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RESEARCH ARTICLE

Spatial Distribution Pattern of Hypertension: Case of Jakarta, Indonesia

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Abstract. Hypertension is one type of Non-communicable Disease (NCD) that is a burden on the government in disease control every year. Hypertension is caused by various risk factors. Most of the risk factors for hypertension are lifestyles that can be changed. This study aims to determine the pattern of distribution of hypertension cases based on risk factors, social factors, health care facilities. The spatial approach was used to determine the spatial relationship between hypertension risk factors and hypertension cases in the Jakarta province. The spatial approach was used to determine the spatial relationship between hypertension risk factors and hypertension cases in the Jakarta province. The results showed that the screening program variable had a spreading pattern with a negative spatial relationship and there was a spatial interaction between the screening program variables and hypertension cases. Improving the quality and quantity of Non-communicable Disease Integrated Assistance Post activities of local health centers, which are the front line in preventive and promotive activities is expected to be the key to successful control of hypertension cases in the Jakarta.

1. Introduction

Hypertension is a condition when the blood pressure in the blood vessels increases significantly, this is because the heart works harder when pumping blood to distribute oxygen throughout the body (Kayima et al., 2015; Laohasiriwong et al., 2018; Mills et al., 2020). Hypertension is characterized by systolic blood pressure reaching > 140 mmHg and/or diastolic blood pressure reaching > 90 mmHg (Unger et al., 2020; Wang et al., 2018; X. Zhang & Kanbur, 2005). Hypertension is the silent killer of other cardiovascular diseases such as heart disease, kidney failure, stroke, and diabetes. Hypertension is also the first rank as a cause of death in the world every year (Laohasiriwong et al., 2018)

Hypertension is a silent killer which is the gateway to other cardiovascular diseases such as heart disease, kidney failure, stroke, to diabetes. Hypertension is also the first rank as a cause of death in the world every year. According to WHO, of the approximately 1.13 billion people who suffer from hypertension, less than 1 in 5 people can control it. The main contributors to the increase in hypertension are unhealthy diet, lack of physical activity and consumption of alcohol and tobacco (WHO, 2019). In 2025 it is estimated that 1.5 billion people suffer from hypertension and as many as 9.4 million people die from hypertension and complications due to hypertension. A study showed that the prevalence of hypertension in adults increased from 594 million cases to 1.13 billion cases from 1975 to 2015. The average increase in cases occurred in low- and middle-income countries. This is due to the increase in risk factors for hypertension in the population in these countries (Benjamin et al., 2019).

Implementing a healthy lifestyle is one way to prevent hypertension and reduce the risk of cardiovascular disease. However, several studies have shown that regional socioeconomic conditions have a significant relationship with cases of hypertension (Alcocer & Cueto, 2008; Shapiro et al., 2020) As a lower-middle-income country, Indonesia still has a lot of poor people, based on BPS data in 2021 the percentage of the urban poor in March 2021 was 7.89 percent, down to 7.60 percent in September 2021. While the percentage of poor rural people in March 2021 in March 2021 by 13.10 percent, down to 12.53 percent in September 202. The number of poverties in Jakarta in 2021 is 501.92 thousand people. The administrative city of North Jakarta is the area with the poorest population of 132.73 thousand people. Another poverty indicator is the Jakarta Human Development Index (IPM) in 2021, which is 81.11 percent. Jakarta still occupies the highest HDI ranking of all provinces in Indonesia (BPS, 2022). One of the factors that can influence hypertension is the level of education. A person's education level can affect a person's attitudes and behavior in implementing healthy living behavior. The higher the level of education of a person, the wider the knowledge in maintaining his health (Di Chiara et al., 2017; Pandit et al., 2009; Samal et al., 2007)

The prevalence of hypertension cases based on the results of population measurements in Indonesia has increased from 2007 to 2018. The prevalence of hypertension in Indonesia is 34.1%, increased by 2.4% in 2013 to 31.7%. According to data National Research Survey in 2018, the prevalence of hypertension is higher in urban populations compared to rural populations, namely urban areas at 34.4% and rural areas at

33.7%. The prevalence of hypertension cases in Jakarta based on Jakarta surveillance data in 2019 reached 34.1% of cases, while according to the Jakarta Health Profile in 2019 as many as 2,655,351 inhabitants were estimated to have hypertension. This estimation figure is obtained from the multiplication of the prevalence of hypertension cases by the number of people aged > 15 years and then divided by 100. The high number of hypertension cases in the Jakarta province, it can be a consideration for policy makers at the Health Service and Public Health Centers *(Puskesmas)* level in determining the treatment priorities of health problems. In total, only 7 out of 42 sub-districts in the Jakarta province have the lowest number of hypertension cases. A total of 35 other sub-districts still shows high cases of hypertension.

Spatial analysis is used to analyze the relationship between the human environment and health aspects such as nutrition, disease, and the health care system to be able to explain the interrelationships spatially. Spatial analysis is considered more accurate when compared to non-spatial analysis because non-spatial analysis is considered unable to answer several questions such as knowing the distribution of health problems (Cromley & McLafferty, 2012).

In analyzing objects related to space, the first describes the characteristics of the region that distinguish one region from another, then proceeds with the analysis of spatial relationships (Lepper et al., 1995). Spatial techniques commonly used in health research include disease mapping, clustering techniques, diffusion studies, identification of risk factors through map comparison and regression analysis. Spatial clustering techniques are important with consideration of statistical techniques to form the initial step in the development of models to predict the location of disease risk. The prevalence of chronic diseases such as hypertension varies according to the physical and socio-economic environment of the area where the individual lives and the individual's health behavior. In this regard, it is necessary to approach intervention efforts spatially for each small unit area if the prevalence continues to be high in an area by analyzing certain factors related to the area using sub-district data (Kim & Park, 2018; Nurhasana & Hartono, 2021).

Spatial autocorrelation is a measure of the similarity of objects in space (distance, time, and area) and is the correlation between a variable and itself based on space, spatially it can mean the correlation between the value at location-*i* and the value at location-*j* (Anselin & Getis, 1992).

Although lifestyle has a relationship with hypertension cases, this research only focuses on the level of education and Public health centers. This is because lifestyle is an individual variable that cannot be intervened spatially. Hypertension research in Indonesia explains a lot about the factors that influence it and is carried out using individual data and does not use a spatial approach (Azhari, 2017; Damayantie et al., 2018; Sartik et al., 2017). This study was conducted to determine the distribution pattern of hypertension based on hypertension risk factors which include social factors (education) and health care facilities factors in the Jakarta province so that the program implemented is right on target and is able to control hypertension cases in the Jakarta province.

2. Methods

This research uses an ecological study design with a spatial approach. Models in ecology serve a variety of purposes, which range from illustrating ideas to parameterizing complex real-world situations. They are used to make general predictions up to a statistical and spatial analysis, the development of which is a statistical approach designed to test spatial autocorrelation to obtain spatial patterns (Koenig, 1999; Legendre & Fortin, 1989).

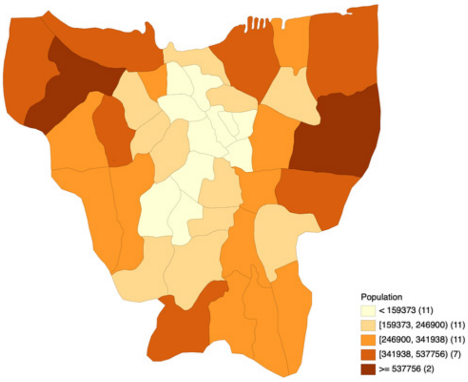
The dependent variable in this study was the percentage of hypertension, measured by the number of hypertension patients divided by the total provincial hypertension cases. Hypertension cases were determined based on reports from surveillance at the district level. The independent variables were the level of education and the number of Public Health Centers (*Puskesmas*). Hypertension case data and education level data were obtained from the Jakarta Surveillance data in 2019. The data is individual data on hypertension patients recorded at health facilities in Jakarta, then from individual data, aggregated data is made into data with regional administrative units.

The category of low education is the number of people who have not received education and who have studied up to elementary school. Selection of district level indicators that may be associated with hypertension cases were selected based on previous findings on factors that contribute to hypertension, namely access to health services (Elias et al., 2018; Musinguzi et al., 2015; Okuyama et al., 2019) and socio-economic factor (education) of the region (Di Chiara et al., 2017; Pandit et al., 2009; Park et al., 2016; Suroto et al., 2019; Zhou et al., 2012)

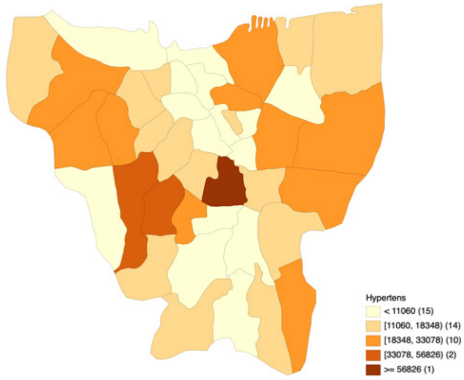
This study uses secondary data obtained from various sources. the Jakarta Provincial Health Office, the Central Statistics Agency, and a map of the Jakarta administration area obtained from the Geospatial Information Agency. Jakarta province has a total of 44 sub-districts and 267 urban villages spread over 6 administrative cities. Based on the results of the 2020 Population Census, the population in Jakarta is 10,562,088 people, consisting of 5.33 million male residents and 5.23 million female residents. The population growth rate in Jakarta per year is 0.92% with a population density of 14,555 people per km^2 according to data from Statistics Data Jakarta Province, 2021). This study does not include the administrative cities of the Thousand Islands, so it only includes the administrative cities of East Jakarta, West Jakarta, South Jakarta, North Jakarta, and Central Jakarta. This is because in conducting a spatial analysis the influence of neighbors is very important (Koenig, 1999; Legendre & Fortin, 1989), so that in an area with an archipelagic shape, there is a distance that separates it (the sea), so the Thousand Islands are not included in the analysis. The unit of analysis in this study is the sub-districts in Jakarta (outside the administrative city of the Thousand Islands) as many as 42 sub-districts. The population and sample in this study were residents with hypertension in every sub-district in Jakarta in the unit of analysis for the sub-district area.

This spatial analysis was carried out using statistical spatial methods. Spatial regression analysis was carried out at an early stage to assess the relationship between the variables of low education and Public Health Centers (*Puskesmas)* on the prevalence of hypertension in all sub-districts. Spatial autocorrelation technique used Moran's Index to obtain a hypertension risk model, and analysis of the spatial distribution of hypertension and spatial risk factors for hypertension.

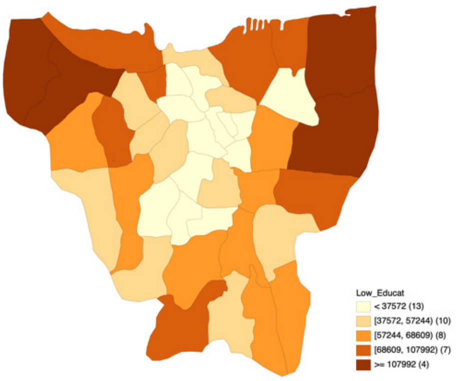
Spatial analysis using the Local Indicator Spatial Autocorrelation (LISA) approach, descriptive univariate spatial is the distribution of hypertension cases and the risk factors for hypertension cases (education level, number of



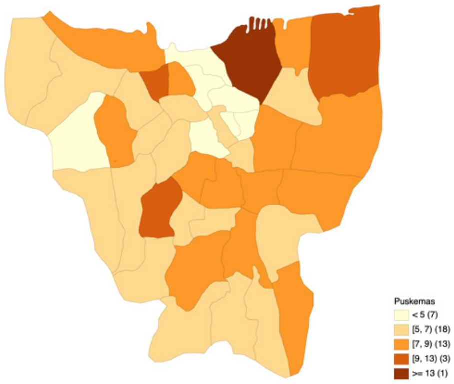
(a) Population



(b) Hypertensions



(c) Low Education



(d) Public Health Center (*Puskesmas*)

Figure 2. Overview of Variables

health centers), while bivariate spatial analysis is to obtain a spatial interaction between the dependent variable and the independent variable. Furthermore, the results of the LISA calculations were identified using the Moran Scatterplot to determine the spatial effect. The Moran's Index map is represented by a five-color scheme, with highs designated as red (hot spots), lows as blues (cold spots), lows as light blues, highs as lows as pink and random patterns displayed as white (Anselin & Getis, 1992). Hotspot areas are considered to have a high prevalence of hypertension, while cold spot areas show a low prevalence. A mixture of high and low values in neighboring areas is considered a spatial outlier. Processing and analyzing data using Spatial Statistical Mapping (GeoDa) software application.

Local Moran's Index to identify spatial autocorrelation and local autocorrelation of hypertension risk score. Global Moran's Index informs the spatial dependence or spatial independence of the data . A Global Moran's I value (between -1 and 1) which is higher than the observed value of Moran's I – E(I) – indicates a positive spatial autocorrelation (i.e., greater data similarity between neighboring locations or clustering heights and/or low values in the data set). The results of the Moran's Index value show the distribution pattern of the variables, if the value $I > E(I)$ has a clustered spatial pattern and if the value $I < E(I)$ has a spreading pattern. However, if the Global Moran's I value is lower than E(I) it indicates a negative spatial autocorrelation (that is, the difference or dispersion of high and/or low values in the data set). The presence of spatial autocorrelation was also evaluated with Global Moran's I significant p value ($p < 0.05$) using 99 permutations criteria (Anselin & Getis, 1992; Taher Buyong, 2007).

3. Results and Discussion

This study has many limitations that may affect the results of the study. The limitations found in this research process are (1) this study uses secondary data, the majority of which are obtained from the Jakarta Health Office. The absence of some of the data requested by the researcher became an obstacle in itself in conducting this research. (2) This study does not see that exposure causes disease (temporal-ambiguity), meaning that this study does not prove that the hypertension risk factors that are variables in this study directly cause hypertension. (3) The level of validity and reliability, all the data used in this study is secondary data with the type of aggregate data, the level of validity and reliability of this data cannot be ascertained especially in the process of collecting, recording, and reporting. (4) Weaknesses in the use of aggregated data in an area as the unit of analysis in this study can lead to the potential for ecological bias (ecological fallacy). Ecological bias occurs when the results of aggregate data analysis are used to explain causality effects at the individual level (Greenland & Morgenstern, 1989).

Regions with the highest cases of hypertension are shown in the darkest color. The number of hypertension cases in the region is about 56 thousand residents (0,53%). The areas with the highest number of hypertension cases are in the west, north and east areas of Jakarta. The number of Public Health Centers (*Puskesmas)* in Jakarta in 2019 Tanjung Priok Sub-district in

Table 1. Spatial Regression Model

Variable	Coefficient	Std.Error	z-value	Probability
W_Case	0.497587	0.16769	2.96731	0.00300
CONSTANT	3.04173	5.2442	0.580018	0.56190
Low Education	-0.0803695	0.221819	-0.362319	0.71711
Puskemas	0.349584	0.347054	1.00729	0.31379
R-squared	0,220667			

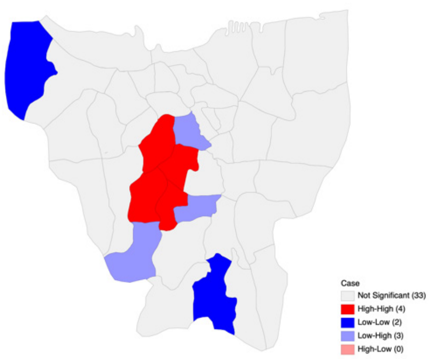
North Jakarta had the most Public Health Centers (*Puskesmas*) with a total range of 13 Public Health Centers (*Puskesmas*). This is evidenced by the area that has the darkest color on the map. On the other hand, the area with the least number of Public Health Centers *(Puskesmas)* with the number of Public Health Centers *(Puskesmas)* ranging from 4 Public Health Centers *(Puskesmas)* per sub-district is indicated by the lightest color. Similar to the previous explanation, the dark colored area in Figure 2 shows the area that has the lowest educated population. The range of the population with the highest low education is between 86,927 to 137,165 residents. On the other hand, areas that tend to be white in color have the least number of people with low education, between 17,203 and 26,495 people.

The model generated from the autocorrelation spatial regression output (Table 1) shows an estimated value of 0.4978 (P value = 0.003) indicating that a location will have a high hypertension percentage value if it is adjacent to or neighboring another location that has a high hypertension percentage as well, this parameter shows a significant effect on hypertension, so it can be said that there is a spatial effect on the incidence of hypertension in Jakarta. The results of the spatial regression analysis showed that low education and the availability of Puskesmas did not show a significant value for hypertension cases. This shows that the variables of low education and Puskesmas do not have a spatial effect on hypertension cases.

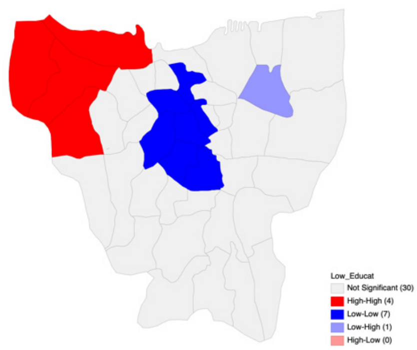
The coefficient value of the low education variable (-0.0803695) indicates that if the case of hypertension with low education is negative (low value), it means that the lower the hypertension patient with low education, the lower the incidence of hypertension. The coefficient value of the Public

Table 2. Moran's Index Univariate Table

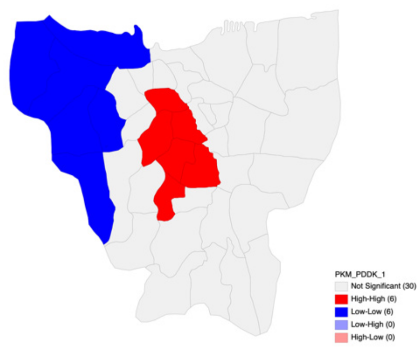
Variable	E[I]	Moran's Index	Z-value	Pattern
Hypertensions		0,0291	3,5211	Clustered
Low Education	-0,0244	-0,128	4,1143	Clustered
Puskesmas		0,405	4,5718	Clustered



a. LISA (univariate) Hypertensions



b. LISA (univariate) Low Education



c. LISA (univariate) Public Health Centers *(Puskesmas)*

Figure 3. LISA Univariate

Health Centers *(Puskesmas)* variable is positive (0.349584), which means that the higher the number of Public Health Centers *(Puskesmas)*, the higher the incidence of hypertension. These two variables do not have a spatial effect on the incidence of hypertension (P value > 0.05). The R-squared value in the equation is 0.22067.

The Moran's Index value of all variables shows a value greater than the value of E(I), thus indicating that the variables of hypertension, low education, and Public Health Centers *(Puskesmas)* have a clustered pattern. The P-value of all variables shows a value that is smaller than the value of (0.05) so that there is a spatial autocorrelation between regions, meaning that hypertension, low education, and Public Health Centers *(Puskesmas)* in one location are interconnected, especially those that are neighbors (Table 2). The Low-Low (Cold-spot) area is mostly found in the low education variable as many as 7 sub-districts, while the High-high (Hot-spot) area is mostly found in the Public Health Centers *(Puskesmas)* variable (Figure 3)

Based on the results of the LISA (Local Indicator of Spatial Association) hypertension in Figure 3 (a) shows that the Kebayoran Baru and Mampang Prapatan sub-districts in South Jakarta have a spatial relationship in the High-High category. The spatial relationship of the High-High category shows that areas with high hypertension cases are surrounded by areas that have high hypertension cases as well. While the spatial relationship of the Low–Low category shows that areas with low hypertension cases are adjacent to areas with low hypertension cases. Areas with the Low–Low category include Senen District in Central Jakarta and Taman Sari District in West Jakarta. Areas that are colored light blue have a spatial relationship in the Low-High category where the area has low hypertension cases but is adjacent to areas that have high hypertension cases as indicated by the red color (High-High). These areas include Pesanggrahan District, Cilandak District, Setiabudi District and Jatinegara District. Regions with a spatial relationship in the High–Low category have high hypertension cases but are adjacent to areas that have a low number of hypertension cases. The area with the High–Low category is Tambora District. The results of the univariate LISA Hypertension showed a Moran's Index value of 0.0291 with an Expected value Moran's Index (E[I]) value of -0.0244. The distribution pattern can be known by comparing the Moran's Index value with the value E[I], where the value I > E(I), indicates that the number of hypertension cases in the Jakarta province has a positive spatial autocorrelation and has a clustered pattern (Table 2).

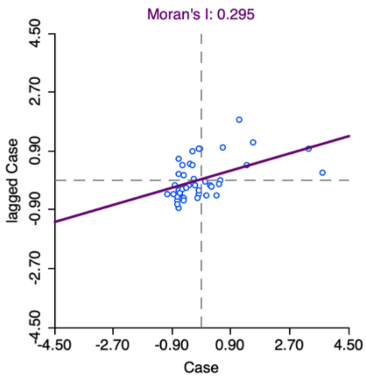
According to the results of the LISA univariate analysis of low education areas with the High-High category, it shows that the area with hypertension sufferers with low education is close to the area with hypertension sufferers with low education. It can be seen on the red map that Kali Deres, Cengkareng, Kembangan, and Penjaringan sub-districts have hypertension sufferers, and their areas are close to each other. Regions that have the Low-Low category also have a small number of people with hypertension-low education and are close to each other with other regions that have several people with hypertension with low education. Areas that have the Low-Low category include Sawah Besar, Kemayoran, Gambir, Tanah Abang, Menteng, Senen sub-districts in the Central Jakarta area, as well as Setiabudi and Tebet sub-districts in the South Jakarta area. Kelapa Gading sub-district has a Low-High category, which means that the area has a high number of hypertension sufferers with low education, adjacent to an area that has a high number of low-educated hypertension sufferers (figure 3.b). This can be caused by the distribution of hypertension patients with the highest low education in Kali Deres Sub-district (27.46%) and Cengkareng District (24.86%) in West Jakarta, Cilincing District (25.08%) in North Jakarta. and Cakung Sub-district (22.0%) in East Jakarta.

The results of the LISA analysis of low education produce a Moran's Index value of 0.3670 and an E[I] value of -0.0244 which means the Moran's Index value is greater than the E[I] value. This shows that the distribution pattern of the low educated population in the Jakarta province has a positive spatial autocorrelation, or it can be said that the low education variable has a pattern that tends to clump together and a z-value of 4.1143 is obtained (Table 2).

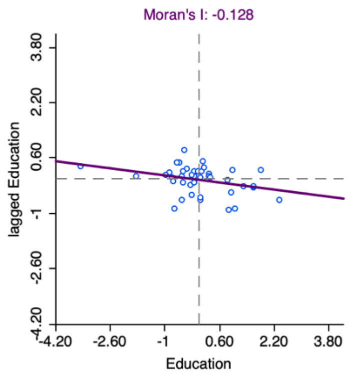
The level of education affects healthy ways and behavior, especially in implementing a healthy lifestyle. A person's level of education is related to their health knowledge (Pandit et al., 2009). Hypertension is more commonly found in individuals who have low education. Even though hypertension cases have higher education, they have greater motivation to take medication and change their lifestyle according to the recommendations of doctors and other health workers compared to hypertension cases with low education (Di Chiara et al., 2017; Samal et al., 2007). Seeing the effect between the level of knowledge and the prevention and management of hypertension, health promoters should use methods that are easily understood by residents. For residents who are known to have low education, health promoters must be able to provide clear information and health interventions so that they can be well absorbed.

The results of the LISA univariate analysis of Public Health Centers *(Puskesmas)*, there are 6 sub-districts that have the spatial category of High-High (figure 3c), which means that the area has the highest number of health centers adjacent to areas that have many health centers as well. This can be seen from Figure 3c, where Gambir District is shown in red and surrounded by dark red as well. Areas with the Low-Low category shown in dark blue are in 5 sub-districts, 3 sub-districts in North Jakarta, 1 sub-district in West Jakarta and 1 sub-district in South Jakarta. The spatial category is Low – Low, which means that the area has a small number of health centers and is surrounded by areas that also have a small number of health centers. The results of the LISA analysis of the Public Health Centers *(Puskesmas)* showed that the Moran's Index value was 0.405 and the E[I] value was -0.0244. The results of this analysis also produce a z-value of 4.571 so that it is known that the spatial autocorrelation is positive, and the Public Health Centers *(Puskesmas)* variables tend to be clustered (Table 2).

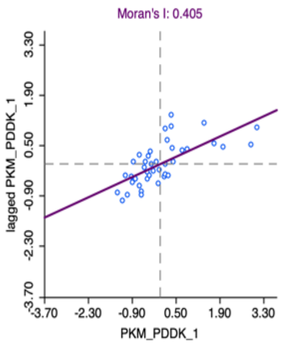
In the scatter-plot diagram (Figure 4), the incident of hypertension and Public Health Centers *(Puskesmas)* variables show a positive direction, which means that there is a positive autocorrelation between neighboring areas, the Moran's Index scatter plot graph shows a positive direction, thus the hypertension variable, Public Health Centers *(Puskesmas)* gives a positive autocorrelation value in the surrounding area. The variable of low education shows a negative direction on the scatter plot graph, this shows that low education gives a negative autocorrelation value in the surrounding area. The positive autocorrelation of hypertension case data and the availability of Puskesmas shows that, hypertension cases and the availability of Puskesmas have a regional influence, where



a. Hypertensions



b. Low Education



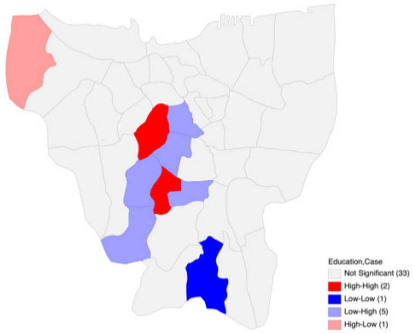
c. Public Health Centers *(Puskesmas)*

Figure 4. Moran's Scatter Plot Univariate

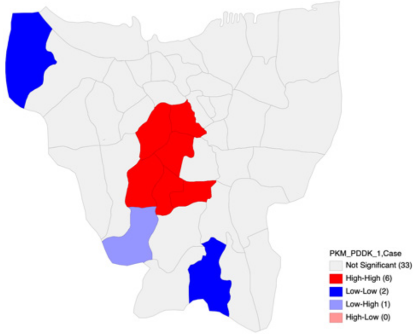
they influence each other between sub-districts in Jakarta. In other words, hypertension cases in Jakarta have almost the same number of cases in every sub-district. The negative autocorrelation at the level of education indicates that the level of education has an unequal distribution of data in each sub-district, based on the data previously presented, that the sub-districts with low education that have the highest numbers are in the Kali Deres District, Cengkareng District, Cilincing District, Cakung District.

Based on bivariate analysis, Moran's Index showed that there was a spatial relationship, areas that fall into the hot-spot category (High-High) are low education variables with hypertension found in 2 sub-districts, while the hot-spot area as a result of the relationship between Public Health Centers *(Puskesmas)* and hypertension variables is in 5 sub-districts located in the central area of Jakarta. The cold-spot (Low-Low) area as a result of the relationship between low education and hypertension is in the southern region of Jakarta, the variables of Public Health Centers *(Puskesmas)* and hypertension are in the north and south of Jakarta (Figure 5). The results of bivariate spatial analysis show that there are areas that have outlier values, where areas that fall into the High-Low and Low-High categories, this becomes an outlier value because the region has a high value among its neighbors, an area with a low value or a high area and has neighbors. with low value. Districts with the High-Low category are located in 5 sub-districts that are close to each other, namely Menteng sub-district, Setia Budi sub-district, Kebayoran baru sub-district, Cilandak sub-district, and Pancoran sub-district. Districts with Low-High are only found in Kalideras sub-district.

In the scatter-plot diagram (Figure 6), all variables show a positive direction, which means that there is a positive autocorrelation between neighboring regions, the Moran's Index scatter plot graph shows a positive direction, thus

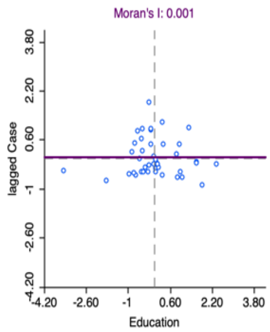


a. Low Education - Hypertensions

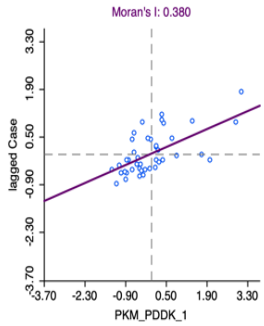


b. Public Health Centers *(Puskesmas)* – Hypertensions

Figure 5. LISA Bivariate analysis



a. Low Education - Hypertensions



b. Public Health Centers *(Puskesmas)* – Hypertensions

Figure 6. Scatter Diagram Moran's Index

Table 3. Moran's Index Bivariate Table

Variable	E[I]	Moran's Index	Z-value	P-value	Pattern
Low education	-0,0244	0,011	0,0003	0,4990	Clustered
Puskesmas		0,0379	0,5221	0,0011	Clustered

the variables of low education on hypertension and Public Health Centers *(Puskesmas)* on hypertension give a positive autocorrelation value. This shows that there is a spatial interaction in the surrounding area. Spatial autocorrelation can be interpreted as a correlation between variables and themselves or it can also be interpreted as a measure of the similarity of objects in a space. The onset of spatial randomness indicates a spatial pattern such as clustered, dispersed, or random. Positive spatial autocorrelation indicates that adjacent locations have similar values and tend to be clustered. Negative spatial autocorrelation indicates that adjacent locations have different values and tend to spread out. And no spatial autocorrelation indicates a random location pattern.

The results of spatial bivariate analysis (Table 3) show that there is a positive spatial autocorrelation on the Moran's Index for the variable of low education and Public Health Centers *(Puskesmas)* on the incidence of hypertension, but only the Public Health Centers *(Puskesmas)* variable is significant at the 0.05 level, meaning that there is an effect of spatial interaction between the Public Health Centers *(Puskesmas)* on hypertension. The spatial pattern of the two independent variables (low education and Public Health Centers *(Puskesmas)*) forms a clustered pattern, this is the same as the result of the univariate spatial.

Hypertension is a non-communicable disease that is commonly found in urban areas (Wang et al., 2018; Y. Zhang et al., 2016). The prevalence of hypertension in Jakarta ranks 9th out of all provinces in Indonesia, according to *Riskesdas* data in 2018 the prevalence of hypertension in Jakarta is 33.43%. The highest prevalence increase was in Jakarta province at 13.4% according to data from National Research Survey, 2018. Geographical differences in urban and socioeconomic contexts can explain the spatial variation of non-communicable diseases (Pou et al., 2017). Spatial analysis can reveal different socio-economic and demographic risk factors for NCDs, including individual factors that influence them (age, gender, lifestyle). Many studies have highlighted the importance of community-specific interventions and the need for a region-based approach to address NCDs (Tuoane-Nkhasi & van Eeden, 2017). Spatial analysis is very necessary because it can be a decision support system to carry out regional and problem-based interventions (specific area intervention model). This method helps policy makers to see where the incidence of stunting is and what types of interventions can be carried out at the district/city level or down to the village level (Yadav et al., 2015).

Spatial distribution is usually used in the context of communicable diseases, but this concept also applies to non-communicable diseases. Non-communicable diseases such as obesity, diabetes, and cancer also have a spatial distribution. This spatial distribution may be related to the spatially distributed environmental factors. Spatial distribution may also occur in terms of behavior and vulnerability. Human health is thus closely related to the context of the region and the behavior attached to it; where they are spatially structured (Siangphoe & Wheeler, 2015; Souris, 2018).

The results of the spatial autocorrelation regression show that hypertension has a spatial influence with the surrounding area. Spatial autocorrelation is the basis for doing spatial analysis (Grekousis, 2020; Thill, 2018), which means that the prevalence of hypertension in one area is related to the prevalence of hypertension in other nearby areas (neighbors). This autocorrelation indicates that the prevalence of hypertension -either high or low - in one district/city does not occur randomly but is related to the prevalence of hypertension in the surrounding districts/cities. The purpose of spatial autocorrelation is indeed to prove that the spatial distribution of attribute values of a variable does not occur randomly (Grekousis, 2020; Souris, 2018).

Spatial concepts in the health sector can be used to address the problem of inequality in health, health system analysis, problems related to demand and supply. Accessibility is an important factor in analyzing the benefits of a health care system; In this case, the purpose of spatial analysis is to identify and analyze regional social health imbalances within a region. Accessibility of health services is not only a spatial concept, but also multidimensional which includes spatial aspects (health service provision, procurement of goods, transportation, etc.) and non-spatial aspects (socio-economic environment, cultural environment, etc.). Screening activity is one of the activities as a form of primary prevention in controlling hypertension. However, low knowledge is the most common barrier to hypertension awareness, hypertension screening activities, both home-based, health centers, and communities are very necessary to find the presence of new cases and be able to carry out hypertension management as early as possible such as education, care, and treatment especially for the elderly (Littenberg, 1990).

The results of the bivariate spatial analysis showed that the Public Health Centers *(Puskesmas)* had a spatial influence on the incidence of hypertension or indicated a spatial interaction between regions. Spatial autocorrelation technique to determine the pattern of distribution of the number of health centers and its relationship with the incidence of hypertension in all sub-districts in the Jakarta province, except for the Thousand Islands Administrative District. The result shows that the spatial autocorrelation of the number of Public Health Centers *(Puskesmas)* variables is positive and the distribution pattern tends to cluster. Access to health services geographically to health facilities for screening tests for hypertension is something that greatly influences someone to do screening and treatment (Kuupiel et al., 2020).

Spatial autocorrelation analysis in the health sector can provide an overview of mapping the grouping of health problems in an area. The mapping can clarify the health problems of an area. Furthermore, the results of this mapping can assist in assessing risk factors spatially for policy makers in determining what health policies are most appropriate for planning and implementing health services. The results of this mapping can greatly affect the performance and effectiveness in providing health services for the community (Tsai et al., 2009).

Spatial autocorrelation is defined as the relationship between the values of a single variable. This relationship is due to the geographical arrangement of the unit areas on the map and can be used to identify the degree of spatial grouping (Griffith et al., 1991; Kitron & Kazmierczak, 1997). Spatial autocorrelation is useful for mapping regional health service problems. Mapping helps clarify issues such as the spatial aspects of internal and external correlations of leading health care events. This helps planners to assess spatial risk factors, and to determine the type of health care policy that is most favorable to health care planning and implementation. These issues can greatly affect the performance and effectiveness of health services and also help us better understand outcomes (Tsai et al., 2009).

Although based on the results of the spatial regression of the Puskesmas it did not affect spatially the cases of hypertension (table 1), but the role of the Puskesmas as a health service facility for hypertension patients was very necessary. Public Health Centers *(Puskesmas)* is one of the important facilities in comprehensive Non-Communicable Disease (NCD) control services, both in promotive and preventive activities as well as in holistic activities. As a First Level Health Facility (FKTP) it is appropriate for the Public Health Centers *(Puskesmas)* to carry out primary prevention activities, namely activities to reduce and stop hypertension risk factors before the disease gets worse. The community also needs to receive education through health promotion activities organized by the Public Health Centers *(Puskesmas)*. The screening program as a form of secondary prevention is also the responsibility of the Public Health Centers *Puskesmas* to find the disease early and treat it as early as possible. Furthermore, tertiary prevention is carried out on people who have been diagnosed with hypertension. Tertiary prevention is also intended to control disability or premature death due to hypertension.

The program of the Ministry of Health of the Republic of Indonesia in tackling Non-communicable Diseases (NCD) is the *CERDIK* and *PATUH* programs. *CERDIK* is an acronym for Periodic health checks, get rid of cigarette smoke, Diligent in physical activity, Healthy diet with balanced calories, Get enough rest, and Control stress. The target of this program is a group of people who are still healthy or have NCD risk factors. The second program is *PATUH*, which targets people with NCD with the aim that they are diligent in taking medication and have regular check-ups. *COMPLIANCE* is a routine health check and follow the doctor's advice, overcome disease with regular and appropriate treatment, maintain a healthy diet with a balanced nutritional menu, strive to do safe physical activities, and avoid alcohol, cigarettes, and other carcinogenic substances by health centers in each area. The activities carried out in the program include preventive, promotive, curative, and rehabilitative activities. Public Health Centers *(Puskesmas)* has a role as a First Level Health Facility (FKTP) whose task is to carry out early detection (screening) of risk factors, conduct blood pressure checks, and surveillance of hypertension. Seeing the high number of hypertension cases in the Jakarta province, it can be a consideration for policy makers at the Health Service and Public Health Centers *(Puskesmas)* level in determining priorities for handling health problems. In total, only 7 out of 42 sub-districts in the Jakarta province have the lowest number of hypertension cases. A total of 35 other sub-districts still shows high cases of hypertension.

Preventive activities at the FKTP level are conducting early detection of risk factors, measuring blood pressure, hypertension surveillance, and partnerships. These activities are facilitated by the Healthy Indonesia Program with a Family Approach (*PIS-PK*), Regency/City Minimum Service Standards (*SPM),* NCD guide, School Health Center (*UKS*) through the *CERDIK* program, Chronic Disease Management Program (*PROLANIS*) by *BPJS*, Public Health Nursing (*PERKEMAS*), referrals from *POSBINDU* NCD/ *UKBM* (Community Based Health Efforts), and other FKTPs. The curative and rehabilitative activities carried out are hypertension management and referrals to other health facilities.

Spatially, the level of education does not have a spatial interaction with the incidence of hypertension. Low education level shows no spatial autocorrelation, meaning that low education does not have a spatial effect on hypertension, but based on the results of spatial regression analysis, it shows that the lower the hypertensive patient with low education, the lower the incidence of hypertension. This is because low education gives a negative autocorrelation value on the incidence of hypertension. One study showed that common socioeconomic determinants, such as education, income, occupation, and urban or rural residence, were associated with hypertension (Grotto et al., 2008). Figures 2 and 3 show that the Kalideres sub-district which has the highest population value with low education in Jakarta and based on the Moran's Index analysis is a Hot-Spot area, while the results of the bivariate LISA analysis are in the High-Low category. This shows that the Kalideres sub-district is a spatial outlier of hypertension, meaning that the area has a high number of people with low education, but a low number of hypertension cases. Kalideres sub-district is the most distant sub-district from the city center, the imbalance in the position between the city center and areas on the outskirts of the city causes many problems of uneven development (Senadza, 2012; X. Zhang & Kanbur, 2005; Y. Zhang et al., 2016).

The level of education contributes as one of the factors that influence the incidence of infectious diseases (Rawal et al., 2017; Yosmar et al., 2018). The level of education is an important factor for hypertensive patients so that they can change their lifestyle to be healthier, besides the willingness to health literacy is very necessary, so in addition to education, health promotion about hypertension needs to be done (Minkler, 1989; Pandit et al., 2009; Samal et al., 2007). An educational approach with health promotion is one of the best ways to provide reliable information and motivation to the community and help individuals develop decision-making abilities and provide an image for the community to explore and develop appropriate attitudes and actions (Darmawan & Zulfa, 2015).

4. Conclusion

The distribution pattern of the hypertension variable, the number of Public Health Centers *(Puskesmas)* and low education, is clustered. The variable of low education has a negative spatial autocorrelation value. There are sub-districts into the High-Low and Low-High categories which are areas with outlier values because the area has a high value among its neighbors, an area with a low value or a high area and has neighbors with a low value. Regions that are included as outliers need to be intervened with a spatial approach, through each health facility in the sub-district.

There is a regional influence or spatial interaction between Public Health Centers *(Puskesmas)* variables on hypertension cases. Improving the quality and quantity of infectious disease prevention activities at local health centers which are the frontline in preventive and promotive activities and is expected to be the key to successful control of hypertension cases in the Jakarta province.

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