Analysis of Risk Factors and Diarrhea-Prone Mapping in West Java Province in 2023

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ABSTRACT

Background: West Java is one of the provinces with the highest prevalence of diarrhea. In 2023, the province reported 1,346,230 diarrhea cases of all age groups. Mapping high-risk areas for diarrhea will help in decision-making for the implementation of prevention and control efforts. **Methods**: This is a descriptive study using secondary data from Open Data Jabar 2023. The analysis was conducted to produce maps showing the distribution of dependent and independent variables, as well as the level of diarrhea risk in each district/city through scoring of all independent variables. **Results**: Out of 27 districts/cities, 6 were categorized as very high-risk and 3 as high-risk, with the highest scored variables were drinking water facilities, access to proper sanitation and stopping open defecation. However, when the risk levels were compared with the number of diarrhea cases, some districts/cities with low risk reported high and very high numbers of diarrhea cases, while some with very high risk had relatively low case numbers. **Conclusion**: The analysis shows that in 2023, about one-third districts/cities in West Java fall into the at-risk category for diarrhea. Prevention efforts should be focused on districts/cities with high risk. Further studies are needed to understand the role of other risk factors, as there is an inconsistency between risk levels and reported cases in several districts/cities.

Introduction

The World Health Organization (WHO) defines diarrhea as when people have defecation with a liquid stool consistency about 3 or more times a day [1]. Diarrhea can be caused by viruses, bacterias, or parasites that infect the digestive tract [1]. In many developing countries, the disease is still one of the main causes of death among under five children, therefore it becomes a public health burden. Deaths among this age group reached 26.9% globally and 89,4% in South Asia and Sub-Saharan Africa [2].

According to the results of 2018 Basic Health Research, it was known that the prevalence of diarrhea in Indonesia reached 8% among all age groups, with the highest prevalence among infants (10.6%) and children aged 1-4 years (12.8%) [3]. This percentage has decreased to 4.3% among all age groups, 6.4% among infants and 7.6% among children aged 1-4 years, based on the the results of 2023 Indonesian Health Survey (IHS) [4]. The HIS also identified four highest prevalence provinces namely Central Papua, Highland, South Papua and West Java [4]. The West Java Provincial Government reported a total of 1,346,230 cases of diarrhea among all age groups in 2023 [5].

In descriptive epidemiological approach, a disease can be analyzed through 3 main variables of person, place and time. These variables can provide information on disease transmission patterns that would help decision makers to understand and identify vulnerable communities. Diarrhea is a waterborne disease that can be transmitted in a wide set of areas, therefore factors affecting safe water supply and hygiene, transmission through the environment as well as case management to prevent severity are key to understand potency of the disease in an area. This study focused on analysis of place-related factors that influence risk of diarrhea incidence, such as population density, open defecation behaviors, availability of drinking water facilities, access to proper sanitation, and availability of primary health care services (puskesmas), and rainfall level [1]. Secondary source data was available for these variables and was accessible to review and analyzed.

Geographical information systems are widely utilized to support epidemiological surveillance, especially in analyzing place or region variables in relation to a disease or health problems [6]. Risk mapping can provide key information that is useful for the implementation of disease prevention efforts [6,7].

This research aimed to study the distribution of health and non-health related risk factors of diarrhea in West Java Province in 2023 through spatial distribution analysis using Geographic Information System (GIS) and determine the most and least high-risk areas to provide evidence-based recommendations in supporting local and national government as well as other authorities in strengthening diarrhea prevention and control strategies.

Materials and Method

Descriptive epidemiological approach through analysis of diarrhea-prone area mapping was performed in the study using secondary data sourced from Open Data Jabar. The year of analysis was 2023 with 27 districts/cities in West Java Province as the unit of analysis. The whole number of West Jawa population in 2023 is the population of the study, that counts 49.860.330 of people [8]. The dependent was diarrhea cases in all age groups, while the independent variables were population density, number of Stop Open Defecation Villages, availability of drinking water facilities, access to proper sanitation, number of health centers and rainfall level in West Java Province.

Quantum GIS 3.34.11 software tool was used to produce data presentation in maps. The maps figure areas based on the distribution of each dependent and independent variables. In addition, scoring of all independent variables was also counted to obtain the overall vulnerability or risk level of diarrhea and produce maps illustrating them. The cut off numbers of very high – high – medium – low criterias were generated by the system, and the order of the scores was set by considering the association of each variable to the incidence of diarrhea for example high

population density will affect to high diarrhea incidence and the high number of drinking water facilities will result to low diarrhea incidence.

Table 1. Scoring of Independent Variables

Variables	Scores
Population Density	a. Very high : 4 b. High : 3 c. Medium : 2 d. Low : 1
Rainfall Level	a. Very high : 4 b. High : 3 c. Medium : 2 d. Low : 1
Number of drinking water facilities	a. Very high : 1 b. High : 2 c. Medium : 3 d. Low : 4
Access to proper sanitation	a. Very high : 1 b. High : 2 c. Medium : 3 d. Low : 4
Number of Stop Open Defecation Villages	a. Very high : 1 b. High : 2 c. Medium : 3 d. Low : 4
Number of health centers	a. Very high : 1 b. High : 2 c. Medium : 3 d. Low : 4

Results

Distribution of Diarrhea Cases in West Java Province in 2023

Of the 27 districts, 4 of them namely Bekasi, Bogor, Sukabumi and Bandung, had very high number of reported diarrhea cases. Meanwhile, 6 districts had low number of diarrhea cases which mostly were urban areas : Sukabumi City, Cimahi City, Cirebon City, Tasikmalaya City, Banjar City and Pangandaran.
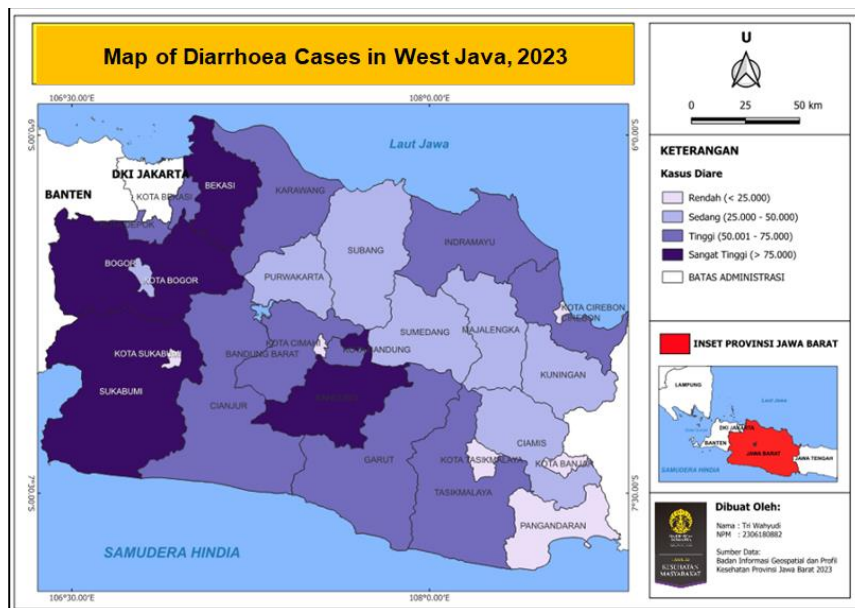
Figure 1. Map of Diarrhea Case Distribution in West Java Province in 2023

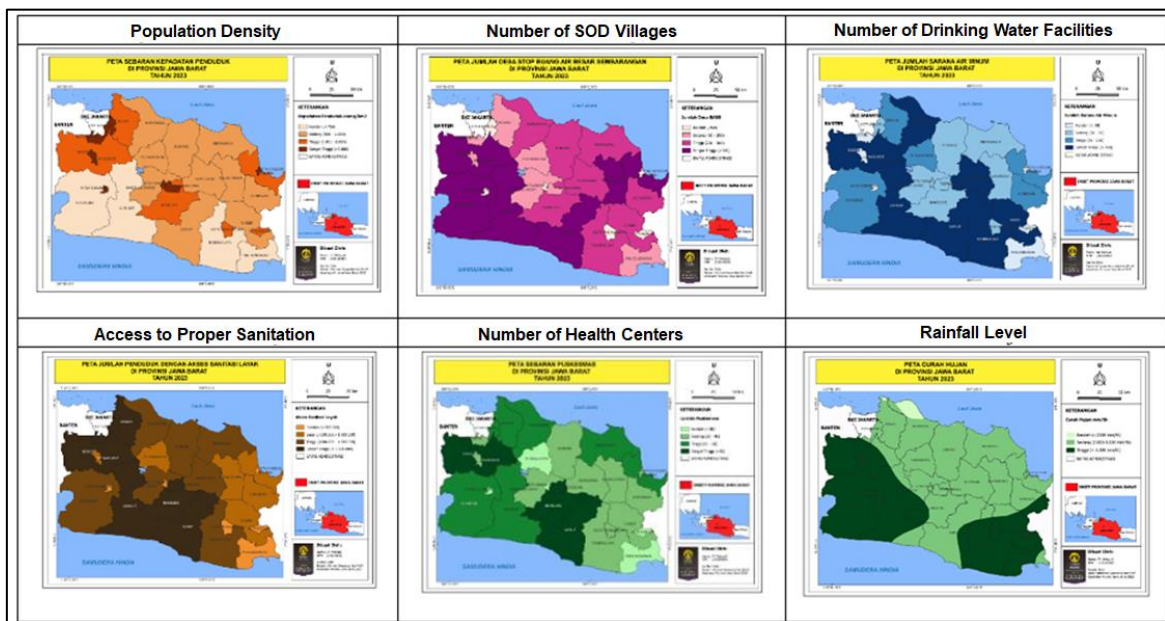**Mapping of Diarrhea Risk Factors in West Java Province in 2023**

Figure 2. Mapping of Diarrhea Risk Factors in West Java Province in 2023

Most of the urban and buffering areas of the capital city such as Bekasi City, Depok City, Bogor City, Sukabumi City, Cirebon City, Bandung City, Cimahi City, Bekasi, Bogor, Bandung, Cirebon, Tasikmalaya   and Banjar City had very high and high population density. Among them there were 3 districts, Bekasi City, Sukabumi City and Cirebon City, which had low number of Stop Open Defecation villages. In addition, Tasikmalaya City and Banjar City also had low number of Stop Open Defecation villages.

Depok City, Bogor City, Cirebon, Banjar City and Pangandaran, had low number of drinking water facilities. Sukabumi, Cimahi, Cirebon, Tasikmalaya, Banjar and Pangandaran were at the lowest position for the number of populations with access to proper sanitation, meanwhile

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Sukabumi, Purwakarta, Cimahi, Banjar and again Pangandaran had the lowest number of health centres.

High rainfall levels happened in parts of the southern and western regions of the province, such as Sukabumi, Sukabumi City, Bogor, Bogor City, Tasimalaya City, Banjar City and Pangandaran as well as some parts of Cianjur, Bandung, West Bandung, Depok City, Garut, Kuningan, Ciamis, and Tasikmalaya.

Mapping of Diarrhea-prone Areas in West Java Province

All variables were scored to provide information on the level of diarrhea vulnerability in each district/city, can be seen in Table 2.

Table 2. Scoring Results of Diarrhea Vulnerability Level by Districts/Cities in West Java, 2023

Districts/Cities	Population Density	Number of Drinking Water Facilities	Population with Access to Proper Sanitation	Number of SOD Villages	Number of Health Centers	Rainfall Levels	Overall Scores
Sukabumi City	4	4	4	4	4	3	23
Banjar City	3	4	4	4	4	3	22
Cirebon City	4	4	4	4	3	2	21
Cimahi City	4	3	4	4	4	2	21
Bogor City	4	4	3	3	3	3	20
Tasikmalaya City	3	3	4	4	3	3	20
Pangandaran	1	4	4	3	4	3	19
Depok City	4	4	1	3	3	3	18
Bekasi City	4	3	1	4	2	2	16
Bandung Barat	2	3	2	3	3	2	15
Purwakarta	2	2	3	3	3	2	15
Cirebon	3	2	3	1	3	2	14
Bandung City	4	3	1	3	1	2	14
Ciamis	2	1	3	2	3	3	14
Kuningan	2	2	3	2	3	2	14
Majalengka	2	3	3	1	3	2	14
Subang	2	3	2	2	3	2	14
Bekasi	3	2	1	3	2	2	13
Indramayu	2	3	2	2	2	2	13
Bandung	3	3	1	2	1	2	12
Tasikmalaya	1	1	2	2	3	3	12
Sumedang	2	1	2	2	3	2	12
Sukabumi	1	2	2	1	2	3	11
Karawang	2	1	2	2	2	2	11
Bogor	3	1	1	1	1	3	10
Cianjur	1	1	1	1	2	3	9
Garut	2	1	1	1	1	2	8

Total score ≥ 20 were categorized as very high, scores 16-19 are categorized as high. According to the scoring results, there were 6 cities with very high level of vulnerability, Sukabumi City, Banjar City, Cirebon City, Cimahi City, Bogor City, and Tasikmalaya City. Meanwhile 3 of 27 districts/cities had high level of vulnerability, namely Pangandaran, Depok City, and Bekasi City. Districts/cities with low levels of vulnerability were Bogor, Karawang, Cianjur, Garut, and Sumedang. The mapping of this scoring result is displayed in the form of a map in Figure 3.
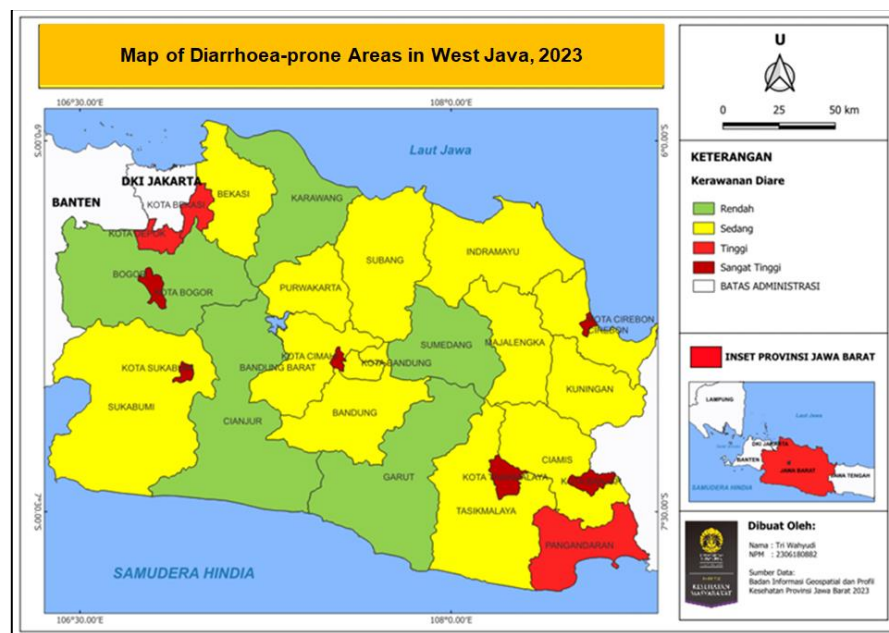
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Figure 3. Mapping of Diarrhea-Prone Areas in West Java Province in 2023

Comparison of Number of Diarrhea Cases with the Level of Vulnerability

Table 3 shows us an analysis of the number of diarrhea cases with the level of vulnerability based on the analysis of 5 independent variables, by district.

Table 3. Analysis of Diarrhea Cases and Level of Vulnerability

District/City	Vulnerability	No. of Diarrhea Cases	District/City	Vulnerability	No. of Diarrhea Cases
Sukabumi City	Very High	Low	Majalengka	Medium	Medium
Banjar City	Very High	Low	Subang	Medium	Medium
Cirebon City	Very High	Low	Bekasi	Medium	Very High
Cimahi City	Very High	Low	Indramayu	Medium	High
Bogor City	Very High	Medium	Ciamis	Medium	Medium
Tasikmalaya City	Very High	Low	Bandung	Medium	Very High
Pangandaran	High	Low	Tasikmalaya	Medium	High
Depok City	High	High	Sukabumi	Medium	Very High
Bekasi City	High	High	Sumedang	Low	Medium
Bandung Barat	Medium	High	Karawang	Low	High
Purwakarta	Medium	Medium	Bogor	Low	Very High
Cirebon	Medium	High	Cianjur	Low	High
Bandung City	Medium	High	Garut	Low	High
Kuningan	Medium	Medium			

Among 9 districts/cities with very high and high vulnerability, there were 2 of them (Depok City and Bekasi City) had high number of cases. Of 13 districts that had medium vulnerability there were 8 districts with very high and high number of diarrhea cases (Bekasi, Ciamis, Bandung Barat, Cirebon, Bandung City, Bandung, Tasikmalaya and Sukabumi). Meanwhile, 5 districts with low vulnerability level, 1 of them had very high diarrhea cases (Bogor) and 3 districts had high diarrhea cases (Karawang, Cianjur, Garut).

Discussion

From scoring and mapping above, we can identify grade of vulnerability risk for each district/city in West Java Province. The districts/cities are categorized with very high, high, medium and low levels of vulnerability.

Of the 6 districts/cities with very high level of vulnerability, all are urban areas. Of the 3 districts/cities with high vulnerability, 2 of them are also urban areas. This picture is quite different from a study held in Kendari City, Southeast Sulawesi province which identified that urban areas have better sanitation conditions and clean water availability than rural areas therefore can prevent diarrhea incidence [9].

In accordance with a study conducted by Hariani and Ramlah in Polewali Mandar District, West Sulawesi Province, there were several problems identified that hampered the success of diarrhea prevention and control program implementation at Matakali Health Centre including less performance of health officers due to concurrent workloads, limited media for health promotion, and lack of community awareness and participation in [10]. These obstacles can also potentially occur in other provinces including West Java.

Geographical location is also likely to affect the incidence of diarrhea. From Figure 3 we see that most of districts/cities with very high and high vulnerability are in the northern and eastern areas of the province and neighboring to each other, except for a few cities such as Bogor City and Sukabumi City which are medium vulnerability areas. In some districts/cities, areas with low vulnerability had high number of cases, while some districts/cities with very high vulnerability reported low number of cases of diarrhea. There could be other influencing factors for example household waste management and use of public toilet, either supporting or hindering the diarrhea prevention and control efforts, aside from the five variables that are the focus of analysis [11].

Mapping shows that population density in highly vulnerable districts is also at very high and high levels. This factor not only affects diarrhea but can affect all aspects of public health, especially communicable disease transmission. When the population density is high, the direct impact it can cause is limited access to clean water [12]. The decline in living quality caused by high population density will also lead to problems in education and income level in the community [12]. The capacity and knowledge of a person in practicing a clean and healthy lifestyle is influenced by their level of education. Previous study showed the higher a person's education level the higher his ability to practice daily healthy lifestyle [13]. Another study in Tasikmalaya City also found there was a relationship between education level and the incidence of diarrhea [14].

In addition, higher education can also raise positive attitudes, especially related to health maintenance and health care seeking when sick [14]. Meanwhile, a significant relationship between income levels and diarrhea incidence was identified by another study conducted in Padang City and explained that income level affects household's ability to provide clean and nutritious food and infrastructure for practicing hygiene [15].

In the Sustainable Development Goals/SDGs, universal access to safe and equitable sanitation is targeted to be achieved by 2030, where one of the goals is to improve access to sanitation and hygiene and end open defecation [16]. Therefore, improving access to safe sanitation and stopping open defecation must become a priority. Based on the scoring, there are 5 cities with low scores for both the number of populations with access to proper sanitation and the number of villages that Stop open defecation, namely Sukabumi City, Cirebon City, Cimahi City, Banjar City, and Tasikmalaya City. The factors causing low score of both variables need serious attention considering that they contradict the standard condition of urban areas which should have better conditions compared to rural areas.

Stopping open defecation is one of the pillars of Community-Based Total Sanitation or STBM. Data from the Ministry of Health showed an increase in the percentage of villages that achieved open defecation free from 2021 to 2023, 50.2% in 2021, 57% in 2022 and 70% in 2023 [17]. If the community still practices open defecation behaviors, diarrhea will still occur, especially among toddlers. Defecating not in latrines, for example in rivers, gardens or other opened places, can increase the risk of disease-causing germs transmission, one of which can cause diarrhea [18]. A previous study conducted in Lampung Province found a significant relationship between open defecation behavior and diarrhea incidence [18]. To improve the community's defecation behavior, we must increase access to safe sanitation through the provision of healthy latrines for the families. A healthy latrine should have a roof that can protect the users, has a feces disposal hole whether with a goose neck shape or not, the floor is not slippery and watertight, is equipped with a wastewater drainage channel in the middle of the building and a septic tank at the bottom [18]. Aside from the use of toilets or latrines, we also must ensure that the toilets are of good

quality and meet standards. Previous studies showed that the incidence of diarrhea has a significant relationship with the type and condition of the toilets [19,20,21].

It is very important to maintain the quality and cleanliness of the food and drinks since diarrhea is transmitted through the fecal-oral route. The quality of water that is consumed daily will prevent diarrhea, therefore it is important to ensure that all households have access to clean drinking water to reduce diarrhea. This is in line with the study in Central Sulawesi Province concluded that the quality of water consumed daily had relationships with diarrhea incidence among toddlers [20]. There was also a study in Tapin, South Kalimantan Province, which found that mothers' habit in preparing water before drinking had effects on diarrhea cases. Toddlers whose mothers do not boil the water before it is consumed have risk of getting diarrhea 168 times more compared to those whose mothers always boil the water before consumption [22]. Another research also found a relationship between drinking water quality and diarrhea incidence among the elderly people [23]. There were 7 of 27 districts/cities in West Java had adequate drinking water facilities. All of them are not urban areas. Efforts are needed to anticipate households that use water sources such as well water, for example through health promotion highlighting about how to treat water safely as well as the disadvantages of consuming water that does not meet health standards [24].

Adequate number of health centers could also have impacts on the diarrhea incidence especially regarding the practice of proper diarrhea case management and health promotion to the community. Previous research showed that health workers have a very important role in preventing diarrhea [25]. However, some efforts were not yet optimal such as promotion and education efforts related to the disease and its prevention, case investigations, as well as education on environmental sanitation and personal hygiene practices [25].

Not only the number of health centers that matters but also the reach of the health centres to the community in their working areas. The reach of health centers as providers of first-level health services has an important role in ensuring high degree of public health of the surrounding community [26]. A study in Banyumas addressed the distance between health centers to the community is one of the factors influencing vulnerability of an area and therefore had relationship to diarrhea incidence [26].

Besides all mentioned factors above, community participation also needs to be improved because even with adequate sanitation support facilities, infrastructure and good program management, diarrhea prevention and control will not be successful without active contributions from all community members [27].

Many existing research analyzed health-based aspects only, but this study focused not only factors which are the responsibility of health sectors but also environment and socio demographic factors that for sure are responsibility of non-health counterparts. As one important strategy to reduce waterborne disease transmission including diarrhea, the Community-Based Total Sanitation (Sanitasi Total Berbasis Masyarakat/STBM) program is implemented nationwide in the country. The STBM highlights crucial 5 pillars: free of open defecation practices, hand washing with soap, household drinking water and food management, household waste management and household liquid waste management [28]. The pillars can effectively prevent diarrhea especially among under five [29]. This study reviewed at least 2 pillars of STBM, the open defecation free practices and household drinking facilities and therefore may support improvement of these two variable improvements specifically in West Java province. Not only sanitation related factors, diarrhea control strategy needs a standardized case management as well to properly cure the patients and prevent severe episodes and mortality especially among children [30].

Conclusion

The analysis shows that in 2023, most districts/cities in West Java were categorized as very vulnerable to diarrhea. Almost all districts/cities with very high vulnerability are urban areas. In implementing diarrhea prevention and control efforts, the focus of program improvement can be focused at districts/cities with very high and high vulnerability level, however, further studies to analyze the role of other influencing factors are also needed considering that districts/cities with low vulnerability had a high number of cases meanwhile some districts/cities with very high vulnerability had a low number of cases.

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Declaration

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