

ORIGINAL ARTICLE

Mapping Hypertension Case Distribution as the Comorbidity of Diabetes Mellitus

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Abstract

Non-Communicable Diseases (NCDs) have become an increasingly significant public health issue annually, emerging as a leading cause of mortality worldwide. Diabetes mellitus is prevalent among the population, often accompanied by comorbidities such as hypertension. Hypertension frequently manifests without symptoms, leading affected individuals unaware of their condition. Data processing is essential to transform hypertension cases due to diabetes mellitus into comprehensible information. Mapping

the distribution of hypertension cases using Quantum GIS (Q-GIS) is one method to achieve this. This study aims to map the distribution of hypertension cases using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency, based on village or sub-district, age, and gender. This study employs a descriptive quantitative research design. The instruments utilized include Geographic Information Systems, observation sheets, hardware, software, and digital maps. Data analysis involves univariate analysis, with a simple random sampling technique applied. Preliminary research conducted in January by the Ciamis District Health Office identified Cipaku District as having the highest number of hypertension cases in Ciamis Regency in 2022, totaling 5,528 cases of hypertension.

Key Words: *Mapping; Hypertension; Q-GIS.*

Introduction

NCDs currently constitute over fifty percent of the worldwide disease burden [1]. Hypertension, characterized by consistently high systolic blood pressure (SBP) exceeding 140 mmHg and/or diastolic blood pressure (DBP) of at least 90 mmHg (according to the International Society of Hypertension guidelines), impacts more than 1.5 billion individuals globally [2].

Hypertension occurs at a significantly higher rate in individuals with diabetes compared to other patients without diabetes. Furthermore, patients with hypertension frequently show symptoms of insulin resistance and face a heightened risk of developing diabetes compared to those with normal blood pressure. Cardiovascular disease stands as the primary contributor to illness and death among diabetes patients, a risk further compounded by the presence of

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hypertension [3]. Hypertension is observed not only as a complication arising from diabetes but also appears to share a common underlying mechanism, especially in cases of non-insulin-dependent diabetes [4].

Hypertension commonly coexists with Type 2 diabetes, obesity, dyslipidaemia, sedentary lifestyle, and smoking leading to risk amplification. Blood pressure lowering by lifestyle modifications and antihypertensive drugs reduce cardiovascular (CV) morbidity and mortality [5]. Van der Sande et al. (2000) conducted research indicating a notable prevalence of diabetes within urban populations also affected by hypertension. Moreover, Petry et al. (2021) found in a recent study exclusively involving women that 17% exhibited the simultaneous presence of multiple cardiometabolic risk factors, notably including diabetes and hypertension [6].

Based on 2018 Basic Health Research (Riskesdas) data, it shows that there has been an increase in the prevalence of hypertension in Indonesia from 25.8% in 2013 to 34.1% in 2018 [7]. In the Health Profile of West Java Province in 2021, the coverage of health services for hypertension sufferers based on the results of blood pressure measurements in West Java in 2021 was 34.5%, with the highest Regency/City in Bogor City (101.9%), and the lowest in Regency Bandung (8.5%) [8]. Ciamis Regency is one of the regions that has health service coverage for hypertension sufferers of 34.3% based on the results of blood pressure measurements according to districts/cities in West Java province in 2021 (West Java Provincial Health Office, 2021). Based on the Health Profile of Public Health Centers in Ciamis Regency in 2021, hypertension ranks first in the top 10 diseases for all age groups in Ciamis Regency in 2021 with a total of 80,612 people with hypertension [9].

Geospatial reasoning involves a wide range of activities associated with the position and arrangement of objects in both temporal and spatial dimensions. These activities include navigating through landscapes, as well as interpreting and using maps. The complexity of geospatial reasoning tasks can vary significantly. In more intricate scenarios, decision-makers may need to retain geo-referenced data across multiple factors in memory while incorporating additional information, such as the effectiveness of operational tasks. These efforts collectively enhance environmental comprehension and facilitate the determination of optimal courses of action [10].

Geographic Information Systems are used for mapping purposes in research in the health sector. One of them is research which aims to analyze areas with the prevalence of hypertension sufferers who are most at risk to control the disease and improve health services through mapping using the Q-GIS application [11].

The emerging field of medical geographic information systems (Medical GIS) has proven invaluable in comprehending broader public health dynamics. This discipline possesses significant potential to analyze not just disparities but also commonalities in global population health. By integrating medical geography, public health, and informatics, the primary aim is to elucidate the diverse impacts of numerous health issues on populations and the patterns through which these populations are influenced [12]. Utilizing geographic information system (GIS) technology aids in comprehending spatial availability of services [13]. The aim of this research is knowing the mapping in order health center can manage and facilitate the patients' treatment.

Methods

The type of research used in this research is quantitative research with a descriptive research design that presents a complete picture and description of the distribution of hypertension as comorbidity of diabetes mellitus in Cipaku District, Ciamis Regency, which will later be created in the form of a Geographic Information System-based map. The research locations chosen were Cipaku Health Center and Cieurih Community Health Center, Cipaku District, Ciamis Regency. This study conducted from February to May 2023.

The population in this study includes the number of cases of patients diagnosed with hypertension in Cipaku District, Ciamis

Regency in the fourth quarter of 2022, totaling 1,245 cases of hypertension. The sample used was the number of cases of patients diagnosed with hypertension in Cipaku District, Ciamis Regency in the fourth quarter of 2022, 93 cases of hypertension. The inclusion criteria for hypertension in this study were all outpatients who had hypertension as the comorbidity of diabetes mellitus. The exclusion criteria are the patients having hypertension which is not the comorbidity of diabetes mellitus.

Results

Mapping the distribution of hypertension cases by village using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Table 1).

TABLE 1

Number of hypertension cases by village in 2022 in Cipaku District, Ciamis Regency.

No	Village	Number of Hypertension Cases	
		N	%
1	Gereba	485	4.4%
2	Cieurih	544	4.9%
3	Ciakar	544	4.9%
4	Mekarsari	579	5.2%
5	Pusakasari	624	5.6%
6	Sukawening	630	5.7%
7	Bangbayang	648	5.8%
8	Cipaku	738	6.6%
9	Selacai	1,003	9.0%
10	Jalatrang	1,154	10.4%
11	Selamanik	1,220	11.0%
12	Muktisari	1,417	12.7%
13	Buniseuri	1,552	13.9%
	Total	11,138	100%

From Table 1, it is known that the village with the highest cases of hypertension is Buniseuri Village with a total of 1,552 cases of hypertension with a percentage of 13.9%, while the lowest cases of hypertension is Gereba Village with a total of 485 cases with a percentage of 4.4%. The data that has been grouped in table 4.2 is then entered into the Quantum GIS (Q-GIS) application and processed into a map where case categories from lowest to highest are classified based on the color on the map.

Based on Table 1 above, a mapping of the distribution of hypertension cases was created as follows:

Figure 1 above is the result of mapping the distribution of Hypertension cases by Village, where the Village with the highest Hypertension cases is marked in solid green and the lowest Village is marked in white. So, the darker the color in the map area, the higher the number of hypertension cases.

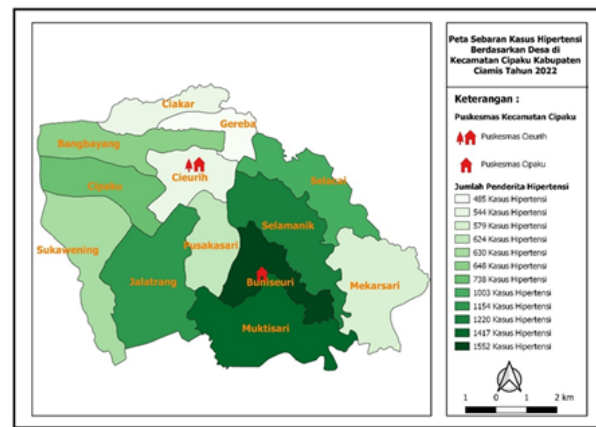


Figure 1) Map of the distribution of hypertension cases by village using the Q-GIS application in 2022 in Cipaku District.

Mapping the distribution of hypertension cases based on age using the Q-GIS application in 2022 in cipaku district, ciamis regency (Table 2).

Table 2 shows that the village with the highest cases of hypertension occurring in the age group >65 years was 3,592 cases of hypertension with a percentage of 32.25%. The highest cases of hypertension occurring in the age group >65 years were in Buniseuri Village with 586 cases of hypertension with a percentage of 5.26%.

TABLE 2

Number of hypertension cases based on age in 2022 in Cipaku District, Ciamis Regency.

No	Village	Total							Percentage (%)						
		13-16 years	17-25 years	26-35 years	35-45 years	46-55 years	56-65 years	>65 years	13-16 years	17-25 years	26-35 years	36-45 years	46-55 years	56-65 years	>65 years
1	Cieurih	2	51	61	112	153	115	50	0.02%	0.46%	0.55%	1.01%	1.37%	1.03%	0.45%
2	Cipaku	5	71	89	154	190	157	72	0.04%	0.64%	0.80%	1.38%	1.71%	1.41%	0.65%
3	Gereba	5	42	66	125	126	103	18	0.04%	0.38%	0.59%	1.12%	1.13%	0.92%	0.16%
4	Bangbayang	5	39	90	163	197	116	38	0.04%	0.35%	0.81%	1.46%	1.77%	1.04%	0.34%
5	Ciakar	5	32	77	132	154	95	49	0.04%	0.29%	0.69%	1.19%	1.38%	0.85%	0.44%
6	Mekarsari	0	8	8	49	198	185	131	0.00%	0.07%	0.07%	0.44%	1.78%	1.66%	1.18%
7	Pusakasari	0	0	1	6	70	229	318	0.00%	0.00%	0.01%	0.05%	0.63%	2.06%	2.86%
8	Sukawening	0	0	1	12	89	209	319	0.00%	0.00%	0.01%	0.11%	0.80%	1.88%	2.86%
9	Selacai	0	15	18	27	131	385	427	0.00%	0.13%	0.16%	0.24%	1.18%	3.46%	3.83%
10	Jalatrang	1	9	7	44	232	415	446	0.01%	0.08%	0.06%	0.40%	2.08%	3.73%	4.00%
11	Selamanik	1	6	3	11	156	463	580	0.01%	0.05%	0.03%	0.10%	1.40%	4.16%	5.21%
12	Muktisari	0	1	4	63	318	473	558	0.00%	0.01%	0.04%	0.57%	2.86%	4.25%	5.01%
13	Buniseuri	0	7	3	74	343	539	586	0.00%	0.06%	0.03%	0.66%	3.08%	4.84%	5.26%
	Total	24	281	428	972	2.357	3.484	3.592	0.22%	2.52%	3.84%	8.73%	21.16%	31.28%	32.25%

Meanwhile, the lowest number of hypertension incidents occurred in the 13-16 years age group with 24 cases of hypertension with a percentage of 0.22%.

Based on Table 2 above, a mapping of the distribution of hypertension cases based on age was created as follows.

Mapping the distribution of hypertension cases based on the 13-16 Year age group using the Q-GIS application in 2022 in Cipaku district, Ciamis Regency (Figure 2).

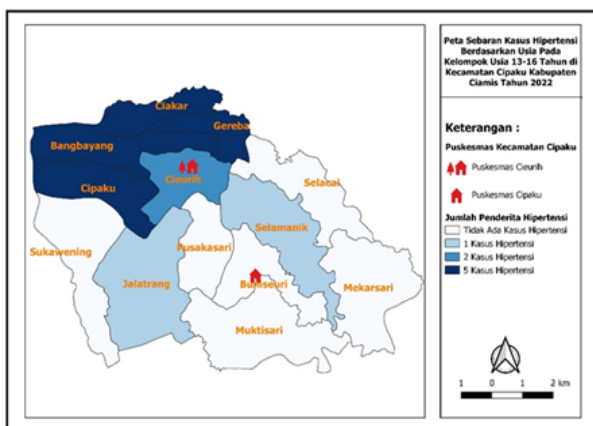


Figure 2) Map of the distribution of hypertension cases based on age in the 13-16 year age group using the Q-GIS application in 2022 in Cipaku District.

Mapping the distribution of hypertension cases based on age in the 17-25 year age group using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Figure 3).

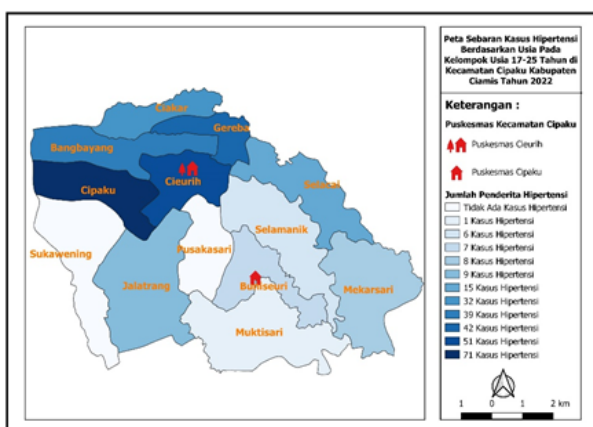


Figure 3) Map of the distribution of hypertension cases based on age group 17-25 years using the Q-GIS application in 2022 in Cipaku District.

Mapping the distribution of hypertension cases based on age in the 26-35 year age group using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Figure 4).

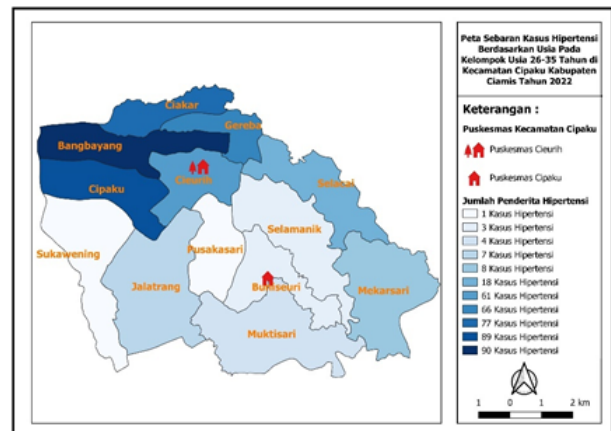


Figure 4) Map of the distribution of hypertension cases based on age group 26-35 years using the Q-GIS application in 2022 in Cipaku District.

Mapping the distribution of hypertension cases based on age in the 36-45 year age group using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Figure 5).

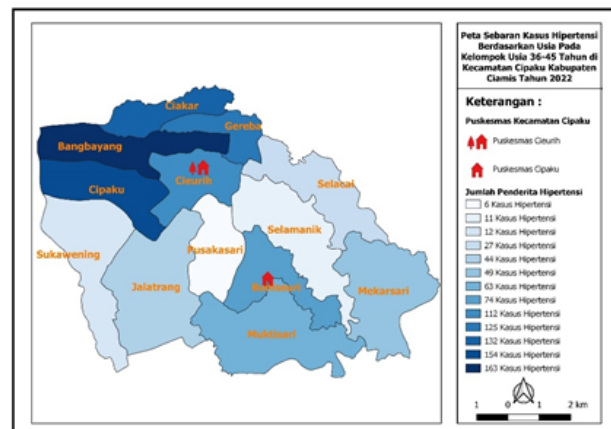


Figure 5) Map of the distribution of hypertension cases based on age in the 36-45 year age group using the Q-GIS application in 2022 in Cipaku District.

Mapping the distribution of hypertension cases based on age in the 46-55 year age group using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Figure 6).

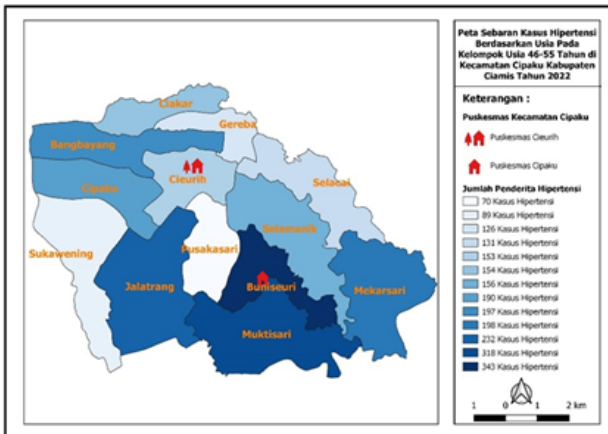


Figure 6) Map of the distribution of hypertension cases based on age in the 46-55 year age group using the Q-GIS application in 2022 in Cipaku District.

Mapping the distribution of hypertension cases based on age in the 56-65 year age group using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Figure 7).

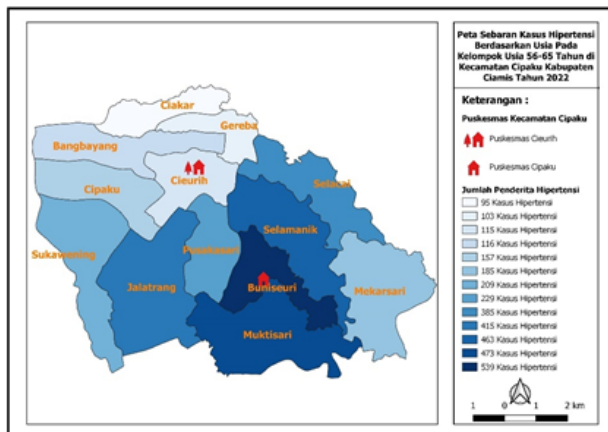


Figure 7) Map of the distribution of hypertension cases based on age in the 56-65 year age group using the Q-GIS application in 2022 in Cipaku District.

Mapping the distribution of hypertension cases based on age in the >65 year age group using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Figure 8).

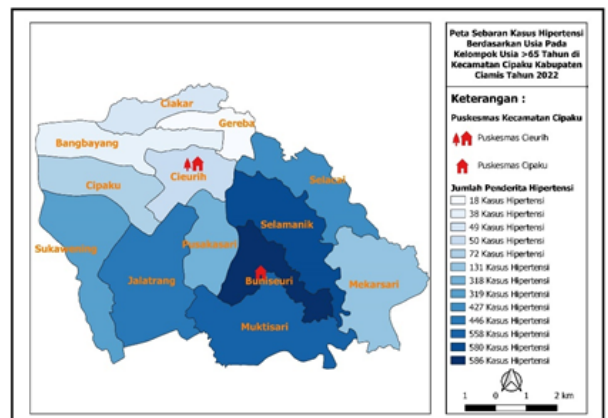


Figure 8) Map of the distribution of hypertension cases based on age in the age group >65 years using the Q-GIS application in 2022 in Cipaku District.

Mapping the distribution of hypertension cases based on gender using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Table 3).

Table 3 shows that the number of hypertension cases in male sufferers is higher than in female sufferers. Cases among male sufferers amounted to 6,076 cases of hypertension with a percentage of 54.6%, while for female sufferers there were 5,062 cases of hypertension with a percentage of 45.4%.

Based on Table 3 above, a mapping of the distribution of hypertension cases based on gender was created as follows.

Mapping the distribution of hypertension cases based on gender in men using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Figure 9).

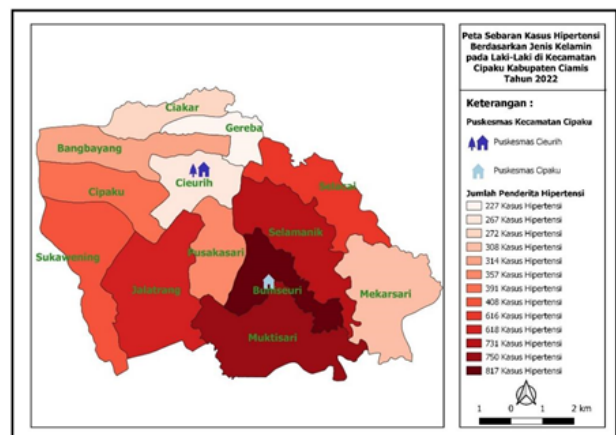


Figure 9) Map of the distribution of hypertension cases based on gender in men using the Q-GIS application in 2022 in Cipaku District.

Mapping the distribution of hypertension cases based on gender in women using the Q-GIS application in 2022 in Cipaku District, Ciamis Regency (Figure 10).

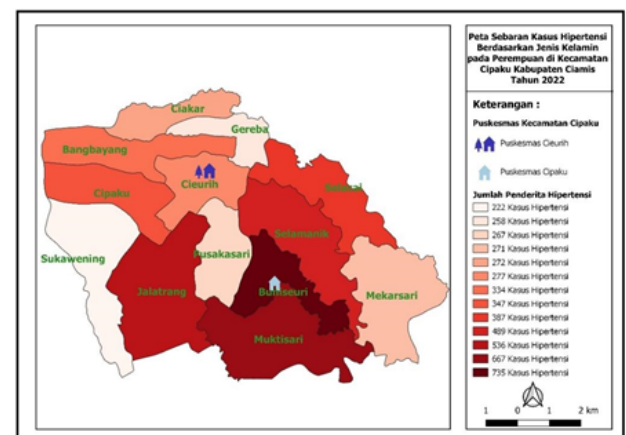


Figure 10) Map of the distribution of hypertension cases based on gender in women using the Q-GIS application in 2022 in Cipaku District.

TABLE 3**Number of hypertension cases based on gender in 2022 in Cipaku District, Ciamis Regency.**

No	Village	Total		Percentage (%)		Jumlah (M+F)	Persentase (M+F)
		M	F	M	F		
1	Cieurih	267	277	2.4%	2.5%	544	4.9%
2	Cipaku	391	347	3.5%	3.1%	738	6.6%
3	Gereba	227	258	2.1%	2.3%	485	4.4%
4	Bangbayang	314	334	2.8%	3.0%	648	5.8%
5	Ciakar	272	272	2.4%	2.4%	544	4.9%
6	Mekarsari	308	271	2.8%	2.4%	579	5.2%
7	Pusakasari	357	267	3.2%	2.4%	624	5.6%
8	Sukawening	408	222	3.7%	2.0%	630	5.7%
9	Selacai	616	387	5.5%	3.5%	1003	9.0%
10	Jalatrang	618	536	5.5%	4.8%	1154	10.4%
11	Selamanik	731	489	6.6%	4.4%	1220	11.0%
12	Muktisari	750	667	6.7%	6.0%	1417	12.7%
13	Buniseuri	817	735	7.3%	6.6%	1552	13.9%
	Total	6076	5062	54.6%	45.4%	11138	100%

Discussion

Mapping in the health sector can describe the distribution of related phenomena spatially, and mapping via Geographic Information Systems (GIS) can help health researchers find areas that have a high risk of a disease. This mapping is made in the form of a map in presenting the data by showing spatial distribution or location. According to Dickinson (1975) in Fadjarani (2020), data is mapped for a variety of reasons. Maps can generate increased interest in the items they depict, clarify and simplify complex information, emphasize topics in written or spoken discussions, and serve as a valuable resource for those seeking detailed information [14].

In this study, researchers utilized the Geographic Information System in making maps to carry out mapping regarding the distribution of hypertension cases using the Quantum GIS (Q-GIS) application. This application was chosen because it has the advantage of being Geospatial

Quantum GIS data processing software which is open source and free [15]. Mapping the distribution of hypertension cases in this study is represented by a color, the darker the color in the map area, the higher the hypertension cases in that area. Thus, the map produced in this study is a map that has color gradations to show the level of the number of hypertension cases in each region. The following is a discussion of the results of mapping the distribution of hypertension cases by village, age and gender in Cipaku District, Ciamis Regency. The villages are having the same characteristics or heterogen.

Cipaku District has an area of 78.73 km² and a density of 887 people/Km² consisting of 13 villages and there are 11,138 registered sufferers with a primary diagnosis of hypertension and who have received services. The data is then processed using the Quantum GIS (Q-GIS) application to produce a map of the distribution of hypertension cases by village which is differentiated using colors starting from the

lowest distribution of cases to the highest distribution. Mapping is depicted in green, where the darker the color in a map area, the higher the number of hypertension cases in that area. Based on the mapping that has been carried out on the map, it shows that Buniseuri Village has a dark green color among other villages. This shows that Buniseuri Village is the area with the highest distribution of hypertension cases in Cipaku District with a total of 1,552 hypertension cases.

Based on demographic data, Buniseuri Village is a densely populated residential area with an area of 39.51 km² and has a population of 8,743 people. Based on the research results, it shows that the highest population with the highest cases of hypertension is in the same village, namely Buniseuri Village, and the lowest population with the lowest cases of hypertension is in the same village, namely Gereba Village, which has a population of 3,372 people. Population is one of the factors that can influence the number of cases in an area because if hypertension cases are high in an area it could be due to the high population in that area.

As additional information, the proportion of hypertension in each village is also presented, where the proportion is used to compare an event with the number of people affected by the event. If we look at the proportion of hypertension incidents per village, the highest in Cipaku District is in Muktisari Village, namely 22.67% and the lowest proportion of hypertension incidents in Cipaku District is in Cieurih Village, namely 10.74% (can be seen in attachment 20) . Therefore, the mapping results cannot be a conclusion between population size and the proportion of hypertension in each village.

Looking at the location of the Cipaku Health Center, it is in Buniseuri Village, but based on the results of mapping the distribution of

hypertension cases in Cipaku District, it shows that Buniseuri Village is the highest contributor to hypertension cases in Cipaku District. This is contrary to the results of research by Damayanti (2017) which states that the further the distance between a residence and a health service facility, the lower the level of interest in outpatient services in a health service. This is due to the distance of the community from health services, as well as the time that must be provided and the costs required to access these health service facilities [16].

Based on data from the Cipaku Community Health Center's Non-Communicable Diseases Integrated Service Training (PANDU PTM) report, 796 out of 1,552 hypertension sufferers in Buniseuri Village have a smoking habit, 36 out of 1,552 hypertension sufferers in Buniseuri Village consume too much salt, 427 out of 1,552 hypertension sufferers don't eat enough fruit and vegetables, so it can be concluded that based on this the highest risk factor in Buniseuri Village is smoking. Based on research, the substances in cigarettes are very dangerous, one of which has an impact on increasing blood pressure. Smoking is also known to increase inflammatory substances, endothelial dysfunction, plaque formation and vascular damage which will ultimately cause blood pressure to increase. The nicotine in cigarettes has a direct effect on the release of the hormone's epinephrine and norepinephrine, these hormones can increase blood flow to the muscles and brain and stimulate the heart to beat faster [17].

Hypertension sufferers in Buniseuri Village need immediate medical attention and treatment so that hypertension cases in the village can decrease. People's unhealthy lifestyles can influence the incidence of hypertension, such as poor sleep quality, consumption of alcoholic drinks, high salt consumption, smoking or can be caused by hereditary factors, apart from

that, the incidence of hypertension can also be influenced by gender and age [11].

In this study, a mapping was created for each age group to show the distribution of hypertension cases per age group. This mapping is depicted by a color where the darker the color in the map area, the higher the hypertension cases. The results of research on tables and mapping of the distribution of hypertension cases based on age show that the highest cases of hypertension occurred in the age group >65 years with 3,592 cases of hypertension with a percentage of 32.25%. Meanwhile, the lowest cases of hypertension occurred in the 13-16 years age group, namely 24 cases of hypertension and a percentage of 0.22%. These results show that the majority of hypertension cases occur in the age group >65 years (seniors) compared to the age group 13-16 years (early adolescents). This is in line with the results showed that those aged >60 years had a 4.5 times risk of suffering from hypertension compared to those aged 25-39 years (26.27%), this could be caused by the elasticity of the vessels. reduced blood [18].

The older a person gets, the more the working pattern and function of the heart decreases. In old age, systolic blood pressure increases, and diastolic blood pressure decreases. This occurs as a result of structural changes in the main blood arteries, which become stiffer and less flexible. The stiffness of the blood vessel walls encourages narrowing of the blood vessels, resulting in decreased blood flow to the body's tissues and organs. As a result, systolic blood pressure increases to ensure adequate blood flow to the body's tissues and organs [19].

The results of research on tables and mapping of the distribution of hypertension cases based on gender show that cases of hypertension in male sufferers are higher than in female sufferers. The number of cases of hypertension in male sufferers was 6,076 cases of hypertension with

a percentage of 54.6%. Meanwhile, the number of hypertension incidents in female sufferers was 5,062 with a percentage of 45.4%. This is according to WHO data in 2000, around 972 people or 26.4% of the world's population suffer from hypertension, with a ratio of 26.6% men and 26.1% women [20]. The majority of hypertension cases occur in men, which can be caused by lifestyle such as smoking, which is increasing in men, both in the elderly and young. In research conducted by Falah (2019), research results also showed that there was a relationship between smoking habits and hypertension, namely that it was influenced by the duration of smoking and the type of cigarette [21]. This is in line with Arum's (2019) research that men (43.8%) have more cases of hypertension than women (31.0%). This is most likely caused by changes in the hormonal system which affects blood pressure. In addition, the difference in cases of hypertension between men and women is triggered by smoking behavior which is much higher in men [22].

However, not all villages where the majority of hypertension cases occur are male sufferers. Based on the research results, hypertension cases in the villages of Cieurih, Gereba, Bangshadow were more likely to occur in women, with 277, 258, and 334 cases of hypertension with percentages of 2.5%, 2.3%, and 3, respectively. 0%. This is in line with the research results of Siswanto et al., (2020) which showed that female respondents (36.5%) had more cases of hypertension than male respondents (30.1%). This can occur due to a person's lifestyle, especially the diet of women who like to consume fatty or high-sodium foods. Likewise, women over the age of 45 years are at higher risk of developing hypertension since they enter menopause. This will be associated with a decrease in estrogen production which affects the cardiovascular system, where there is a loss of blood vessel flexibility due to the estrogen

hormone which has been protecting blood vessels from damage [23].

In the book Pradono et al. (2020) explained that gestational hypertension, or hypertension during pregnancy that occurs in women, is thought to be caused by placental failure. Another theory holds that gestational hypertension occurs because the trophoblast does not invade far enough into the uterine lining, which causes the fetal structures to not fully develop into the uterine wall and the fact that the spiral arteries do not completely transform into ducts increases resistance to uterine blood flow. Genetic factors also play a role, women with a family history of the condition are three times more likely to suffer from gestational hypertension when they become pregnant. According to the Health Research and Development Agency of the Republic of Indonesia in 2018 in the book Pradono et al (2020), the results of the 2016

Sample Registration System (SRS) research analysis stated that the most common cause of maternal death was due to hypertensive disorders during pregnancy, childbirth and during the postpartum period [19]. The study limitation is the villages are having the same characteristics, so we can not see further variables beside age and gender.

Conclusion

These results show that the majority of hypertension cases occur in the age group >65 years (seniors) compared to the age group 13-16 years (early adolescents). The results of research on tables and mapping of the distribution of hypertension cases based on gender show that cases of hypertension in male sufferers are higher than in female sufferers. The number of cases of hypertension in male sufferers was 6,076 cases of hypertension with a percentage of 54.6%.

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