Analysis of Regional-based Infectious Disease Vulnerability in Semarang City

Mochamad Abdul Hakam[1] , Hanif Pandu Suhito[2], Dina Nur Anggraini Ningrum[3], Muhammad Solihuddin Muhtar[4]

[1]Faculty of Medicine, Universitas Dian Nuswantoro, Semarang City, Indonesia
[2]Faculty of Health, Universitas Dinas Nuswantoro, Semarang City, Indonesia
[3]Public Health Study Program, Faculty of Medicine, Universitas Negeri Semarang, Semarang City, Indonesia
[4]International Ph.D. Program in Biotech and Healthcare Management, Taipei Medical University, Taiwan

abdulhakam.semarang@gmail.com

Abstract. Decision-making in infectious disease control must be based on data and evidence-based approaches. The objective of this study is to depict the regional-based vulnerability of infectious diseases in Semarang City. Using data from routine services provided by 37 health centers (Puskesmas) from 2020 to January 2023, a total of 159,898 patients were included. A quantitative descriptive analysis approach was used to determine the distribution of infectious diseases based on age groups, spatial locations, and time periods. The results show that diarrhea is the highest prevalent infectious disease over the three-year period, followed by COVID, Typhoid, and HIV. Patients from outside Semarang City still dominate the reported cases of infectious diseases. The sub-districts of Banyumanik, Pedurungan, and Tembalang tend to have the highest number of infectious disease cases. In terms of time distribution, the number of infectious disease cases varies significantly, with a tendency to increase during the last quarter of the year or after long holidays. These findings are likely influenced by the conditions during the COVID pandemic, but diseases like Diarrhea, Typhoid, and HIV tend to remain high even during the pandemic. Given Semarang City's strategic position, cases from outside the city also play a significant role in the epidemiology of infectious diseases within Semarang. This vulnerability analysis can assist decision-makers, even at the village level, in diagnosing and prioritizing health issues, particularly infectious diseases.

Keywords: population vulnerability, communicable disease, digital epidemiology

1 Introduction

Infectious diseases pose a significant global challenge, affecting public health and societal well-being, as well as public health policy and overall national (health) sover-

A. Khoironi et al. (eds.), *Proceedings of the International Seminar and Workshop Public Health (ISWHOPHA 2023)*, Advances in Health Sciences Research 75,
https://doi.org/10.2991/978-94-6463-421-1_25

eignty [1]. In recent years, the importance of data-driven and evidence-based decision-making in disease control has become increasingly evident [2]. Additionally, considering the multi-sectoral impacts of infectious diseases is crucial for effective decision-making and prevention efforts [3]. As cities expand and urban populations grow, the dynamics of infectious disease transmission and vulnerability have undergone profound changes, necessitating targeted interventions and policies. Urban planning and infrastructure play a significant role in controlling infectious diseases, as they create the necessary conditions for healthy living and prevent the spread of diseases in cities [4]. Effective decision-making in infectious disease control is essential for preventing and managing outbreaks. Research has shown that evidence-based approaches and data-driven policies are key to successful disease control [5].

Previous studies focusing on regional-based vulnerability mainly used the social vulnerability index [6] as the tool of measurement, associated with the spreading of infectious diseases, in this case is COVID-19 [7]. Further assessment of OneHealth in regard to vulnerability threats from infectious diseases and social science perspective suggested that it is important to consider both social and environmental factors[8]. An Analytic Hierarchy Process (AHP)-based regional COVID-19 vulnerability model study identified four types of vulnerability factors: regional, pathological, medical, and response attribute factors. The model can be used to analyze quantitatively the importance of various vulnerability factors, of which, one important factor is healthcare infrastructure [9]. Another study highlighted the importance of community engagement in addressing the social and environmental factors that contribute to vulnerability to infectious diseases [10]. Besides the social and environmental factors, it turned out that economic factors also play a significant role in assessing infectious disease vulnerability [11]. Geographical profiles, as well as the population movement tend to affect the exposure of potential pathogens, such that the knowledge of geographic distribution and burden of infectious diseases is very crucial for informed evaluation and care of patients [12]. Furthermore, the Infectious Disease Vulnerability Index can help policymakers identify regions with high population densities or poor sanitation infrastructure that may be more vulnerable to infectious diseases and develop targeted interventions to disrupt transmission [13]. One of the important goals of these studies is to assess the preparedness for the next outbreak, which highlighted factors such as outbreak preparedness indices vary by their geographical unit of analysis and the types of measures included; existing local-level indices mostly measure vulnerability to natural disasters or specific diseases, such as COVID-19; and few indices assess local-level metrics applicable to future communicable disease outbreaks[14].

This paper aims to contribute to the realm of infectious disease control by shedding light on the regional-based vulnerability of infectious diseases within the context of Semarang City. By analyzing the distribution patterns of diseases across age groups, spatial locations, and time periods, this study aims to provide crucial insights that can inform decision-making policies at the city level.

2 Methods

Using data from routine services provided by 37 health centers (Puskesmas) from 2020 to January 2023, a total of 159,898 patients were included. A quantitative descriptive analysis approach was used to determine the distribution of infectious diseases based on age groups, spatial locations, and time periods. The visualization and statistical analysis generated with the help of Tableu software

3 Results and Discussion

3.1 Results

The results show in Fig 1, we found that diarrhea is the highest prevalent infectious disease over the three-year period, followed by COVID, Typhoid, and HIV.

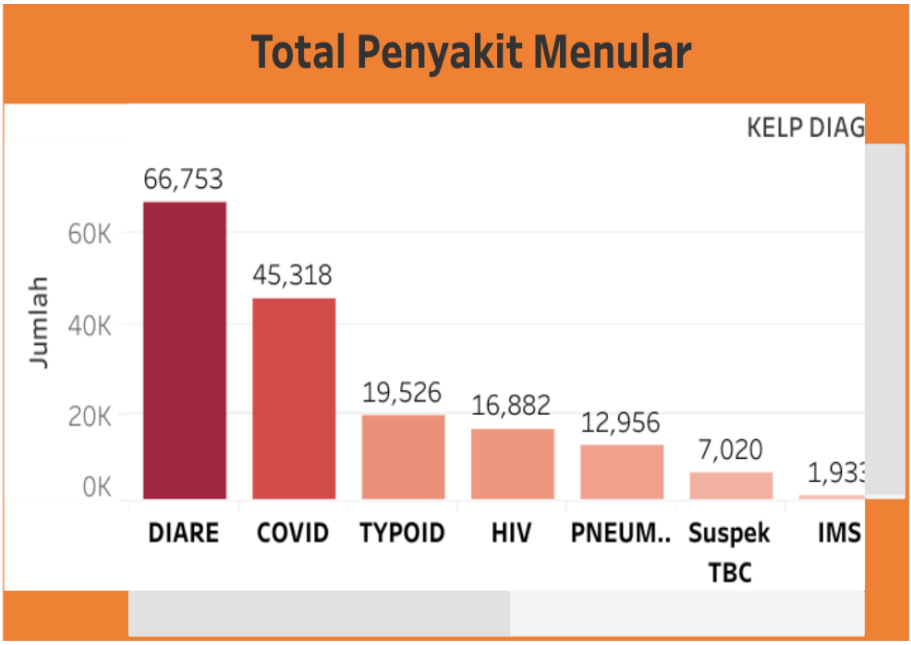

Fig 1. Patients Frequency Distribution of Infectious Diseases in Semarang City During 2020-January 2023.

Further inspection on Fig 2, an interesting finding shows that patients from outside Semarang City still dominate the reported cases of infectious diseases. From the administrative areas point of view, the sub-districts of Banyumanik, Pedurungan, and Tembalang tend to have the highest number of infectious disease cases.

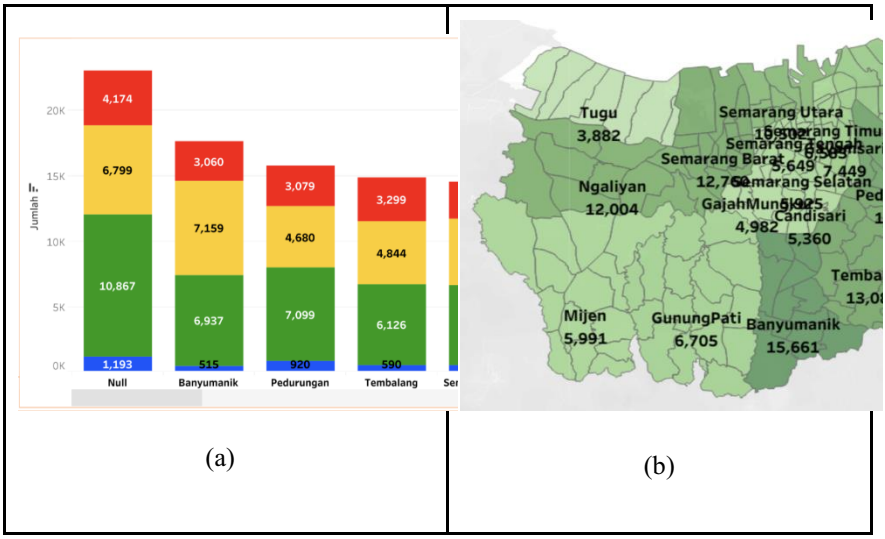

Fig 2. Patients Frequency Distribution of Infectious Diseases Based Sub-District Areas in Semarang City During 2020-January 2023, (a) Patients Frequency Distribution of Infectious Diseases from Null (Outside Semarang City Area) dominating compared with Sub-District Areas in Semarang City During 2020-January 2023, (b) Patients Frequency Distribution of Infectious Diseases from Sub-District Banyumanik, Tembalang, and Pedurungan dominating compared with other Sub-District Areas in Semarang City During 2020-January 2023.

In terms of time distribution (Fig 3), the number of infectious disease cases varies significantly, with a tendency to increase during the last quarter of the year or after long holidays.

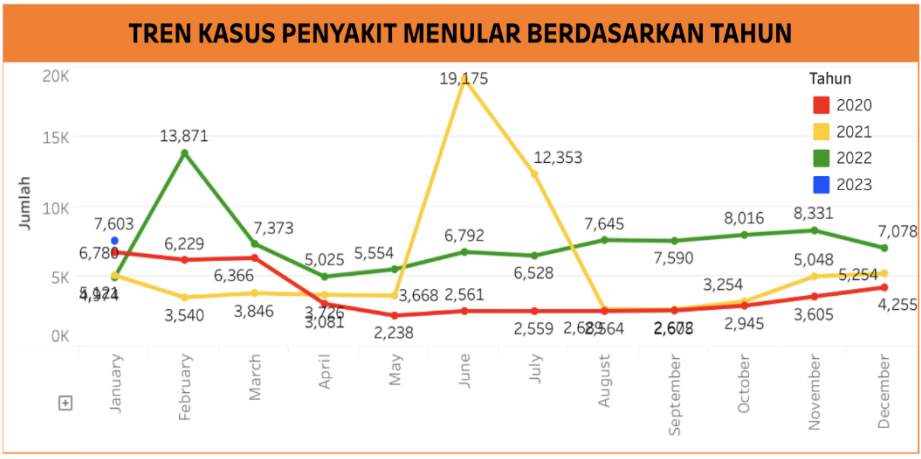

Fig 3. Patients Frequency Distribution of Infectious Diseases Based Time (per-Month) in Semarang City During 2020-January 2023.

Moreover, based on the age-group category, we found that productive ages, specifically among youth and adult age groups dominated the proportion of overall infectious cases.

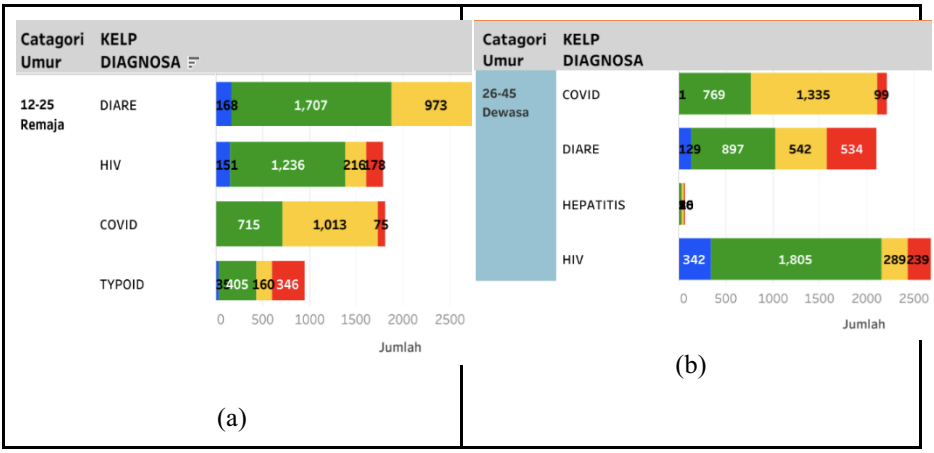

Fig 4. Patients Frequency Distribution of Infectious Diseases Based Age Groups from Outside Semarang City Area During 2020-January 2023, dominated by (a) youth age group (12-25 years old) and (b) adult age group (26-45 years old).

3.2 Discussion

These findings are likely influenced by the conditions during the COVID pandemic, but diseases like Diarrhea, Typhoid, and HIV tend to remain high even during the pandemic. Given Semarang City's strategic position, cases from outside the city also play a significant role in the epidemiology of infectious diseases within Semarang. This vulnerability analysis can assist decision-makers, even at the village level, in diagnosing and prioritizing health issues, particularly infectious diseases.

4 Conclusions

These findings are likely influenced by the conditions during the COVID pandem-ic, but diseases like Diarrhea, Typhoid, and HIV tend to remain high even during the pandemic. Given Semarang City's strategic position, cases from outside the city also play a significant role in the epidemiology of infectious diseases within Semarang. This vulnerability analysis can assist decision-makers, even at the village level, in diagnosing and prioritizing health issues, particularly infectious diseases.

5 Author Contributions

Conceptualization, M.A.H., H.P.S., and D.N.A.N.; methodology, H.P.S., S., and D.N.A.N.; software, X.X.; validation, X.X., Y.Y. and Z.Z.; formal analysis, X.X.; investigation, X.X.; resources, X.X.; data curation, X.X.; writing– original draft prepara-tion, X.X.; writing– review and editing, X.X.; visualization, X.X.; supervision, X.X.; project administration, X.X.; funding acquisition, Y.Y. All authors have read and agreed to the published version of the manuscript." Authorship must be limited to those who have contributed substantially to the work reported.

6 Funding

This research was funded by NAME OF FUNDER, grant number XXX" and "The APC was funded by XXX".

7 Institutional Review Board Statement

In this section, you should add the Institutional Review Board Statement and approval number, if relevant to your study. You might choose to exclude this statement if the study did not require ethical approval. Please note that the Editorial Office might ask you for further information. Please add "The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of NAME OF INSTITUTE (protocol code XXX and date of approval)." for studies involving humans. OR "The animal study protocol was approved by the Institutional Review Board (or Ethics Committee) of NAME OF INSTITUTE (protocol code XXX and date of approval)." for studies involving animals. OR "Ethical review and approval were waived for this study due to REASON (please provide a detailed justification)." OR "Not applicable" for studies not involving humans or animals.

8 Acknowledgments

In this section, you can acknowledge any support given which is not covered by the author contribution or funding sections. Mention non-co-authors people who contribute in the study. This may include administrative and technical support, or donations in kind (e.g., materials used for experiments).

9 Conflicts of Interest

Declare conflicts of interest or state "The authors declare no conflict of interest." Authors must identify and declare any personal circumstances or interest that may be perceived as inappropriately influencing the representation or interpretation of report-

ed research results. Any role of the funders in the design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript; or in the decision to publish the results must be declared in this section. If there is no role, please state “The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results”.

References

Krause, G. (2009). Infectious disease control policies and the role of governmental and intergovernmental organisations. In Modern Infectious Disease Epidemiology (pp. 69–82). Springer New York. http://dx.doi.org/10.1007/978-0-387-93835-6_4

Kriegova, E., Kudelka, M., Radvansky, M., & Gallo, J. (2021). A theoretical model of health management using data-driven decision-making: The future of precision medicine and health. Journal of Translational Medicine, 19(1). https://doi.org/10.1186/s12967-021-02714-8

Smith, K. M., Machalaba, C. C., Seifman, R., Feferholtz, Y., & Karesh, W. B. (2019). Infectious disease and economics: The case for considering multi-sectoral impacts. One Health, 7, 100080. https://doi.org/10.1016/j.onehlt.2018.100080

Ellwanger, J. H., Veiga, A. B. G. da, Kaminski, V. de L., Valverde-Villegas, J. M., Freitas, A. W. Q. de, & Chies, J. A. B. (2021). Control and prevention of infectious diseases from a One Health perspective. Genetics and Molecular Biology, 44(1 suppl 1). https://doi.org/10.1590/1678-4685-gmb-2020-0256

Harder, T., Takla, A., Rehfuess, E., Sánchez-Vivar, A., Matysiak-Klose, D., Eckmanns, T., Krause, G., de Carvalho Gomes, H., Jansen, A., Ellis, S., Forland, F., James, R., Meerpohl, J. J., Morgan, A., Schünemann, H., Zuiderent-Jerak, T., & Wichmann, O. (2014). Evidence-based decision-making in infectious diseases epidemiology, prevention and control: Matching research questions to study designs and quality appraisal tools. BMC Medical Research Methodology, 14(1). https://doi.org/10.1186/1471-2288-14-69

ATSDR. (2021, June 10). Agency for Toxic Substances and Disease Registry (ATSDR). CDC SVI documentation 2018. CDC/ATSDR; 2018 https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/SVI_documentation_2018.htm

Kim, D. (2022). Exploring spatial distribution of social vulnerability and its relationship with the Coronavirus disease 2019: The Capital region of South Korea. BMC Public Health, 22(1). https://doi.org/10.1186/s12889-022-14212-7

Jeleff, M., Lehner, L., Giles-Vernick, T., Dückers, M. L. A., Napier, A. D., Jirovsky-Platter, E., & Kutalek, R. (2022). Vulnerability and One Health assessment

approaches for infectious threats from a social science perspective: A systematic scoping review. The Lancet Planetary Health, 6(8), e682–e693. https://doi.org/10.1016/s2542-5196(22)00097-3

Gao, Z., Jiang, Y., He, J., Wu, J., Xu, J., & Christakos, G. (2021). An AHP-based regional COVID-19 vulnerability model and its application in China. Modeling Earth Systems and Environment, 8(2), 2525–2538. https://doi.org/10.1007/s40808-021-01244-y

Osborne, J., Paget, J., Giles-Vernick, T., Kutalek, R., Napier, D., Baliatsas, C., & Dückers, M. (2021). Community engagement and vulnerability in infectious diseases: A systematic review and qualitative analysis of the literature. Social Science & Medicine, 284, 114246. https://doi.org/10.1016/j.socscimed.2021.114246

Moore, M., Gelfeld, B., Okunogbe, A., & Paul, C. (2016). Identifying future disease hot spots: Infectious disease vulnerability index. RAND Corporation. http://dx.doi.org/10.7249/rr1605

Wilson, M. E. (2010). Geography of infectious diseases. In Infectious Diseases (pp. 1055–1064). Elsevier. http://dx.doi.org/10.1016/b978-0-323-04579-7.00101-5

Powderly, W. G. (2016). Public policy and infectious disease prevention and control. In Prevention, Policy, and Public Health (pp. 197–214). Oxford University Press. http://dx.doi.org/10.1093/med/9780190224653.003.0010

Rogers, C. J., Cutler, B., Bhamidipati, K., & Ghosh, J. K. (2023). Preparing for the next outbreak: A review of indices measuring outbreak preparedness, vulnerability, and resilience. Preventive Medicine Reports, 35, 102282. https://doi.org/10.1016/j.pmedr.2023.102282

Mah, J. C., Penwarden, J. L., Pott, H., Theou, O., & Andrew, M. K. (2023). Social vulnerability indices: A scoping review. BMC Public Health, 23(1). https://doi.org/10.1186/s12889-023-16097-6