuals (22.4%) have an average waist circumference.

Table 4. Frequency Distribution of Blood Pressure based on Waist Circumference

Variable	Blood Pressure				Total
	Normal	Pre-Hypertension	Stage 1 Hypertension	Stage 2 Hypertension	
Waist Circumference					
Normal	10	6	2	1	19
Central Obesity	14	32	14	6	66

Table 4 shows that subjects with average waist circumference more dominantly have typical blood pressure values, comprising ten individuals. In contrast, subjects with abnormal waist circumference or central obesity have more pre-hypertension blood pressure values, totalling 32 individuals.

Table 5. Frequency Distribution of Subject Characteristics based on Blood Pressure

Blood Pressure	Frequency	Percentage (%)
Normal	24	28.2
Pre-Hypertension	38	44.7
Stage 1 Hypertension	16	18.8
Stage 2 Hypertension	7	8.2
Total	**85**	**100**

Based on Table 5, the frequency distribution of samples shows that there are 24 individuals (28.2%) with normal blood pressure, 38 individuals (44.7%) with pre-hypertension, 16 individuals (18.8%) with stage 1 hypertension, and (8.2%) with stage 2 hypertension.

Table 6. Relationship between Waist Circumference and Blood Pressure

Variable Correlation	Correlation	p Value
Waist Circumference Blood Pressure	0.255	0.018

Based on Table 6, bivariate analysis using a non-parametric Spearman rho test shows a significant relationship between waist circumference and blood pressure, as evidenced by a p-value of 0.018 ($p<0.05$) and a correlation coefficient of 0.255, which is positive. The positive correlation coefficient value indicates that the relationship is positive and has a weak correlation level.

DISCUSSION

Characteristics of Research Subjects

This study was conducted in the Mengwi district using menopausal women as subjects. The total number of respondents who met the criteria was 85, aged 45-55. The mean age of the subjects was 51.21, with a standard

deviation of 2.351. Women were found to have a higher prevalence of central obesity compared to men.[17] As age increases, it affects the increase in fat distribution, increasing waist circumference.[18] The increase in waist circumference tends to begin appearing in the age group of 35-44 years and continues until 45-54 years old.[13]

Looking at the distribution of waist circumference, 77.6% of the subjects have a large or abnormal waist circumference, while 22.4% have an average waist circumference. Menopausal women with abnormal waist circumferences are more prevalent than those with average waist circumferences. Waist circumference is used as a predictor of central obesity risk. Various factors, including gender, genetics, lack of physical activity, and calorie intake, cause fat accumulation in the abdomen.[14]

The research results indicate that subjects with abnormal waist circumference tend to experience increased blood pressure, categorised as pre-hypertension, stage 1 hypertension, and stage 2 hypertension. In contrast, subjects with average waist circumference tend to have more individuals with normal blood pressure, totalling ten. Asians tend to have higher amounts of abdominal fat and total body fat, which is associated with a higher risk of hypertension through various mechanisms, including leptin resistance, hydrostatic blood vessel pressure, systemic inflammation, distribution of fat around the kidneys, and other factors such as genetics and lifestyle factors like physical activity and excessive salt intake, which can affect blood pressure values.[19]

Reviewed from the distribution of blood pressure, the number of subjects with pre-hypertension, stage 1 hypertension, and stage 2 hypertension is higher than the number of subjects with normal blood pressure. The loss of estrogen hormone influences the increase in blood pressure in menopausal women.[3] Blood pressure can increase with age due to a gradual decrease in arterial distensibility.[20]

The relationship between waist circumference and increased blood pressure

Waist circumference is used as a predictor of central obesity risk.[11] As age increases and the effects of menopause set in, there is an increase in central body fat distribution. This aligns with findings from this study, indicating a higher prevalence of central obesity compared to average waist circumference. Menopausal women experience a decrease in estrogen hormone levels. Estrogen and estrogen receptors play crucial roles in regulating glucose and lipid metabolism. Disruption in the signalling of glucose and lipid metabolism leads to the development of metabolic syndrome and a higher cardiovascular risk in women.[3]

Based on the results of the data analysis using non-parametric Spearman's rho, a p-value of 0.018 ($p > 0.05$) was found, indicating a significant relationship between waist circumference and blood pressure. The positive relationship ($r = 0.255$) suggests that larger waist circumference is associated with higher blood pressure, albeit with a weak correlation. Consistent with Puspita's study in 2018, chi-square analysis based on systolic blood pressure (SBP) yielded a p-value of 0.001, and for diastolic blood pressure (DBP), a p-value of 0.007 was found, indicating a significant relationship between waist circumference and SBP and DBP based on hypertension indication analysis. Respondents with central obesity are at a 4.362 times higher risk based on SBP measurements and 3.302 times higher risk based on DBP measurements compared to respondents without central obesity.[21] The same research was also conducted by Arifin et al. (2019) on the relationship between waist circumference and blood pressure. The bivariate analysis with 51 samples concluded that there is a significant relationship between waist circumference and SBP and DBP with a p-value of <0.001.[22]

The study by Herinasari in 2022 suggests that there is a significant relationship between waist circumference and blood pressure (p=0.04) with a weak positive correlation (0.275). The positive correlation in Herinasari's research indicates a positive correlation, meaning that an increase follows an increase in waist circumference and blood pressure.[16] Another supporting study conducted by Amanda & Martini in 2018 shows that one of the risk factors for hypertension is abdominal obesity. The analysis evidences these results with a p-value of 0.002 and a PR value of 2.556, meaning that individuals with abdominal obesity are 2.556 times more likely to be at risk than those without abdominal obesity. When waist circumference exceeds standard criteria, indicating excess fat around the abdomen, it can increase blood pressure.[15]

Excessive distribution of fat in the central body leads to decreased adiponectin levels, which acts as an anti-atherogenic agent and results in intracellular uptake of free fatty acids, thereby reducing oxidation. This can lead to the accumulation of free fatty acids within cells. Consequently, the renin-angiotensin-aldosterone system (RAAS) is activated.[17] Renin functions to convert angiotensinogen into angiotensin I, which is then converted into angiotensin II by the angiotensin-converting enzyme (ACE). Angiotensin II plays a role in the secretion of the hormone aldosterone. This hormone causes increased sodium reabsorption in the kidneys. Sodium is involved in maintaining the balance of intracellular and extracellular fluid. Sodium and water retention raises fluid volume in the extracellular space, consequently raising blood pressure.[23]

The findings of this research underscore the importance of maintaining heart health in women during the menopausal period by keeping waist circumference controlled and regularly checking blood pressure to prevent central obesity and elevated blood pressure. The implications of this study include the potential development of interventions to maintain waist circumference and avoid blood pressure elevation. Health programs can be focused on implementing prevention strategies, such as increasing physical activity, adopting a healthy diet, and routinely checking blood pressure in menopausal women. Physiotherapists and other healthcare professionals are crucial in educating people about the importance of controlling waist circumference to avoid complications from increased blood pressure.

The researchers identified limitations in the study, focusing solely on the correlation between waist circumference and elevated blood pressure without controlling confounding variables such as physical activity, stress, and BMI, which can influence blood pressure and were not analysed. It should be noted that the generalizability of the study's findings may not fully reflect the situation in other menopausal women populations or different locations, so caution is required when generalising these findings. Further research is needed involving a broader and more diverse

population of menopausal women, and consideration should be given to adding other potential factors that may affect blood pressure to enhance the generalizability of these findings.

CONCLUSION

Based on the above research findings, it can be concluded that there is a significant relationship between waist circumference and increased blood pressure in menopausal women in the Mengwi District, with a weak positive correlation coefficient indicating a positive correlation. This suggests that a larger waist circumference is associated with higher blood pressure. This study serves as a reference for educating physiotherapists or other healthcare professionals on maintaining controlled waist circumference and preventing increased blood pressure by increasing physical activity, adopting a healthy diet, and regularly checking blood pressure in menopausal women.

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