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The Effect of Residential Proximity to the Beach and Industrial Area on the Incidence of Hypertension in Kendal District

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Abstract

The hospital is one of the institutions engaged in health services. The Hypertension is when the results of systolic blood pressure (SBP) measurements are ≥140 mmHg and/or diastolic blood pressure (DBP) are ≥90 mmHg. According to the World Health Organization, hypertension in 2015 was around 1.13 billion and is estimated to be 1.5 billion in 2025. The prevalence in Indonesia in 2023 was around 30.8% and in Kendal it continues to increase every year. People living in coastal areas have risk factors for hypertension such as salt consumption, consumption of foods high in sodium (shrimp, dried fish and salted fish), and lack of physical activity. Various types of air pollutants such as particulate matter (PM) are widely recorded as being associated with cardiovascular disease, especially in industrial areas and big cities. Objective: This study is to analyze the effect of proximity to the beach and industrial areas on the incidence of hypertension in Kendal Regency. Method: This study uses observational analytics with a cross-sectional research design. The sampling technique used is purposive sampling. Univariate and bivariate analysis using the Chi-Square test. Results: Significant results were obtained based on the Chi-Square test on the effect of residence in coastal areas and industrial areas on the occurrence of hypertension with a p-value of 0.000 (p-value <0.05). Conclusion: This study shows the effect of proximity to the beach and industrial areas on the incidence of hypertension in Kendal Regency.

Introduction

Hypertension is commonly referred to as a chronic disease and ranks high among cardiovascular death risk factors (Dybiec et al ., 2023). Blood pressure has two measurements, namely systolic pressure (pressure when the heart contracts and pumps blood into the arteries) and diastolic pressure (pressure when resting heart between beats). A person has hypertension when the results of systolic blood pressure (SBP) measurements are ≥140 mmHg and/or diastolic blood pressure (DBP) are ≥90 mmHg (Wati et al., 2023).

Globally, based on WHO data (2023) shows that hypertension has increased in people in the world from 594 million in 1975 to around 1.13 billion in 2015 (Rizqiya et al ., 2023). In 2025, it is estimated that there will be 1.5 billion people suffering from hypertension and every year there are 9.4 million people who die from hypertension and complications (Purwono et al., 2020).

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Based on the results of the 2023 Indonesian Health Survey (SKI), the prevalence of hypertension was 30.8% (Ministry of Health of the Republic of Indonesia, 2023). Meanwhile, in the 2018 Basic Health Research (Riskesdas), the prevalence of hypertension was 34.1%, which increased from the 2013 Riskesdas of 25.8% (Tika, 2021). In 2021, Central Java is still the province with the largest proportion of NCD cases, namely 76.5% (Sriyanto et al ., 2017). The prevalence of hypertension in Kendal Regency continues to increase every year by 9.74% in 2019, 18.21% in 2020, and 32.32% in 2021 (Hintari & Fibriana, 2023).

People living in coastal areas have risk factors for hypertension such as salt consumption, consumption of foods high in sodium (shrimp, dried fish and salted fish), and lack of physical activity (Fitri et al ., 2022) . Based on the results of Rahmadhani's research (2021), statistical test analysis concluded that there was a significant relationship between salt intake and hypertension with a p value = 0.000 (p <0.05) which means it is very significant (Rahmadhani, 2021) . However, this is different from the research of Rokot et al. (2019) who stated that as many as 38.5% of people who eat sea fish mostly have normal blood pressure and said that there was no relationship between sea fish consumption and the incidence of hypertension (Rokot et al ., 2019; Samiei et al., 2024).

Various types of air pollutants such as particulate matter (PM) have been widely recorded as being associated with cardiovascular disease , especially in industrial areas and large cities (Zhang et al ., 2023; Du et al., 2016). According to the results of a study by Jing Xu et al. in 2022, the higher the level of air pollution, the stronger the relationship with hypertension (Xu et al ., 2022) . This is different from Kephart's study (2020) which found that increased CO exposure caused a decrease in systolic blood pressure of 0.17 mmHg (95% CI = -2.38, 2.03) and CO had no association with diastolic blood pressure (- 0.06 mmHg, 95% CI -1.48 to 1.35) (Kephart et al ., 2020).

Based on this background, there are differences in research results so that researchers are interested in conducting this research to prove whether there is an influence related to residence in coastal areas and industrial areas with the occurrence of hypertension in Kendal Regency.

Methods

The method used is observational analytic with a cross-sectional approach. This study was conducted at the Cepiring Health Center (Coastal Area), Brangsong Health Center (Industrial Area), and Patebon Health Center (Area far from the coast and industrial areas). The sample was participants of the Integrated Development Post (Posbindu) in May to July 2024 who lived in coastal areas (Cepiring Health Center), industrial areas (Brangsong Health Center), and not both (Patebon Health Center). The sample size was calculated using the lemeshow formula and a minimum of 96 samples were obtained in each health center. Sampling was carried out using a purposive sampling type where the samples were taken based on certain criteria. The inclusion criteria for this study were s all posbindu participants in coastal areas (Cepiring Health Center), industrial areas (Brangsong Health Center), and not both areas (Patebon Health Center), all posbindu participants aged ≥40 years, and have complete health records (address and blood pressure). The type of data used in this study is secondary data. The variables studied were coastal area residence with the criteria of near the beach and far from the beach, as well as industrial area residence with the criteria of near industry and far from industry which will be measured using Google Earth, and blood pressure variables with the criteria of no hypertension (systolic <140 mmHg or diastolic <90 mmHg) and hypertension (systolic ≥140 mmHg or diastolic ≥90 mmHg). Data analysis was carried out univariately and bivariately. The statistical test used was the Chi-Square test with a confidence level of 95% (0.05). The researcher has obtained a research permit from the Faculty of Medicine, Muhammadiyah University of Surakarta No.4377./C.4-III/FK/VIII/2024 and research approval from the Head of the National Unity and Politics Agency of Kendal Regency No. 000.9/1537/VIII/2024.

Result and Discussion

Secondary data in this study are residential address, blood pressure, gender and age. The research data were analyzed using *SPSS 25.0 for Windows software* consisting of univariate analysis to determine the frequency distribution and bivariate analysis using the *Chi-Square test.* The following are the results of the data analysis:

Respondent Characteristics

The following univariate t analysis shows that the description of the characteristics of the respondents in this study can be seen in the following table:

Table 1. Characteristics of Respondents' Residential Areas

Region Category	Frequency	Percentage
Near the Beach	110	26.6%
Industrial area	110	26.6%
Far from the beach and industrial areas	194	46.9%
Total	**414**	**100%**

Source: Secondary Data (2024)

Based on univariate analysis using SPSS version 26 on the category of area, it is known that there are 110 people with a percentage of 26.6% who live near the coast, there are 110 people with a percentage of 26.6% who live near the industrial area, and there are 194 people with a percentage of 46.9% who live far from the coast and industrial area. Based on gender, it is known that the characteristics of respondents in this study can be seen in the following table:

Table 2. Respondents' Gender

Gender	Frequency	Percentage
Man	70	16.9%
Woman	344	83.1%
Total	**414**	**100%**

Source: Secondary Data (2024)

Based on univariate analysis using SPSS version 26 on gender, it is known that there are 70 people with a percentage of 16.9% who are male and there are 344 people with a percentage of 83.1% who are female. The following univariate analysis on the blood pressure variable can be seen in.

Table 3. Respondents' Blood Pressure Characteristics

Blood pressure	Frequency	Percentage
Normotensi	250	60.4%
Hypertension	164	39.6%
Total	**414**	**100%**

Source: Secondary Data (2024)

Based on univariate analysis using SPSS version 26 on blood pressure, it is known that there are 250 people with a percentage of 60.4% who are normotensive and there are 164 people with a percentage of 39.6% who have hypertension from all the total samples available. The following univariate analysis of the age variable can be seen in the following table:

Table 4. Respondents' Age Distribution Characteristics

Age	Frequency	Percentage
Pre-elderly and below	309	74.6%

Elderly	105	25.4%
Total	**414**	**100%**

Source: Secondary Data (2024)

Based on univariate analysis using SPSS version 26 regarding age, it is known that there are 309 people with a percentage of 74.6% who are pre-elderly and below and there are 105 people with a percentage of 25.4% who are elderly from all the total samples available.

Bivariate Analysis

The influence of proximity of residence to the beach and industrial areas on the incidence of hypertension.

Table 5. Distribution of Blood Pressure Categories by Region

Region category	Blood pressure		total	X^2	p
	Normal (n/%)	Hypertension (n/%)			
Area Beach	47 (42.7)	63 (57.3)	110	33,751	0,000
Industrial area	58 (52.7)	52 (47.3)	110		
Control areas (not coastal areas and industrial areas)	145 (74.7)	49 (25.3)	194		

Source: Secondary Data (2024)

Significant results were obtained based on the *Chi-Square test* on the effect of coastal and industrial area residences on the occurrence of hypertension with a p-value of 0.000 (*p-value* <0.05). In the bivariate analysis above, respondents with coastal residences were more likely to have hypertension, as many as 63 samples (57.3%). Meanwhile, respondents with industrial residences who suffered from hypertension were 52 samples (47.3%), so that when compared to coastal and industrial areas, those experiencing hypertension were more likely to be found in coastal areas.

The Effect of Proximity of Residence to Coastal Areas on the Incidence of Hypertension

Based on research, it is known that there is an influence of proximity to coastal areas on the incidence of hypertension. in Kendal Regency. This is proven by the large *p-value* obtained of 0.000 (0.000<0.05). So it can be concluded that there is an influence of the proximity of residence to the coastal area on the incidence of hypertension In Kendal Regency, the closer the residential area is to the coastal area, the greater the risk of developing hypertension.

One of the factors that influences the high risk of hypertension in coastal communities is excessive sodium consumption (Cahyani et al., 2019). Salt or sodium chloride is an important substance for the body because every cell in the body needs sodium as a regulator of fluid balance, nerves and muscles to function properly. However, excessive salt consumption can result in increased blood volume and peripheral vascular resistance so that high blood pressure can occur and can increase heart disease or stroke (Yang et al., 2018; Campese, 1994). The effect of sodium intake on high blood pressure occurs through increased blood plasma volume and blood pressure. Sodium is the main cation in extracellular fluid which plays an important role in maintaining plasma and extracellular volume, acid-base balance and neuromuscular. High sodium intake can cause sodium concentrations in the extracellular fluid to increase so that to normalize it, extracellular fluid is drawn out. This causes blood volume to increase, which has an impact on increased blood pressure (Yunus et al., 2023; El-Hajj & Kyriacou, 2020).

The results of this study are in line with the results of a study conducted by Rahmadhani (2021) which found that there was a significant relationship between excessive salt intake and the

incidence of hypertension (Rahmadhani, 2021; Hasibuan et al., 2023). The results of another study conducted by Rumaolat & Soamole (2023) found that there was a relationship between sodium consumption and the incidence of hypertension in fishermen living on the coast of Titawaai Village, Central Maluku Regency (Rumaolat & Soamole, 2023). In contrast to the two research results, the results of Prihanto's study (2024) concluded that there was no relationship between the area of residence and the incidence of hypertension. This is evidenced by the results of the study which found that there was no difference between the systolic blood pressure of residents of the Gurabunga area and the coastal area of Maitara Island (Prihanto et al., 2024; Prihanto et al., 2024).

The Influence of Proximity of Residence to Industrial Areas on the Incidence of Hypertension

Based on the study, it is known that there is an influence of the proximity of residence in the industrial area on the incidence of hypertension in Kendal Regency. This is evidenced by the large p-value obtained of 0.000 (0.000 <0.05). So it can be concluded that there is an influence of the proximity of residence in the Industrial Area on the incidence of hypertension in Kendal Regency. The industrial area is an area consisting of large factories so that most people who are close to this area generally face various environmental problems such as pollution, noise, heavy traffic, even causing stress and can affect health problems (Dewi et al., 2021; Hidayati, 2009).

Air pollution around industrial areas has an impact on health both in the short and long term. Some health problems that are often experienced by people living in industrial areas include respiratory tract disorders, heart disease, cancer of various organs of the body, reproductive disorders and hypertension (Sudaryanto et al., 2022). One type of pollutant associated with hypertension is nitrogen oxide (NO) . Nitrogen oxide (NO) can increase blood pressure by increasing arterial stiffness and endothelial dysfunction when exposed (Hahad et al., 2023). Another pollutant that is also associated with hypertension is carbon monoxide. Carbon monoxide (CO) is an odorless, tasteless, and colorless compound resulting from an imperfect combustion process originating from fuels with carbon content such as burning oil, coal, wood, or kerosene. Carbon monoxide that is inhaled and absorbed by the lungs will bind to hemoglobin and form carboxyhemoglobin (COHb) which damages the absorption of oxygen in the blood, thereby accelerating blood clotting and causing vasoconstriction which results in hypertension (Rizaldi et al., 2022; Larsen, 1993).

The results of this study are in line with the results of research conducted by Jing Xu (2022) who found that the higher the level of air pollution, the stronger the relationship with hypertension (Xu et al., 2022). The results of another study conducted by Zahra (2021) found that long-term exposure to air pollutants in the form of nitrogen dioxide pollutants and short-term exposure to sulfur dioxide exhaust gas and particulates such as dust can have a risk of hypertension. Another risk factor is exposure to carbon monoxide, with the highest concentrations found in heavy traffic and industrial combustion (Zahra et al ., 2021). Different results were found in Kephart's study (2020) which concluded that increased exposure to CO in people living in industrial areas can cause a decrease in systolic and diastolic blood pressure . So it can be concluded that there is no relationship between air pollution in industrial areas and the incidence of hypertension (Kephart et al., 2020).

Research Limitations

This research is not free from several weaknesses which are limitations of the research, the limitations in this research are: This study uses a *cross-sectional research design* as a research approach. *Cross-sectional research design* is carried out to measure independent and dependent variables at the same time. As a result, researchers cannot analyze other factors that

may affect respondents' blood pressure before measurements are taken. Not all risk factors for hypertension can be found, because the analysis carried out is only based on the data found.

Conclusion

Based on the results of the study and discussion on respondents at the Cepiring Health Center, Brangsong Health Center, and Patebon Health Center, it can be concluded that there is a significant relationship between the proximity of residence to the beach and the incidence of hypertension in Kendal Regency with *a p-value* of 0.000 (<0.05 means very significant), and there is a significant relationship between the proximity of residence to the industrial area and the incidence of hypertension in Kendal Regency with *a p-value* of 0.000 (<0.05 means very significant), and the number of respondents who experience hypertension is greater in coastal areas than in industrial areas. The implications of this study indicate that the proximity of residence to the beach and industrial areas are risk factors for hypertension in Kendal Regency.

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