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Correlation Between Body Mass Index, Blood Pressure, and Visceral Fat Levels amongst Varying Individuals: A Health Evaluation Study Within the Local Populacy of Cimahi in Indonesia

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ABSTRACT

Introduction: *Obesity is characterized by the excessive accumulation of lipids in the subcutaneous and visceral parts of the body. Body mass index (BMI) is commonly used to estimate fat levels and has a known correlation with metabolic syndrome (MetS). Risk factors for cardiovascular complications include hypertension, obesity, low HDL, hyperglycemia, and hypertriglyceridemia. Sustained hypertension and obesity, especially with adipocytes containing ALDH1A1, can lead to high visceral fat levels, which induce eNOS and increase both NO and ROS, eventually resulting in endothelial dysfunction. This study aims to investigate the correlation between BMI, blood pressure, and visceral fat levels among residents of Rukun Warga (RW) 01, Cibeber, Cimahi.*

Objectives: *The objectives of this study are twofold. First, it seeks to explore the relationship between body mass index (BMI) and blood pressure, examining how variations in BMI might influence changes in blood pressure among the study population. Second, the study aims to assess the correlation between BMI and visceral fat levels, focusing on how increased BMI may be associated with higher levels of visceral fat, which is known to contribute to various metabolic and cardiovascular risks.*

Methods: *This study employed a cross-sectional analytic design with 224 respondents selected through consecutive sampling. Data were gathered through measurements of anthropometrics, blood pressure, BMI, and bioimpedance analysis (BiA). The data analysis focused on correlations between these variables.*

Results: *The study found that 37.5% of respondents fell into obesity class II, with a significant increase in blood pressure in this group, particularly among those with grade II hypertension (34.8%). Visceral fat measurements revealed that 46% of participants had high visceral fat levels (≥13). The findings also indicated that females experienced higher incidences of obesity, hypertension, and high visceral fat levels compared to males. There was a significant correlation (p=0.023) between BMI and blood pressure, as well as between BMI and visceral fat levels (p=0.000). These correlations suggest that an obese body condition increases cardiovascular strain and contributes to insulin resistance, ROS, NO metabolism, and the buildup of visceral fat.*

Conclusions: *The study highlights a strong correlation between BMI and blood pressure, as well as between BMI and visceral fat levels. Obesity class II (37.5%) was the most common, with a significant association with grade II hypertension (34.8%). High visceral fat levels (≥13) were observed in 46% of respondents, with females showing a higher prevalence of these conditions. The data suggest that obesity exacerbates cardiovascular issues and visceral fat accumulation, leading to increased insulin resistance and related metabolic complications.*

Keywords: Body mass index, blood pressure, visceral fat

INTRODUCTION

Today's health issues have undergone a significant shift, moving from communicable diseases to degenerative

diseases or non-communicable diseases (NCDs). NCDs are medical conditions that cannot be transmitted from one individual to another, and included in this category are diseases such as diabetes mellitus (DM), hypertension, heart disease, and cancer. Along with the increasing population and rapid lifestyle changes, NCD cases, especially diabetes mellitus and hypertension, are increasing in Indonesia.

This increase in NCD cases can be attributed to various factors, including unhealthy diet, lack of physical activity, and prolonged stress. For example, the consumption of foods high in sugar and fat, as well as reduced physical activity in urban communities, are the main causes of the increasing prevalence of diabetes and hypertension. This shows that the transformation in people's lifestyles requires deep attention from all parties, especially in terms of education and health promotion.

The inclusion of NCDs in the 2030 Sustainable Development Goals (SDGs) shows that this issue is not only the responsibility of the health sector but also requires attention across sectors. Non-communicable diseases have the potential to hinder the achievement of the SDGs, particularly goals related to good health and well-being. Handling NCDs needs to be done with a holistic approach, including prevention, early detection, and sustainable management to improve the quality of life of the community (Chigom, 1988; Kementerian Kesehatan Republik Indonesia, 2008).

Data from the World Health Organization (WHO) shows that NCDs kill around 41 million people each year, accounting for 71% of all deaths worldwide. This figure reflects the huge impact of NCDs on global public health. With the COVID-19 pandemic, attention to NCDs has increased, as individuals with underlying health conditions are at higher risk of serious complications from the virus. Understanding and managing NCDs is therefore crucial to strengthening public health resilience and achieving global health targets (Chigom, 1988; Kementerian Kesehatan Republik Indonesia, 2008).

Cardiovascular disease (CVDs) is a collection of heart and blood vessel disorders, including coronary heart disease (CHDs), cerebrovascular disease, rheumatic heart disease (RHDs) and other conditions of heart and blood vessel disorders. More than four out of five deaths from cardiovascular disease are caused by heart attacks and strokes. One-third of deaths from heart and blood vessel disorders occur before the age of 70th (Chigom, 1988; World Health Organization, 2012). Cardiovascular disease causes the majority of NCDs deaths, or 17.9 million people each year. It represents 31% of total deaths in a year worldwide, followed by cancer (9.3 million), chronic respiratory diseases (4.1 million), and diabetes (1.5 million). Based on WHO data, sudden cardiac arrest accounts for at least 7 million deaths per year worldwide. Sudden cardiac arrest condition accounts for at least 50% of deaths from coronary heart disease (CHDs), and an estimated 0.1% of the entire population in the United States experience Out-of-hospital cardiac arrest (OHCA) (Powell-Wiley et al., 2021).

A major risk factor for cardiovascular disease is metabolic syndrome (MetS), which is a collection of interrelated medical conditions that significantly increase a person's likelihood of developing heart disease and type 2 diabetes (Rohman, 2007). Metabolic syndrome consists of several components, including central obesity, hypertension, dyslipidemia, and hyperglycemia. When a person experiences several of these conditions simultaneously, the risk of developing cardiovascular problems and diabetes increases exponentially.

The prevalence of doctor-diagnosed heart disease in Indonesia stands at 1.5%. North Kalimantan Province recorded the highest rate, at 2.2%, indicating that health conditions in the area require special attention from the authorities (Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan, 2018). This high rate can be caused by various factors, including unhealthy lifestyles, lack of physical activity, as well as an unbalanced diet that tends to be rich in saturated fat and sugar.

On the other hand, West Java province, which has a prevalence of 1.6%, is the eighth highest in Indonesia (Pratiwi et al., 2017). The association between metabolic syndrome and cardiovascular disease in West Java may be influenced by high levels of urbanization and lifestyle changes that are often accompanied by increased consumption of fast food and reduced physical activity.

Metabolic syndrome is defined as a collection of metabolic symptoms that may increase the risk of cardiovascular disease. The main components of MetS include central obesity characterized by an increase in waist circumference above normal values, hypertension, increased triglyceride levels, decreased high-density lipoprotein (HDL) levels, and hyperglycemia or increased blood sugar levels (Hardisari & Koiriyah, 2019; World Health Organization, 2012). Central obesity, as measured by waist circumference, serves as a key indicator of visceral fat accumulation that is associated with higher metabolic risk.

The main causes of the increasing prevalence of metabolic syndrome in modern society include unhealthy lifestyles, such as a diet high in fat and sugar, lack of physical activity, and prolonged stress. Sedentary lifestyles, especially in this digital age, further exacerbate individual health conditions, leaving many people unaware of the risks they face. Metabolic syndrome is not only an individual health issue but also a challenge to public health systems, given its far-reaching impact on productivity and quality of life.

Visceral adipose tissue or visceral fat is a metabolically active tissue, whereas intra-abdominal obesity is an independent risk factor for metabolic changes in MetS. This situation is related to the development of cardiovascular disease and type 2 diabetes mellitus (Type 2 DM) in children, adolescents, and adults (Amato et al., 2011; Shuster et al., 2012). If any of these disorders coexist, the person is at increased risk of macrovascular disease (Tune et al., 2017). The prevalence of MetS varies widely because of the different criteria used, such as differences in ethnicity or race, age, and gender (Dieny et al., 2020). The increase in metabolic risk factors is consistently associated with a high accumulation of adipose tissue in the abdomen, especially in visceral adipose tissue or visceral fat. A feature of central obesity, or visceral fat, is that there is an enlargement of adipose tissue, thereby releasing metabolic products such as pro-inflammatory cytokines, pro-coagulants, inflammatory peptides and angiotensinogen (Shuster et al., 2012).

Fat localized in the visceral compartment, better known as visceral fat, has been classified into three types, namely omental, mesenteric, and retroperitoneal fat (Dieny et al., 2020). Visceral fat has the unique characteristic of being highly metabolically active, thus continuously releasing free fatty acids (FFAs) into the portal circulation (Sahu, 2011).

The role of visceral fat in human health is significant, especially in the development of metabolic syndrome. Visceral fat contributes to various components of metabolic syndrome, including hyperinsulinemia, systemic inflammation, dyslipidemia and atherosclerosis. Hyperinsulinemia, which is a condition in which blood levels of insulin are elevated, often occurs in response to insulin resistance triggered by excess visceral fat. Adipocytes (fat cells) in visceral tissue produce pro-inflammatory cytokines, which can trigger systemic inflammation. This inflammation, in turn, contributes to a variety of serious health conditions, including type 2 diabetes, heart disease and hypertension.

Elevated levels of free fatty acids, particularly those derived from visceral fat, are strongly associated with a range of metabolic disturbances that can severely impact cardiovascular health. One of the most significant effects of visceral fat accumulation is its role in promoting dyslipidemia, a condition marked by abnormal lipid levels, including elevated triglycerides and reduced levels of high-density lipoprotein (HDL), commonly referred to as “good cholesterol.” Dyslipidemia is a critical risk factor for the development of atherosclerosis, where fatty deposits accumulate on the arterial walls, leading to narrowing and hardening of the arteries. Over time, this process increases the risk of cardiovascular events such as heart attacks and strokes by reducing blood flow and oxygen supply to vital organs.

Moreover, visceral fat does not only affect lipid metabolism; its influence extends to blood pressure regulation. The excess accumulation of visceral fat is often linked to the activation of the renin-angiotensin-aldosterone system (RAAS), a hormonal system that regulates blood pressure and fluid balance. Overactivation of RAAS can lead to increased blood pressure, a hallmark of hypertension. This occurs due to visceral fat releasing various adipokines and inflammatory mediators, which contribute to vascular dysfunction and systemic inflammation, further exacerbating hypertension. Chronic hypertension, in turn, places significant strain on the heart and blood vessels, increasing the risk of coronary artery disease, heart

failure, and renal complications.

In addition, visceral fat plays a role in the development of insulin resistance, which further compounds metabolic dysfunctions. Insulin resistance can worsen lipid profiles and elevate blood pressure, creating a vicious cycle where excess visceral fat perpetuates a variety of interconnected health risks, including obesity, diabetes, and cardiovascular diseases.

Although obesity is often considered a major factor in metabolic syndrome, the exact mechanism behind this relationship is still not fully understood (Rustika et al., 2019; Sihombing & Tjandrarini, 2015). Some studies suggest that in addition to genetic factors, environment and lifestyle also play an important role. For example, an unhealthy diet, low physical activity and stress can increase visceral fat accumulation and worsen health conditions.

Increased lipid metabolism that occurs due to obesity can lead to increased production of reactive oxygen species (ROS) in the blood circulation system and adipocyte tissue (Supadianto et al., 2021). ROS are highly reactive oxygen-containing molecules that can damage body cells if the amount is excessive. This condition is known as oxidative stress, which contributes to the development of various diseases, including diabetes, cardiovascular disease and cancer. In adipocyte tissue, increased ROS can trigger inflammation and impaired cell function, further exacerbating metabolic conditions.

Obesity itself is a condition in which the body has an excessive amount of fat, with a body mass index (BMI) value ≥25 kg/m² (Cahyaningrum, 2018). Obesity occurs when energy intake chronically exceeds energy expenditure. A combination of interacting factors often causes this phenomenon. Some of these include genetic factors, which may predispose a person to fat accumulation; epigenetic factors, which refer to changes in gene expression due to environmental factors; and hormonal factors, such as hormonal imbalances that play a role in appetite regulation and metabolism. Lifestyle, including an unhealthy diet and lack of physical activity, are also major contributors to the development of obesity.

Interestingly, the number of adipocytes in the body is believed to be largely determined from childhood to adolescence (Dieny et al., 2020). Research shows that individuals who are obese at an early age tend to have a greater number of fat cells and find it more difficult to reduce weight later in life. This is due to the fact that adipocytes can increase in number when fat accumulation occurs, and although weight may decrease, the number of adipocytes does not always decrease. As a result, the individual may be at a higher risk of becoming obese again in the future.

During the development of obesity, adipose tissue can undergo two main processes, namely hypertrophy and hyperplasia. Hypertrophy refers to an increase in the size of adipocytes, while hyperplasia is an increase in the number of adipocytes that occurs due to the recruitment of new adipocytes. Both of these processes contribute to the accumulation of fat in the body, which is the main feature of obesity.

Obesity is often characterized by adipocyte dysfunction. Under conditions of caloric excess, adipocytes begin to hypertrophy, which in turn causes them to secrete different types of adipokines. Adipokines are molecules produced by adipose tissue and have important roles in the regulation of metabolism, inflammation and insulin sensitivity. One of the adaptive functions of adipokines is to protect the body from adverse metabolic consequences. However, over time, this process can lead to further impairment of adipocyte function.

When hypertrophic adipocytes continue to produce large amounts of adipokines, this can lead to the recruitment of additional pre-adipocytes, which then differentiate into mature adipocytes or mature adipocytes. While this may be considered an initial protective mechanism against the negative impact of excess fat, as the number of adipocytes continues to increase, the risk of developing more serious conditions also increases. Excessive fat accumulation, especially visceral fat, can trigger systemic inflammation and increase the risk of various metabolic diseases, such as type 2 diabetes, hypertension and cardiovascular disease.

Adipocyte dysfunction is also associated with imbalances in adipokine production. For example, increased

levels of leptin (an adipokine that regulates appetite and energy) are common in obese individuals. However, leptin resistance may develop, leading to increased appetite and reduced energy expenditure. On the other hand, decreased levels of adiponectin (an adipokine that has anti-inflammatory effects and improves insulin sensitivity) are also seen in obese individuals, which can worsen metabolic conditions (Spalding et al., 2008).

Based on the latest data obtained from the Cibeber Health Center, South Cimahi, the incidence of metabolic syndrome (MetS) in the area reached 54.5%, with the obesity component contributing 37.8% (Ernalia, 2014; Listyandini et al., 2020). Although this figure shows a fairly high prevalence, information regarding the description of visceral fat in respondents is still not available. Visceral fat, which is fat accumulated around the internal organs, plays an important role in the pathogenesis of various metabolic and cardiovascular diseases. It is important to understand the relationship between visceral fat, body mass index (BMI), and blood pressure.

This study aims to investigate the relationship between BMI, blood pressure, and visceral fat levels in the community of RW 01 Cibeber, Cimahi, which is the working area of Cibeber Health Center. Data on visceral fat is essential to provide a clearer picture of the health risks faced by individuals in this group. Therefore, researchers used the bioimpedance analysis (BiA) method to measure visceral fat levels. This method is non-invasive and efficient, so it can provide accurate information about body composition, including BMI and visceral fat levels, without causing discomfort to the respondent (Kushner, 1992; Mialich et al., 2014).

BiA measurements work on the principle that electric current flows more easily through body tissues that have a high water content, such as muscle, compared to fat-containing tissues. By analyzing the resistance and reactance generated by this current flow, the BiA device can estimate body composition, including body fat percentage and visceral fat distribution. The accuracy of this method makes it an ideal choice for studies aimed at understanding the health risks associated with obesity and visceral fat.

By understanding the relationship between BMI, blood pressure and visceral fat levels, this study is expected to provide valuable insights to identify individuals at high risk of metabolic syndrome and cardiovascular disease. This knowledge may assist in the development of more focused prevention programs, including healthy lifestyle promotion and community-based interventions.

In addition, the results of this study can contribute to a more comprehensive database on the health condition of the community in Cibeber, thus supporting more effective health policies. Thus, this study not only aims to expand scientific understanding but also to make a real contribution to improving public health and reducing the prevalence of metabolic syndrome in the region.

MATERIALS AND METHODS

This study uses a descriptive-analytic method with a cross-sectional design, which aims to evaluate the relationship between variables at one specific time without any intervention from the researcher. This method is suitable for research that wants to describe the prevalence or distribution of phenomena in a particular population and identify the correlation between the variables studied. In this study, the sample size was determined using the two proportions t-test formula. Based on the calculation results, a minimum of 32 samples is required to meet the expected validity and reliability criteria. The number of samples is considered representative of the condition of the population under study.

Sampling was carried out using a consecutive sampling technique, where subjects who met the inclusion criteria were selected successively until the sample size was met. This technique was chosen because it allows researchers to obtain samples that are in accordance with the research objectives in a relatively efficient time. The inclusion criteria in this study were subjects who lived in the Cibeber area, RW 01, Cimahi, and had an age of more than 17 years. These criteria were chosen to ensure that the subjects studied had similar environmental and age characteristics that could affect the variables analyzed. In addition, this study also set exclusion criteria, namely subjects who had incomplete data and women who were pregnant, because these conditions could affect the measurement results.

Data collection began with the initial process of collecting demographic data and providing informed consent to the research subjects. Informed consent is necessary to ensure that each subject understands the purpose and procedures of the study and gives their consent knowingly and voluntarily. After that, subjects who meet the inclusion criteria will undergo several examinations, including blood pressure measurement, Body Mass Index (BMI), and bioimpedance analysis (BiA). Blood pressure measurement aims to see the subject's cardiovascular health condition, while BMI is used to determine the subject's nutritional status based on the ratio between body weight and height. BiA analysis was conducted to measure the subject's body composition, such as body fat percentage and muscle mass, which can be important indicators in health research.

In addition to physical examination data, the study also collected data through questionnaires designed to gather further information about the subjects' lifestyle, eating habits, and physical activity. Data obtained from the questionnaires, physical measurements, and documentation were presented in narrative and graphical form to provide a clearer and more comprehensive overview. The use of both forms of data presentation was intended to facilitate analysis and minimize interpretation bias.

Once all data had been collected, the processing was carried out using the Statistical Package for the Social Sciences (SPSS), a software commonly used for statistical analysis in social and health research. The processed data were then analyzed using a non-parametric statistical test, specifically the chi-square test. This test was used to identify the presence of relationships or correlations between the variables being studied. This method of analysis was chosen due to the nominal and ordinal nature of the data and the chi-square test's ability to provide valid results when assessing associations between variables.

The study was conducted in RW 01, Cibeber District, Cimahi, and the biochemistry laboratory of the Faculty of Medicine at Universitas Jenderal Achmad Yani (Unjani). The data collection and analysis process took place over three months, from November 2022 to January 2023. The location was selected based on considerations of accessibility and the characteristics of the population, which were deemed relevant to the research topic.

RESULTS

The characteristics of the research subjects described are based on gender and age, which can be seen in Table 1. This research was conducted on 224 research samples, including 63 males, with a percentage of 28.1%, and 161 other people were females, with a percentage of 71.9%. The age group of the research sample was 56-65, with a total of 84 people and a percentage of 37.5%. The youngest subject is 17 years old, while the oldest is 79 years old, which can be seen in Table 2:

Table 1. *Characteristics of Research Subjects by Age and Sex*

Characteristics	Frequency	Percentage
Gender		
Male	63	28,1
Female	161	71,9
Age (Years)		
17-25	13	5,8
26-35	12	5,4
36-45	36	16,1
46-55	68	30,4
56-65	84	37,5
65-75	11	4,9

Table 1 provides an overview of the demographic characteristics of the research subjects based on two key variables: gender and age. A total of 224 subjects participated in the study, with a gender distribution heavily skewed toward females. Out of the total sample, 63 participants were males, representing 28.1% of the total, while the majority, 161 participants, were females, accounting for 71.9% of the subjects. This significant

gender disparity suggests that the research sample was predominantly female, a factor that could influence the generalizability of certain findings, particularly those related to gender-specific health issues.

The age distribution of the participants shows a broad range, spanning from 17 to 79 years. The largest proportion of the sample came from the 56-65 year-old age group, which comprised 37.5% of the total, amounting to 84 individuals. This indicates that the majority of participants were middle-aged or older, with a substantial portion of the sample being within an age range often associated with an increased risk for chronic conditions like obesity, hypertension, and metabolic disorders. The second largest group was the 46-55-year-old age group, making up 30.4% of the sample, or 68 individuals.

In contrast, the younger age groups were represented in smaller numbers. The 17-25 year-old group included only 13 participants (5.8%), while the 26-35 year-old group had just 12 participants (5.4%). Meanwhile, the 65-75 year-old group constituted only 11 individuals, or 4.9% of the total. This distribution suggests that the study's focus was predominantly on older adults, with fewer younger participants. The range of ages captured in this study allows for a comprehensive examination of age-related trends in the research findings, particularly with respect to how certain health outcomes may vary by age group.

Table 2. *Descriptive Statistics of the Research Sample's Age*

	Minimum	**Maximum**	**Std. Deviation**
Age	17	79	12.594

Table 2 presents key descriptive statistics regarding the ages of the study participants, offering a clear view of the age distribution within the sample. The minimum age recorded among the respondents was 17 years, indicating the inclusion of younger individuals in the study, likely representing adolescents or early adults. Conversely, the maximum age reached 79 years, highlighting the participation of older adults, which is significant given the focus on age-related health issues.

The standard deviation of 12.594 years reflects a considerable degree of variability in the ages of the respondents. This substantial standard deviation suggests that while some participants are clustered around the average age, others are distributed widely across the age spectrum. Such variability is essential for conducting in-depth analyses regarding the relationships between age and various health conditions explored in the study, such as obesity and hypertension.

The description of the body mass index (BMI) of the population of RW 01 Cibeber is calculated based on height and weight grouped based on the modified WHO body mass index for Asians. The results of the classification can be seen in Table 3 below:

Table 3. *Body Mass Index (BMI) Distribution of the RW 01 Cibeber Community According to WHO Classification for Asians*

Body Mass Index	**Frequency**	**Percentage**
Normal	47	21,0
Overweight	48	21,4
Obesity class I	45	20,1
Obesity class II	84	37,5
Total	**224**	**100,0**

Table 3 presents the distribution of Body Mass Index (BMI) of the RW 01 Cibeber community based on the modified WHO classification for Asian populations. Of the total 224 respondents, 47 people (21.0%) had a BMI in the normal category, while 48 people (21.4%) were classified as overweight. The class I obesity category included 45 people (20.1%), and the class II obesity category included 84 people (37.5%). This data shows that the proportion of obesity among the RW 01 Cibeber community is quite significant, especially in class II obesity, which reaches almost 38%. This indicates the need for further attention to the obesity problem

in the area.

Table 4. *Body Mass Index (BMI) Distribution of the RW 01 Cibeber Population by Gender*

Body Mass Index	Gender			
	Male		Female	
	N	%	N	%
Normal	22	34,9	25	15,5
Overweight	8	12,7	40	24,8
Obesity class I	14	30,2	65	40,4
Obesity class II	19	12,7	40	24,8

Table 4 illustrates the distribution of BMI by gender. From this table, it can be seen that among men, 22 people (34.9%) were in the normal category, while 25 people (15.5%) of women were in the same category. For the overweight category, men only reached 8 people (12.7%), while women were higher with 40 people (24.8%). In the class I obesity category, there were 14 males (30.2%) and 65 females (40.4%), showing that females had a greater proportion in this category. For grade II obesity, 19 males (12.7%) and 40 females (24.8%) were found. These findings confirm that women are more prone to obesity than men in this population, which could be influenced by lifestyle and hormonal factors.

Blood pressure measurements in the population of RW 01 Cibeber were conducted using a digital tensimeter, and the results were grouped based on the JNC VII classification. Table 5 below shows the grouping.

Table 5. *Blood Pressure Description of the RW 01 Cibeber Cimahi Population According to JNC VII Classification*

Blood Pressure	Frequency	Percentage
Normal	22	9,8
Pre Hypertension	47	21,0
Hypertension Grade I	77	34,4
Hypertension Grade II	78	34,8
Total	224	100,0

Table 5 provides an overview of the description of blood pressure in RW 01 Cibeber, Cimahi, based on the JNC VII classification. Of the total 224 respondents, only 22 people (9.8%) had normal blood pressure, while 47 people (21.0%) were in the pre-hypertension category. The largest proportion was in grade I hypertension, with 77 people (34.4%) and grade II hypertension reaching 78 people (34.8%). These results show that more than half of the population (around 69.2%) in RW 01 Cibeber have hypertension, both first and second-degree. This condition indicates the need for more focused health interventions to reduce the prevalence of hypertension in this community.

Table 6. *Blood Pressure Distribution of the RW 01 Cibeber Cimahi Population by Gender*

Body Mass Index	Gender			
	Male		Female	
	N	%	N	%
Normal	6	27,3	16	72,7
Pre Hypertension	16	34,0	31	66,0
Hypertension grade I	22	28,6	55	71,4
Hypertension grade II	19	28,1	59	71,9

Table 6 presents the distribution of blood pressure by gender in RW 01 Cibeber. From this table, it can be seen that of the 6 males (27.3%) who had normal blood pressure, there were 16 females (72.7%) in the same

category. In the pre hypertension category, 16 males (34.0%) and 31 females (66.0%) were identified. In grade I hypertension, 22 males (28.6%) and 55 females (71.4%) were found, while in grade II hypertension, there were 19 males (28.1%) and 59 females (71.9%).

From these data, it can be concluded that women in RW 01 Cibeber tend to have a higher prevalence of hypertension than men in all categories measured. This reflects a trend often seen in the epidemiology of hypertension, where women, especially older ones, may be more susceptible to elevated blood pressure. These findings suggest the importance of targeting more effective hypertension prevention and management programs for women in this community, taking into account lifestyle factors, diet, and access to health services.

Examination of visceral fat levels is carried out simultaneously with BMI examination. The results of examining visceral fat using BiA for the research sample can be seen in Table 7 below:

Table 7. *Visceral Fat Levels in the RW 01 Cibeber Cimahi Community*

Visceral Fat Levels	Frequency	Percentage
Normal	121	54,0
High	103	46,0
Total	224	100,0

Table 7 presents the results of the examination of visceral fat levels in the community of RW 01 Cibeber, Cimahi. Of the total 224 respondents, 121 people (54.0%) had normal visceral fat levels, while 103 people (46.0%) showed high visceral fat levels. These findings suggest that almost half of the population studied had excess visceral fat, which is an important risk factor for various metabolic and cardiovascular diseases. Increased visceral fat may contribute to the development of metabolic syndrome and other health conditions, so these results underscore the need for more attention to weight management and metabolic health in this community.

Table 8. *Visceral Fat Levels in the RW 01 Cibeber Cimahi Community by Gender*

Visceral Fat Levels	Gender			
	Male		Female	
	N	%	N	%
Normal	38	60,3	83	51,6
High	25	39,7	78	48,4

Table 8 shows the distribution of visceral fat levels by gender. Of the 38 men (60.3%) who had normal visceral fat levels, there were 83 women (51.6%) in the same category. On the other hand, 25 males (39.7%) had high visceral fat levels, while 78 females (48.4%) also showed the same condition.

These results show that although a higher proportion of men had normal visceral fat compared to women, the difference was not significant. This reflects the similarity in the influence of factors such as diet and lifestyle between the two sexes in this community. However, the high percentage of women with high visceral fat (48.4%) suggests the need for more health strategies focused on lifestyle interventions for women, especially in relation to diet and physical activity.

Table 9. *Correlation Between BMI and Blood Pressure in the RW 01 Cibeber Cimahi Community*

BMI (kg/m²)	Normal	Pre-Hypertension	Hypertension Stage 1	Hypertension Stage 2	Total	P-Value
	N	%	N	%	N	%
18.5 – 22.9	10	21.3	11	23.4	13	27.7
23.0 – 24.9	2	4.2	8	16.7	15	31.3
25.0 – 29.9	2	4.4	7	15.6	23	51.1
≥ 30	8	9.5	21	25.0	26	31.0

Table 9 shows the relationship between body mass index (BMI) and blood pressure in the community of RW 01 Cibeber, Cimahi. The analysis shows that different BMI categories have varying proportions of respondents based on blood pressure classification. For IMT category 18.5 - 22.9, there were 10 people (21.3%) with normal blood pressure, 11 people (23.4%) in the pre-hypertension category, and 13 people (27.7%) in grade I hypertension. The BMI categories of 23.0 - 24.9 and 25.0 - 29.9 showed a significant increase in the proportion of individuals with hypertension, with 31.3% in grade I hypertension for BMI 23.0 - 24.9 and 51.1% in grade II hypertension for BMI 25.0 - 29.9. Meanwhile, the BMI ≥ 30 category showed that 31.0% of individuals had grade II hypertension.

The significant p-value ($p < 0.05$) indicates a strong association between BMI and blood pressure. This finding confirms the importance of monitoring BMI as a risk indicator for hypertension in this population, where the higher the BMI, the more likely an individual is to develop hypertension, further contributing to an increased risk of cardiovascular disease.

Table 10. *Correlation Between BMI and Visceral Fat Levels in the RW 01 Cibeber Cimahi Community*

Variable	Visceral Fat Levels				Total	P-Value
	< 13		≥ 13			
	N	%	N	%		
BMI (kg/m2)						
18,5 – 22,9	47	100,0	0	0,0	47	0,000
23,0 – 24,9	41	91,1	4	8,9	45	
25,0 – 29,9	33	39,3	51	60,7	84	
≥ 30	0	0,0	48	100,0	48	

Table 10 displays the correlation between BMI and visceral fat levels in the community of RW 01 Cibeber, Cimahi. From the data, it can be seen that individuals with BMI in the 18.5 - 22.9 category all (100%) have visceral fat levels below 13, indicating an excellent relationship between healthy BMI and low visceral fat. In contrast, individuals with a BMI ≥ 30 showed that all (100%) had visceral fat levels above 13, indicating that individuals with obesity tend to have high visceral fat.

The BMI 23.0 - 24.9 category showed 91.1% of respondents had visceral fat levels below 13, while the other 8.9% had increased. The BMI 25.0 - 29.9 category showed a larger proportion, with 60.7% of individuals having visceral fat levels ≥ 13, indicating significant visceral fat accumulation.

The highly significant p-value ($p < 0.05$) confirmed that there was a clear association between BMI and visceral fat levels. This suggests that good weight management, through controlling BMI, may contribute to reducing visceral fat and, in turn, reduce the risk of metabolic syndrome and other related diseases.

DISCUSSION

The characteristics of the research subjects described are based on gender and age, which can be seen in Table 1. This research was conducted on 224 research samples, including 63 males, with a percentage of 28.1%, and 161 other people were females, with a percentage of 71.9%. The age of the research sample was 56-65, with a total of 84 people and a percentage of 37.5%. The youngest subject is 17 years old, while the oldest is 79 years old. In Table 3, it can be seen that the population of RW 01 Cibeber who has a body weight above the normal value, has the highest presentation in obesity class II, as many as 37.5% totaling 84 people, and the smallest presentation is in obesity, I as many as 45 people with a percentage of 20.1%. The research sample had a normal BMI of 21.0% and totaled 47 respondents.

Based on Table 4, the population research sample in RW 01 Cibeber, Cimahi, is most obese is a female population, with a total of 65 people for obesity I and 40 people for obesity class II, with a percentage of 40.4% and 24.8 respectively %. In comparison, in the male population, there are at least 14 people with obesity class I condition, and there are 19 people with obesity class II with a respective percentage of 30.2% and 12.7%. The results of the data above are in line with the 2018 West Java Riskesdas data that obesity is

more common in Cimahi City compared to Bandung City, with a total percentage of 24.87% and 23.84%. The percentage of the population in Cimahi City based on gender is 33.09% female and 16.59% male (Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan, 2018).

Based on the results of research conducted in East Kalimantan in 2012, women have a 0.595% greater chance of being obese compared to men. This finding is in line with research conducted at Muhammadiyah University of East Kalimantan in 2015, which involved 90 samples. Of these samples, 57 women (63.3%) were obese, while 33 men (36.7%) were identified with similar conditions (Nugroho, 2020).

These statistics show that women tend to have more body fat than men. The main reason for this difference is that women have a higher percentage of body fat, which is related to the role of hormones in their bodies. The hormone estrogen in women contributes to the accumulation of fat in certain areas, such as the hips and thighs, which is a biological adaptation to support reproductive function.

In addition, the generally lower levels of physical activity in women compared to men also contribute to increased body fat. A less active lifestyle makes women more prone to weight gain, especially when calorie intake is not balanced with energy expenditure. Differences in diet and daily activity between the sexes can also affect body fat percentage and total body fat.

Gender becomes one of the factors recognized as a cause of obesity in H.L. Blum's theory, which states that biological, psychological and environmental factors contribute to the development of obesity (Hardisari & Koiriyah, 2019; Puspitasari, 2018; Susantiningsih, 2015). By understanding the factors that contribute to differences in obesity between women and men, obesity prevention and management interventions can be designed more effectively, targeting the specific needs of each gender.

Based on Table 5, the average BMI of RW 01 Cibeber community is 50.08, with the lowest BMI of 19.2 and the highest of 45.5. Table 5 shows that the research sample of RW 01 Cibeber Cimahi community with blood pressure conditions above normal is more than normal. The highest percentage was grade II hypertension (blood pressure >160 mmHg) 78 people (34.8%), Grade I hypertension (blood pressure 140-159 mmHg) 77 people (34.4%), Pre Hypertension (blood pressure 120-139 mm Hg) 47 people (21.0%). The results of this research are in line with research at the Rendang Bali Health Center in 2015 regarding the frequency of hypertension in the same research sample aged 17-75 years, showing results with grade I hypertension of 26 people (43.3%), Hypertension degree II 34 cases (56.7 %). The results of this research are also in line with research in Karanganyar Village, Kalianget District, Sumenep 2019, regarding the description of the blood pressure status of hypertensive respondents with 18 grade I hypertension (56.25%), 11 cases of grade II hypertension (34.38%). 118 This research is also in line with data based on the National Health and Nutrition Examination Survey (NHANES), which shows that hypertension occupies 87% of cases at the age of over 60 years. It is explained that 65% of people aged over 65 years suffer from hypertension, and research in Tanzania in 2013 shows the incidence of hypertension in older people (> 60 years) reached 69.9% of 2,223 elderly (Anbarasan, 2015).

Based on Table 6, the analysis of the research sample from RW 01 Cibeber, Cimahi shows that most of the individuals who experience hypertension are women. The breakdown of the number is 31 people in the pre-hypertension category, 55 people for grade I hypertension, and 59 people for grade II hypertension, with percentages reaching 66.0%, 71.4%, and 71.9%, respectively.

In comparison, in the male population, there were 31 people for pre-hypertension, 55 people for grade I hypertension, and 59 people for grade II hypertension, which received similar percentages of 66.0%, 71.4%, and 71.9%. Meanwhile, in the female population, there were 16 people for pre-hypertension, 22 people for grade I hypertension, and 19 people for grade II hypertension, with percentages of 34.0%, 28.6%, and 28.1%, respectively. This finding shows that the prevalence of hypertension is higher among women, especially in the more severe degrees of hypertension.

The results of this study are in line with a study conducted in Karanganyar Village, Kalianget Subdistrict,

Sumenep District in 2019, which also found that the majority of people with hypertension were women, with a total of 18 people (56.25%) (Suprayitno, 2019). This phenomenon shows a similar trend in various locations, indicating that hypertension can be a significant health issue for women.

Previous research conducted in North Sumatra also showed that the average woman aged 45 years had an increased risk of hypertension (Caroline, 2018). This can be related to hormonal changes that occur with age, especially in women who have not experienced menopause. Higher estrogen levels in young women can help increase levels of high-density lipoprotein (HDL) cholesterol, which plays a role in protecting heart health. However, after menopause, a decrease in estrogen levels can lead to changes in the lipid profile, where HDL cholesterol tends to decrease and low-density lipoprotein (LDL) cholesterol increases, potentially triggering atherosclerosis (Berawi & Agverianti, 2017; Caroline, 2018; Herdiani, 2019).

Based on the description in Table 7, it was found that 121 research samples, with a percentage of 54.0%, had normal visceral fat levels, and as many as 103 research samples (46.0%) had increased visceral fat levels. At the frequency based on sex, it was found that 25 male research samples (39.7%) had high levels of visceral fat (≥ 13), and in females, 78 research samples (48.4%) had high levels of visceral fat (≥ 13). The results of this research are in line with research in Pematangsiantar City, North Sumatra, in 2018, with a total sample of 52 people showing 26 people (50.0%) had high levels of visceral fat (≥ 13) and the results of research at Ohio State University, United States of America in 2016 stated that the accumulation of High levels of visceral fat (≥ 13) are more common in females than men. Factors that cause an increase in visceral fat levels in females are genetic factors and adipocyte tissue that contain large amounts of ALDH1A1 (Aldehyde Dehydrogenase 1), which will be proportional to the formation and storage of increased visceral fat in the body (Anjana et al., 2004; Wajchenberg, 2000)

The correlation between body mass index (BMI) and blood pressure was tested by bivariate analysis using chi-square to get a p-value of 0.023, where the p-value < 0.05, which indicates that there is a significant correlation between body mass index and blood pressure. This research is in line with research in the 2019 Gayungan Village, Surabaya City, where there is a significant correlation between BMI and hypertension. It is also in line with research conducted by Dr Moewardi Surakarta 2017 (Caroline, 2018). However, the results of this research are different from the research conducted in Samosir Village 2013 using the same research method, namely chi-square analysis showing that there is no significant correlation between nutritional status and the incidence of hypertension (p-value = 0.000 with p-value <0.05).128 Research conducted at the University of North Sumatra 2012 showed that there was a correlation (p-value 0.160, with p> 0.05) between an increase in BMI and an increase in blood pressure that the higher a person's BMI, the greater the likelihood of developing hypertension (Dien et al., 2020; Suprayitno, 2019).

According to previous studies, obesity is one of the causes of high blood pressure. When someone is fat, or in other words overweight, they need more blood to carry oxygen and nutrients to the body's tissues so that the volume of blood circulating through the blood vessels increases, and cardiac output also increases, and finally, blood pressure also increases (Frank et al., 2019; Goodpaster et al., 2005; Kinlen et al., 2018). Factors that often cause high blood pressure include heredity, personal characteristics and lifestyle. Lifestyle habits that often lead to high blood pressure include obesity or overeating (Ansari et al., 2020; Kinlen et al., 2018; Rachmawati et al., 2021). Many health studies are showing that there is a link between being overweight (obesity) and high blood pressure. Although the mechanism by which obesity causes high blood pressure is unclear, it has been shown that losing weight can lower blood pressure. Factors that influence the increase in blood pressure are food factors and weight factors. Obese people are more likely to have high blood pressure because arteries or veins are more likely to become blocked by atherosclerosis, causing blood pressure to increase (Caroline, 2018; Dien et al., 2020; Frank et al., 2019; Jensen et al., 2014; Kinlen et al., 2018; Suprayitno, 2019; Susantini, 2021).

Bivariate analysis conducted to test the correlation between body mass index (BMI) and visceral fat levels showed significant results. Based on the results of the analysis with the chi-square test, a p-value of 0.000 was

obtained, where this p-value is smaller than 0.05. This indicates that there is a significant correlation between BMI and visceral fat levels, which indicates that changes in BMI can have an impact on changes in visceral fat levels (Purwanti Susantini, 2021).

These results are in line with research conducted by Purwanti Susantini, who examined the relationship between BMI, percent body fat, and visceral fat in Semarang City (Susantini, 2021). The study used the Pearson correlation test, and the results showed that there was a significant relationship between BMI and visceral fat (p=0.000). BMI itself is calculated based on height and weight, so it is very relevant in determining visceral fat levels, which are part of the total body fat that can affect overall health.

Susantini's research showed that of the 21 respondents, 18.3% had a high visceral fat score, while 10 people (8.7%) had a very high score. This suggests that a portion of the population has a high risk of visceral fat, which could contribute to various health problems such as type 2 diabetes and heart disease. The significant association between BMI and visceral fat (p=0.000) reflects the importance of monitoring BMI as an early indicator of metabolic disease risk (Susantini, 2021).

In addition, research at the Faculty of Medicine, Diponegoro University (UNDIP) Semarang in 2014, using the Spearman rank correlation test, also found a significant positive relationship between BMI and visceral fat values ($p<0.05$, rho=0.912) (Archilona et al., 2016). This study showed that a strong correlation not only exists between BMI and visceral fat but is also influenced by other factors such as smoking habits.

BMI, as an indicator that shows a person's nutritional status, is the result of a calculation between height and weight, so visceral fat as a component of the body can also affect BMI. As body components increase, body proportions also increase, one of which is visceral fat because at least 45% of visceral fat contributes to body fat mass. Visceral fat itself is related to obesity, namely central obesity, which, when increased, will cause insulin resistance, which is the basis of metabolic syndrome disorders (Bixby et al., 2019; Wajchenberg, 2000). One of the symptoms of metabolic syndrome is insulin resistance, which triggers DM. Visceral fat will also affect the size of the abdominal circumference, so the higher the percentage of visceral fat, the higher the risk of experiencing central obesity (Anjana et al., 2004; Camhi et al., 2011). Visceral fat is an accumulation of intra-abdominal fat (central obesity), which is stored deeper under the skin than subcutaneous fat. The increased secretion of inflammatory mediators observed in visceral fat in obese individuals reflects ongoing chronic inflammation in adipose tissue in these individuals. Body weight, BMI, waist circumference, body fat, and visceral fat are significantly associated with insulin resistance (Anjana et al., 2004; Camhi et al., 2011).

CONCLUSION

This study included a total of 224 respondents, with the majority falling within the age group of 56-65 years. Of the total respondents, 28.1% were males, and 71.9% were females, indicating a higher proportion of female participants. The findings revealed a substantial prevalence of obesity, with 37.5% of the respondents classified as class II obese. Notably, females showed a greater vulnerability to obesity compared to their male counterparts, suggesting that gender may play a role in susceptibility to excessive weight gain. This trend is consistent with previous research that often points to hormonal, genetic, and lifestyle factors contributing to higher obesity rates in women, especially in older age groups.

In addition to obesity, the study also uncovered a concerning prevalence of hypertension among the respondents. Specifically, 34.8% of the participants were diagnosed with stage II hypertension, with the condition being more pronounced in older individuals, particularly females. This highlights a significant public health concern, as hypertension is a major risk factor for cardiovascular diseases, which are prevalent among aging populations. The higher prevalence of both obesity and hypertension among female respondents emphasizes the need for targeted interventions and preventive measures that focus on addressing these issues in women, especially in older age groups.

The study also measured visceral fat levels, with 46% of participants showing high levels of visceral fat (≥13). Visceral fat, which accumulates around internal organs, is known to increase the risk of several metabolic and cardiovascular complications. The findings suggest that females not only have higher rates of obesity and

hypertension but also tend to have higher levels of visceral fat, further compounding their risk of developing serious health conditions. This underscores the need for strategies aimed at reducing visceral fat through lifestyle modifications such as diet, physical activity, and medical interventions where necessary.

The analysis revealed a significant correlation between Body Mass Index (BMI) and blood pressure, as well as between BMI and visceral fat levels. Specifically, an increase in BMI was associated with higher blood pressure and greater accumulation of visceral fat, suggesting that excess body weight contributes directly to the exacerbation of cardiovascular risks. The relationship between BMI and these health outcomes points to the role of obesity in increasing cardiovascular strain, promoting insulin resistance, and contributing to the buildup of reactive oxygen species (ROS) and nitric oxide (NO) imbalances, all of which are linked to endothelial dysfunction. These findings align with existing research, which identifies obesity as a key driver of hypertension and metabolic syndrome.

Despite these significant findings, the study has several limitations that should be acknowledged. One of the primary limitations is the cross-sectional design, which limits the ability to establish causal relationships between the variables studied. Since data were collected at a single point in time, it is difficult to determine whether obesity directly causes hypertension or vice versa. Longitudinal studies, which follow participants over time, would be more effective in identifying the causal pathways between obesity, hypertension, and visceral fat accumulation. Additionally, the study relied on self-reported data for some variables, which may introduce bias. Participants may have underreported or overreported certain behaviors, such as dietary habits or physical activity, which could affect the accuracy of the results.

Future research should aim to address these limitations by incorporating longitudinal designs to understand better the temporal relationships between obesity, hypertension, and other metabolic risks. Moreover, expanding the study to include a more diverse population, both in terms of demographics and geographic location, would enhance the generalizability of the findings. A broader sample would provide a more comprehensive understanding of how obesity and hypertension affect different populations, including men, younger individuals, and those from various socioeconomic backgrounds.

In conclusion, this study highlights the strong correlation between BMI and blood pressure, as well as between BMI and visceral fat levels. The high prevalence of class II obesity (37.5%) and stage II hypertension (34.8%) among the respondents underscores the significant health risks associated with excess body weight, particularly among older adults. The findings also point to a particularly high burden of obesity and related conditions among females, with 46% of the participants showing high visceral fat levels. These results suggest that obesity exacerbates cardiovascular stress and contributes to metabolic complications, including insulin resistance and oxidative stress.

Given the significant health risks posed by obesity and hypertension, especially among older women, there is an urgent need for effective public health interventions. These interventions should focus on promoting healthier lifestyles, including regular physical activity, balanced diets, and weight management strategies, as well as providing education on the risks of hypertension and obesity. Health programs tailored to the needs of older adults and women may prove particularly effective in mitigating the growing burden of these conditions. Furthermore, the insights gained from this study provide valuable guidance for future research and policy efforts aimed at addressing the rising prevalence of obesity and hypertension in aging populations.

Ethical-Clearance

The authors, wish to declare that this research has ethically been cleared by the Ethical Clearance Team from *Fakultas Kedokteran, Universitas Jenderal Achmad Yani, with ethical clearance Number:* 010/UM1.01/2023.

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