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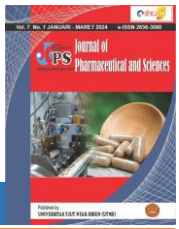

Determinants of Hypertension Among Rural Communities in the Working Area of Simarmata Public Health Center, Simanindo Subdistrict, Samosir Regency, 2024

Determinan Kejadian Hipertensi pada Masyarakat Pedesaan di Wilayah Kerja Puskesmas Simarmata Kecamatan Simanindo Kabupaten Samosir 2024

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Abstract

Background: Hypertension is a major global health issue and a significant risk factor for cardiovascular and renal diseases. Data from the Samosir Regency Health Office in 2022 indicated a high prevalence of hypertension (30%) among adults in Simanindo District, highlighting a critical local public health concern. **Objectives:** This study aimed to identify the determinants associated with the incidence of hypertension in the working area of the Simarmata Public Health Center, Simanindo District, Samosir Regency. **Methods:** A quantitative study with a cross-sectional design was conducted. A sample of 95 respondents was selected proportionally from four villages. Data on Body Mass Index (BMI), alcohol consumption, smoking habits, and dietary patterns were collected through interviews and measurements. Data analysis employed the Chi-square test and multivariate logistic regression. **Results:** The study revealed significant relationships between hypertension and BMI (p=0.000), alcohol consumption (p=0.000), smoking habits (p=0.000), and dietary patterns (p=0.018). Multivariate analysis identified smoking habit as the most dominant factor, with smokers having 9.758 times higher odds of developing hypertension (Exp(B) = 9.758; 95% CI: 2.697–35.303). **Conclusion:** Smoking habit is the most dominant determinant of hypertension in this community. It is recommended that the head of the Simarmata Public Health Center enhance the role of health workers in providing health education, particularly on the dangers of smoking and its impact on hypertension, to reduce its incidence.

Keywords*: *Hypertension, Alcohol Consumption, Smoking Habits, BMI, Diet.

Abstrak

Latar Belakang: Hipertensi merupakan masalah kesehatan global utama dan faktor risiko signifikan untuk penyakit kardiovaskular dan ginjal. Data dari Dinas Kesehatan Kabupaten Samosir tahun 2022 menunjukkan prevalensi hipertensi yang tinggi (30%) pada orang dewasa di Kecamatan Simanindo, yang mengindikasikan masalah kesehatan masyarakat yang serius di tingkat lokal. **Tujuan:** Penelitian ini bertujuan untuk mengetahui determinan yang berhubungan dengan kejadian hipertensi di wilayah kerja Puskesmas Simarmata, Kecamatan Simanindo, Kabupaten Samosir. **Metode:** Penelitian kuantitatif dengan desain *cross-sectional* dilakukan. Sampel sebanyak 95 responden dipilih secara proporsional dari empat desa. Data Indeks Massa Tubuh (IMT), konsumsi alkohol, kebiasaan merokok, dan pola makan dikumpulkan melalui wawancara dan pengukuran. Analisis data menggunakan uji Chi-square dan regresi logistik multivariat. **Hasil:** Analisis menunjukkan hubungan yang signifikan antara hipertensi dengan IMT (p=0,000), konsumsi alkohol (p=0,000), kebiasaan merokok (p=0,000), dan pola makan (p=0,018). Analisis multivariat menidentifikasi kebiasaan merokok sebagai faktor paling dominan, dimana perokok memiliki odds 9,758 kali lebih tinggi untuk menderita hipertensi (Exp(B) = 9,758; 95% CI: 2,697–35,303). **Kesimpulan:** Kebiasaan

merokok merupakan determinan paling dominan terhadap kejadian hipertensi pada masyarakat di wilayah ini. Disarankan kepada kepala Puskesmas Simarmata untuk meningkatkan peran tenaga kesehatan dalam melakukan pendidikan kesehatan, khususnya tentang bahaya merokok dan dampaknya terhadap hipertensi, untuk menurunkan kejadian hipertensi.

Kata Kunci: *Hipertensi, Konsumsi Alkohol, Kebiasaan Merokok, IMT, Pola Makan.*

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Introduction

Hypertension is a major global health problem with a high prevalence and a profound impact on public health. It is often referred to as a *silent killer* because it is typically asymptomatic, yet significantly increases the risk of serious complications, including heart disease, stroke, and kidney failure. According to the World Health Organization (WHO), approximately 1.28 billion people worldwide are living with hypertension, of whom 46% are unaware of their condition. Alarmingly, only one in five patients successfully controls their blood pressure despite the availability of effective and affordable treatments [1].

In developed countries such as South Korea, Canada, and Iceland, the rate of hypertension control is relatively high (>70%). In contrast, Sub-Saharan Africa and South Asia continue to face significant challenges, with treatment coverage remaining below 25% in women and under 20% in men. These disparities reflect inequalities in healthcare access and quality across regions [1].

In Indonesia, hypertension is a leading cause of morbidity and mortality. The 2018 Basic Health Research (Riskesdas) reported a prevalence of 34.1% among adults aged ≥18 years [2]. In North Sumatra Province, the prevalence was reported at 6.7%, with Medan City reaching 28.1%. Data from the Samosir Regency Health Office in 2022 indicated a prevalence of 20% among adults, rising to 30% in Simanindo Subdistrict, particularly among the elderly [2,3].

Multiple determinants have been identified as risk factors for hypertension, including genetic predisposition [4], environmental exposure such as air pollution [5,6], socioeconomic conditions [7], high-salt diet, obesity [8], smoking and alcohol consumption [9], and physical inactivity [10]. Global studies also emphasize the roles of psychosocial stress, noise exposure, and extreme climate change in increasing hypertension risk [11,12].

A preliminary survey in the working area of Simarmata Public Health Center identified 28 individuals with hypertension. Field observations revealed dietary habits characterized by high salt intake, smoking behavior, which is culturally believed to reduce cold sensations, and the consumption of traditional alcoholic beverages (*tuak*) as part of social activities. These factors may exacerbate the risk of hypertension within this community.

Although national and provincial data on hypertension prevalence have been well documented, scientific evidence regarding specific determinants of hypertension in rural populations, particularly in Simanindo Subdistrict, Samosir Regency, remains limited. Identifying local determinants is essential for designing community-based interventions that are more effective and culturally appropriate.

Therefore, this study aims to analyze the determinants of hypertension among the rural community in the working area of Simarmata Public Health Center, Simanindo Subdistrict, Samosir Regency in 2024, focusing on key risk factors such as body weight, alcohol consumption, smoking habits, and dietary patterns.

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Experimental Section

Research Design

This study employed a quantitative method with a cross-sectional design, in which the independent variables (body weight, alcohol consumption, smoking habits, and dietary patterns) and the dependent variable (hypertension) were measured simultaneously at a single point in time.

Population and Sample.

The study population comprised all residents aged over 45 years living in the working area of Simarmata Public Health Center, totaling 1,772 individuals. The sample size was determined using the Slovin formula with a 10% margin of error, resulting in 95 respondents. The sample was proportionally distributed across four villages: Cinta Dame (28 respondents), Simarmata (25 respondents), Dosroha (16 respondents), and Sihusapi (26 respondents). The inclusion criteria were residents aged ≥45 years, diagnosed with hypertension by healthcare professionals, residing in Simarmata village, communicating properly, and being willing to participate by signing an informed consent form. Exclusion criteria included pregnant women. Sampling was conducted using simple random sampling through lottery selection based on Simarmata Public Health Center data. Selected respondents were visited at their homes for interviews using the research questionnaire.

Data Collection.

Data consisted of both primary and secondary sources. Primary data were collected through interviews using a structured questionnaire covering body mass index (BMI), alcohol consumption, smoking habits, dietary patterns, and systolic blood pressure measurement to determine hypertension status. Secondary data were obtained from relevant institutions, including demographic information, family records, and reports on hypertension prevalence. Maftur Al Rafi (2021) had previously tested the research instrument for validity and reliability in a study on hypertension-related factors at Latemmamala Hospital, Soppeng Regency. Therefore, further validity and reliability testing were not repeated in this study [13].

Operational Definitions and Measurements.

The dependent variable was hypertension, defined as blood pressure ≥140/90 mmHg. Independent variables included BMI, alcohol consumption, smoking, and dietary patterns. BMI was calculated as body weight (kg) divided by height squared (m^2) and classified into obese (BMI ≥25) and non-obese (BMI <25). Alcohol consumption was assessed based on reported drinking habits and categorized into consumers and non-consumers. Smoking habits were categorized into smokers and non-smokers. Dietary patterns were assessed using 10 questionnaire items, with scores of 6–10 classified as healthy nutritional patterns and scores of 0–5 as unhealthy dietary patterns.

Data Processing.

Data processing included editing, coding, entry, tabulation, and cleaning. Editing ensured completeness and consistency of responses, while coding assigned numerical values to variables according to operational definitions. Data was entered using computer software, followed by tabulation into frequency tables. Cleaning was conducted to check for errors before analysis.

Data Analysis.

Univariate analysis was applied to describe the frequency distribution of each variable, including BMI, alcohol consumption, smoking habits, dietary patterns, and hypertension status. Bivariate analysis was performed using the Chi-square test with a 95% confidence level to assess associations between independent variables and hypertension. A p-value of <0.05 was considered statistically significant. Multivariate analysis was carried out using logistic regression to evaluate the simultaneous effect of independent variables on hypertension. The logistic regression model included variables important in the bivariate analysis to identify the most influential determinants.

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Results and Discussion

Results

The results of the study will present data on the description of the research location, univariate analysis (describing the frequency distribution of BMI variables, alcohol consumption, smoking habits, diet and the incidence of hypertension) and bivariate analysis (the relationship between BMI, alcohol consumption, smoking habits, diet with the incidence of hypertension) as well as the dominant variables that influence the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency in 2024.

Description of Research Location

This research was conducted in the Simarmata Community Health Center, Simanindo District. Administratively, Simanindo District is within the Samosir Regency, North Sumatra Province. In 2003, Law No. 36/2003 divided Toba Samosir Regency into two regencies: Toba Samosir Regency and Samosir Regency. Samosir Regency includes sub-districts on Samosir Island and part of the mainland of Sumatra Island.

Simanindo District has four villages: Cinta Dame, Simarmata, Dosroha, and Sihusapi. The district's topography varies, from lowlands to higher hills. This geographic location impacts the accessibility and distribution of healthcare services, contributing to the spread of diseases such as hypertension.

Demographically, most people in the Simanindo District are of the Toba Batak ethnic group, with a distinctive language and culture firmly maintained. Most residents work in the agriculture, fisheries, and tourism sectors. Regarding health, lifestyles associated with traditional diets (e.g., foods high in salt and oil) and varying levels of physical activity across villages may influence the prevalence of hypertension in this region. People in this area often have a diet rich in traditional and salty foods, which can increase the risk of hypertension.

Sociocultural aspects also influence healthcare management. The Toba Batak people tend to rely on traditional medicine and have social norms that prioritize the role of the family in maintaining health. However, the understanding of conditions like hypertension is not yet entirely accepted, especially when compared to modern medical approaches. This leads to delays in diagnosis and treatment, as well as an increased incidence of undetected hypertension.

Furthermore, education levels and accessibility to healthcare facilities also play a role in the incidence of hypertension in Simanindo District. Although there is a daily community health center (Puskesmas Hari) in this district, infrastructure and healthcare facilities are still limited, impacting hypertension prevention and treatment efforts.

Univariate Analysis

Univariate analysis presents the results of the research variables descriptively. The variables in this study are the independent variables (BMI, alcohol consumption, smoking habits, diet) and the dependent variable (hypertension incidence). The tabular results present incidence rates and percentages based on each studied variable category.

Frequency Distribution Based on BMI

Table 1 presents the distribution of BMI frequency in the community that served as the sample for the study on hypertension incidence in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024.

Table 1. Distribution of BMI Frequency in the Community in the Working Area of the Simarmata Health Center, Simanindo District, Samosir Regency, 2024

No	IMT	n	%
1	Obesity	27	28,4
2	Not Obese	68	71,6
	Amount	95	100,0

Based on Table 1 above, the distribution of BMI frequency in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency in 2024 was highest in the non-obese category, 68 people (71.6%), and lowest in the obese category, 27 people (28.4%).

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Frequency Distribution Based on Alcohol Consumption

Table 2 presents the frequency distribution of alcohol consumption in the community, which served as the sample for the study on hypertension incidence in the community within the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024.

Table 2. Distribution of Alcohol Consumption Frequency in the Community in the Working Area of the Simarmata Health Center, Simanindo District, Samosir Regency, 2024

No	Alcohol Consumption	n	%
1	Consuming	40	42,1
2	Do Not Consume	55	57,9
	Amount	95	100,0

Based on Table 2 above, the distribution of the frequency of alcohol consumption in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency in 2024 was highest in the category of not consuming alcohol, namely 55 people (57.9%), and lowest in the category of consuming alcohol, namely 40 people (42.1%). The majority of respondents who drink alcohol are male. If alcohol consumption habits are considered by gender, that is, only male respondents, the frequency distribution of alcohol consumption habits among respondents is as shown in Table 3.

Table 3. Distribution of Alcohol Consumption Frequency in Men in the Working Area of Simarmata Community Health Center, Simanindo District, Samosir Regency, 2024

No	Alcohol Consumption	n	%
1	Consuming	30	73,1
2	Do Not Consume	11	26,9
	Amount	41	100,0

Table 3 shows that the distribution of the frequency of alcohol consumption habits in men in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024 was highest in the consuming category, namely 30 people (73.1%), and the lowest in the non-consuming category, namely 11 people (26.9%).

Frequency Distribution Based on Smoking Habits

Table 4 presents the frequency distribution of smoking habits in the community, which served as the sample for the study on hypertension incidence in the community within the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024.

Table 4. Distribution of the Frequency of Smoking Habits in the Community in the Work Area of the Simarmata Health Center, Simanindo District, Samosir Regency, 2024

No	Smoking Habit	n	%
1	Smoking	44	46,3
2	No Smoking	51	53,7
	Amount	95	100,0

Based on Table 4 above, the distribution of the frequency of smoking habits in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency in 2024 was highest in the non-smoking category, namely 51 people (53.7%), and lowest in the smoking category, namely 44 people (46.3%).

The majority of respondents who smoke are male. The frequency distribution of smoking habits in Table 4 represents the overall picture of the respondents. If smoking habits are considered by gender, that is, only male respondents, then the frequency distribution of respondents' smoking habits is as in Table 5.

Table 5 shows that the distribution of smoking habits in men in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024 was highest in the smoking category, namely 37 people (90.2%), and lowest in the non-smoking category, namely four people (9.8%).

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Table 5. Distribution of the Frequency of Smoking Habits in Men in the Working Area of the Simarmata Community Health Center, Simanindo District, Samosir Regency, 2024

No	Smoking Habit	n	%
1	Smoking	37	90,2
2	No Smoking	4	9,8
	Amount	41	100,0

Frequency Distribution Based on Diet

Table 6 presents the frequency distribution of dietary patterns in the community, which served as the sample for the study on hypertension incidence in the community within the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024.

Table 6. Distribution of Eating Pattern Frequency in the Community in the Working Area of Simarmata Health Center, Simanindo District, Samosir Regency, 2024.

No	Dietary habit	n	%
1	Good	36	37,9
2	Not good	49	62,3
	Amount	95	100,0

Based on Table 6 above, the distribution of eating pattern frequencies in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency in 2024 was highest in the poor category, namely 49 people (62.3%), and lowest in the good category, namely 36 people (37.9%).

Frequency Distribution Based on Hypertension Incidence

Table 7 presents the frequency distribution of hypertension incidence in the community, which served as the sample for the study on hypertension incidence in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024.

Table 7. Distribution of the Frequency of Hypertension Incidents in the Community in the Working Area of the Simarmata Health Center, Simanindo District, Samosir Regency, 2024

No	Hypertension Incident	n	%
1	Hypertension	31	32,6
2	No Hypertension	64	67,4
	Amount	95	100,0

Based on Table 7 above, the distribution of the frequency of hypertension incidents in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency in 2024 was highest in the non-hypertension category, namely 64 people (67.4%), and lowest in the hypertension category, namely 31 people (32.6%).

Bivariate Analysis

Bivariate analysis presents the results of a statistical analysis of the relationship between independent variables (BMI, alcohol consumption, smoking habits, and diet) and the dependent variable (incidence of hypertension) in the community in the working area of the Simarmata Community Health Center, Simanindo District, Samosir Regency in 2024.

The Relationship between BMI and the Incidence of Hypertension in the Community in the Work Area of the Simarmata Community Health Center, Simanindo District, Samosir Regency in 2024

Table 8 presents the study's results on the relationship between BMI and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024.

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Table 8. The Relationship between BMI and the Incidence of Hypertension in the Community in the Working Area of the Simarmata Health Center, Simanindo District, Samosir Regency in 2024.

IMT	Hypertension Incident				**Total**		**Sig..**
	Hypertension		**No Hypertension**				
	n	**%**	**n**	**%**	**n**	**%**	
Obesity	19	70,4	8	29,6	27	100,0	0,000
Not Obese	12	17,6	56	82,4	68	100,0	
Total	31		64		95		

Based on Table 8 above, it can be seen that of the 27 people with a BMI in the obese category, 19 people (70.4%) had hypertension, and eight people (29.6%) did not have hypertension. Of the 56 people who were not obese, 12 people (17.6%) had hypertension, and 56 people (82.4%) did not. The chi-square test statistical results showed a significance value (sig.) of 0.000. This value is smaller than the degree of error (α = 0.05), so it can be concluded that a relationship exists between BMI and the incidence of hypertension in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency.

The Relationship between Alcohol Consumption and Hypertension in the Community in the Working Area of the Simarmata Community Health Center, Simanindo District, Samosir Regency, 2024

Table 9 below presents the research results on the relationship between alcohol consumption and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024.

Table 9. The Relationship between Alcohol Consumption and the Incidence of Hypertension in the Community in the Simarmata Health Center Working Area, Simanindo District, Samosir Regency, 2024.

Alcohol Consumption	**Hypertension Incident**				**Total**		**Sig..**
	Hypertension	**%**	**No Hypertension**	**%**	**n**	**%**	
Consuming	24	60,0	16	40,0	40	100,0	
No Consuming	7	12,7	48	87,6	55	100,0	0,000
Total	31		64		95		

Based on Table 9 above, it can be seen that of the 40 people who consumed alcohol, 24 people (60.0%) had hypertension, and 16 people (40.0%) did not have hypertension. Of the 55 people who did not consume alcohol, seven people (12.7%) had hypertension, and 48 people (87.6%) did not have hypertension. The results of statistical tests using the chi-square test showed a significance value (sig.) of 0.000. This value is smaller than the degree of error (α = 0.05), so it can be concluded that there is a relationship between alcohol consumption and the incidence of hypertension in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency.

The Relationship between Smoking Habits and Hypertension Incidence in the Community in the Working Area of the Simarmata Health Center, Simanindo District, Samosir Regency, 2024

Table 10 presents the research results on the relationship between smoking habits and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024.

Table 10. The Relationship between Smoking Habits and the Incidence of Hypertension in the Community in the Working Area of the Simarmata Health Center, Simanindo District, Samosir Regency, 2024.

Smoking Habit	**Hypertension Incident**				**Total**		**Sig..**
	Hypertension	**%**	**No Hypertension**	**%**	**n**	**%**	
Smoking	26	59,1	18	40,9	42	100,0	0,000
No Smoking	5	9,8	46	91,2	53	100,0	
Total	31		64		95		

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Based on Table 10 above, it can be seen that of the 42 people who have a smoking habit, 26 people (59.1%) have hypertension, and 18 people (40.9%) do not have hypertension. Of the 53 people who do not have a smoking habit, five people (9.8%) still have hypertension, and 46 people (91.2%) do not have hypertension. The results of statistical tests using the chi-square test show a significance value (sig.) of 0.000. This value is smaller than the degree of error (α = 0.05), so it can be concluded that there is a relationship between smoking habits and the incidence of hypertension in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency.

The Relationship Between Dietary Patterns and Hypertension Incidence in the Community in the Working Area of the Simarmata Community Health Center, Simanindo District, Samosir Regency, 2024

Table 11 presents the research results on the relationship between dietary patterns and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024.

Table 11. The Relationship between Dietary Patterns and the Incidence of Hypertension in the Community in the Working Area of the Simarmata Health Center, Simanindo District, Samosir Regency, 2024.

Dietary habit	Hypertension Incident				Total		Sig..
Hypertension		%	No Hypertension	%	n	%	
Good	6	16,7	30	83,3	36	100,0	0,018
Not good	25	42,4	34	27,6	59	100,0	
Total	31		64		95		

Table 11 above shows that of the 36 people with a good diet, six (16.7%) had hypertension, and 30 (83.3%) did not. Of the 59 people who had a poor diet, 25 people (42.4%) still had hypertension, and 34 people (27.6%) did not have hypertension. The results of statistical tests using the chi-square test showed a significance value (sig.) of 0.018. This value is smaller than the degree of error (α = 0.05), so it can be concluded that there is a relationship between diet and the incidence of hypertension in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency.

Multivariate Analysis

Bivariate Selection

After bivariate analysis, a multivariate analysis is conducted to determine the most dominant relationship between the independent and dependent variables. The initial stage of multivariate analysis involves determining the potential independent variables (multivariate candidate variables) to be included, specifically variables from the bivariate analysis results with a p-value <0.25 (Lemeshow, 1990). The multivariate analysis used in this study is the t-test. *Logistic Regression is simple.* For more details, see Table 12.

Table 12. Candidate Variables for Multivariate (*Binary Logistic Regression*)

No	Variables	*p-value* (<0,25)	Information
1.	IMT	0,000	Candidate
2.	Alcohol consumption	0,000	Candidate
3.	Smoking habit	0,000	Candidate
4	Dietary habit	0,018	Candidate

Based on Table 12 above, the analysis results between the independent and dependent variables show that all independent variables have a P value <0.25. These variables are BMI, alcohol consumption, smoking habits, and diet, so all independent variables meet the requirements to be included in the final modeling through regression testing—binary *logistic*.

Final Modeling

The second stage in multivariate analysis involves constructing a complete model by including all candidate variables for analysis. Multivariate analysis aims to find the best model to determine the determinants of hypertension incidence in the Simarmata Community Health Center, Simanindo District,

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Samosir Regency. In this case, all candidate variables were tested together to form the final equation model. For more details, see Table 13.

Table 13. Final Model of Multivariate Analysis of Multiple Logistic Regression on BMI, Alcohol Consumption, Smoking Habits, and Diet.

	Variables	**B**	*Sig.*	*Exp*	*95% C.I for*	*EXP (B)*
Level End					*Lower*	*Upper*
	IMT	1.903	0.004	6.706	1.861	24.161
	Alcohol consumption	1.795	0.004	6.019	1.780	20.359
	Smoking habit	2.278	0.001	9.758	2.697	35.303

Based on Table 13, it is known that the final results of modeling using the regression test*binary logistic* shows that there are three variables, namely BMI, alcohol consumption and smoking habits which have a significant value of p <0.005, so it can be concluded based on the results of the variable analysis, with a binary regression test (*logistic regression*), the most dominant variable is smoking habit with a significance value of 0.001 with an Exp B value of 9.758. Based on this value, it can be concluded that the smoking habit will have a 9.758 times greater chance of experiencing hypertension compared to people who do not smoke in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency. Smoking is the dominant factor causing hypertension, but it's not the only factor. This study identified three other variables contributing to hypertension: alcohol consumption, BMI, and diet. Beyond these four variables, different factors, such as genetics, can influence hypertension.

Discussion

The Relationship between BMI and the Incidence of Hypertension in the Community in the Work Area of the Simarmata Health Center, Simanindo District, Samosir Regency in 2024

The results of statistical tests indicate a relationship between BMI and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024. This has been proven statistically, with a significance value (sig.) of 0.000. This value is smaller than the degree of error ($\alpha = 0.05$), so it can be concluded that there is a relationship between BMI and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency.

Body Mass Index (BMI) is an indicator used to assess whether a person's weight is within the normal range, overweight, or obese. Many studies have shown that increased BMI, especially that reflecting obesity, is associated with an increased risk of hypertension. Hall et al. (2015) examined in depth the mechanisms linking obesity to hypertension through interactions between the neurohumoral system and kidney function. The researchers explained that increased adipose tissue in obese individuals leads to increased levels of hormones such as leptin, which triggers sympathetic nervous system activation [8]. This activation increases heart rate and blood vessel tone, increasing blood pressure. In addition, obesity also stimulates the renin-angiotensin-aldosterone system (RAAS), which increases sodium and water retention and activates kidney function.

The combination of these mechanisms results in chronic elevation of blood pressure.

Deng, Danying, et al. (2023) conducted a study on the association between body mass index and hypertension among Chinese adults: A cross-sectional study. This cross-sectional study involved thousands of adult participants from China and confirmed that increasing BMI was significantly associated with an increased risk of hypertension. Multivariate analysis showed that each unit increase in BMI increased the odds of developing hypertension, even after controlling for other factors such as age, sex, and lifestyle factors [14]. This study emphasizes the importance of weight management as a population-level hypertension prevention effort. Stated that systemic inflammation is a critical mediator in the relationship between obesity and hypertension. In obesity, adipose tissue accumulation leads to increased release of proinflammatory cytokines, which impact endothelial dysfunction and increased oxidative stress. Both conditions increase vasoconstriction and impair blood pressure regulation. This review integrates findings from various recent studies, providing a comprehensive overview of the mechanisms underlying obesity-induced hypertension [15,16].

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Explored novel biomarkers suggesting a link between obesity and hypertension. Some of the biomarkers identified include increased levels of pro-inflammatory cytokines, changes in the expression of genes involved in adipocyte metabolism, and fluctuations in hormones that regulate blood pressure. This article confirms that biochemical mechanisms triggered by excess adipose tissue not only underlie vascular dysfunction but also play a crucial role in the pathogenesis of hypertension. These findings pave the way for developing novel diagnostic and therapeutic strategies [17,18].

The Relationship between Alcohol Consumption and Hypertension in the Community in the Working Area of the Simarmata Community Health Center, Simanindo District, Samosir Regency, 2024

The results of statistical tests indicate a relationship between alcohol consumption habits and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024. This has been proven statistically, with a significance value (sig.) of 0.000. This value is smaller than the degree of error (α = 0.05), so it can be concluded that there is a relationship between alcohol consumption habits and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency.

Alcohol consumption is also a significant risk factor for the development of hypertension. The link between alcohol consumption and blood pressure has been demonstrated through numerous studies. Excessive alcohol consumption can increase sympathetic nervous system activity, which causes vasoconstriction (narrowing of blood vessels) and increased heart rate, thus directly raising blood pressure. Alcohol can affect hormonal balance, for example, increasing cortisol levels and disrupting the renin-angiotensin-aldosterone system (RAAS), which plays a role in regulating blood pressure through sodium and water retention. [19].

Excessive alcohol consumption increases the production of free radicals, which can lead to oxidative stress. This contributes to endothelial damage (the inner lining of blood vessels), reducing the blood vessels' ability to vasodilate (widen blood vessels), ultimately leading to increased blood pressure. Many studies have shown a dose-response relationship, where moderate alcohol consumption sometimes has no significant effect on hypertension. Still, heavy consumption (or binge drinking) consistently increases the risk of hypertension. [20,21].

A Prospective study involving thousands of participants examined alcohol consumption patterns and quantity in relation to the development of hypertension. The results showed that high alcohol consumption, especially with irregular drinking patterns, is associated with an increased risk of hypertension. These findings highlight the importance of alcohol consumption patterns and dosage in blood pressure regulation, where excessive consumption significantly increases blood pressure through mechanisms of sympathetic nervous system activation and endothelial dysfunction. [19].

Study on alcohol consumption and its association with hypertension: A population-based study in Korea. In this population-based study, researchers examined the relationship between alcohol consumption and blood pressure in a Korean adult population. The results showed that excessive alcohol consumption was consistently associated with increased blood pressure and the risk of hypertension. This study also described the underlying mechanisms, including increased oxidative stress and inflammation that impair endothelial function, all contributing to an increased risk of hypertension [20,21]. Alcohol consumption, especially when consumed excessively, is a contributing factor to increased blood pressure through various physiological mechanisms. Therefore, controlling alcohol consumption—along with managing other risk factors such as obesity—is an essential component of hypertension prevention and management strategies.

The Relationship between Smoking Habits and Hypertension Incidence in the Community in the Working Area of the Simarmata Health Center, Simanindo District, Samosir Regency, 2024

The results of statistical tests indicate a relationship between smoking habits and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024. This has been proven statistically, with a significance value (sig.) of 0.000. This value is smaller than the degree of error (α = 0.05), so it can be concluded that there is a relationship between smoking habits and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency.

Smoking is also a significant risk factor for increased blood pressure and the development of hypertension. Nicotine and other chemicals in cigarettes stimulate the sympathetic nervous system, leading to increased heart rate and vasoconstriction (narrowing of blood vessels). This process acutely increases blood

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pressure. Cigarette smoke contains numerous free radicals that can cause oxidative stress. This damages the endothelial lining (the inner lining of blood vessels), reducing the blood vessels' ability to vasodilate (widen blood vessels), and increasing inflammation. This endothelial damage plays a role in the development of hypertension. Smoking also increases the risk of atherosclerosis (hardening and narrowing of the arteries) through inflammation and plaque thickening. Atherosclerosis can lead to increased vascular resistance and increased blood pressure. Although some studies suggest that smokers tend to have lower body weight than non-smokers, the effects of smoking on the cardiovascular system, such as endothelial damage and increased oxidative stress, overall increase the risk of hypertension and cardiovascular disease [22,23].

This meta-analysis compiled data from various studies and showed that smoking is significantly associated with increased blood pressure. These findings highlight that the effects of smoking are not only acute but also have long-term impacts on cardiovascular health through mechanisms such as increased oxidative stress and endothelial damage[22,23].

Further scientific evidence was obtained from research by Alzahrani, A., Patel, S., & Singh, R. (2022), who conducted a study entitled "Smoking and Hypertension: Insights from a Longitudinal Cohort Study." This longitudinal study examined the long-term relationship between smoking habits and the development of hypertension[24]. The results revealed that smokers have a higher risk of hypertension than non-smokers, and this relationship is strengthened by mechanisms such as increased sympathetic nervous system activity and impaired endothelial function [24,25]. Smoking increases blood pressure by activating the sympathetic nervous system, oxidative stress, and endothelial damage. This confirms that, in addition to managing other risk factors such as obesity and alcohol consumption, smoking cessation is also an essential step in the prevention and management of hypertension.

The Relationship Between Dietary Patterns and Hypertension Incidence in the Community in the Working Area of the Simarmata Community Health Center, Simanindo District, Samosir Regency, 2024

The results of statistical tests indicate a relationship between dietary patterns and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency, in 2024. This has been proven statistically, with a significance value (sig.) of 0.018. This value is smaller than the degree of error ($\alpha = 0.05$), so it can be concluded that there is a relationship between dietary patterns and the incidence of hypertension in the community in the working area of the Simarmata Health Center, Simanindo District, Samosir Regency.

Several studies have shown that the high-salt diet of the Toba Batak people contributes to the incidence of hypertension. Nababan (2020) found that the consumption of salt-rich foods in Paniaran Village, Siborong-borong District, correlated with a high prevalence of hypertension in the elderly [26]. Another study by Krisnawati (2009) at the HKBP Manyar Church in Surabaya also revealed a relationship between the diet and lifestyle of the Batak people and the incidence of hypertension [27]. Furthermore, Lubis (2022) confirmed that excessive salt consumption in the elderly in Joring Natobang Village, Angkola Julu District, significantly increased the risk of hypertension. These findings indicate that the habit of high salt consumption in the Toba Batak people's dietary culture may be a significant risk factor in the increasing prevalence of hypertension [28].

Diet plays a crucial role in regulating blood pressure and preventing hypertension. Excessive salt consumption increases gas retention in the body, increasing blood volume and the workload on the heart and blood vessels. This contributes to increased blood pressure. Reducing salt intake is a key recommendation in managing hypertension. Diets high in saturated and trans fats can improve blood cholesterol levels, accelerate atherosclerosis (hardening and narrowing of the arteries), and disrupt endothelial function. This endothelial damage reduces the blood vessels' ability to dilate normally, thereby increasing blood pressure [29].

A diet high in sugar, particularly from sugary drinks and processed foods, not only increases the risk of obesity but also contributes to insulin resistance and inflammation. All of these factors are known risk factors for the development of hypertension. The DASH diet (*Dietary Approaches to Stop Hypertension*) emphasizes consuming fruits, vegetables, whole grains, and low-fat dairy products, while reducing salt, saturated fat, and sugar intake. Many studies have shown that the DASH diet effectively lowers blood pressure. Mediterranean Diet: This diet, rich in fruits, vegetables, nuts, fish, olive oil, and whole grains, has been linked to a reduced risk of cardiovascular disease, including hypertension. The nutrients it contains, such as antioxidants, potassium, and fiber, help reduce oxidative stress and inflammation [30].

A balanced diet can help lower blood pressure through several mechanisms. Increasing potassium availability helps counteract the effects of sodium and increases sodium excretion through the kidneys, thus

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helping to lower blood pressure. Nutrients such as vitamins, minerals, and antioxidants in fruits and vegetables can combat oxidative stress and inflammation, contributing to endothelial dysfunction. A healthy diet helps maintain blood vessel elasticity and improves vasodilatory responses, thereby improving circulation and reducing blood pressure [29]

Dia, FJ, Li, J., & MacGregor, GA (2020) conducted a study on "The effect of long-term salt reduction on blood pressure," using the Cochrane Database of Systematic Reviews in 2020. This Cochrane study evaluated the impact of long-term salt reduction on blood pressure. The analysis showed that moderate salt reduction significantly lowers blood pressure, especially in individuals with hypertension. These findings support adopting a low-salt diet as part of a hypertension control strategy [29].

Another study by Wang, Cuicui, et al. (2022) revealed the relationship between various dietary patterns and the risk of hypertension based on data from several cohort studies. The results showed that a diet rich in fruits, vegetables, whole grains, and low-fat dairy products (as recommended in the DASH diet) was consistently associated with a reduced risk of hypertension [31]. This study underscores the importance of dietary quality in blood pressure regulation and cardiovascular disease prevention .

An unhealthy diet characterized by high salt, saturated fat, and sugar intake can increase the risk of hypertension through various physiological mechanisms. Conversely, adopting a healthy eating pattern such as the DASH or Mediterranean diet can help lower blood pressure and reduce the risk of cardiovascular disease. Dietary control is an essential approach in hypertension prevention and management strategies.

Conclusion

Based on the overall findings of this study, it can be concluded that there is a significant association between Body Mass Index (BMI), alcohol consumption, smoking habits, and dietary patterns with the incidence of hypertension in the working area of Simarmata Public Health Center. Among these four factors, smoking was identified as the most dominant determinant, with smokers having a 9.758 times higher risk of developing hypertension compared to non-smokers after controlling for other variables. This finding reinforces the evidence that smoking is a serious health threat that significantly contributes to the burden of hypertension in this rural area. Furthermore, the high prevalence of traditional alcohol (tuak) consumption, particularly among men (73.1%), and the majority of respondents with unhealthy dietary patterns (62.3%) exacerbate the condition. Therefore, hypertension prevention and control efforts in this region must prioritize community-based and culturally sensitive promotive-preventive approaches, focusing on intensive health education programs about the dangers of smoking, campaigns to reduce alcohol and salt consumption, and community empowerment through the modification of traditional dietary habits into healthier patterns without diminishing their cultural values. A strong commitment from all stakeholders is essential to create an environment that supports healthy lifestyles and reduces the incidence of hypertension in Samosir Regency.

Conflict of Interest

The author declares no competing interests and asserts that the research was conducted autonomously, safeguarding the impartiality and validity of the results.

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Supplementary Materials

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