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SPATIAL ANALYSIS OF HIV CASE DISTRIBUTION AND KEY POPULATION DISTRIBUTION IN BANDUNG CITY

Alnidi Sarafach Bratanegara, Aldi Maulana Yusuf, Fiqhi Adha Arlisadi
Geography Education Study Program, Faculty of Social Science Education
Universitas Pendidikan Indonesia, Jawa Barat, Indonesia

e-mail: alnidi.bratanegara@upi.edu

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Abstract

HIV is a disease that can attack a person's immune system, and there is no effective drug to eliminate HIV disease. Indonesia is one of the countries with the fifteenth largest population affected by HIV disease in the world. The city of Bandung is the area that has the most HIV cases in the province of Java; based on data from the Bandung City Health Office, there were 4,620 people infected with HIV in 2018. The purpose of this study was to analyze the relationship between the distribution of HIV cases and the distribution of key populations in the city of Bandung. The research method used is a quantitative description method by collecting various secondary data from the health department so that it is processed using a Geographic Information System. The spatial analysis used is the Spatial Autocorrelation Report, which will describe based on data on HIV cases and key populations. The results of the study illustrate that HIV cases have a random distribution pattern and have no correlation between locations and HIV cases. Meanwhile, the distribution pattern of the key population has a random distribution pattern or does not correlate with the location and the key population, so there is a tendency for a relationship between HIV cases and the number of key populations.

Keywords: HIV, Key Population, Geography Information System, Bandung

INTRODUCTION

Human Immunodeficiency Virus (HIV) is a virus that attacks the immune system (Arif et al., 2016; Centers for Disease Control and Prevention, 2021; Vanangamudi et al., 2021). Until now, there is no proven effective drug to cure people with HIV because this virus will continue to be owned by people with HIV (Singh & Das, 2022). Based on data from World Health Organization (WHO) in 2019 (WHO, 2022), Indonesia is one of the fifteen countries with the highest number of people living with HIV. WHO has estimated that 540,000 people are living with HIV in Indonesia. Indonesia ranks fourteenth out of the fifteen countries with the highest number of people living with HIV in 2019.

HIV can be transmitted through sex, blood transfusion, sharing needles, and transmission from mother to child (Christane, 2014; Elisanti & Ardianto, 2018; Tahir et al., 2015). According to (Mohapatra & Sahoo, 2019), HIV attacks or infects white blood cells and lowers the human body's immunity. Based on data from the Ministry of Health of the Republic of Indonesia (Kemenkes RI, 2017), most people reported to be infected with HIV are men. Still, almost 60% of people with HIV reported in Papua are women. This figure is in stark contrast to the 37% figure for women living with HIV in all other parts of Indonesia.

HIV infection was first detected in Indonesia in 1987 (Depkes RI, 2006). Since the initial discovery of HIV cases until December 31, 2006, the number of people living with HIV in Indonesia was reported to have reached 5,230 people. HIV cases in Indonesia from year to year have increased. The peak of the increase occurred in 2006, with the number of cases as many as 986 people infected with HIV (Figure 1).

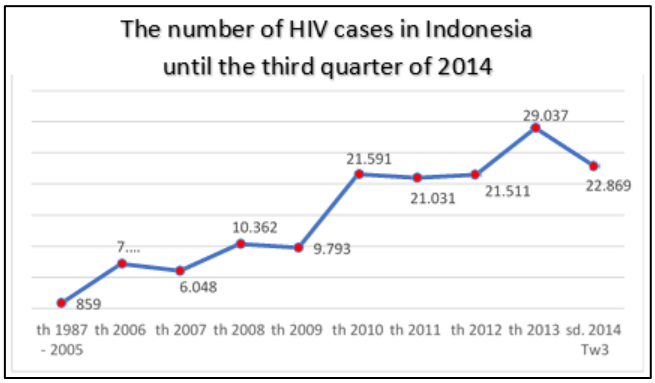

Figure 1. Graph of the Number of HIV Cases in Indonesia (Source: Kemenkes RI, 2014)

West Java Province is one of the eight provinces with the highest number of cases in Indonesia in 2018 (Kementrian Kesehatan RI, 2018). West Java ranks third out of eight provinces with the highest HIV cases in 2018. One of the important factors that cause an increase in HIV cases is the number of key populations in an area (Dellar et al., 2015; Garnett, 2021). A key population is a group with high-risk behaviors that can affect the dynamics of HIV transmission (Fraser et al., 2021; Stone et al., 2021). Meanwhile, the Pan America Health Organization (PAHO, n.d.) defines a key population as a group that can increase the risk of HIV infection due to high-risk behavior (Ravasi et al., 2016), so this key population is very important and must be considered because it greatly influences the dynamics of the population. HIV transmission and increase the vulnerability of a region to HIV. Each region must be alert and prioritize the HIV response and focus on key populations that are the most vulnerable (Fraser et al., 2021). Key populations are community groups at high risk of contracting and transmitting HIV due to factors that cause unsafe sex and the use of unsterilized injecting drugs (Decker et al., 2022).

Knowledge of key populations is very important for the community to know and assess the risk of the threat of HIV disease transmission in the community (Woodford et al., 2016). Based on data from the Bandung City Health Office as of December 2018, there were 4,620 people infected with HIV in the city of Bandung, with the highest factor being caused by key population groups such as female sex workers, injecting drug users, and so on who came from within and outside the city of Bandung who was highly mobilized and in large enough quantities (Indrayani et al., 2020). Therefore, the public must be able to know about the process of HIV transmission, especially due to the presence of key populations, so that the community can evaluate and monitor existing health programs, especially in preventing HIV transmission.

Each country has a major challenge in dealing with national-level key population estimates (Ghys et al., 2018), but to evaluate and monitor the need for a technological update, one of which is relying on and utilizing information systems. One of the information system technologies that can be relied upon and utilized by the health sector is Geographic Information Systems (GIS) (Cromley & McLafferty, 2012; Fradelos et al., 2014). GIS applications can assist in analyzing health data, especially HIV cases so that disease phenomena in an area can be identified properly (Kandwal et al., 2009). According to research by (Kandwal et al., 2009), GIS acts as a spatial database related to HIV cases to assist health workers in making policies and the analysis process.

GIS is commonly used to analyze public and professional health, including policymakers, statisticians, and regional and district medical officers. According to (Kandwal et al., 2009), some of the benefits of GIS used in public health are (1) Geographic distribution and variation of disease; (2) Analysis of spatial and temporal trends; (3) Identifying gaps in

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immunization; (4) mapping of at-risk populations and stratification risk factors; (5) Documenting community health care needs and assessing resource allocation; (6) Forecasting epidemics; (7) Planning and targeting interventions; (8) Monitoring disease and interventions over time; (9) Managing patient care environment, materials, supplies, and human resources; (10) Monitoring the utilization of puskesmas; (11) Routes of health workers, equipment and supplies to service locations; (12) Publishing health information using maps, etc. The availability of accurate geospatial information related to health, especially HIV, can improve decision-making that is more efficient, effective, and communicative (Mapala, 2017).

Especially for the case of HIV, GIS can be used to obtain basic information that is later needed to plan interventions for key populations (Fradelos et al., 2014; Kandwal et al., 2009). In addition, the GIS can also find out the number of populations and the hotspots for HIV key populations to facilitate the planning of field officers in reaching key populations and determining services in appropriate places for key populations. Meanwhile, according to the Indonesian Ministry of Health (Kementrian Kesehatan RI, 2015), GIS can also be used as a reference for estimating the number of key populations and modeling the National HIV epidemic.

Based on the problems above, the researcher formulates several problem formulations that will be studied in this study as follows: (1) How is the distribution and average of HIV case findings from 1991 - 2021 in Bandung City based on age and occupation; (2) How is the distribution of HIV key population in Bandung City; and (3) Is there a relationship between the distribution of HIV cases and the distribution of key populations in Bandung City.

RESEARCH METHODS

This research uses a quantitative description method. The research location is in the administrative area of Bandung City, West Java Province, Republic of Indonesia. The coordinates of Bandung City are 6°54'53.08" LS and 107°36'35.32" LU. Topographically, the city of Bandung is located at an altitude of 791 meters above sea level (asl), the highest point in the north with an altitude of 899 meters and the lowest in the south at 400 meters above sea level (asl) (Statistics, 2017). The boundaries of Bandung City are: (1) North Boundary: Bandung Regency and West Bandung Regency; (2) Southern Boundary: Bandung Regency; (3) West Boundary: Cimahi City; (4) Eastern Boundary: Bandung Regency (Figure 2).

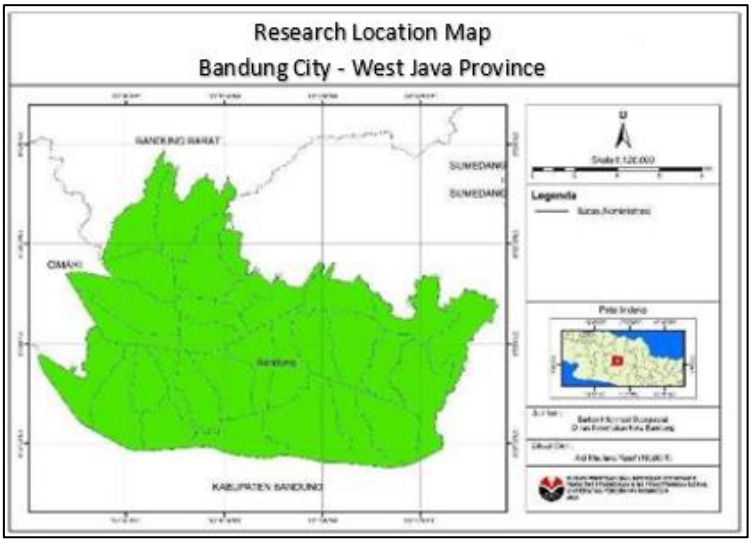

Figure 2. Research Location Map (Source: Research Results, 2022)

The tools used in this research are (1) Hardware in the form of a laptop with AMD Ryzen 7 2700U Radeon Vega 10 Processor specifications; (2) 8GB RAM; and (3) Windows 10 operating system. In addition, the software used in this study is (1) Microsoft Word 2013; (2) Microsoft Excel 2013; and (3) ArcGIS 10.4.1. The data used in this study are secondary (Table 1). Then the secondary data was processed using ArcGIS 10.4.1 software.

Table 1. Research Data

No	Data	Data Type	Data source
1	Data on the Number of HIV Patients Cumulative	Secondary	Bandung City Health Office
2	Key Population Data	Secondary	Bandung City Health Office
3	Bandung City Administrative Boundary	Secondary	Ina-Geoportal

(Source: Research Results, 2022).

The following is the research flow used, namely collecting secondary data from the Bandung City Health Office in the form of cumulative HIV patient data and key population data. In addition, there are administrative data for the City of Bandung from Ina-Geoportal by the Geospatial Information Agency. This data can be processed to produce spatial data and non-spatial data. Spatial data produces two maps, namely, a map of the distribution of cumulative HIV cases and a map of the distribution of key populations in the city of Bandung. Meanwhile, non-spatial data produces information in tables based on people living with cumulative HIV and key populations used as research parameters. From the parameters used, it can analyze the distribution pattern between people living with HIV and key populations in Bandung to determine the distribution pattern based on the sub-districts in Bandung.

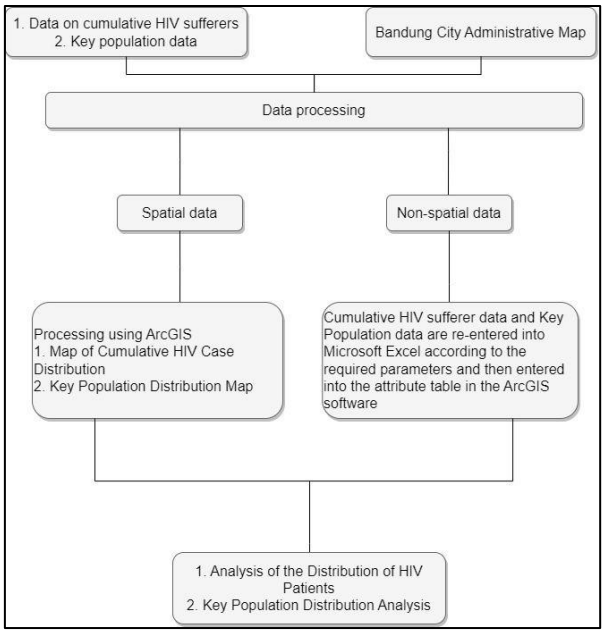

Figure 3. Research Flow (Source: Research Results, 2022).

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There are various stages carried out in this study, namely the first data collection carried out secondary data collection. Secondary data is obtained from indirect or second-hand sources, such as government agencies or libraries (Ahyar et al., 2020). Second, data processing to process HIV cases and key populations using the ArcGIS application based on the data that has been collected.

RESULTS AND DISCUSSION

Bandung is located in the province of West Java, the center of government and the capital of West Java. Geographically, Bandung City is located in the middle of West Java Province. The city of Bandung consists of 30 districts. The number of HIV cases recorded at the Bandung City Health Office reached 5,843 cases from 1991 to 2021, but the number of mapped cases was only 5,238. This is because there are data on HIV cases unknown by the sub-district. The sub-districts with the most HIV cases in Bandung are Bojongloa Kaler and Coblong sub-districts (Figure 4).

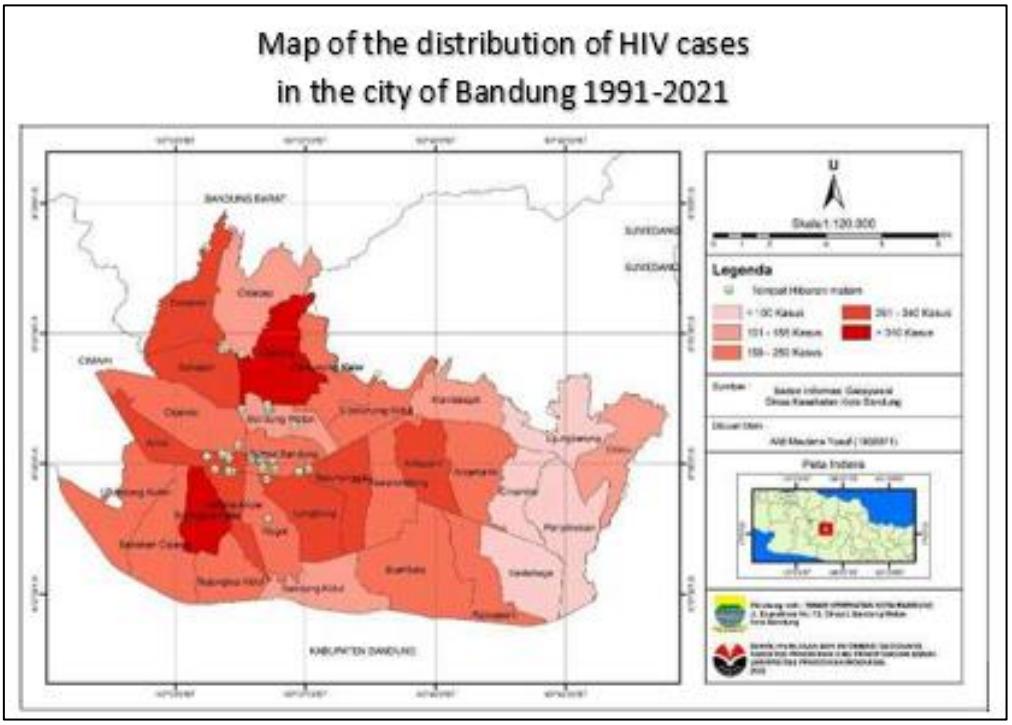

Figure 4. Map of the distribution of HIV cases in the city of Bandung in 1991-2021 (Source: Research Results, 2022)

The distribution of HIV cases in Bandung City from 1991 to 2021 formed a random pattern from data processing using Moran's spatial autocorrelation method (Figure 5). Figure 5 shows the z-score or standard deviation in HIV cases in Bandung is at -1.65 – 1.65 with a z-score value of 1.080569 which means that this HIV case does not correlate with location and HIV cases. Then the p-value or level of significance in this HIV case is 0.279889, which means there is still a high possibility of grouping the data based on the results of a random pattern.

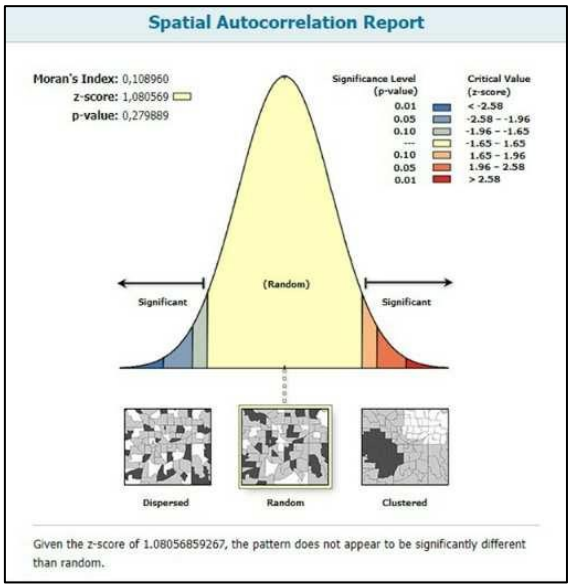

Figure 5. Spatial Autocorrelation Report HIV Case (Source: Research Results, 2022)

From the number of existing HIV cases, the average finding of HIV cases from 1991 to 2021 was obtained. The average finding of HIV cases in the city of Bandung was 202 cases. The average number of HIV cases in Bandung is mostly found in Bojongloa Kaler and Coblong sub-districts, with an average of 10-14 case.

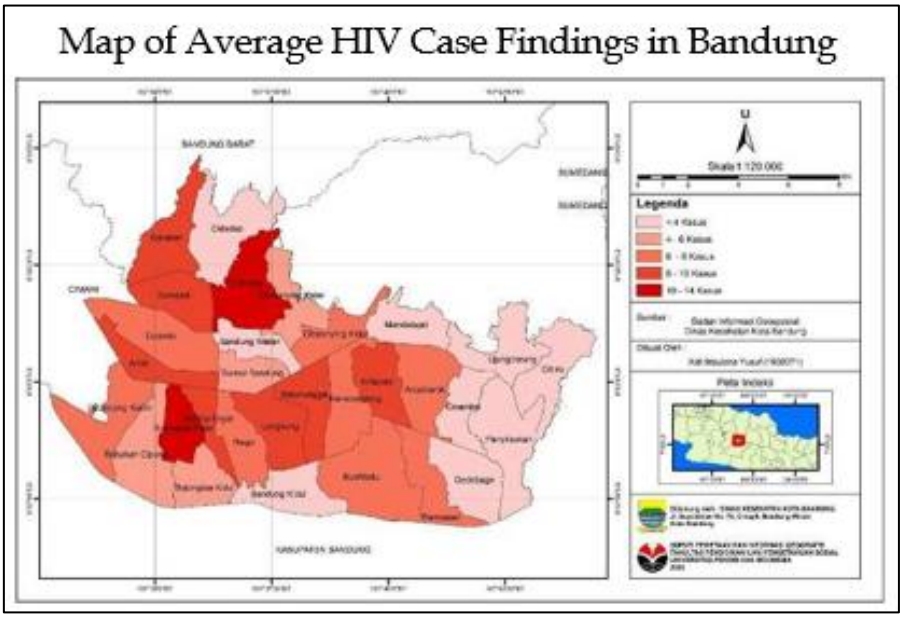

Figure 6. Map of Average HIV Case Findings in Bandung (Source: Research Results, 2022)

The distribution of HIV cases in Bandung City by age group in Bandung City from 1991 to 2021 can be seen in Figure 6. The Bandung City Health Office noted that the age group most infected with HIV in Bandung City was 30-39. Ranks first with the number of people with 2,064 people (35.32%) (Table 2).

HIV cases in Bandung City by age group in Bandung City from 1991 to 2021 can be seen in Figure 4.4. Bojongloa Kaler sub-district is dominated by the age group of 30 – 39 years with 187 sufferers and the age group 20 – 29 years with 150 sufferers. Followed by the age group 40-49 years with 87 sufferers, the age group over 50 years with 37 sufferers, the age group 14-19 years with six sufferers, and the age group whose age is unknown, there are six people.

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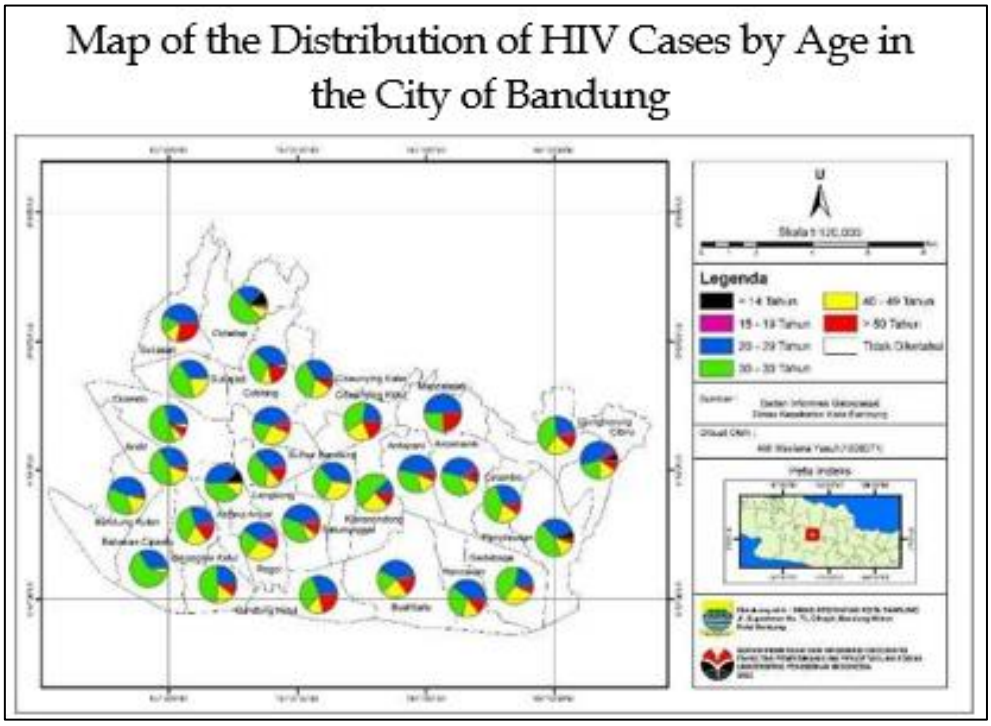

Figure 7. Map of the Distribution of HIV Cases by Age in the City of Bandung
(Source: Research Results, 2022)

The Health Office noted that the age group most infected with HIV in the city of Bandung is the age group of 30-39 years which ranks first with the number of people with 2,064 people (35.32%). Followed by the age group 20-29 years with the second place with the number of sufferers 2,029 people (34.73%). Then the age group 40-49 people with several sufferers 969 people (16.58%), the age group over 50 years with several sufferers 541 people (9.26%); the age group 15-19 years with several sufferers 106 people (1.81%), the group age less than 14 years with 104 sufferers (1.78%) and an unknown age group with 30 sufferers (0.51%).

Table 2. Number of age groups infected with HIV

Age Group	Total	Percentage (%)
< 14 years	104	1.78
15 – 19 years	106	1.81
20 – 29 years	2.029	34.73
30 – 39 years	2.064	35.32
40 – 49 years	969	16.58
>50 years	541	9.26
Unknown	30	0.51
Amount	5.843	100

(Source: Research Results, 2022)

Based on occupational groups, most of those infected with HIV were private workers in Bojongloa Kaler District and Sukajadi District. The District of Bojongloa Kaler is the sub-district with the highest HIV cases in Bandung City. It is dominated by private workers, with several sufferers of 122 people (2.09%) (Figure 8). The Bandung City Health Office noted that the occupational group most infected with HIV in Bandung was private workers, ranking first with 1618 people (27.69%) (Table 3).

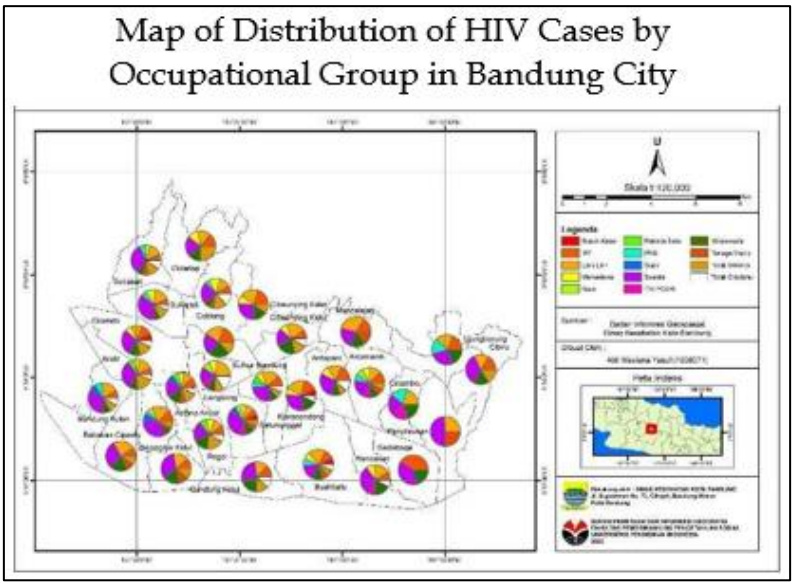

Figure 7. Map of Distribution of HIV Cases by Occupational Group in Bandung City
(Source: Research Results, 2022)

In Table 3, a group of Housewives (IRT) in the 4th rank is very vulnerable to contracting HIV. This can happen because HIV can be transmitted by her husband, who commits social deviations, whether he likes to change partners or because his husband is addicted to drugs. Then the common knowledge and awareness of HIV transmission among homemakers affect the factors of vulnerability to HIV transmission.

Table 3. Number of Occupational Groups Infected with HIV

Profession	Amount	Percentage (%)
Private	1.618	27.69
Etc	977	16.72
Self-employed	730	12.49
IRT	630	10.78
Doesn't work	539	9.22
Student	322	5.51
Unknown	309	5.29
Medical Personnel	169	2.89
Civil Servant	158	2.70
Prisoner	85	1.45
Army Police	84	1.44
Sex Worker	81	1.39
Driver	71	1.22
Unskilled Laborers	70	1.20
Amount	5.843	100

(Source: Research Results, 2022)

Based on data recorded at the Bandung City Health Office, the number of key populations in Bandung City is 20,918 (Table 4). One sub-district with the largest number of key populations is Andir District (Figure 9). Andir sub-district has a key population of 2,290 – 4,235 people. This number includes the number of female sex workers, waria, sexually transmitted infections, injecting drug users, and men having sex with men.

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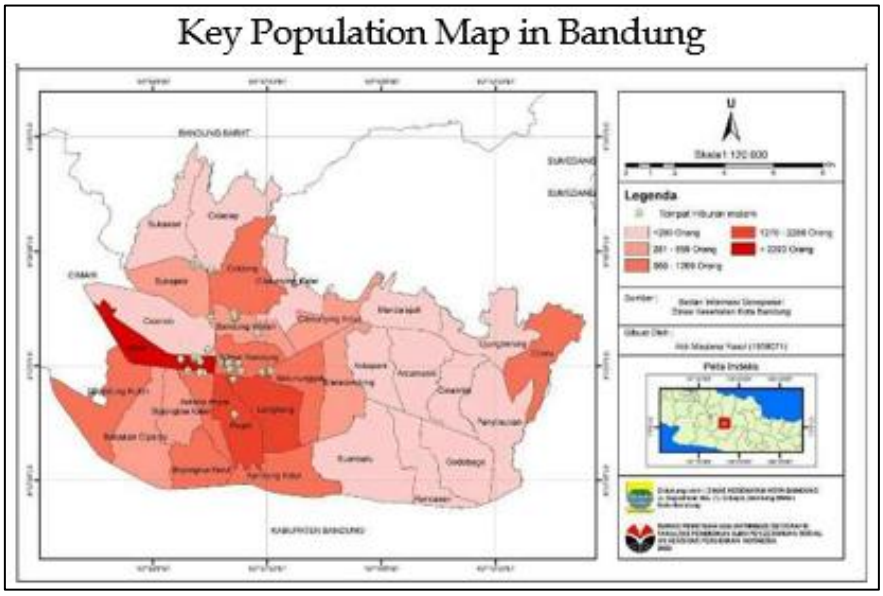

Figure 9. Key Population Map in Bandung (Source: Research Results, 2022)

The distribution of key populations in Bandung City from 1991 to 2021 forms a random pattern (Figure 10). The pattern is obtained from the processing results using Moran's I spatial autocorrelation method. Figure 9. shows the z-score or standard deviation in this key population in the numbers -1.65 – 1.65 with a z-score value of 1.011944, which means this key population did not correlate with location and HIV cases. Then the p-value or level of significance in this key population is found at 0.311565, which means that there is still a high possibility of grouping the data based on the results of random patterns.

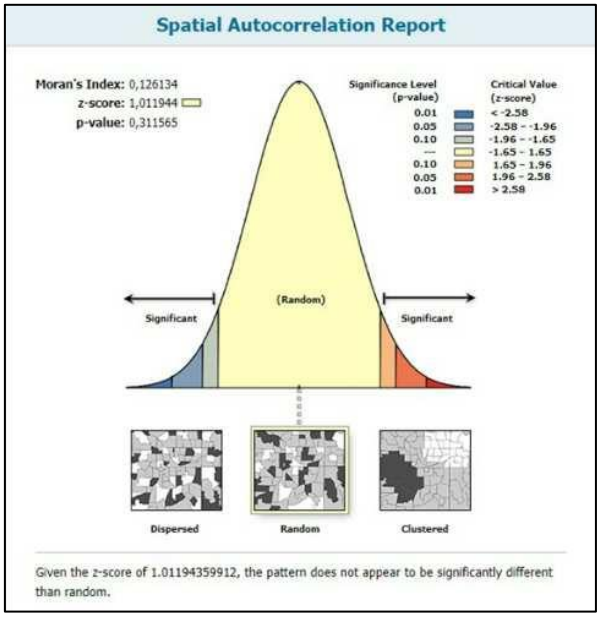

Figure 10. Spatial Autocorrelation Report Key Population (Source: Research Results, 2022)

Based on data recorded at the Bandung City Health Office, the number of key populations in the city of Bandung which is mapped the most in the group of men having sex with men (MSM) or in English Man sex Man (MSM) with a total of 11,456 people (Table 4). This group is the first group with the highest number of key populations.

Table 4. Number of Key Populations in Bandung

No	Key Population Group	Amount
1	Man Sex Man (MSM)	11.456
2	Infeksi Menular Seksual (IMS)	5.494
3	Wanita Pekerja Seks (WPS)	2.626
4	Penggunan Narkoba Suntik (Penasun)	966
5	Waria	376

(Source: Research Results, 2022)

Based on data obtained from the Bandung City Health Office, Andir and Regol sub-districts are the sub-districts that have the highest number of Man Sex Man (MSM) in Bandung (Figure 11). The number of MSM in Andir and Regol sub-districts is 950-2,131 people.

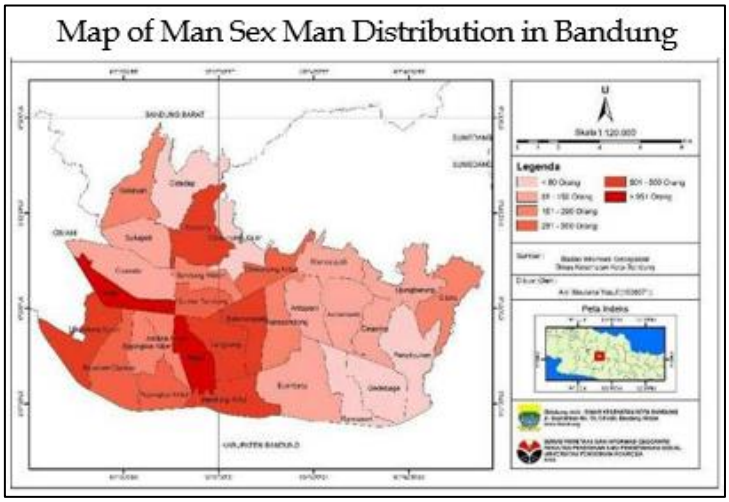

Figure 11. Map of Man Sex Man Distribution in Bandung (Source: Research Results, 2022)

For cases of Sexually Transmitted Infections (STI), based on data obtained from the Bandung City Health Office, Andir District is the sub-district that has the highest number of Sexually Transmitted Infections (STIs) in Bandung. The number of STIs in Andir District is 623-1,161 (Figure 12).

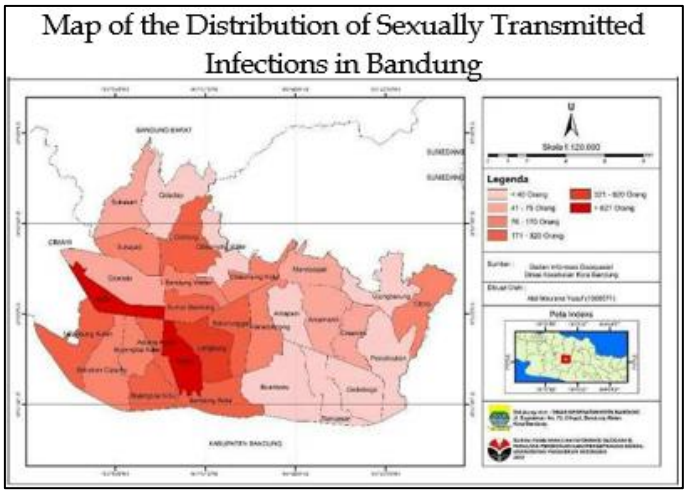

Figure 12. Map of the Distribution of Sexually Transmitted Infections in Bandung (Source: Research Results, 2022)

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For the distribution of female sex workers, the Andir sub-district also ranks first in Bandung. The number of female sex workers in Andir District is 569–710 people (Figure 13).

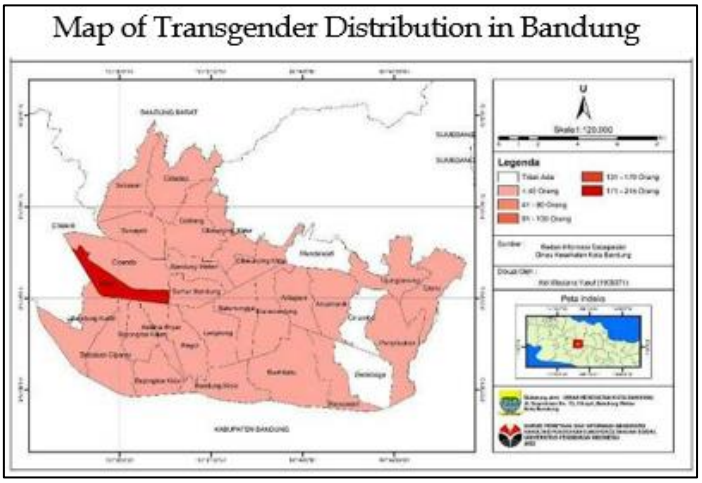

Figure 13. Map of Transgender Distribution in Bandung (Source: Research Results, 2022)

There is a link or relationship between HIV cases and key populations, especially in Bandung. The same thing stated through the research results from (Stone et al., 2021) also revealed a positive relationship between key populations and the number of HIV cases. The community needs to know about the risk of the presence of key populations because key populations have high-risk behavior in HIV transmission (Woodford et al., 2016). Identifying key populations should be undertaken to measure the key populations' contribution to ongoing HIV transmission and identify interventions to reduce this risk (Fraser et al., 2021).

Identifying key populations is useful for estimating the best achieved from targeted interventions to different key populations or risk behaviors. Interventional approaches are needed to prevent and respond to diverse key HIV populations and identify priority areas for further development, rigorous evaluation, and implementation of evidence-based practices in priority areas. The intervention must include comprehensive prevention and response (Decker et al., 2022). The intervention was carried out to prevent transmission, which is embedded in HIV risk reduction and related health promotion. The intervention program is carried out to reduce sexual risk behavior and sexual violence. It demonstrates the synergistic impact of integrated interventions and care and policy collaboration, which is very important to improve, measure, and evaluate the interventions carried out.

The analysis in this study uses GIS (Geographic Information System) which helps in health analysis, especially those related to the distribution of key populations at high risk of transmitting HIV. The analysis in this study uses GIS because a dynamic spatial data infrastructure and routines support it. Health data can provide valuable information for planners to address issues related to HIV/AIDS and support monitoring, evaluation, and planning. GIS can also be an effective tool for managing and monitoring HIV/AIDS and related routine activities. Since health is largely determined by spatial factors (including the socio-cultural and physical environment, which vary greatly in space), health always has an important spatial dimension. Like all other advanced technologies, GIS can be applied by practitioners experienced in public health methodologies. It can be a very important tool for health research and education. The spatial modeling capacity offered by GIS can help to understand the spatial variation in disease incidence and its

covariation with environmental factors in health care.

The facts and figures presented in this study suggest a sharp increase in the estimated number of HIV infections which could translate to a large number of people infected in the key population. An understanding of the principles and methods of epidemiology is required to structure a study and interpret the results for appropriate socioeconomic development at various levels of society. It is, therefore, necessary to use GIS-based mapping to generalize, symbolize, and classify data so that maps communicate effectively rather than distort data behind the map and can help in combating the geographic spread of HIV/AIDS, and trends in its distribution patterns. Related is confirmed. Appreciation of this fact is important in planning appropriate interventions and effective measures to control the epidemic, especially controlling the spread of the HIV/AIDS virus.

An example of an HIV case can be seen in Figure 3, which shows that Bojongloa Kaler and Coblong sub-districts are the sub-districts that have the highest number of HIV cases in the city of Bandung with a total of 286–431 cases. Then it can be seen in Figure 8 that the number of key populations in Bojongloa Kaler District is 281–717 people, and in Coblong District, it is 718-1,269 people. Based on the research data described previously, the number of key populations has the highest number compared to the case of HIV. This indicates that almost all key populations are infected with HIV because key populations are very vulnerable to HIV infection due to high-risk behavior possessed by these key populations.

CONCLUSION

The importance of using geospatial technology is needed to improve decision-making. However, most of the adoption and implementation have not been successful. The adoption and implementation of geospatial technology and techniques used to analyze the spread of HIV/AIDS in Bandung are still rarely done. As a result, adoption, and implementation depend on the internal motivation of the policy champions, mastery of geospatial technology, support, encouragement, and motivation from the organization and their management.

Based on the results and discussion, with the formulation of the research problem, it can be concluded that: (1) The distribution pattern of HIV cases in Bandung City has a random distribution pattern that does not correlate with locations and HIV cases; (2) The average finding of HIV cases in Bandung is 202 cases per year; (3) The distribution pattern of the key population in Bandung has a random distribution pattern or does not have a correlation between the location and the key population, and there is a tendency for the relationship between HIV cases and the number of key populations.

In this case, the researcher concludes that there is a need for further research on the factors that support and influence an organization or management in adopting and implementing geospatial techniques in decision-making or determining interventions, especially in the health sector.

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