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DETERMINANTS OF HYPERTENSION IN DIABETES PATIENTS IN RURAL INDONESIA: THE ROLE OF AGE AND BODY MASS INDEX

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ABSTRACT
Hypertension is a global health problem and a significant contributor to cardiovascular morbidity and mortality. In Indonesia, the prevalence of hypertension is increasing due to demographic and epidemiological changes. Multifactorial factors such as age, gender, body mass index, population density, and level of industrialization, this risk is especially seen in patients with Type 2 Diabetes Mellitus (T2DM). To assess demographic (age, gender), anthropometric (BMI), and environmental factors and their contribution to the prevalence of hypertension in patients in Gatak District, Sukoharjo Regency. A large-scale case-control study involving secondary data was conducted. Data were accessed from the Gatak Community Health Center management system (SIMPUS). The case group consisted of patients with T2DM and secondary hypertension. The control group consisted of patients who underwent routine check-ups (ICD-10: Z00) without hypertension and diabetes. Participants were selected through specific procedures and inclusion criteria were age 18 years and above and complete medical records, a total of 1,108 participants were analyzed using chi-square and t-test, followed by multivariate logistic regression. The majority of participants were women (65.2%), aged > 45 years (56.4%), and had normal body weight (63%). Multivariate analysis showed that age ⩾ 45 years significantly increased the risk of hypertension (p=0.000), and being overweight was also associated with an increased risk (p=0.000). However, gender, population density, and the presence of a manufacturing industry were not significantly associated with hypertension. The most significant predictors of hypertension were age and body mass index, while environment and gender were not associated.

Keywords: age; BMI; gender; hypertension; ICD 10; manufacture

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INTRODUCTION

Hypertension is a significant global public health problem and a major contributor to morbidity and mortality from cardiovascular disease (WHO, 2023). In Indonesia, data from the Basic Health Research (Riskesdas) shows a steadily increasing prevalence of hypertension, in line with the ongoing epidemiological and demographic transitions of non-communicable diseases (Kemenkes, 2018). Central Java Province, as one of the most densely populated regions, represents a complex dynamic where urbanization, industrialization, and lifestyle changes interact with a social order oriented towards traditional values. An example of this phenomenon would be the Gatak Community Health Center located in Sukoharjo Regency. It has one of the most interesting and variable landscapes which includes and extends to rural as well as industrial settings. This opens the opportunity to explore the various determining factors of hypertension. It is important to comprehend the complex interrelationship between the non-modifiable and modifiable factors as well as the population and industrial exposure to devise relevant public health interventions (Astutik et al., 2021; Choi et al., 2017; Rietveld et al., 1994; Sutriyawan et al., 2022; Tesfaye et al., 2007).

The research on high blood pressure for the Gatak district departs through different multivariate streams of risk factors. Age is an important predictor, as aging causes an increase in the hardening of the arteries and changes in the blood vessels which increases blood pressure (Benetos et al., 2019). Alongside other factors, gender also changes the risk of high blood pressure. Males are at high risk at younger ages, while females face the risk significantly after menopause, which implies the existence of hormonal and lifestyle differences (Everett & Zajacova, 2015). The main metabolic risk factor of high blood pressure is body mass index (BMI), which indicates the level of nutrition and body fat. Increased BMI, through different pathophysiological mechanisms such as the activation of the renin-angiotensin-aldosterone system, systemic inflammation, and high sympathetic nervous system activity, directly increases blood pressure (Hall et al., 2015).

These individual factors are embedded within a macro-level ecological and socioeconomic spectrum. Population density, as a proxy for urbanization, has significant impacts on lifestyles, including decreased physical activity due to changes in transportation and employment modes, a shift in dietary patterns toward highly processed foods high in sodium, and exposure to air pollution and noise (Huang et al., 2024). Industrialization in the manufacturing sector presents a unique set of occupational exposures, such as psychosocial stress due to job demands, chronic noise exposure, and shift work, all of which have been identified as independent risk factors for hypertension (Inoue et al., 2024). These factors do not operate in isolation but interact in a complex manner to mitigate hypertension risk at the individual and population levels (Astutik et al., 2021; Choi et al., 2017; Rietveld et al., 1994; Sutriyawan et al., 2022).

The population with T2DM, classified with ICD-10 code E11, has a higher predisposition to hypertension due to insulin resistance, endothelial dysfunction, and sodium retention (Jia et al., 2018). The comorbidity of diabetes and hypertension significantly increases the risk of macrovascular and microvascular complications, making it a significant clinical challenge (Petrie et al., 2018). This study aims to analyze and compare the influence of demographic (age, sex), anthropometric, and environmental (population density, exposure to manufacturing industry) risk factors on the incidence of hypertension in a population of diabetic patients, compared with a control population undergoing routine health checks (ICD-10 Z00). By utilizing large-scale secondary data from the Gatak Community Health Center Management Information System (SIMPUS), this study is expected to provide strong empirical evidence regarding the main determinants of hypertension in the context of a diabetic population and a dynamic environment.

METHOD

This study used a case-control design based on extensive data from other sources. This design was selected to examine the interaction between a group of risk factors and the development of hypertension in the target population. The case group included individuals with T2DM (ICD-10 code: E11) with hypertension as a secondary diagnosis. The control group consisted of patients undergoing routine examination (ICD-10 code: Z00) without a history of high blood pressure or T2DM. We retrieved the data from the management system of the Gatak Community Health Center (Puskesmas). The system (SIMPUS) contributes to strong statistical power for the analysis of large datasets. The study group was selected from this population through a specific sampling procedure, with the main selection requirements being that participants must be over 18 years of age and have complete medical records. Patients with incomplete data were excluded from the analysis.

The dependent variable in this study was hypertension status, which was classified as binary (control). Independent variables included demographic, anthropometric, and environmental factors. Data on age (years), gender (male/female), and weight and height were taken directly from patient medical records. Body Mass Index (BMI) was calculated as a numeric variable (kg/m^2). Environmental variables were generated based on the patient's residential address. Data on population density (persons/km^2) and the number of manufacturing industries per village/sub-district were obtained from the official publication of the Central Statistics Agency (BPS) of

Sukoharjo Regency for the respective year. All raw data from SIMPUS were then cleaned, geocoded, and integrated into a final dataset for analysis.

The Chi-square test was used on categorical variables, then an independent t-test or Mann-Whitney U-test was applied to the numbers, based on how normally distributed the data were. The strength of the association in this phase was adjusted using odds ratios (ORs) and 95% confidence intervals. The second phase was a multivariate analysis using a multiple logistic regression model. Variables were also included in the model because they were significant in the bivariate regression analysis. These variables were confounding variables and identified as independent predictors (McHugh, 2009; Thompson & Zeni, 2011). According to the analysis results, the outcome is described as having ORs with 95% confidence intervals, which describes the actual relation of the risk factors and outcomes (Ali et al., 2018; McNutt, 2003; Tchetgen Tchetgen, 2013).

It is the substantial boundedness of the statistical model which requires the most attention. For example, the Hosmer-Lemeshow Goodness-of-Fit test assesses the logistic regression model and Ali et al. (2018) and Sarkar and Midi (2010) argue that p-values greater than 0.05 are considered as positive data fits to the model (Ali et al., 2018; Sarkar & Midi, 2010). A model is said to have Nagelkerke R-squared, the independent variable, freedom, is set and the model is then predicted. This shows in what proportion the independent variables being analyzed explain the variation in the status of hypertension (Gómez-Benito et al., 2009; Lumley, 2017). As the full set of procedures, the relevant ethics boards have approved, which includes anonymising and securely storing the patient information to protect the subject's privacy (Agrawal et al., 2008; Pristianty et al., 2023; Rietveld et al., 1994).

RESULT

Based on the participant profile of the survey, which included 1,108 respondents, the average demographic of the sample was women aged 45 years and above. Most participants (80.3%) lived in areas classified as having a very low population density (less than 3,230 people/km²). In terms of health, most respondents (63.0%) were classified as normoweight. Furthermore, a very large majority (79.7%) of participants lived in areas without secondary (manufacturing) industries. This indicates that the sample population largely resided in non-industrialized areas.

Tabel 1.
Characteristics of research participants (n= 1108)

Variable	Attribute	f	%
Age	< 45yo	483	43.6
	45yo ++	625	56.4
Population density	< 3230/Km^2	890	80.3
	3230/Km^2 ++	218	19.7
Gender	Woman	722	65.2
	Man	386	34.8
BMI	Normoweight	698	63.0
	Overweight	410	37.0
Manufacture	< 2	883	79.7
	2++	225	20.3

The results of the analysis showed that age is a significant risk factor for hypertension, where in the age group <45 years most respondents were in the normotensive category (88.0%) and only 12.0% were hypertensive, while at the age of ≥45 years the proportion of hypertension increased to 42.7% with OR = 5.465; p = 0.000 and aOR = 5.417; p = 0.000. Population density factors were not significantly related to hypertension because in areas <3230/km² the proportion of hypertension was 28.5% and in ≥3230/km² it was 32.6%, with the results of OR = 1.209; p = 0.242 and aOR = 0.973; p = 0.879. Similarly, gender did not show a significant relationship, where hypertension in women was recorded at 28.5% and in men 30.8%, with OR = 1.116; p = 0.424 and aOR = 1.137; p = 0.386. In contrast, body mass index was shown to be a significant risk factor, where the prevalence of hypertension in the overweight group reached 36.6% compared to normoweight at 25.1%, with OR = 1.724; p = 0.000 and aOR = 1.670; p = 0.000. Meanwhile, the variable of manufacturing presence

was not significantly related because the prevalence of hypertension was relatively the same in areas with a score of <2 (29.7%) and ≥2 (28.0%), with OR = 0.922; p = 0.623 and aOR = 0.972; p = 0.878.

Tabel 2.
Bivariate and Multivariate analysis of risk factors for hypertension (n=1108)

Blood Pressure				Bivariate analysis		Multivariate analysis	
Variable	Attributes	Normo Tension (n=) Σ (%)	Hypertension (n=) Σ (%)	OR	P	aOR†	p
Age	< 45 yo	425 (88.0)	58 (12.0)	5.465	0.000	5.417	0.000
	45 yo ++	358 (57,3)	267 (42.7)				
Population density	< 3230/km2	636 (71.5)	254 (28.5)	1.209	0.242	0.973	0.879
	3230/km2 ++	147 (67.4)	71(32.6)				
Gender	woman	516 (71.5)	206 (28.5)	1.116	0.424	1.137	0.386
	man	267 (74.9)	119 (30.8)				
BMI	normoweight	523 (74.9)	175 (25.1)	1.724	0.000	1.670	0.000
	overweight	260 (63.4)	150 (36.6)				
Manufacture	< 2	621(70.3)	262 (29.7)	0.922	0.623	0.972	0.878
	2 ++	162 (72.0)	63(28.0)				

The Hosmer and Lemeshow test yielded a result of p = 0.154 (p > 0.05), indicating a good model fit, so that the predicted model results do not differ significantly from the observed data results (Archer & Lemeshow, 2006; Fagerland & Hosmer, 2012; Nattino et al., 2020). However, the Nagelkerke R-squared value of 0.177 indicates that the model can explain 17.7% of the variation in the dependent variable under study (Fagerland & Hosmer, 2012; Li et al., 2017).

DISCUSSION

Age and Prevalence of Hypertension

The prevalence of hypertension shows a significant increase with age, especially after individuals reach 45 years of age. This increase is evidenced by the increasingly high odds ratio in each subsequent age group, with the elderly being the population at highest risk (Karlen et al., 2023; Nugroho et al., 2020; Sutriyawan et al., 2022). Hypertension can also be found in young adults (26–35 years), although the prevalence is relatively lower at around 4.1%. It should be noted that the prevalence of hypertension in the younger population is associated with multiple risk factors, such as obesity, diabetes, and mental health disorders (Putri et al., 2025). Furthermore, the increasing risk of hypertension with age is certainly related to the interaction with comorbidities that are typical of older adults. Given these findings, it is concluded that although age itself is a constant parameter, the differences in trends between young and older groups are related to the number of risk factors.

Modifiable risk factors significantly amplify the influence of age on high blood pressure. Stress plays a significant role in the relationship between age and high blood pressure. Older adults who experience high levels of stress have up to a 4.2-fold higher risk (Eka et al., 2022; Sutriyawan et al., 2022). Stress increases the risk of high blood pressure in older adults by activating the sympathetic nervous system and RAAS, leading to blood vessel constriction and fluid retention, and by overactivating the HPA axis, leading to long-term elevations in cortisol (Gideon et al., 2020; Kim & Thiruvengadam, 2024). Inflammation and narrowed blood vessels further complicate blood pressure control in adults (Gideon et al., 2020; Kim & Thiruvengadam, 2024).

Furthermore, excessive sodium intake is a major factor that increases the risk of high blood pressure. Studies show that agricultural workers and the elderly are five times more likely to experience excessive sodium intake (Astuti et al., 2024; Sutriyawan et al., 2022). Excessive sodium intake increases the amount of extracellular fluid and its outflow to the heart. This activates the rennin-angiotensin-aldosterone system and increases vascular resistance, resulting in added burden on the heart (Bailey & Dhaun, 2024). Both as individual risk factors and in combination, physical inactivity and excess weight increase the risk of high blood pressure, especially in older age (Purba

et al., 2019; Sutriyawan et al., 2022). Physical inactivity increases the risk of high blood pressure by lowering sympathetic nervous system activity, insulin sensitivity, and oxidative stress as well as inflammation, and by increasing inflammation. These factors lead to impaired blood vessel function and increased vascular resistance (Clayton et al., 2023).

Psychosocial stress in itself is a risk factor which aggravates the hypertension that comes with increasing age (Istiana, 2019; Sutriyawan et al., 2022). Therapies nonadherence and clinical outcomes for depressed elderly patients are usually much worse (Yogisutanti & Suhat, 2025). Individuals in this age group are at risk of developing hypertension and psychosocial stress, which group therapy and stress management have been effective in treating, is a risk factor for this (Rohmana et al., 2021). Considering all above, the risk of hypertension is largely age dependent in the elderly; age is the non modifiable risk factor, while the other risks are modifiable. Stress and salt are the main and most direct targets for hypertension prevention and treatment in the elderly (Eka et al., 2022; Karlen et al., 2023; Suprapti et al., 2023; Sutriyawan et al., 2022)

Population Density and Hypertension

Astutik et. Al. (2021) has conducted an analysis which indicates that there is a significantly higher concentration of urban dwelling elderly women with high blood pressure. The authors of the study point out a troubling deficit in the literature. Specifically, there is a gap in the study where the prevalence of hypertension and where the women in the countryside is lower at 27.8% compared to the 37.25% hypertension prevalence of women located in the urban areas. Such studies indicate that urban migration, regardless the socioeconomic status of the individual, is a health detriment for the migrant. One explanation of the urban health disadvantage is the population is unable to maintain a properly balanced diet. The combination of a diet consisting primarily of calorie dense foods, a lack of physical activity (due to the difficulty in urban sprawl traffic) and high levels of pollution greatly endangers health. These studies suggest that migration to urban settings is associated with lifestyle and behavioral changes with regard to hypertension, more so for the older population (Astutik et al., 2021). The result of this is that women residing in these areas tend to have increased blood pressure which indicates that health policies aimed at promoting supportive lifestyle changes are insufficient. The growing disease burden for people living beyond the city given new intricacies like a swiftly increasing aging population, clouded barriers to healthcare, absence of health education, and other such factors is acute. As alarming as it may sound, chronic conditions, especially hypertension, are shockingly widespread among the elderly population in the rural areas (Mulia & Prajitno, 2020). Without a tiered approach to healthcare, ineffective pathways and the growing population are all particularly of concern because the aging process inevitably happens to everyone. Aging cycles lead to decline in organ functional ability, decreased elasticity of arterial and organ, and diminishing organ capacity.(Ng et al., 2006). Individuals have displayed with age an increasing number of intricate details as to the above conditions. This translates to a much higher level of organ dysfunction and hypertension. The cited studies, particularly the first, demonstrate the rural areas is the region where the greatest lack of hypertension treatment is available. Having said that, it is said hypertension treatment, once started, goes on an unlimited escalatory course and is lack the contrary to the rural areas where treatment is the most needed (Mulia & Prajitno, 2020; Ng et al., 2006).

Access levels is an important issue of why patients are non adherent to therapy and antihypertensive medication. Adherence is better the closer one lives to the health center. People in the far zone, especially with mobility constraints, are worse off than those near a health center and face more difficulties in accessing and monitoring blood pressure and therapy adherence (R. Rahmawati & Bajorek, 2018a). The removal of mobility barriers to health services, coupled with evidenced based education, is vital to improve hypertension control (R. Rahmawati & Bajorek, 2018b; Yunus, 2025).

Increasing with age, in remote areas, hypertension is found in approximately 15% to 30% of the total population. This is well known, and documented all over the world. It is said that as one gets older, their blood vessels stiffen, decreasing elasticity (Agrawal et al., 2008). Those vessels become more difficult, and require more effort from the heart to pump blood through. There is a variety of

factors that influence blood pressure. Beyond age, as one region of the country more developed than others, certain social conditions greatly affect the spread of hypertension. Such factors include lack of medical attention, poor education, and lack of understanding of the urgency for taking action in hypertension (Agrawal et al., 2008). Citizens in the unexamined category, as well as those in the untreatable category, come from the lower region of the country, where proper medical attention and care is highly lacking. This dramatically increases the chances for cardiovascular diseases as well as premature death.

Feedback given to and trained with health professionals in the support and education of the community in the management of hypertension in rural areas has been shown to be beneficial. These programs tend to start with surveys and interviews to understand community needs, the provision of professional community-based programs, and the establishment of local support groups for blood pressure monitoring. Participants of this outreach, that encompasses presentations and discourse with an aim of advancing community knowledge on hypertension, blood pressure self-monitoring, and medication adherence at the population level, are provided with educational materials such as brochures and explained and pictorial posters (R. Rahmawati & Bajorek, 2015). The integration of health professionals, such as practitioner health monitors, to assist local health systems, have been trained in the skills of measuring, recording and analyzing blood pressure (Salazar et al., 2005). More practitioner health monitors are needed to accomplish this (R. Rahmawati & Bajorek, 2015). Reports have shown that the community, knowledge, attitude and practice changes have been made positive in terms of hypertension management together with the increase in blood pressure and medication adherence (Salazar et al., 2005).

The Gender Difference in Hypertension

It's demonstrated that it occurs at a younger age with men more than it does with women. Above the age of sixty men also manage the condition much more effectively than women. The situation with women is different. She has a much greater decline in control rates for the age group when compared to men (Antonicelli et al., 2000; Choi et al., 2017; Dorobantu et al., 2021; Yeo et al., 2024). Authored studies have characterized it with greater prevalence in postmenopausal women older than 50 years of age. The high number of reported cases may be associated with decreased control rates due to side effects of therapy and poor adherence. Collected data indicate that women, especially those who are older or have comorbidities, are at higher risk of experiencing side effects.

The higher risk of side effects in women leads to lower disease control, despite the greater awareness and therapeutic treatment women receive compared to men (Andala et al., 2024; Setiati & Sutrisna, 2005; Suprapti et al., 2023). Moreover, several factors, such as medication adherence and medication use, also influence disease control. According to (R. Rahmawati & Bajorek, 2015; Widayani et al., 2024), medication adherence is influenced by knowledge, acceptance, and perceived benefits. The more knowledgeable patients are about their disease, the more they adhere to their medication because they are aware of the consequences. Other factors, such as acceptance of the therapy, must first be experienced by the patient so that they can feel the benefits of the therapy. The existence of pharmacist-supported programs and simple regimens can help patients improve their medication adherence by being consistent in taking their medication. This is because pharmacists support them indirectly by providing information, counseling, and periodic monitoring, as well as identifying problems with medication administration. Moreover, simple treatment regimens can simplify the treatment process for patients.

Pharmacist-based programs and their simplified regimens aim to help patients, particularly in rural Java, who still strongly prefer traditional medicine, use their medications correctly. In fact, many rural residents still prefer traditional medicines over conventional ones. Some even use the technique of mixing medicines before taking them (Basuki et al., 2004; N. Rahmawati et al., 2021; R. Rahmawati & Bajorek, 2016). Drug substitution and mixing practices are influenced by several factors, such as culture, availability, cost, and inherited beliefs. Local culture and inherited beliefs play a significant role in influencing adherence levels. Rural families often adhere to patriarchal

practices, which often hinder women's adherence to treatment, as health decisions can be influenced by male family members (Puspitasari et al., 2022; Widyakusuma et al., 2023). Furthermore, rural communities are still afraid of modern developments and therefore still prefer to use traditional medicines. They believe that drugs can cause dependence (Pristianty et al., 2023; R. Rahmawati & Bajorek, 2016)

Correlation of BMI and Hypertension

Body mass index (BMI) is an anthropometric measure that has a significant and consistent association with an increased risk of hypertension. Epidemiological evidence shows that an increase in BMI correlates with a 7.64-fold increased risk of hypertension. This shows that individuals with a high BMI, such as those who are overweight or obese, have an almost eight times higher risk than individuals with a normal BMI (Tesfaye et al., 2007). This relationship is consistent and persistent: for every 1 kg/m² increase in BMI, systolic blood pressure increases by approximately 1.6 mmHg (Yusni et al., 2024). Explanations for this relationship range from stimulation of the renin-angiotensin-aldosterone system, increased insulin resistance, abnormalities of the blood vessel wall, and increased sympathetic nervous system activity. All of these factors contribute to elevated blood pressure.

Other signs to measure Class one Obesity having a BMI between 30 to 35 threshold is also abdominal golden ratio also assessed based on waist circumference. Over the years and stronger and weaker, almost open and closer and, free fatty acids. Such as bolus type, starker and starker in what is strong, blood free fatty acids weak fat tissue. Clinically, and more is over the waist circumference is waist more than the other indicators central Blood pressure Waist is one of the central Both blood pressure BMI is body waist circumference and Cardiovascular Metabolic high blood pressure is BMI and others. Doom of fat waist circumference central as compared and more. Chronic baseline, and other blood pressure and the measure is taken with an ounce.Solely including Body Mass Index (BMI) & waist circumference among other factors is Body Mass Index (BMI) & waist NCC circumference among other factors is waist circumference is still waist circumference is still waist circumference is still considered the most accurate predictors of high blood pressure risks especially in women. Excess visceral fat is capable of liberating free fatty acids and inflammatory factors which provoke and maintain inflammatory and oxidate stress related chronic diseases. This diminishes blood vessels and provokes high blood pressure (Dewi et al., 2019). Several studies prove waist circumference is more accurate than BMI predicting the risks of cardiovascular and other metabolic diseases and hypertension because it directly measures fat considered lethal of the body (Tuan et al., 2009). Hence, in clinical medicine intertwined with epidemiology and in the realm of public health practice This can aid in identifying target at-risk population and enhance hypertension control strategies tailored to these individuals. Urban residents face obesity as a consequence of not meeting energy intake and energy expenditure equilibrium as noted by Aizawa (2018). City residents do not practice good nutrition due to low socio-economic status and do not bother to buy healthy food. The higher spending on ultra-processed food that is high in carbohydrate, fat and sugar is a predictor of obesity and urban hypertension in developing countries (Baliwati et al., 2025; Evans, 1990).

The Effect of Industrialization on Hypertension

A direct correlation between the number of manufacturing industries in a region, such as Gatak, and the prevalence of hypertension has not been specifically documented in epidemiological studies. Indirect evidence strongly suggests that the industrialization process creates an environment conducive to the development of hypertension. Industrialization basically magnifies the workplace stressors that have been identified as important risk factors for hypertension (Karlen et al., 2023; Sutriyawan et al., 2022; Wilujeng et al., 2023; Wirayudha et al., 2024). The link further gains strength upon observation of the complex interrelationship between psychosocial stress, workplace condition factors, and lifestyle factors on an individual level.

The amount of psychosocial stress that industrial workers may experience has a direct correlation to their likelihood of developing hypertension. Demonstrate that industrial workers who operated under stress experienced hypertension six times more than their lower-stress counterparts (Rengganis et al., 2020). Psychosocial stress can be caused by oppressive workloads, high ambient temperatures, or a lack of support and encouragement from peers and superiors (Cristenzein & Adhi, 2021; Putra et al., 2021). Astuti et al. (2024) and Saputri et al. (2020) describe how high ambient temperatures can induce dehydration, and coupled with excessive sweating and increased strain on the cardiovascular system, can precipitate short- and long-term high blood pressure.

The aforementioned factors, in conjunction with the lifestyle choices a person makes, can lead to higher levels of stress and are more likely to contribute to hypertension. Smoking, physical inactivity, and a diet high in salt and fat designed to relieve tension and the psychosocial aspects of work tend to be counterproductive and worsen the overall condition. Analysis of work stress factors, both qualitative (e.g., role conflict) and quantitative (e.g., long working hours), shows a 4- to 7-fold increased risk of hypertension (Krisnawati et al., 2006). Heat stress in a factory environment can increase physiological burden and raise blood pressure (Ridwan et al., 2023; Rinawati et al., 2019). Comparisons between manufacturing and non-manufacturing workers consistently show that the unique occupational exposures in industrial environments place manufacturing workers at a higher risk category (Istiana, 2019; Ramachandran et al., 2022; Ridwan et al., 2023).

The limitations of direct epidemiological data do not negate the validity of the industrial work environment as a significant determinant of health. Existing scientific evidence collectively confirms that the work environment in the manufacturing sector is a substantial and, in principle, modifiable risk factor for hypertension. Interventions working on managing work stress, enhancing environmental ergonomics as well as healthy lifestyle promotions reduce this risk considerably (Krisnawati et al., 2006; Putra et al., 2021; Rengganis et al., 2020).

Practical Implications

Community-based volunteer activities in rural areas are highly effective in spreading information about high blood pressure and its treatment. The members of the community are responsive to the volunteered training on physical activity, stress management, and salt intake reduction (R. Rahmawati & Bajorek, 2015). In the community they serve, volunteers actively support treatment adherence and long-term management by monitoring blood pressure, medication intake, and offering psychosocial support. Organized programs at the workplace seen to encompass stress management, reduction of workloads, and the encouragement of healthy behaviors go a long way in minimizing the high blood pressure risks linked to prolonged sitting and high-pressure occupations (Salazar et al., 2005). There is an increased productivity and a reduction in work related hypertension cases. These programs greatly depend on the understanding of cultural differences. According to R. Rahmawati & Bajorek (2015), the acceptability and effectiveness of the treatment increases when traditional medicine is complemented with evidence-based medicine and local cultural beliefs and gender perspectives are taken into account. Moreover, the use of Body Mass Index (BMI) guidelines appropriate for the Asia-Pacific region helps to better assess risk among the Indonesian population due to the low body composition and metabolic response compared to Western countries (Mulyasari et al., 2023). This approach allows for much earlier identification of subjects at risk and more tailored interventions.

CONCLUSION

Age and Body Mass Index (BMI) are factors that can be used to predict high blood pressure. People over 45 have a five fold risk of high blood pressure compared to those under 45. Overweight people have 1.7 fold risk of high blood pressure compared to people of normal weight. Gender, population density, and living near a factory were not significantly associated with high blood pressure. This suggests that the prevention of high blood pressure should be aimed at older adults and overweight people by encouraging more healthy living and better detection programs.

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REFERENCES

Agrawal, V. K., Bhalwar, R., & Basannar, D. R. (2008). Prevalence and determinants of hypertension in a rural community. Medical Journal Armed Forces India, 64(1), 21–25. https://doi.org/10.1016/S0377-1237(08)80139-6

Aizawa, T. (2018). Regional Disparity in the Body Mass Index Distribution of Indonesians: New Evidence Beyond The Mean. Bulletin of Indonesian Economic Studies, 54(1), 85–112. https://doi.org/10.1080/00074918.2017.1406596

Ali, Z., Adam, F., & Baharum, A. (2018). Modeling quality of life of end stage renal disease patients in Kelantan using binary logistic regression. 020030. https://doi.org/10.1063/1.5041561

Andala, S., Sofyan, H., & Hasballah, K. (2024). Knowledge and acceptance associated with medication adherence among hypertension individuals in Aceh province, Indonesia. Heliyon, 10(7). https://doi.org/10.1016/j.heliyon.2024.e29303

Antonicelli, R., Gesuita, R., & Paciaroni, E. (2000). Sexual dimorphism in arterial hypertension: An age-related phenomenon. Archives of Gerontology and Geriatrics, 29(3), 283–289. https://doi.org/10.1016/S0167-4943(99)00041-2

Archer, K. J., & Lemeshow, S. (2006). Goodness-of-fit Test for a Logistic Regression Model Fitted using Survey Sample Data. The Stata Journal: Promoting Communications on Statistics and Stata, 6(1), 97–105. https://doi.org/10.1177/1536867X0600600106

Astuti, I. S. W., Raharjo, A. M., Hakiim, A., Nurmaida, E., & Oktadianto, L. (2024). Identification of Risk Factors for the High Prevalence of Hypertension Among Farm Workers in the Agro Industry Area Jember. Malaysian Journal of Medicine and Health Sciences, 20, 176–180. https://doi.org/10.47836/mjmhs.20.s9.29

Astutik, E., Farapti, F., Tama, T. D., & Puspikawati, S. I. (2021). Differences risk factors for hypertension among elderly woman in rural and urban Indonesia. Yale Journal of Biology and Medicine, 94(3), 407–415. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85117202622&partnerID=40&md5=c069ff62e7747b7a67c85fac75c5bee0

Bailey, M. A., & Dhaun, N. (2024). Salt Sensitivity: Causes, Consequences, and Recent Advances. Hypertension, 81(3), 476–489. https://doi.org/10.1161/HYPERTENSIONAHA.123.17959

Baliwati, Y. F., Laely, P. N., & Rusyda, A. L. (2025). A SEM-PLS ANALYSIS OF HYPERTENSION DETERMINANTS IN WEST JAVA, INDONESIA: SOCIO-ECOLOGICAL MODEL APPROACHES. Media Gizi Indonesia, 20(2), 211–222. https://doi.org/10.20473/mgi.v20i2.211-222

Basuki, B., Siagian, M., Ilyas, E. I., & Amri, Z. (2004). Combined traditional medicine and pharmacological antihypertensive drugs in a rural community of West Java, Indonesia. Medical Journal of Indonesia, 13(4), 246–251. https://doi.org/10.13181/mji.v13i4.160

Benetos, A., Petrovic, M., & Strandberg, T. (2019). Hypertension Management in Older and Frail Older Patients. Circulation Research, 124(7), 1045–1060. https://doi.org/10.1161/CIRCRESAHA.118.313236

Choi, H. M., Kim, H. C., & Kang, D. R. (2017). Sex differences in hypertension prevalence and control: Analysis of the 2010-2014 Korea national health and nutrition examination survey. PLoS ONE, 12(5). https://doi.org/10.1371/journal.pone.0178334

Clayton, T. L., Fitch, A., & Bays, H. E. (2023). Obesity and hypertension: Obesity medicine association (OMA) clinical practice statement (CPS) 2023. Obesity Pillars, 8, 100083. https://doi.org/10.1016/j.obpill.2023.100083

Cristenzein, L. R., & Adhi, K. T. (2021). Factors Related to Work Stress among Health Office Employees during Covid-19 Pandemic. Indonesian Journal of Occupational Safety and Health, 10(3), 389–401. https://doi.org/10.20473/ijosh.v10i3.2021.389-401

Dewi, R., Ramayati, R., Rosdiana, N., Ramayani, O. R., Siregar, R., & Siregar, B. (2019). Waist circumference, body mass index, and skinfold thickness as potential risk factors for high blood pressure in adolescents. Paediatrica Indonesiana(Paediatrica Indonesiana), 59(2), 79–86. https://doi.org/10.14238/pi59.2.2019.79-86

Dorobantu, M., Gheorghe-Fronea, O.-F., Scafa-Udriste, A., Onciul, S., Pop, C., Dorobantu, L., & Darabont, R. (2021). Gender disparities in the prevalence, awareness, treatment, and control of high blood pressure. Current Pharmaceutical Design, 27(29), 3173–3179. https://doi.org/10.2174/1381612827666210125154749

Eka, N. G. A., Florensa, M. V. A., & Pakpahan, M. (2022). Stress associated with hypertension in middle-age and elderly in Binong, Tangerang. Bali Medical Journal, 11(2), 547–550. https://doi.org/10.15562/bmj.v11i2.3356

Evans, J. (1990). The economic status of older men and women in the Javanese household and the influence of this upon their nutritional level. Journal of Cross-Cultural Gerontology, 5(3), 217–242. https://doi.org/10.1007/BF00117000

Everett, B., & Zajacova, A. (2015). Gender Differences in Hypertension and Hypertension Awareness Among Young Adults. Biodemography and Social Biology, 61(1), 1–17. https://doi.org/10.1080/19485565.2014.929488

Fagerland, M. W., & Hosmer, D. W. (2012). A Generalized Hosmer–Lemeshow Goodness-of-Fit Test for Multinomial Logistic Regression Models. The Stata Journal: Promoting Communications on Statistics and Stata, 12(3), 447–453. https://doi.org/10.1177/1536867X1201200307

Gideon, A., Sauter, C., Fieres, J., Berger, T., Renner, B., & Wirtz, P. H. (2020). Kinetics and Interrelations of the Renin Aldosterone Response to Acute Psychosocial Stress: A Neglected Stress System. The Journal of Clinical Endocrinology & Metabolism, 105(3), e762–e773. https://doi.org/10.1210/clinem/dgz190

Gómez-Benito, J., Hidalgo, M. D., & Padilla, J.-L. (2009). Efficacy of Effect Size Measures in Logistic Regression. Methodology, 5(1), 18–25. https://doi.org/10.1027/1614-2241.5.1.18

Hall, J. E., do Carmo, J. M., da Silva, A. A., Wang, Z., & Hall, M. E. (2015). Obesity-Induced Hypertension. Circulation Research, 116(6), 991–1006. https://doi.org/10.1161/CIRCRESAHA.116.305697

Huang, X., Wang, Z., Lei, F., Liu, W., Lin, L., Sun, T., Cao, Y., Zhang, X., Cai, J., & Li, H. (2024). Association of urban environments with Atherosclerotic cardiovascular disease: A prospective cohort study in the UK Biobank. Environment International, 193, 109110. https://doi.org/10.1016/j.envint.2024.109110

Inoue, Y., Yazawa, A., Muto, S., Odagiri, Y., Miyake, H., Tobayama, M., & Mizoue, T. (2024). Association between workplace social capital and systolic blood pressure among 23 173 workers at 367 small-sized and medium-sized enterprises in Japan: a cross-sectional study. BMJ Open, 14(1), e074125. https://doi.org/10.1136/bmjopen-2023-074125

Istiana, M. (2019). The effect of psychosocial stress on the incidence of hypertension in rural and urban communities. Media Kesehatan Masyarakat Indonesia, 15(4), 408–417. https://doi.org/10.30597/mkmi.v15i4.7988

Jia, G., Whaley-Connell, A., & Sowers, J. R. (2018). Diabetic cardiomyopathy: a hyperglycaemia- and insulin-resistance-induced heart disease. Diabetologia, 61(1), 21–28. https://doi.org/10.1007/s00125-017-4390-4

Karlen, J., Berbudi, A., & Wahyudi, K. (2023). Determinant of Hypertension among Adults in West Java, Indonesia: Analysis of National Basic Health Research Data 2018. Althea Medical Journal, 10(4), 214–220. https://doi.org/10.15850/amj.v10n4.2826

Kemenkes. (2018). Laporan Riskesdas 2018 Nasional.pdf. In Lembaga Penerbit Balitbangkes (p. hal 156).

Kim, J. H., & Thiruvengadam, R. (2024). Hypertension in an ageing population: Diagnosis, mechanisms, collateral health risks, treatments, and clinical challenges. Ageing Research Reviews, 98, 102344. https://doi.org/10.1016/j.arr.2024.102344

Krisnawati, F., Basuki, B., & Nainggolan, G. (2006). Job stressors and other risk factors related to the risk of hypertension among selected employees in Jakarta. Medical Journal of Indonesia, 15(3), 177–184. https://doi.org/10.13181/mji.v15i3.236

Li, J., Lian, H., & Jing, L. (2017). Quantitative analysis on the influencing factors of public service equalization level based on logistic regression model. Boletin Tecnico/Technical Bulletin, 55, 112–120.

Lumley, T. (2017). Pseudo- R 2 statistics under complex sampling. Australian & New Zealand Journal of Statistics, 59(2), 187–194. https://doi.org/10.1111/anzs.12187

McHugh, M. (2009). The odds ratio: calculation, usage, and interpretation. Biochemia Medica, 120–126. https://doi.org/10.11613/BM.2009.011

McNutt, L.-A. (2003). Estimating the Relative Risk in Cohort Studies and Clinical Trials of Common Outcomes. American Journal of Epidemiology, 157(10), 940–943. https://doi.org/10.1093/aje/kwg074

Mulia, E. P. B., & Prajitno, S. (2020). Neglected Cases of Hypertension in Rural Indonesia: A Cross-Sectional Study of Prevalence and Risk Factors on Adult Population. IOP Conference Series: Earth and Environmental Science, 441(1). https://doi.org/10.1088/1755-1315/441/1/012167

Mulyasari, I., Afiatna, P., Maryanto, S., & Aryani, A. N. (2023). Body Mass Index as Hypertension Predictor: Comparison between World Health Organization and Asia-Pacific Standard. Amerta Nutrition, 7(2SP), 247–251. https://doi.org/10.20473/amnt.v7i2SP.2023.247-251

Nattino, G., Pennell, M. L., & Lemeshow, S. (2020). Assessing the goodness of fit of logistic regression models in large samples: A modification of the Hosmer ‐ Lemeshow test. Biometrics, 76(2), 549 ‐ 560. https://doi.org/10.1111/biom.13249

Ng, N., Stenlund, H., Bonita, R., Hakimi, M., Wall, S., & Weinehall, L. (2006). Preventable risk factors for noncommunicable diseases in rural Indonesia: Prevalence study using WHO STEPS approach. Bulletin of the World Health Organization, 84(4), 305–313. https://doi.org/10.2471/BLT.05.023721

Nugroho, P. S., Wijayanti, A. C., Sunarti, S., Suprayitno, & Sudirman. (2020). Obesity and its risk factors among adolescent in Indonesia. Malaysian Journal of Medicine and Health Sciences, 16(2), 173–179.

Petrie, J. R., Guzik, T. J., & Touyz, R. M. (2018). Diabetes, Hypertension, and Cardiovascular Disease: Clinical Insights and Vascular Mechanisms. Canadian Journal of Cardiology, 34(5), 575–584. https://doi.org/10.1016/j.cjca.2017.12.005

Pristianty, L., Priyandani, Y., & Rahem, A. (2023). The correlation between knowledge, attitude and family support on compliance of outpatients with hypertension in a healthcare centre in Indonesia. Pharmacy Education, 23(2), 25–30. https://doi.org/10.46542/pe.2023.232.2530

Purba, E. N., Santosa, H., & Siregar, F. A. (2019). The relationship of physical activity and obesity with the incidence of hypertension in adults aged 26-45 years in Medan. Open Access Macedonian Journal of Medical Sciences, 7(20), 3464–3468. https://doi.org/10.3889/oamjms.2019.447

Puspitasari, I. M., Azizah, L. N., Sinuraya, R. K., Alfian, S. D., & Abdulah, R. (2022). Measuring medication adherence of hypertensive patients with monotherapy treatment in a community health center by utilizing medication possession ratio. Pharmacia, 69(2), 345–350. https://doi.org/10.3897/PHARMACIA.69.E82330

Putra, R. S., Rahmadhani, T. N., & Hidayat, S. (2021). Factors Related to the Risk of Occupational Stress among Nurses in the Emergency Room at Sosodoro Djatikoesoemo Bojonegoro Hospital. Indonesian Journal of Occupational Safety and Health, 10(3), 299–308. https://doi.org/10.20473/ijosh.v10i3.2021.299-308

Putri, L. R., Azam, M., Nisa, A. A., Fibriana, A. I., Kanthawee, P., & Shabbir, S. A. (2025). Prevalence and Risk Factors of Hypertension among Young Adults: An Indonesian Basic

Health Survey. Open Public Health Journal, 18. https://doi.org/10.2174/0118749445361291241129094132

Rahmawati, N., Mustofa, F. I., Haryanti, S., & Mujahid, R. (2021). Medicinal plant utilization for hypercholesterolemia by traditional healers in Java island. IOP Conference Series: Earth and Environmental Science, 637(1). https://doi.org/10.1088/1755-1315/637/1/012043

Rahmawati, R., & Bajorek, B. (2015). A community health worker-based program for elderly people with hypertension in Indonesia: A qualitative study, 2013. Preventing Chronic Disease, 12(10). https://doi.org/10.5888/pcd12.140530

Rahmawati, R., & Bajorek, B. (2016). Perspectives on antihypertensive medication: a qualitative study in a rural Yogyakarta province in Indonesia. Drugs and Therapy Perspectives, 32(2), 76–83. https://doi.org/10.1007/s40267-015-0263-4

Rahmawati, R., & Bajorek, B. (2018a). Factors affecting self-reported medication adherence and hypertension knowledge: A cross-sectional study in rural villages, Yogyakarta Province, Indonesia. Chronic Illness, 14(3), 212–227. https://doi.org/10.1177/1742395317739092

Rahmawati, R., & Bajorek, B. V. (2018b). Access to medicines for hypertension: A survey in rural Yogyakarta province, Indonesia. Rural and Remote Health, 18(3). https://doi.org/10.22605/RRH4393

Ramachandran, V., Pradhan, A., Kumar, A., Sarvepalli, B., Rao, S., Oswal, K., Kommu, R., Sharma, M., Pathak, S., Kunnambath, R., Kuriakose, M. A., Rengaswamy, S., Alajlani, M., & Arvanitis, T. N. (2022). A Distributed Cancer Care Model with a Technology-Driven Hub-and-Spoke and further Spoke Hierarchy: Findings from a Pilot Implementation Programme in Kerala, India. Asian Pacific Journal of Cancer Prevention, 23(9), 3133–3139. https://doi.org/10.31557/APJCP.2022.23.9.3133

Rengganis, A. D., Rakhimullah, A. B., & Garna, H. (2020). The Correlation between Work Stress and Hypertension among Industrial Workers: A Cross-sectional Study. IOP Conference Series: Earth and Environmental Science, 441(1). https://doi.org/10.1088/1755-1315/441/1/012159

Ridwan, F. H., Anua, S. M., Aji, B. S., Nurdin, R., Rizky, M. H., & Tejamaya, M. (2023). Assessment of Occupational Heat Stress in A Selected Indonesian Steel Mill. Indonesian Journal of Occupational Safety and Health, 12(2), 292–303. https://doi.org/10.20473/ijosh.v12i2.2023.292-303

Rietveld, P., Schipper, Y., & Vlaanderen, N. (1994). Infrastructure and industrial development: The case of central java. Bulletin of Indonesian Economic Studies, 30(2), 119–132. https://doi.org/10.1080/00074919412331336617

Rinawati, S., Utari, S., Rachmawati, S., & Suryadi, I. (2019). Analysis of Heat Pressure with Systolic-Diastolic Blood Pressure and Fatigue in Karak Industrial Workers Gadingan Sukoharjo. E3S Web of Conferences, 125. https://doi.org/10.1051/e3sconf/201912516006

Rohmana, O., Rochayati, A. S., Hidayat, E., & Sansuwito, T. B. (2021). COMPARISON OF THE EFFECT GROUP ACTIVITY THERAPY: PERCEPTION STIMULATION AND DEEP BREATH THERAPY. Malaysian Journal of Nursing, 12(4), 104–110. https://doi.org/10.31674/mjn.2021.v12i04.014

Salazar, M. R., Carbajal, H. A., Aizpurua, M., Riondet, B., Rodrigo, H. F., Rechifort, V., Quaini, S. M., & Echeverria, R. F. (2005). Decrease of blood pressure by community-based strategies. Medicina, 65(6), 507–512. https://www.scopus.com/inward/record.uri?eid=2-s2.0-31144463928&partnerID=40&md5=2fb4c1f156aaebfbfe9ed6e15a007f9b

Saputri, M. I., Muniroh, L., & Paramita, S. (2020). CORRELATION BETWEEN FAT CONSUMPTION, SMOKING HABIT, AND STRESS WITH HYPERTENSION AMONG DRIVERS. Media Gizi Indonesia, 15(3), 152–158. https://doi.org/10.20473/mgi.v15i3.152-158

Sarkar, S. K., & Midi, H. (2010). Importance of Assessing the Model Adequacy of Binary Logistic Regression. Journal of Applied Sciences, 10(6), 479–486. https://doi.org/10.3923/jas.2010.479.486

Setiati, S., & Sutrisna, B. (2005). Prevalence of hypertension without anti-hypertensive medications and its association with social demographic characteristics among 40 years and above adult population in Indonesia. Acta Medica Indonesiana, 37(1), 20–25.

https://www.scopus.com/inward/record.uri?eid=2-s2.0-26944455599&partnerID=40&md5=c0b7379891363c3858b6e4bcdb144c11

Suprapti, B., Izzah, Z., Anjani, A. G., Andarsari, M. R., Nilamsari, W. P., & Nugroho, C. W. (2023). Prevalence of medication adherence and glycemic control among patients with type 2 diabetes and influencing factors: A cross-sectional study. Global Epidemiology, 5. https://doi.org/10.1016/j.gloepi.2023.100113

Sutriyawan, A., Fardhoni, F., Yusuff, A. A., Akbar, H., & Sangaji, M. (2022). Risk Factors Predicting Hypertension in the Elderly. Iranian Journal of War and Public Health, 14(4), 433–438. https://doi.org/10.29252/ijwph.14.2.433

Tchetgen Tchetgen, E. J. (2013). On a Closed-Form Doubly Robust Estimator of the Adjusted Odds Ratio for a Binary Exposure. American Journal of Epidemiology, 177(11), 1314–1316. https://doi.org/10.1093/aje/kws377

Tesfaye, F., Nawi, N. G., Van Minh, H., Byass, P., Berhane, Y., Bonita, R., & Wall, S. (2007). Association between body mass index and blood pressure across three populations in Africa and Asia. Journal of Human Hypertension, 21(1), 28–37. https://doi.org/10.1038/sj.jhh.1002104

Thompson, D. R., & Zeni, M. B. (2011). Monte Carlo theoretical trials of methods for assessing statistical significance for differences between adjusted odds ratios. Quality & Quantity, 45(2), 319–328. https://doi.org/10.1007/s11135-009-9298-8

Tuan, N. T., Adair, L. S., Suchindran, C. M., Ka, H., & Popkin, B. M. (2009). The association between body mass index and hypertension is different between East and Southeast Asians. American Journal of Clinical Nutrition, 89(6), 1905–1912. https://doi.org/10.3945/ajcn.2008.26809

Widayani, N. M. A., Suyasa, I. G. P. D., Kamaryati, N. P., & Rahyanti, N. M. S. (2024). Perceived benefit is the strongest determinant factor of medication adherence in the elderly with hypertension. Jurnal Keperawatan Padjadjaran, 12(2), 153–161. https://doi.org/10.24198/jkp.v12i2.2384

Widyakusuma, N. N., Suryawati, S., & Wiedyaningsih, C. (2023). What Do Seniors Believe About Medication Adherence? A Qualitative Study Among Seniors with Chronic Conditions in Yogyakarta, Indonesia. Patient Preference and Adherence, 17, 1381–1392. https://doi.org/10.2147/PPA.S412981

Wilujeng, C. S., Habibie, I. Y., Rahayu, D. S., Sari, N., & Nugroho, T. N. (2023). ASSOCIATION OF MACRONUTRIENT AND MICRONUTRIENT INTAKE, AND NUTRITIONAL STATUS WITH SYSTOLIC BLOOD PRESSURE IN ELDERLY. Southeast Asian Journal of Tropical Medicine and Public Health, 54, 169–182. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85205289734&partnerID=40&md5=ac7bb9b7fbca58b6525319d52dd467c8

Wirayudha, G., Ilmi, I. M. B., & Marjan, A. Q. (2024). Analysis of Risk Factors Contributing to Hypertension in Pre-Elderly and Elderly Populations in the Kedaung Subdistrict, Depok, Indonesia. Amerta Nutrition, 8(3SP), 269–274. https://doi.org/10.20473/amnt.v8i3SP.2024.269-274

World Health Organization (WHO). (2023). Global report on hypertension. In Universitas Nusantara PGRI Kediri (Vol. 01).

Yeo, W.-J., Abraham, R., Surapaneni, A. L., Schlosser, P., Ballew, S. H., Ozkan, B., Flaherty, C. M., Yu, B., Bonventre, J. V, Parikh, C. R., Kimmel, P. L., Vasan, R. S., Coresh, J., & Grams, M. E. (2024). Sex Differences in Hypertension and Its Management Throughout Life. Hypertension, 81(11), 2263–2274. https://doi.org/10.1161/HYPERTENSIONAHA.124.22980

Yogisutanti, G., & Suhat, S. (2025). The role of stress in hypertension treatment adherence: Findings from Cimahi City. Multidisciplinary Science Journal, 7(9). https://doi.org/10.31893/multiscience.2025467

Yunus, A. P. (2025). Geographic and Risk Factor Analysis of Non-Communicable Cardiovascular Diseases in Central Java using Machine Learning. Proceedings of International Conference on Artificial Life and Robotics, 735–738. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85219516706&partnerID=40&md5=ef04ddbc6a6726796b9a60997e39ba56

Yusni, Y., Rahman, S., & Naufal, I. (2024). Positive correlation between body weight and body mass index with blood pressure in young adults. Narra J, 4(1). https://doi.org/10.52225/narra.v4i1.533