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ORIGINAL

Analysis of structural equation modeling (SEM) The most significant risk factor for Hypertension in the islands region

Análisis de modelos de ecuaciones estructurales (SEM): El factor de riesgo más significativo para la hipertensión en la región insular

Nur Rahmah[1,2], Amran Razak[3], Agus Bintara Birawida[4] ✉, Irwandy[5], Darmawansyah[6], Arif Sumantri[6], Balqis[3], Rijal Idrus[7,8], Shaharuddin Mohd Sham[9], Anwar Mallongi[2]

[1]Hasanuddin University, Doctoral Program. Makassar, Indonesia.
[2]Alauddin State Islamic University, Departement of Public Health. Makassar, Indonesia.
[3]Hasanuddin University, Department of Health Administration and Policy. Makassar, Indonesia.
[4]Hasanuddin University, Department of Environmental Health. Makassar, Indonesia.
[5]Hasanuddin University, Department of Hospital Management. Makassar, Indonesia.
[6]Syarif Hidayatullah State Islamic University, Public Health Study Program. Makassar, Indonesia.
[7]Hasanuddin University, Department of Marine Science. Makassar, Indonesia.
[8]Hasanuddin University, Centre for Climate Change Research. Makassar, Indonesia.
[9]Universiti Putra Malaysia, Department of Environmental and Occupational Health. Makassar, Indonesia.

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Corresponding author: Agus Bintara Birawida ✉

ABSTRACT

Introduction: hypertension is a non-communicable disease which is a major global public health challenge, especially in areas with limited access to health such as island areas. Island residents also have the potential to experience hypertension, the more dominant factor in this region is limited access to health facilities. While lifestyle, work and physical activity also play a role, barriers to obtaining health services are the main factors influencing the prevalence of hypertension in the islands. This study aims to analyze the risk factors for hypertension on three islands in Sangkarrang Islands District, Makassar City, namely Barrang Lompo Island, Kodingareng Island, and Barrang Caddi Island.
Method: the method used is approach Structural Equal Modeling (SEM) to identify the risk factors that most influence the incidence of hypertension.
Results: the results of the analysis show that physical activity has a very strong and significant influence on hypertension, with the highest path coefficient on Barrang Lompo Island (0,924). Non-compliance in medication consumption is also the dominant factor contributing to the increase in hypertension on all islands, Kodigareng Island has the highest coefficient of 0,972. Knowledge is also an important factor that contributes to the management of hypertension on all islands, with the greatest influence on Barrang Caddi Island (0,858). On the other hand, the National Health Insurance (JKN) factors (0,197 - 0,719), distance to health facilities (0,388 - 0,577), and duration of suffering from hypertension (0,297 - 0,541) show a weaker and not always significant influence on hypertension.
Conclusions: the factors that most influence hypertension on the three islands are physical activity, adherence to treatment, indirect costs, and level of knowledge. Therefore, effective interventions in controlling hypertension in island regions must focus on improving healthy lifestyles, health education, adherence to treatment, and reducing economic barriers in accessing health services.

Keywords: Hypertension; Structural Equation Modeling; Risk Factors; Island Areas.

RESUMEN

Introducción: la hipertensión es una enfermedad no transmisible que representa un importante desafío para la salud pública mundial, especialmente en zonas con acceso limitado a la salud, como las islas. Los residentes de las islas también tienen el potencial de padecer hipertensión; el factor más predominante en esta región es el acceso limitado a los centros de salud. Si bien el estilo de vida, el trabajo y la actividad física también influyen, las barreras para acceder a los servicios de salud son los principales factores que influyen en la prevalencia de la hipertensión en las islas. Este estudio tiene como objetivo analizar los factores de riesgo de la hipertensión en tres islas del distrito de las islas Sangkarrang, ciudad de Makassar: la isla de Barrang Lompo, la isla de Kodingareng y la isla de Barrang Caddi.
Método: el método utilizado es el Modelado Estructural Igual (SEM) para identificar los factores de riesgo que más influyen en la incidencia de la hipertensión.
Resultados: los resultados del análisis muestran que la actividad física tiene una influencia muy fuerte y significativa en la hipertensión, con el coeficiente de trayectoria más alto en la isla de Barrang Lompo (0,924). El incumplimiento del tratamiento farmacológico es también el factor dominante que contribuye al aumento de la hipertensión en todas las islas. La isla de Kodigareng presenta el coeficiente más alto, con 0,972. El conocimiento también es un factor importante que contribuye al manejo de la hipertensión en todas las islas, con la mayor influencia en la isla de Barrang Caddi (0,858). Por otro lado, los factores del Seguro Nacional de Salud (JKN) (0,197 - 0,719), la distancia a los centros de salud (0,388 - 0,577) y la duración de la hipertensión (0,297 - 0,541) muestran una influencia menor y no siempre significativa en la hipertensión.
Conclusiones: los factores que más influyen en la hipertensión en las tres islas son la actividad física, la adherencia al tratamiento, los costos indirectos y el nivel de conocimiento. Por lo tanto, las intervenciones eficaces para controlar la hipertensión en las regiones insulares deben centrarse en mejorar los estilos de vida saludables, la educación sanitaria, la adherencia al tratamiento y la reducción de las barreras económicas para acceder a los servicios de salud.

Palabras clave: Hipertensión; Modelado de Ecuaciones Estructurales; Factores de Riesgo; Zonas Insulares.

INTRODUCTION

Hypertension, or high blood pressure, is a significant global health problem, with various factors influencing its prevalence. Recent research suggests that factors such as patient knowledge, adherence to treatment, nutritional status, and physical activity play an important role in the management of hypertension. Hypertension, or better known as high blood pressure, is one of the most common and dangerous medical conditions worldwide. This disease serves as a major risk factor for many cardiovascular diseases, which are the leading cause of death in many countries. Considered the "silent killer," hypertension often has no obvious symptoms, but can cause serious damage to organs such as the heart, kidneys, and brain, if not managed properly. According to existing estimates, more than 1,39 billion adults worldwide suffer from hypertension, with a projection of this number increasing to 30 % by 2025.[1] With its very high prevalence, hypertension has become a global health challenge that requires more attention.

For example, in Sub-Saharan Africa, hypertension has become an increasingly worrying health problem. Countries in the region are experiencing a significant increase in the number of cases of hypertension, which is caused not only by genetic factors, but also by environmental and behavioral factors related to poor diet, low levels of physical activity, and high levels of stress. Hypertension in this region contributes to an increasing number of premature deaths, which are often caused by complications such as stroke, coronary heart disease and kidney failure. In rural areas of South Africa, for example, hypertension affects approximately 27-58 % of the population, with control rates remaining suboptimal. This shows how important it is to implement better interventions in the prevention and management of hypertension, especially in underserved áreas.[2]

In many developing countries, including Indonesia, although awareness of hypertension is increasing, there are still many people who do not know that they suffer from hypertension because the symptoms are not felt. Without proper treatment, hypertension can progress to fatal heart disease or stroke. Therefore, a more proactive approach is needed in early detection, public education, and management of hypertension.

The global prevalence of hypertension reaches 1,13 billion people. A third of the global population has been diagnosed with hypertension, according to these figures. It is estimated that by 2025, there will be 1,5 billion people suffering from hypertension and 9,4 million people will die every year.[3] According to the results Riskesdas, 2018 hypertension is the most common NCD in Indonesia, with an estimated prevalence of 63 309 620 cases and 427 218 deaths each year. In addition, 34,1 % of the population aged >18 years have hypertension, with the highest prevalence in South Kalimantan (44,1 %), and the lowest in Papua (22,2 %).[4]

Hypertension is still a significant health problem because it is a disease that is often referred to as a "silent killer." This is caused by a lack of clearly visible signs or symptoms, which can result in serious complications in organs such as the heart, brain and kidneys. There are various factors that influence the development of hypertension, including major factors that we cannot control such as heredity, gender, race, and age, as well as minor risk factors that we can control such as obesity, lack of physical activity, smoking, coffee consumption, sensitivity to sodium, low potassium levels, alcohol consumption, stress, work, education level, and diet.[5] Hypertension is a disorder in the circulatory system that results in an increase in blood pressure above normal levels, which is around ≥ 140/90 mmHg.[6]

The exact causal factors of hypertension are still not clearly and specifically known. However, there are certain factors that may increase the risk of high blood pressure. There are 2 classifications of factors that cause hypertension, namely factors that cannot be changed and those that can be changed. Some risk factors, such as age, gender, family history of disease, genetics, and race, are characteristics that cannot be changed, while others, such as smoking, eating habits, alcohol consumption, body weight, and inactivity, can be changed.[7]

Hypertension is a health condition that is thought to be influenced by location of residence, with significant differences between urban and island areas. Urban residents tend to consume high-calorie foods and live a lifestyle that can increase body mass index. This type of lifestyle contributes to a greater risk of high blood pressure compared to those who live in rural areas, resulting in an increase in the prevalence of hypertension in urban áreas.[8]

On the other hand, although island residents also have the potential to experience hypertension, the more dominant factor in this region is limited access to health facilities. While lifestyle, work, and physical activity also play a role, barriers to obtaining health services are the main factors influencing the prevalence of hypertension in the islands.[9] This shows that apart from genetics and lifestyle factors, the existence of adequate health facilities is very important in preventing and treating hypertension in this region. Therefore, it is important to understand how location of residence, lifestyle, and access to health services contribute to the incidence of hypertension. This can be the basis for developing more effective strategies for preventing and treating hypertension according to the characteristics of each region.

Lifestyle factors such as diet, physical activity, and substance use also play an important role in the prevalence of hypertension. In island populations, traditional diets may shift toward processed foods, contributing to obesity and hypertension. Additionally, alcohol and tobacco consumption have been identified as major risk factors for hypertension in marginalized communities, including in the Nicobar Islands.[10]

Another study conducted in the South Andaman Islands, India, examined the burden of undiagnosed and uncontrolled hypertension. The results showed that 48,1 % of participants had hypertension, either already diagnosed or newly diagnosed during the study. Factors such as age and obesity were found to have a significant influence on the prevalence of hypertension. Older individuals and those who are obese are at higher risk of suffering from hypertension.[11]

Hypertension risk factors influence each other simultaneously and cannot be analyzed separately. Therefore, analysis with ordinary multiple regression is inadequate to understand the complex relationships between risk factors. As an alternative, Structural Equations Modelling (SEM) can be used. SEM is a multivariate statistical analysis model that allows testing the relationship between dependent variables, independent variables and mediating variables, both those that can be observed (observed variables) and those that cannot be directly observed (unobserved variables).

SEM works by examining the structure of relationships through a series of interrelated regression equations. This equation describes the relationship between concepts that are defined theoretically or conceptually but cannot be measured directly, such as latent variables. This latent variable is measured through observable indicators, similar to the approach in factor analysis. Therefore, SEM is considered as a combination of multiple regression analysis and factor analysis.

In this study, SEM was used to identify and analyze the most significant risk factors for hypertension in the Barrang Lompo, Barrang Caddi and Kodingareng Island islands, as well as to understand the causal relationship between these factors. This approach is very relevant because these two factors are latent variables that cannot be measured directly, but are important in understanding the dynamics of hypertension holistically. This research can provide a deeper understanding of the risk factors for hypertension in the island region, as well as the causal relationship between these risk factors.

METHOD

Research uses analysis *Structural Equation Modeling*, SEM analysis can replace regression analysis, variance analysis, correlation analysis, factor analysis, and cluster analysis to explain the role of each indicator in the whole and their interactions with each other.[12]

Research Location and Time

Study carried out in the archipelagic area of the Sankarrang Islands District, Makassar City, namely Barrang Caddi Island, Kodingareng Island and Barrang Lompo Island.

Research Sample

The sample in this study were all hypertensive sufferers in Barrang Caddi Island, Kodingareng Island and Barrang Lompo Island, Sankarrang Islands District, Makassar City.

Data Analysis and Data Interpretation

The aim of the research is to predict in theory development using a reflective measurement model, a complex structural model with a very large number of research hypotheses with a flexible sample size, no data assumptions required, including data normality, so that data processing and validation for each variable uses SmartPLS analysis output.

Path Diagram Development (Path Diagram)

This research uses path analysis with 6 variables. From the results of the model development, it is divided into exogenous (independent) latent variables and endogenous (dependent) variables. A path diagram depicts a hypothetical path.

Convert flowcharts into equations

In this research, SmartPLS SEM was used with considerations including the number of samples (data), the relationship between indicators and constructs, the strength of the theory and the objectives of the analysis. The use of SmartPLS SEM is very sensitive to the sample size used. The relationship between indicators and constructs that involve formative elements or their combination with reflexive elements is a consideration for using SmartPLS in this research in order to analyze the relationship between formative and reflexive constructs or a combination of both.

RESULTS

Produced Model

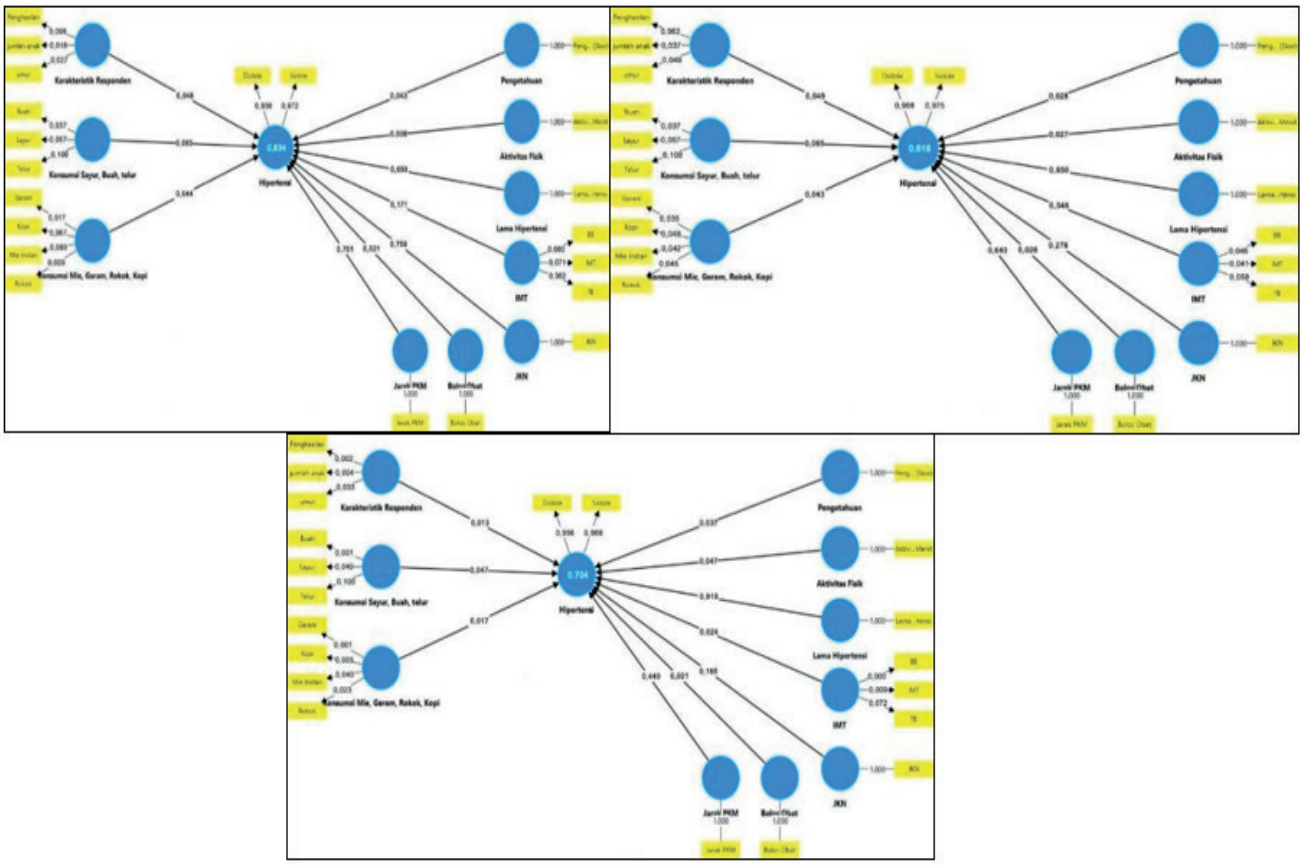

Figure 1. SEM Analysis Model of Hypertension in Three Islands (Barramg Caddi Island, Kodingareng Island, Barrang Lompo Island)

SEM Analysis Comparison of Hypertension Risk Factors in Three Islands (Barrang Lompo Island, Kodingareng, Barrang Caddi Island)

R-Square Value (Determinant Coefficient)

R-Square measures how large a proportion of the variability of the endogenous variable (Hypertension) can be explained by the exogenous variables in the model.

Table 1. SEM Analysis Results Comparison of Endongen Variables for Hypertension in Three Islands (Barrang Lompo Island, Kodingareng, Barrang Caddi Island)

Allow variable to end	R-Square		
	Kodingareng Island	Barrang Caddi Island	Barrang Lompo Island
Hypertension	0,618	0,634	0,704

The Influence of Exogenous Variables on Endogenous Variables (Hypertension) in the Three Islands

The following is the path coefficient value which shows the direction and strength of the relationship between exogenous variables and hypertension in the Three Islands:

Table 2. Results of SEM Analysis Comparison of Exogenous Variables on Hypertension in Three Islands (Barrang Lompo Island, Kodingareng, Barrang Caddi Island)

Research Variables	Kodigareng Island		Barrang Caddi Island		Barrang Lompo Island	
	Path Coefficient	Contact Direction	Path Coefficient	Contact Direction	Path Coefficient	Contact Direction
Physical Activity -> Hypertension	0,672	Positive	0,780	Positive	0,924	Positive
Skipping Medication -> Hypertension	0,972	Positive	0,942	Positive	0,934	Positive
BMI -> Hypertension	0,740	Positive	0,461	Positive	0,625	Positive
JKN -> Hypertension	0,197	Positive	0,360	Positive	0,719	Positive
Distance PKM -> Hypertension	0,399	Positive	0,388	Positive	0,577	Positive
Respondent Characteristics -> Hypertension	0,563	Positive	0,789	Positive	0,952	Positive
Consumption of Vegetables, Fruit, eggs -> Hypertension	0,619	Positive	0,619	Positive	0,821	Positive
Consumption of Noodles, Salt, Cigarettes, Coffee -> Hypertension	0,575	Positive	0,681	Positive	0,836	Positive
Duration of Hypertension -> Hypertension	0,297	Positive	0,408	Positive	0,541	Positive
Knowledge -> Hypertension	0,855	Positive	0,858	Positive	0,834	Positive

SEM Analysis of General Hypertension Risk Factors in the Archipelago Region

R-Square Value (Determinant Coefficient)

R-Square measures how large a proportion of the variability of the main endogenous variable (Hypertension) can be explained by exogenous variables in the model.

Table 3. SEM Analysis Results Comparison of Endongen Variables for Hypertension in General Archipelago Region

Allow variable to end	R-Square	Interpretation
Hypertension	0,652	As much as 65,2 % of the variability in hypertension was explained by exogenous variables in the model, while 34,8 % was explained by other factors not included in the model.

The table shows that the R - Square value obtained is 0,652, which means that the three exogenous variables in the model only explain 65,2 % of the variation in hypertension. The remaining 34,8 % is caused by other variables not included in the model.

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The Great Influence of Exogenous Variables on Endogenous Variables (Hypertension)

The following is the path coefficient value which shows the direction and strength of the relationship between exogenous variables and hypertension:

Table 4. SEM Analysis Results of Comparison of Exogenous Variables on Hypertension in General in the Archipelago Region

Research Variables	Path Coefficient (β)	p-Value	Contact Direction	Interpretation
Physical Activity -> Hypertension	0,792	0,037*	Positive	The positive relationship is very strong and significant. Physical activity has an influence on increasing hypertension by 79,2 %.
Skipping Medication -> Hypertension	0,949	0,023*	Positive	The positive relationship is very strong and significant. Skipping medication has an influence on increasing hypertension by 94,9 %.
BMI -> Hypertension	0,609	0,081	Positive	The positive relationship is very strong and not significant. BMI has an influence on increasing hypertension by 60,9 %.
JKN -> Hypertension	0,425	0,401	Positive	The negative relationship is weak and not significant. Participation in the JKN program has no effect on increasing hypertension levels.
Distance PKM -> Hypertension	0,455	0,594	Positive	The negative relationship is weak and not significant. PKM distance has no influence on hypertension levels.
Individual Characteristics -> Hypertension	0,768	0,037*	Positive	The positive relationship is very strong and significant. Individual characteristics such as age, income and number of children influence the increase in hypertension by 76,8 %.
Consumption of fruit, eggs and vegetables -> Hypertension	0,686	0,059	Positive	The positive relationship is very strong and significant. Consume fruit, eggs and vegetables has an influence on increasing hypertension by 68,6 %.
Consumption of Noodles, Salt, Cigarettes, Coffee -> Hypertension	0,697	0,035*	Positive	The positive relationship is very strong and significant. Consuming Noodles, Salt, Cigarettes, Coffee has an influence on increasing hypertension by 69,7 %.
Duration of Hypertension -> Hypertension	0,415	0,740	Positive	The negative relationship is weak and not significant. The duration of hypertension has no influence on the level of hypertension.
Knowledge -> Hypertension	0,849	0,036*	Positive	The positive relationship is very strong and significant. Low knowledge has an effect on increasing hypertension by 84,9 %.

The Model Produced

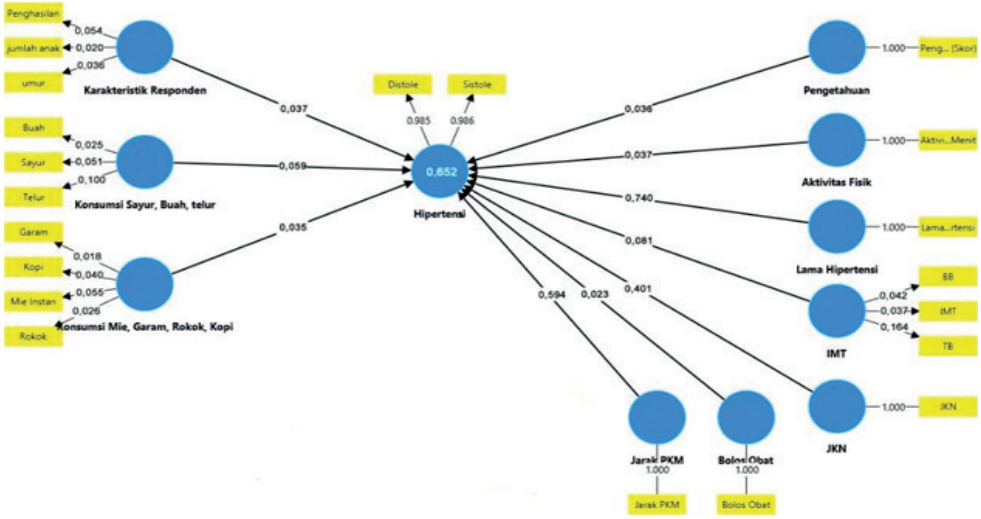

Figure 2. General SEM Analysis Model of Hypertension in Archipelago Region

DISCUSSION

SEM Analysis Comparison of Hypertension Risk Factors in Three Islands (Barrang Lompo Island, Kodingareng, Barrang Caddi Island)

Based on table 1, it shows that Barrang Lompo Island has the highest R-Square value, namely 0,704 (or 70,4 %). This shows that the model applied on this island can explain 70,4 % of the variation in hypertension that occurs on the island. This indicates that the factors in the model have a strong influence in influencing hypertension on Barrang Lompo Island.

Caddi Goods Island has an R-Square value of 0,634 (or 63,4 %). This means that the model on this island can explain around 63,4 % of the variation in hypertension that occurs on Barrang Caddi Island. Even though the R-Square value is lower compared to Barrang Lompo Island, this model still has a fairly good ability to describe factors associated with hypertension.

Kodingareng Island has the lowest R-Square value, namely 0,618 (or 61,8 %). This shows that the model on Kodingareng Island can explain 61,8 % of the variation in hypertension on the island. Although this model still has the ability to explain some of the variability in hypertension, it is possible that other factors not included in the model play a more significant role in this island.

Based on the results in table 2, the SEM analysis results show the comparison of exogenous variables on hypertension in three islands shows that physical activity has a very strong and significant influence on hypertension in the three islands. Barrang Lompo Island shows the strongest relationship with a path coefficient of 0,924, followed by Barrang Caddi Island at 0,780, and Kodigareng Island at 0,672. This shows that the lower the physical activity, the higher the risk of hypertension, with the greatest impact seen on Barrang Lompo Island. This difference could be caused by variations in lifestyle and level of physical activity of people on each island. Previous research shows that regular physical activity can reduce the risk of hypertension, supporting the finding that an active lifestyle contributes to blood pressure control. In addition, physical activity, both recreational and work, has a significant impact on health conditions, including hypertension.[13]

Non-compliance in taking medication or skipping medication is the factor that has the strongest influence on hypertension on all islands. Kodigareng Island has a path coefficient of 0,972, Barrang Caddi Island is 0,942, and Barrang Lompo Island is 0,934. These three values are very high, confirming that non-compliance with hypertension treatment has a very high risk of increasing blood pressure. This highlights the importance of education and compliance in medication consumption for hypertension sufferers in the island region. Previous research also shows that non-adherence to treatment can lead to uncontrolled blood pressure, which has the potential to worsen hypertension or increase the risk of related complications.[1,14] Other research, shows that adherence to hypertension treatment is very important for controlling blood pressure, and that health insurance can play a role in increasing patient compliance.[15] Peer education can increase adherence to treatment among hypertensive patients, indicating the importance of educational interventions in the management of hypertension.[16] Therefore, it is important to increase public awareness of the importance of adherence to treatment in an effort to control hypertension, as well as implementing a more effective approach in increasing public awareness of the importance of regular and timely treatment.[17,18] Research conducted in China shows that community-based hypertension management programs can improve adherence to treatment and blood pressure control, indicating the importance of targeted interventions in improving health outcomes.[17]

Body Mass Index (BMI) also showed a significant effect on hypertension on Kodigareng Island (0,740) and Barrang Lompo Island (0,625), but the effect was weaker and not significant on Barrang Caddi Island (0,461). This suggests that on the first two islands, obesity or excess body weight contributes more to the increase in blood pressure, whereas on Barrang Caddi Island other factors may play a greater role. These results indicate that the higher a person's BMI, the greater the likelihood of experiencing increased hypertension, although the effect is relatively weak. Previous research shows that BMI can serve as an indicator of hypertension risk, where increasing BMI is associated with increasing blood pressure through various mechanisms, including insulin resistance which often occurs in overweight or obese individuals.[19,20] Other research suggests that obesity is a significant risk factor for hypertension, and that weight control may help reduce this risk.[21] In addition, the importance of weight management in the context of hypertension and other related diseases.[22]

Participation in the JKN (National Health Insurance) program shows different effects on the three islands. On Barrang Lompo Island, the path coefficient is quite high (0,719), but not significant. Meanwhile, on Kodigareng Island, the effect is very weak but significant (0,197), and on Barrang Caddi Island it is even weaker and not significant (0,360). This shows that although JKN can help ease the economic burden, its effectiveness in reducing hypertension is still limited and influenced by various other factors. These results indicate that although participation in JKN does not directly affect hypertension, there are indications of a protective effect that can be derived from participation in the program. Participation in JKN has the potential to provide better access to health services, routine check-ups, and treatment that may not be available to those not enrolled in the program. This is in line with research showing that better access to health services can contribute to more effective management of hypertension.[23,24] Other research also highlights the importance of inclusive health

programs in increasing public awareness and understanding of hypertension management.[24] Health insurance coverage can also affect the cost of care and accessibility of health services for hypertensive patients.[25] In addition, access to integrated health services is important for managing hypertension.[26]

Distance to Community Health Center (PKM) has a relatively weak influence on hypertension on the three islands. On Kodigareng Island, the coefficient value is 0,399 and is significant, on Barrang Caddi Island it is 0,388 but not significant, while on Barrang Lompo Island the effect is more moderate with a coefficient of 0,577 but also not significant. This shows that although distance to health facilities can be a factor influencing the accessibility of health services, other factors such as health awareness and lifestyle play a greater role. This indicates that greater distance from health facilities does not contribute significantly to the increase in hypertension prevalence on the island. Previous research also shows that other factors, such as the quality of health services and public awareness, may be more influential in controlling hypertension.[24,27] Research by Aprilia shows that factors such as availability and distance to health facilities can influence access to health services, but their influence on the prevalence of hypertension is not significant.[28] Research by Hasibuan et al. emphasizes the importance of the existence of health facilities in disease case detection, which is also relevant in the context of hypertension.[29] Thus, although distance to PKM may influence access, quality of service and socio-economic factors appear to be more decisive in the prevalence of hypertension on these islands. Accessibility of healthcare services can be influenced by social and economic factors, which contribute to hypertension management.[30]

The influence of individual characteristics on Barrang Lompo Island has the most significant influence on the incidence of hypertension, with a path coefficient value of 0,952. This figure is higher compared to Barrang Caddi Island (0,789) and Kodigareng Island (0,563), which shows striking differences in the contribution of individual characteristics to the prevalence of hypertension on each island. The higher coefficient on Barrang Lompo Island indicates that factors such as income level, age and number of children contribute more to the increased risk of hypertension. This shows that in the context of Barrang Lompo Island, individual characteristics are very important in influencing the prevalence of hypertension. Previous research also shows that older age is often associated with an increased risk of hypertension, because the aging process can cause changes in the circulatory system and blood pressure.[31,32] Additionally, low income is often associated with limitations in accessing adequate health services or living a healthy lifestyle, both of which are major risk factors for hypertension.[33] Having more children can increase the family's economic burden, which in turn can increase stress, one of the factors that can worsen hypertension. On Kodigareng Island, the lower path coefficient (0,563) indicates that although there is a clear relationship, socio-economic factors on this island may have a moderate influence on the prevalence of hypertension when compared with Barrang Lompo and Barrang Caddi Islands. In a broader context, research in various locations shows that individual characteristics have a significant influence on the prevalence of hypertension. For example, research in India shows that individual characteristics contribute to variations in hypertension prevalence at the community level. [33] Other research shows that demographic factors such as age and gender can influence the prevalence of hypertension and its management.[34] Additionally, a study in China found that children from low-income populations had a higher prevalence of hypertension compared with those from high-income populations.[32]

Consumption of vegetables, fruit and eggs has a very strong relationship with hypertension on all islands. Barrang Lompo Island has a very strong and significant influence (0,821). These results are in line with previous research showing that a healthy diet can help reduce the risk of hypertension.[35] Meanwhile, Kodigareng Island and Barrang Caddi both have a value of 0,619. However, on Barrang Caddi Island this relationship was not significant, which may be caused by other factors that have a greater influence on hypertension on the island. Even though the coefficient is positive, its effect is not strong enough to significantly influence the prevalence of hypertension on this island. This is in line with research showing that unhealthy eating patterns, although they have the potential to increase the risk of hypertension, are not always directly related to the incidence of hypertension in certain populations.[36,37] On the other hand, consumption of noodles, salt, cigarettes and coffee had a very strong negative influence on hypertension, especially on Barrang Lompo Island (0,836) and Barrang Caddi Island (0,681). On Kodigareng Island, this relationship is more moderate but still significant (0,575). This shows that consumption of foods high in salt and smoking habits greatly contribute to increasing blood pressure, with the greatest impact on Barrang Lompo Island. This shows that salt and cigarette consumption can contribute very strongly to the increase in hypertension, so that it is the main factor in the prevalence of hypertension on these three islands.[38,39] In addition, other studies show that unhealthy eating patterns and smoking habits contribute to increased blood pressure.[40]

The duration of hypertension has a weak influence on blood pressure. Barrang Lompo Island shows the highest influence with a coefficient of 0,541 (moderate but not significant), followed by Barrang Caddi Island (0,408) and Kodigareng Island (0,297), both with weak influence. This indicates that even though someone has suffered from hypertension for a long time, other factors such as lifestyle and medication determine their blood pressure condition. This shows that the duration of hypertension, or how long a person has suffered from

hypertension, does not have a significant influence on the increase in the prevalence of hypertension on the three islands. These findings are in line with research showing that although a long period of suffering from hypertension can be expected to contribute to the development of complications, the data show that this duration is not directly related to an increase in the prevalence of hypertension. In this context, other factors such as consumption patterns, lifestyle and environmental factors may have a greater influence on hypertension levels in the three islands. Recent research shows that successful interventions in increasing participation in physical activity can reduce the prevalence of hypertension.[41] Other research shows that factors such as physical activity, diet, and stress can play a more dominant role in influencing the prevalence of hypertension.[41,42,43] Overall, the results of this study lead to the conclusion that duration of hypertension is not a strong indicator in predicting increased hypertension. This shows the need to consider other more influential factors, such as a healthy lifestyle and more targeted interventions to treat hypertension. Therefore, a more holistic approach that includes lifestyle, diet and environmental factors should be considered in efforts to prevent and manage hypertension in the region.

Finally, the level of knowledge has a very strong influence on hypertension in all islands, with a coefficient above 0,83. Barrang Caddi Island shows the highest influence (0,858), followed by Kodigareng Island (0,855) and Barrang Lompo Island (0,834). This indicates that the higher the public's knowledge about hypertension, the better their blood pressure management, so that health education becomes an important step in preventing and managing hypertension. Previous research shows that increasing public knowledge about hypertension can contribute to better blood pressure management.[44] In addition, other studies emphasize the importance of health education in increasing awareness and management of hypertension.[25] Furthermore, research on hypertension patients' adherence to treatment shows that factors such as knowledge, family support, and access to health services play an important role in increasing adherence to treatment.[24,45,46] Another study, highlights the importance of educational interventions in the management of hypertension.[16]

SEM Analysis of General Hypertension Risk Factors in the Archipelago Region

Based on SEM results, a comparison of exogenous variables on hypertension in general in the island region in table 4 shows that Physical Activity shows a very strong and significant positive relationship with increasing hypertension, with an effect of 79,2 % (β = 0,792; p = 0,037). This indicates that although physical activity is generally beneficial for health, in this analysis, high levels of physical activity were associated with increased hypertension. Maybe this is caused by the intensity or type of physical activity carried out, or other factors that influence the condition of hypertension.

Skipping Medication had a very strong and significant positive relationship with increased hypertension, with an effect of 94,9 % (β = 0,949; p = 0,023). Non-adherence in taking medication has a huge influence on the increase in hypertension, which emphasizes the importance of compliance with medication to effectively manage hypertensive conditions.

Body Mass Index (BMI) showed a very strong but not significant positive relationship with hypertension (β = 0,609; p = 0,081). Although BMI is often associated with hypertension risk, in this analysis the effect was not significant. This could be caused by other variables that are more dominant in influencing the increase in hypertension.

Participation in the JKN program did not show a significant effect on increasing hypertension, indicating that access to health services through this program is not enough to prevent or control hypertension in the context of this analysis.

Distance to Community Health Center (PKM) showed a very weak and insignificant positive relationship with hypertension (β = 0,455; p = 0,594). This indicates that although the distance to the Community Health Center can influence accessibility, this factor does not have a significant effect on the increase in hypertension.

Individual characteristics, such as age, income, and number of children, have a very strong and significant positive relationship with increasing hypertension, with an effect of 76,8 % (β = 0,768; p = 0,037). These demographic factors contribute greatly to hypertension risk, indicating that individuals with certain factors, such as older age or higher income, tend to be at greater risk for hypertension.

Consumption of Fruit, Eggs and Vegetables showed a very strong and significant positive relationship with increasing hypertension, with an effect of 68,6 % (β = 0,686; p = 0,059). Although a healthy diet tends to reduce the risk of hypertension, in this case a diet that includes consumption of fruit, eggs and vegetables is associated with an increase in hypertension. This may be caused by other factors in diet or living habits which also influence the condition of hypertension. Consumption of Noodles, Salt, Cigarettes and Coffee showed a very strong and significant positive relationship with hypertension, with an effect of 69,7 % (β = 0,697; p = 0,035). The consumption pattern of foods and drinks high in salt, instant noodles, coffee and cigarettes contributes to an increase in hypertension, which shows that unhealthy eating habits play a significant role in worsening the condition of hypertension.

Long time suffering from hypertension showed a very weak and insignificant positive relationship with

hypertension (β = 0,415; p = 0,740). The duration that a person suffers from hypertension does not have a significant effect on the increase in hypertension, which shows that the duration of the disease does not always correlate directly with the level of increase in hypertension.

Level of Knowledge regarding hypertension has a very strong and significant positive relationship with hypertension, with an effect of 84,9 % (β = 0,849; p = 0,036). Low knowledge about hypertension has been proven to have a significant influence on the increase in hypertension, which highlights the importance of education and increasing public awareness about hypertension.

Overall, factors such as physical activity, non-adherence to medication, and knowledge about hypertension have a very large and significant influence on the increase in hypertension. Meanwhile, other factors such as BMI, and access to a health center showed a weaker or insignificant relationship, indicating that factors more directly related to living habits and health management had a greater impact on hypertension.

CONCLUSIONS

The factors that most influence hypertension on the three islands are physical activity, non-adherence to medication, and level of knowledge. Meanwhile, factors such as JKN, distance to health facilities, and duration of suffering from hypertension have a weaker influence and are not always significant. Therefore, health interventions on the three islands should focus on increasing physical activity, adherence to treatment, health education, and reducing the economic burden in accessing health services.

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AUTHORSHIP CONTRIBUTION

Conceptualization: Agus Bintara Birawida, Nur Rahma, Amran Razak.

Data curation: Nur Rahmah, Irwandy.
Formal analysis: Agus Bintara, Nur Rahmah.
Research: Nur Rahmah, Agus Bitara Birawida, Amran Razak.
Methodology: Irwandy, Balqis.
Project management: Agus Bintara Birawida.
Resources: Nur Rahmah, Amran Razak.
Software: Agus Bintara Birawida.
Supervision: Irwandy, Darmawansyah.
Validation: Agus Bintara, Amran Razak, Darmawansyah.
Display: Arif Sumantri, Rijal Idrus, Saharuddin Mohd Sham.
Drafting - original draft: Nur Rahmah.
Writing - proofreading and editing: Nur Rahmah, Agus Bintara Birawida, Amran Razak, Irwandy.