Geographical Disparities in Blood Pressure and Dietary Patterns: A Comparative Study of Mountainous and Coastal Communities in Gorontalo, Indonesia

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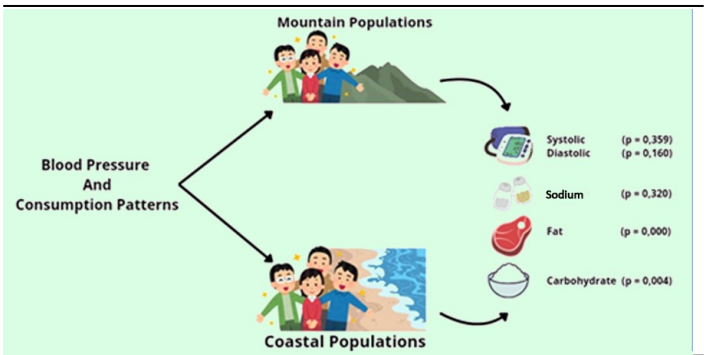
ABSTRACT

Hypertension, a leading cause of early death worldwide, affects 1.94% of the population in Gorontalo Regency, according to the local Health Department. However, limited studies have examined the relationship between hypertension prevalence and dietary patterns among mountain and coastal communities in this region. The purpose of this study was to explore differences in blood pressure and consumption patterns between people living in mountain areas and coastal areas in Gorontalo District. This research employed an analytic observational design with a cross-sectional approach. The study included 126 participants living in mountain and coastal areas of Gorontalo District, selected using a cluster random sampling technique. Data were collected using a 24-hour food recall questionnaire and a tension meter. The data were analyzed using the chi-square test. The findings revealed no significant differences in systolic blood pressure ($p = 0.359$, $p > 0.05$), diastolic blood pressure ($p = 0.160$, $p > 0.05$), or sodium consumption patterns ($p = 0.324$, $p > 0.05$) between residents of mountainous and coastal areas. However, significant differences were found in fat consumption patterns ($p = 0.000$, $p < 0.05$) and carbohydrate consumption patterns ($p = 0.004$, $p < 0.05$) between the two groups. It is recommended that residents regularly monitor their blood pressure to detect potential increases and reduce excessive salt consumption.

ABSTRAK

Hipertensi, sebagai salah satu penyebab utama kematian dini di dunia, tercatat mempengaruhi 1,94% penduduk Kabupaten Gorontalo menurut data Dinas Kesehatan setempat. Namun, kajian yang menghubungkan prevalensi hipertensi dengan pola konsumsi pada masyarakat pegunungan dan pesisir di wilayah ini masih sangat terbatas. Tujuan Penelitian untuk mengeksplor adakah perbedaan tekanan darah dan pola konsumsi antara penduduk yang tinggal di daerah pegunungan dengan pesisir pantai di Kabupaten Gorontalo. Jenis penelitian yang digunakan adalah observasional analitik, dengan menggunakan pendekatan cross sectional. Sampel dalam penelitian ini adalah penduduk yang tinggal di daerah pegunungan dengan pesisir pantai di Kabupaten Gorontalo sebanyak 126 sampel, dengan teknik pengambilan sampel menggunakan cluster random sampling. Data dikumpulkan menggunkan kuesioner food recall 24 jam dan tensimeter. Analisis data yang digunakan adalah uji chi square. Hasil penelitian menunjukkan bahwa tidak ada perbedaan tekanan darah sistol (p value = 0,359) > 0,05, tekanan darah diastol (p value = 0,160) > 0,05, dan pola konsumsi natrium (p value = 0,324) > 0,05 antara penduduk yang tinggal di daerah pegunungan dengan pesisir. Ada perbedaan pola konsumsi lemak (p value = 0,000) < 0,05 dan pola konsumsi karbohidrat (p value = 0,004) < α 0,05 antara penduduk yang tinggal di daerah pegunungan dengan pesisir pantai di Kabupaten Gorontalo. Diharapakan kepada penduduk agar dapat melakukan pemeriksaan tekanan darah secara rutin untuk mendeteksi adanya kenaikan tekanan darah dan mengurangi konsumsi garam berlebihan.

GRAPHICAL ABSTRACT



Keyword
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INTRODUCTION

The consumption patterns of society play a significant role in the prevalence of hypertension, one of the major global health challenges (Zhou et al., 2021). High intake of sodium, saturated fats, and refined carbohydrates, coupled with low consumption of fiber, potassium, magnesium, and calcium, are key factors contributing to the risk of hypertension (Mills et al., 2020). Hypertension is one of the leading causes of premature mortality worldwide. In 2020, approximately 1.56 billion adults were living with hypertension. It claims nearly 8 million lives annually, and nearly 1.5 million adults in Southeast Asia suffer from hypertension (Meher et al., 2023; Oktaviyani et al., 2022). Other contributing factors, such as a sedentary lifestyle, chronic stress, and urbanization-induced changes in traditional dietary patterns, further exacerbate this condition (Martín-Rodríguez et al., 2022). If dietary patterns remain unregulated, hypertension can lead to severe complications, including cardiovascular diseases, kidney failure, and metabolic disorders, which adversely affect quality of life and increase economic burdens. Therefore, public health interventions promoting healthy eating habits, increasing physical activity, and managing stress are essential to mitigate the adverse impacts of hypertension (Carey et al., 2018).

Data from the World Health Organization (WHO) in 2015 indicated that approximately 1.13 billion people globally were living with hypertension. The number of individuals affected by hypertension continues to rise annually, with an estimated 1.5 billion cases projected by 2025 and approximately 10.44 million deaths occurring each year due to hypertension and its complications (Ministry of Health, 2019).

The high prevalence of hypertension is observed not only in developed countries but also in developing nations, such as Indonesia. Findings from Basic Health Research (2018) showed a hypertension prevalence rate of 34.1%, a significant increase from 25.8% in 2013. The highest prevalence was recorded in South Kalimantan Province at 44.1%, while the lowest was observed in Papua Province at 22.2%. Data from the Gorontalo Provincial Health Office in 2018 revealed 19,175 cases of hypertension, equivalent to 1.64% of the population, with the highest number reported in Gorontalo Regency at 7,276 cases or 1.94%. In 2019, the number of hypertension cases rose to 9,763, with Gorontalo Regency still reporting the highest incidence at 6,036 cases or 61.8% (Gorontalo District Health Office, 2018a). According to the Gorontalo Regency Health Office, in 2016, there were 3,629 cases of hypertension among individuals aged 20–44 years and 5,349 cases among those aged 45–54 years. In 2017, the cases among individuals aged 20–44 years increased to 3,664, while those aged 45–54 years recorded 4,295 cases. By 2018, the number of cases among individuals aged 20–44 years rose to 3,961, whereas the figure for those aged 45–54 years decreased to 2,266 cases (Gorontalo District Health Office, 2018b).

In developing countries, a study by Sajid et al. (2024) and Yu et al. (2021) found that traditional diets rich in fiber and low in sodium offer greater protection against hypertension compared to modern diets high in saturated fats. Similarly, a study by Mohan et al. (2023) in China, Appiah et al. (2021) in Ghana, Mphekgwana et al. (2020) in South Africa and Amiri et al. (2019) in Iran, comparing hypertension prevalence in rural and urban communities revealed that dietary changes driven by urbanization contribute to increased blood pressure at populations. While these studies provide valuable insights into consumption patterns and hypertension, most focus on differences due to urbanization or specific dietary interventions. However, research comparing consumption patterns and hypertension based on geographical conditions, such as mountainous versus coastal regions, remains limited, particularly in Indonesia. The aim of this study is to examine differences in blood pressure and consumption patterns among residents living in mountainous and coastal areas of Gorontalo Regency.

METHODS

This study employed an observational analytic design with a cross-sectional approach to examine the differences in blood pressure and consumption patterns between residents in mountainous and coastal regions of Gorontalo Regency. The research was conducted from June to July 2024 in two selected locations: Dulamayo Selatan Village, representing the mountainous region, and Bongo Village, representing the coastal area. The selection of these research locations was based on their geographical and demographic characteristics, which reflect differences in consumption patterns between mountainous and coastal populations. Dulamayo Selatan Village, situated at a high altitude with limited access to processed food products, was assumed to have distinct consumption patterns compared to Bongo Village, which has easier access to processed foods due to its coastal location. Additionally, the two locations exhibit differences in physical activity and environmental conditions that may influence the residents' blood pressure.

The study population included all residents of the two villages, comprising 1,763 individuals in the mountainous region and 704 individuals in the coastal region. The research sample consisted of 126 respondents (63 from each village), selected using a cluster random sampling technique. This method involved grouping the population by village and then randomly selecting samples from each cluster using resident lists provided by local authorities. Inclusion criteria included individuals aged ≥18 years, residing in the study area for at least six months, and willing to participate by signing an informed consent form. Exclusion criteria encompassed residents with a history of chronic hypertension diagnosed prior to the study and individuals with medical conditions affecting dietary patterns or blood pressure.

The dependent variable in this study was the place of residence (mountainous or coastal region). Independent variables included blood pressure (systolic and diastolic) and consumption patterns, which comprised sodium, fat, and carbohydrate intake. Instruments used in the study included a questionnaire to gather demographic and dietary habit data, validated by prior research; a stethoscope and sphygmomanometer for measuring blood pressure, adhering to American Heart Association standards (Benjamin et al., 2018); and a 24-hour dietary recall for collecting daily consumption data, based on the Food and Agriculture Organization (2017) protocol.

Data collection was carried out through structured interviews using questionnaires and a 24-hour dietary recall. Blood pressure measurements were conducted by trained healthcare workers using calibrated digital sphygmomanometers. Prior to data collection, all respondents were provided with a detailed explanation of the study and asked to sign an informed consent form as an agreement to participate. Data analysis was performed using the chi-square test to determine the association between blood pressure and consumption patterns with the place of residence.

RESULTS

Table 1 presents the distribution of respondents based on age groups. Among the 63 respondents (100%) residing in the mountainous region, the majority were aged 30–39 years, with 39 individuals (61.9%), while the least represented age group was those aged >50 years, with only 2 individuals (3.2%). Similarly, among the respondents residing in the coastal area, the majority were also aged 30–39 years, comprising 31 individuals (49.2%), while the least represented age group was those aged >50 years, with only 2 individuals (3.2%).

The distribution of respondents based on occupation shows that among the 63 respondents (100%) in the mountainous region, the majority were homemakers, totaling 31 individuals (49.2%), while the fewest were self-employed workers, with only 2 individuals (3.2%). In the coastal area, the majority of re-

Table 1
Distribution of respondents by characteristics

Characteristic	Mountainous		Coastal		Total	
	n	%	n	%	N	%
Age						
20–29	10	15.9	21	33.3	31	24.6
30–39	39	61.9	31	49.2	70	55.6
40–49	12	19	9	14.3	21	16.7
> 50	2	3.2	2	3.2	4	3.2
Occupation						
Farmer	15	23.8	0	0	15	11.9
Fisherman	0	0	24	38.1	24	19
Government/Contract Worker	4	6.3	9	14.3	13	10.3
Laborer	4	6.3	11	17.5	15	11.9
Self-Employed	7	11.1	0	0	7	5.6
Homemaker	31	49.2	30	47.6	61	48.4
Education						
Elementary School	30	47.6	31	49.2	61	48.4
Junior High School	25	39.7	10	15.9	35	27.8
Senior High School	7	11.1	13	20.6	20	15.9
Bachelor's Degree	1	1.6	9	14.3	10	7.9

spondents were also homemakers, comprising 30 individuals (47.6%), while the least represented occupation was contractual/government employees, totaling 9 individuals (14.3%).

The distribution of respondents based on educational attainment indicates that among the 63 respondents (100%) in the mountainous region, the majority had an elementary school education, with 30 individuals (47.6%), while the fewest had a bachelor's degree (S1), with only 1 individual (1.6%). Similarly, in the coastal area, the majority of respondents had an elementary school education, comprising 31 individuals (49.2%), while the fewest had a bachelor's degree (S1), totaling 9 individuals (14.3%).

Table 2 shows the distribution of respondents based on blood pressure and dietary patterns. Among the 63 respondents (100%) residing in the mountainous region, the majority had systolic blood pressure within the normal range, totaling 36 individuals (57.1%), while the minority had elevated systolic blood pressure, with 27 individuals (42.9%). In contrast, among respondents in the coastal area, the majority also had normal systolic blood pressure, comprising 42 individuals (66.7%), whereas the minority had elevated systolic blood pressure, totaling 21 individuals (33.3%).

Regarding diastolic blood pressure, most respondents in the mountainous region had normal diastolic blood pressure, with 50 individuals (79.4%), while the fewest had high diastolic blood pressure, totaling 13 individuals (20.6%). Similarly, in the coastal area, the majority had normal diastolic blood pressure, comprising 42 individuals (66.7%), whereas the fewest had elevated diastolic blood pressure, with 21 individuals (33.3%).

The distribution based on sodium consumption patterns indicates that among the mountainous respondents, the majority had normal sodium intake, with 48 individuals (76.4%), while the fewest had high sodium intake, totaling 15 individuals (23.8%). Conversely, in the coastal area, the majority of respondents also had normal sodium intake, comprising 42 individuals (66.7%), while the fewest had high sodium intake, with 21 individuals (33.3%).

For fat consumption patterns, most respondents in the mountainous region had inadequate fat intake, with 41 individuals (65.1%), while the minority had adequate fat intake, totaling 22 individuals (34.9%). In contrast, in the coastal area, the majority of respondents had

Table 2
Distribution of respondents by mountainous and coastal regions

Variable	Mountainous		Coastal		Total	
	n	%	n	%	N	%
Systolic Blood Pressure						
Normal	36	57.1	42	66.7	78	61.9
High	27	42.9	21	33.3	48	38.1
Diastolic Blood Pressure						
Normal	50	79.4	42	66.7	92	73
High	13	20.6	21	33.3	34	27
Sodium Consumption Pattern						
Normal	48	76.2	42	66.7	90	71.4
High	15	23.8	21	33.3	36	28.6
Fat Consumption Pattern						
Adequate	22	34.9	47	74.6	69	54.8
Inadequate	41	65.1	16	25.4	57	45.2
Carbohydrate Consumption Pattern						
Adequate	45	71.4	28	44.4	73	57.9
Inadequate	18	28.6	35	55.6	53	42.1

adequate fat intake, with 47 individuals (74.6%), whereas the minority had inadequate fat intake, comprising 16 individuals (25.4%).

Regarding carbohydrate consumption patterns, the majority of respondents in the mountainous region had adequate carbohydrate intake, totaling 45 individuals (71.4%), while the fewest had inadequate carbohydrate intake, comprising 18 individuals (28.6%). In contrast, among respondents in the coastal area, the majority had inadequate carbohydrate intake, with 35 individuals (55.6%), while the minority had adequate carbohydrate intake, totaling 28 individuals (44.4%).

Table 3 illustrates the results of the analysis. Among residents in the mountainous region, the majority had normal diastolic blood pressure, totaling 50 individuals (79.4%), while the minority had elevated diastolic blood pressure, comprising 13 individuals (20.6%). In contrast, among residents in the coastal area, the majority also had normal diastolic blood pressure, with 42 individuals (66.7%), whereas the minority had elevated diastolic blood pressure, totaling 21 individuals (33.3%). The chi-square statistical test yielded a p-value of 0.160, which is greater than the significance level (α) of 0.05. This indicates no significant difference in diastolic blood pressure between residents in mountainous and coastal regions of Gorontalo Regency.

The analysis further showed that among residents in the mountainous region, the majority had normal sodium consumption, with 48 individuals (76.4%), while the minority had high sodium consumption, totaling 15 individuals (23.8%). Similarly, among residents in the coastal area, the majority also had normal sodium consumption, comprising 42 individuals (66.7%), while the minority had high sodium consumption, with 21 individuals (33.3%). The chi-square statistical test yielded a p-value of 0.324, which is greater than the significance level (α) of 0.05. This indicates that the null hypothesis (H0) is accepted, and the alternative hypothesis (Ha) is rejected, showing no significant difference in sodium consumption patterns between residents in mountainous and coastal regions of Gorontalo Regency.

The analysis revealed that among residents in the mountainous region, the majority had inadequate fat consumption, totaling 41 individuals (65.1%), while the minority had adequate fat consumption, comprising 22 individuals (34.9%). Conversely, among residents in the coastal area, the majority had adequate fat consumption, with 47 individuals (74.6%), whereas the minority had inadequate fat consumption, totaling 16 individuals (25.4%). The

Table 3
Differences between residents in mountainous and coastal regions

Variable	Mountainous		Coastal		Total		P-value
	n	%	n	%	N	%	
Systolic Blood Pressure							
Normal (≤120 mmHg)	36	57.1	42	66.7	78	61.9	0.359
High (≥140 mmHg)	27	42.9	21	33.3	48	38.1	
Diastolic Blood Pressure							
Normal (≤80 mmHg)	50	79.4	42	66.7	92	73	0.160
High (≥90 mmHg)	13	20.6	21	33.3	34	27	
Sodium Consumption Pattern							
Normal (≤2 tsp/day)	48	76.2	42	66.7	90	71.4	0.324
High (>2 tsp/day)	15	23.8	21	33.3	36	28.6	
Fat Consumption Pattern							
Adequate (≥80% RDI)	22	34.9	47	74.6	69	54.8	0.000*
Inadequate (<80% RDI)	41	65.1	16	25.4	57	45.2	
Carbohydrate Consumption Pattern							
Adequate (≥80% RDI)	45	71.4	28	44.4	73	57.9	0.004*
Inadequate (<80% RDI)	18	28.6	35	55.6	53	42.1	

Note: *p < 0.05; tsp = Teaspoon; RDI = Recommended Dietary Allowance

chi-square statistical test yielded a p-value of 0.000, which is less than the significance level (α) of 0.05. This indicates that the alternative hypothesis (Ha) is accepted, and the null hypothesis (H0) is rejected, showing a significant difference in fat consumption patterns between residents in mountainous and coastal regions of Gorontalo Regency.

The analysis also showed that among residents in the mountainous region, the majority had adequate carbohydrate consumption, with 45 individuals (71.4%), while the minority had inadequate carbohydrate consumption, comprising 18 individuals (28.6%). In contrast, among residents in the coastal area, the majority had inadequate carbohydrate consumption, totaling 35 individuals (55.6%), while the minority had adequate carbohydrate consumption, with 28 individuals (44.4%). The chi-square statistical test yielded a p-value of 0.004, which is less than the significance level (α) of 0.05. This indicates that the alternative hypothesis (Ha) is accepted, and the null hypothesis (H0) is rejected, showing a significant difference in carbohydrate consumption patterns between residents in mountainous and coastal regions of Gorontalo Regency.

DISCUSSION

Systolic Blood Pressure

Systolic blood pressure is the amount of pressure in the blood vessels when the heart contracts to pump blood. In blood pressure readings, the upper value represents the systolic blood pressure. Systolic blood pressure increases progressively until the age of 70–80 years (Chen et al., 2021).

The chi-square test results showed a p-value of 0.359 (greater than α = 0.05), indicating no significant difference in systolic blood pressure between residents living in mountainous regions and those in coastal areas of Gorontalo Regency. With the acceptance of the null hypothesis (H0) and rejection of the alternative hypothesis (Ha), it can be concluded that residential location—whether in mountainous or coastal areas—does not significantly influence variations in blood pressure among residents. This finding may be attributed to other factors influencing blood pressure, such as dietary patterns, physical activity, access to healthcare services, or genetic factors, which may play a more dominant role than geographical environmental influences.

Research indicates significant differences in blood pressure between populations

residing in mountainous and coastal regions. In highland areas, such as those studied in Bengkulu, Indonesia, lower salt consumption and dietary habits contribute to more stable blood pressure levels compared to coastal populations, where high salt intake is prevalent due to dietary preferences and environmental factors (Siregar et al., 2021; Lilin, 2024). Coastal communities often experience higher blood pressure due to increased salt consumption, which is exacerbated by the high humidity and salty air typical of these regions (Lilin, 2024).

Moreover, studies have shown that the prevalence of hypertension is notably higher in coastal populations, with factors such as lifestyle and dietary habits playing a critical role (Ismah et al., 2021; Harris et al., 2019; Wiliyanarti, 2024). For instance, elderly individuals in coastal areas are particularly vulnerable to hypertension due to poor dietary practices, including excessive salt intake (Amelia & Harahap, 2019; Farapti et al., 2020). Thus, the environmental and lifestyle differences between mountainous and coastal regions significantly influence blood pressure levels, highlighting the need for targeted public health interventions in coastal communities to mitigate hypertension risks (Wiliyanarti, 2024; Amelia & Harahap, 2019; Farapti et al., 2020).

Although there may be physiological variations due to environmental factors, such as altitude, the statistical analysis did not indicate a meaningful difference. Higher altitudes are associated with lower air pressure, a phenomenon influenced by Earth's gravity. Long-term exposure to high-altitude environments may lead to increased red blood cell production as a physiological adaptation (Kandil et al., 2023; Li & Wang, 2022; Verberk & Mieke, 2016).

The average systolic blood pressure among residents of both mountainous and coastal regions was 120 mmHg, with 73 residents in total reporting this measurement. Sodium consumption patterns in both regions were similar, primarily from table salt added to food, with substantial sodium intake observed in both populations.

Diastolic Blood Pressure

Diastolic blood pressure refers to the amount of pressure in the blood vessels when the heart is at rest between beats (Kandil et al., 2023). In blood pressure readings, the lower value represents diastolic pressure. Diastolic blood pressure tends to increase between the ages of 50–60 years, after which it stabilizes or slightly decreases (Jacobsen et al., 2022; Flint et al., 2019).

The chi-square test results showed a p-value of 0.160 (greater than $\alpha = 0.05$), indicating no significant difference in diastolic blood pressure between residents living in mountainous and coastal regions of Gorontalo Regency. With the acceptance of the null hypothesis (H0) and rejection of the alternative hypothesis (Ha), it can be concluded that the residential location—whether in mountainous or coastal areas—does not significantly affect differences in diastolic blood pressure among residents. These findings suggest that other factors, such as lifestyle, dietary habits, and access to healthcare services, may have a greater impact on blood pressure conditions than the geographical environment under study.

Environmental factors, including residential location, dietary patterns, and physical activity levels, may influence blood pressure. For instance, lower vegetable consumption in coastal areas could impact blood pressure. Additionally, advancements in modern living have contributed to changing lifestyles, which may affect blood pressure values in both mountainous and coastal populations (Beddhu et al., 2018; Khan et al., 2018).

Sodium Consumption Patterns

Sodium is the most abundant cation in extracellular fluid, with 35–40% of sodium (Na) stored in the skeletal system. Under normal conditions, sodium excretion by the kidneys is regulated to maintain a balance between intake and excretion, keeping extracellular flu-

id volume stable (Grillo et al., 2019; Prot-Bertoye et al., 2022).

The chi-square test results, with a p-value of 0.324 (greater than α = 0.05), indicate that there is no significant difference in sodium consumption patterns between residents living in mountainous and coastal areas of Gorontalo Regency. With the null hypothesis (H0) accepted and the alternative hypothesis (Ha) rejected, it can be concluded that residential location—whether in mountainous or coastal areas—does not significantly influence sodium consumption patterns.

This finding suggests that other factors, such as daily eating habits, local cultural practices, or access to specific types of food, may play a more prominent role in sodium consumption patterns than geographical differences. This conclusion aligns with the study by Rivanli in Bolaang Mongondow Barat Regency, which found no association between serum sodium levels and systolic or diastolic blood pressure, reporting p-values of 0.514 and 0.526, respectively (>0.05). However, these findings contradict research by Jusniar, which identified differences in dietary sodium consumption between coastal and mountainous regions, with a significant p-value of 0.026 (<0.05).

Sodium consumption in both regions largely falls within the normal range, with most residents consuming less than two teaspoons per day. Sodium consumption patterns significantly impact systolic and diastolic blood pressure, as residents in both mountainous and coastal regions often consume foods with high sodium content, primarily from added table salt used to enhance flavor.

Fat Consumption Patterns

Fat is a structural component of all body cells and is essential for physiological processes. It comprises triglycerides, phospholipids, and sterols, each with specific functions vital to human health. There is a significant difference in fat consumption patterns between residents in mountainous and coastal areas of Gorontalo Regency, with a p-value of 0.000. This finding is consistent with research by Anggun, which identified a relationship between fat intake and hypertension incidence (p-value < 0.05). Similarly, a study by Irwanto et al. (2023) reported an association between fat consumption and blood pressure in hypertensive female patients of Minangkabau ethnicity. In contrast, their analysis of sodium consumption and blood pressure in the same population revealed no significant association, with a p-value of 0.999.

Fat consumption in coastal areas is primarily sourced from fresh fish, anchovies, and fried foods, resulting in higher fat intake compared to residents in mountainous regions. Educational attainment plays a crucial role in understanding the causes of excessive fat consumption and identifying high-fat foods. Most residents in both mountainous and coastal areas have elementary school education, limiting their knowledge of the risks associated with high-fat diets and the sources of foods rich in fat (Andarwulan et al., 2021).

Carbohydrate Consumption Patterns

Carbohydrates are the primary source of energy for the body, commonly found in foods in the form of starches and sugars. Sources of carbohydrates include grains, dried legumes, and root vegetables such as carrots (Wang et al., 2019).

There is a significant difference in carbohydrate consumption patterns between residents in mountainous and coastal areas of Gorontalo Regency, with a p-value of 0.004. This finding aligns with the study by Eko, which identified differences in dietary patterns between mountain and coastal communities, showing that carbohydrate consumption is higher among mountain residents compared to coastal residents, with a significance value of p > 0.05. The higher carbohydrate consumption among mountain residents is attributed to geographical differences.

In mountainous areas, most residents

are farmers who produce a variety of crops, whereas in coastal areas, the majority are fishermen whose livelihoods depend on marine resources. Consequently, mountain residents have greater access to carbohydrate-rich foods such as legumes, tubers, and vegetables (Byun et al., 2019; Li et al., 2021; Jiang et al., 2022).

This study has several strengths, including a clear comparative design between two geographical groups, allowing for a detailed analysis of differences in blood pressure and dietary patterns. The appropriate use of chi-square tests enhances the statistical validity of the results, and the findings are relevant for the development of public health policies that consider geographical environmental factors.

However, the study has certain limitations. It did not control for other variables that may influence blood pressure and dietary patterns, such as socioeconomic factors, lifestyle habits, and access to healthcare. Additionally, the study's sample, limited to Gorontalo Regency, restricts the generalizability of the findings to a broader population. The cross-sectional design of the study prevents direct identification of causal relationships. Another limitation is the reliance on self-reported dietary data, which may be subject to recall bias or reporting errors.

CONCLUSIONS

The study found significant differences in fat and carbohydrate consumption patterns between residents in mountainous and coastal areas of Gorontalo Regency. These findings contribute to understanding variations in blood pressure and dietary patterns between mountain and coastal populations, which can be used to design more effective public health intervention strategies based on geographical environmental factors. Future studies should aim to address some of the limitations highlighted in this research. First, controlling for additional variables such as socioeconomic factors, lifestyle habits (e.g., smoking, physical activity, alcohol consumption), and access to healthcare is recommended to better isolate the independent effects of geographical environmental factors on blood pressure and dietary patterns. Second, expanding the sample population to include regions beyond Gorontalo Regency would improve the generalizability of the findings to broader populations. Lastly, adopting a longitudinal study design could provide deeper insights into the causal relationships between geographical environment, dietary patterns, and blood pressure, while also allowing for the observation of changes over time. It is recommended that the Gorontalo District Health Office conduct more health education programs in both mountainous and coastal areas. Such initiatives can help communities understand the factors influencing blood pressure and dietary patterns, particularly the risks associated with excessive salt consumption.

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AUTHORS' CONTRIBUTIONS

Marselia Sandalayuk designed the study, formulated the concept, performed the field work. Yeni Paramata wrote and reviewed the manuscript. Ririn Pakaya enrolled participants and collected data. Maesarah Yasin acquired and analyzed the data. Herman Hatta revised the manuscript. Nuryani Nuryani read and approved the final manuscript.

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COMPETING INTERESTS

The authors confirm that all of the text, figures, and tables in the submitted manuscript work are original work created by the authors and that there are no competing professional, financial, or personal interests from other parties.

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