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Research Articles

Mapping and determining priority areas interventions for toddler diarrhea in Surabaya

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ABSTRACT

Diarrhea is still the second leading cause of death in toddlers besides pneumonia. The highest number of cases of diarrhea in toddlers in East Java is Surabaya. This study aimed to describe the distribution of toddler diarrhea based on risk factors using a regional mapping approach in Surabaya. This study was an ecological study with a regional mapping approach. The independent variables used as risk factors for toddler diarrhea were healthy latrines, drinking water facilities, open defecation free (ODF), and complete basic immunizations. The unit of analysis used was the districts that were processed from the Surabaya Health Profile data in 2019. Results showed most cases of diarrhea under five occurred in Wonokromo, Sawahan, Tambak Sari, and Kenjeran Districts. There was a significant relationship between toddler diarrhea and complete basic immunization (p = 0.008), while the relationship with healthy latrines, ODF, and drinking water sanitation was insignificant. This study concluded that 8 of 31 districts were prioritized for handling toddler diarrhea in Surabaya. In addition, there is a need for dissemination to the community through optimizing the role of health workers at the Puskesmas regarding complete basic relationships and the incidence of diarrhea in toddlers.

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INTRODUCTION

Diarrhea is the second leading cause of death in toddlers. Toddlers with persistent diarrhea are three times more likely to die (Talbert et al., 2019). Globally, every year deaths from diarrhea occur around 525,000 toddlers with cases of diarrheal disease in toddlers, almost 1.7 billion cases every year (World Health Organization, 2017). In Indonesia, diarrheal disease is an endemic disease and a potential outbreak often accompanied by death. In 2019, the age group with the highest prevalence of diarrhea (based on the diagnosis of health workers) was in the age group 1-4 years at 11.5% and in infants at 9%. In Indonesia, there were 314 deaths (10.7%) in children aged 12 – 59 months caused by diarrhea, this figure is the highest when compared to other causes such as pneumonia and fever (277 deaths and 215 deaths) in 2019 (Kementerian Kesehatan RI, 2020). Under-five mortality due to diarrhea in Indonesia is the second-highest in East Java Province after West Java Province (Kementerian Kesehatan RI, 2020). While the Health Profile of East Java in 2019, diarrhea for toddlers served was mostly in the Surabaya City, namely 19,906 toddlers (Dinkes Jawa Timur, 2020). In addition, Surabaya City was also the area with the highest number of under-five deaths due to diarrhea in East Java Province, which was 7 toddlers (Dinkes Jawa Timur, 2020).

Various causes of diarrhea in toddlers, one of which was the sanitation factor (Azis et al., 2021). The worse the household sanitation, the higher the incidence of diarrhea in toddlers (Imadudin et al., 2021). Sanitation is related to environmental health, which affects the degree of public health. According to the Indonesian Health Profile, the indicator of proper sanitation was people accessing latrines (Kementerian Kesehatan RI, 2020). In 2019, there were 957,260 (98.21%) families with access to proper sanitation (healthy latrines) in Surabaya City. (Dinas Kesehatan Kota Surabaya, 2020). This shows that healthy latrines in Surabaya City were quite good, which means that there were sanitation factors or other factors that impacted the incidence of diarrhea in Surabaya.

Improvements in sanitation facilities have an impact on reducing the prevalence of diarrhea among toddlers in India. However, due to maximally enhanced water coverage, it did not show such an impact on diarrhea prevalence. So policymakers need to focus on coverage and broaden the proper use of sanitation facilities (Mallick et al., 2020). To contribute to designing targeted policies and to reduce the incidence of diarrhea among children, a previous study emphasized that the key is the availability and accessibility of clean water, water storage facilities, and better fecal disposal facilities (Omotayo et al., 2021).

One of the efforts to increase access to sanitation by the Ministry of Health is to change the direction of the sanitation approach policy from previously providing subsidies to community empowerment which focuses on changing the behavior of Open Defecation Free (ODF) which is one of the five pillars of CBTS (Community-Based Total Sanitation) (Dinkes Jawa Timur, 2020). Surabaya City had not been able to reach the CBTS village category because Surabaya City was still implementing 2 of the 5 pillars of CBTS, namely Open Defecation Free (ODF) and Washing Hands with Soap (Dinas Kesehatan Kota Surabaya, 2020). Previous research recommended that government organizations and relevant stakeholders strengthen urban WASH programs to focus on increasing the availability of sufficient water for daily consumption and promoting safe disposal of child waste and good handwashing practices at critical times. Further efforts are needed to make mothers/caregivers aware of diarrhea prevention through effective WASH activities to reduce the burden of this problem on toddlers

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(Getahun & Adane, 2021).

A study developed a model that showed better water sources were strongly associated with diarrhea incidence, while better sanitation had a marginal relationship. Improved water sources and sanitation were necessary to get the maximum benefit from reducing diarrhea in children (Kumie, 2020). A previous study explored the diarrhea prevention awareness of rural communities using a questionnaire survey. A significant association was found between drinking untreated water and the occurrence of diarrhea (Ko & Sakai, 2022).

A previous study stated that drinking water consumed without prior treatment was significantly associated with the incidence of diarrhea in toddlers (Vasconcelos et al., 2018). Regulation of the Minister of Health Number 492 in 2010 states that safe (decent) drinking water for health is drinking water that meets physical, microbiological, chemical, and radioactive requirements. In 2019, there were 106,482 (49.55%) drinking water facilities in Surabaya City with low and medium risk, and 1,649 of them were sampled and examined, with the result that only 1,115 (67.62%) eligible drinking water facilities (Dinas Kesehatan Kota Surabaya, 2020). In addition to sanitation, other factors cause diarrhea in toddlers, both the environment and individuals (Ulfa et al., 2017).

The main source of drinking water, washing hands before taking water from storage containers, domestic waste disposal sites, and soap for washing hands were the most important factors for the prevention of diarrhea in children (Soboksa et al., 2020). Likewise, previous research also showed a relationship between access to drinking water and inadequate sanitation with the incidence of diarrhea found in East Java (Prakoso, 2020).

The risk factors for diarrhea were quite a lot, such as poor personal hygiene, low application of clean and healthy living behavior, low availability of clean water, not getting immunizations, and poor environmental sanitation, including environmental pollution groups (Ira, 2019). Many studies stated toddler diarrhea was also caused by incomplete basic immunization. The previous study stated that there was a significant relationship between the completeness of immunization and the incidence of diarrhea in toddlers (Santoso & Kasman, 2018). In 2019 the coverage of UCI districts in Surabaya was 100% or all districts in Surabaya had achieved complete basic immunization coverage of at least 80% (Dinas Kesehatan Kota Surabaya, 2020).

Based on the background, this study aimed to describe the distribution of cases and their causes with the support of mapping so that it can be seen which areas are priority interventions for diarrhea problems under five in Surabaya in 2019.

METHODS

This was an ecological study with a cross-sectional design supported by mapping (Laksono & Kusrini, 2020; Mahendra et al., 2021). The population in this study is all districts (31 districts) in Surabaya City, East Java province, so the unit of analysis is the district. The data for each district was obtained by adding up the data from each *puskesmas* and then combining them in the same district. The data source in this study was from the Surabaya City Health Profile in 2019. This study used a total sample technique where the number of samples was the same as the total population. The independent variables were the percentage of families having healthy latrines, the percentage of villages having open defecation free, eligible drinking water facilities, and complete basic immunization coverage for infants. While the dependent variable was the number of cases of diarrhea under five. The dependent variable was categorized based on equal intervals to determine the distribution of

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the number of cases in each district. While the independent variables were categorized into two categories based on the equal count mode from the percentage value of each independent variable for diarrhea in toddler.

Mapping was obtained by combining two layers in the form of polygons and geometric points so that the distribution of two variables in one map can be known (Imadudin et al., 2021). The scoring technique is carried out to determine priority areas for handling cases of diarrhea under five in Surabaya City, where the dependent variable was weighted twice that of the independent variable, this weighting aims to more clearly identify the area at the level/classification (Fuada et al., 2012). The classification for determining priority areas for handling toddler diarrhea was made based on the number of cases of diarrhea under five, healthy latrines, open defecation free, and complete basic immunization coverage, then divided into three categories, namely low, medium, and high. However, this study did not research other internal risk factors (such as habit of washing hands in running water). A correlation test was used in this study to determine the significant effect of risk factors on toddler diarrhea. Meanwhile, analysis by mapping was carried out to determine the priority areas intervention for toddler diarrhea (Pertiwi & Widayani, 2019). Data processing in this study was carried out using Quantum Geographic Information System (QGIS) 2.8.1 software to describe conditions based on the distribution of cases and their risk factors. This study was approved by Health Ethics Research Committee from Faculty of Ners, Universitas Airlangga, ref: 1773-KEPK (29 September 2019).

RESULTS

Surabaya is the capital of East Java Province. Surabaya City is located between 112^0 36' until 112^0 54' Bujur Timur and 7^0 9' until 7^0 21' South Latitude. The area of Surabaya City is directly adjacent to the Madura Strait in the north and the east, while in the south, it is bordered by Sidoarjo Regency and bordered by Gresik Regency in the west. The Surabaya City has 31 districts grouped into 5 sub-mayors, namely North Surabaya, East Surabaya, South Surabaya, West Surabaya, and Central Surabaya. The total area of Surabaya is 326.81 $km^{2,}$ with Benowo District being the district with the widest area of 23.73 km^2 located in West Surabaya. Meanwhile, Simokerto District is the district with the smallest area of 2.59 km^2 located in Central Surabaya (Badan Pusat Statistik Kota Surabaya, 2021).

Table 1. Descrip of Toddler Diarrhea Cases and Percentage of Risk Factors in Surabaya 2019

Variables	Minimum	Maximum	Mean	Std. Deviation
Toddler Diarrhea	55	1847	657.12	452.45
Complete Basic Immunization	94.59	103.9	97.34	2.02
ODF Village	0	100	45.24	30.45
Healthy Latrine	91.94	100	98.28	1.71
Eligible Drinking Water Facility	.22	1	.69	.16

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Table 2. Correlation betwen the number of cases of diarrhea in a todler with the risk factors

Variables	r	p-value
Healthy Latrine	0.116	0.534
Complete Basic Immunization	-0.470	0.008*
ODF Village	0.177	0.342
Eligible Drinking Water Facility	0.001	0.997

Table 1 shows that the lowest cases of diarrhea under five in Surabaya were 55 cases in Gunung Anyar District and the most cases were 1847 cases in Tambak Sari District. Based on Table 2, complete basic immunization coverage was significantly associated with diarrhea in toddlers (p = 0.008). The value of r shows an inverse relationship, which means that the lower the complete basic immunization coverage in an area/district, the more cases of diarrhea occur in toddlers (r = -0.470).

Mapping Toddler Diarrhea with Healthy Latrines

The distribution of the percentage of healthy latrines in Surabaya City spread in the northern and central areas of Surabaya City, where several adjacent areas had a low percentage of families with latrines. The percentage of households with healthy latrines that had a high risk of diarrhea cases in toddler was Sawahan and Wonokromo Districts. This can be seen on the map showing cases of diarrhea toddlers in dark red color and the percentage of healthy white latrines, which means it was quite low (Figure 1). Meanwhile, Semampir and Wonocolo districts had a moderate risk of diarrhea toddlers caused by healthy latrines. Semampir and Wonocolo districts had a very high number of cases of toddler diarrhea characterized by a deep red color, even though it had a high percentage of healthy latrines. This can happen because these two districts were surrounded by districts with a low percentage of healthy latrines (white dots).

Mapping of Toddler Diarrhea with ODF Villages

The distribution of the percentage of villages with open defecation free in Surabaya City was low (marked with a red dot) tends to be in the central and southern parts of Surabaya. Table 1 shows that some districts still have not implemented open defecation free. Similar to healthy latrines, Sawahan and Wonokromo districts also had a high risk of cases of diarrhea toddler caused by the ODF factor. In these two districts, villages that have implemented open defecation free were quite low, and the incidence of diarrhea in toddlers was very high, as indicated by a solid red color (Figure 2). In addition, the map shows that the open defecation-free factor was at moderate risk for cases of diarrhea toddlers in Wonocolo District.

Mapping of Toddler Diarrhea with Eligible Drinking Water Facilities

The distribution of the low of eligible drinking water facilities tends to spread in the northern and eastern parts of Surabaya City, where many adjacent districts in the north and east of Surabaya were white dots which indicated that eligible drinking water facilities were low. Figure 3 shows that there were still many districts that had drinking water facilities that did not meet the requirements. Areas that had a high risk of diarrhea toddlers because of the low of eligible drinking water facilities were Kenjeran District and Tambak Sari District. It can be seen on the map that in that district, the cases of diarrhea in toddlers were very high, indicated by a solid red color, and the

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percentage of drinking water facilities was quite low (Figure 3). Meanwhile, the moderate risk of diarrhea in toddlers caused by the low of eligible drinking water facilities was in Semampir and Sukolilo Districts.

Mapping of Toddler Diarrhea with Complete Basic Immunization

The distribution of complete basic immunization coverage has a pattern of spreading in the central Surabaya and North Surabaya areas, where several districts in the region have complete basic immunization coverage, which tends to become low. The high risk of diarrhea in a toddler is caused by the relatively low coverage of complete basic immunization in Sawahan, Kenjeran, and Tambak Sari districts. The spatial picture on the map shows the three districts in solid red, and the coverage of complete basic immunization is lower than in the other districts (Figure 4). 5 areas had a moderate risk of diarrhea for toddlers due to complete basic immunization, namely Tandes District, Wiyung District, Wonocolo District, Sukolilo District, and Semampir District.

Mapping of Priority Areas Interventions for Toddler Diarrhea

The distribution of cases of diarrhea in toddler shows that cases of diarrhea in toddler had a pattern of spreading in the areas of Central Surabaya and North Surabaya, where there were two districts in each region that had a very high number of cases of diarrhea in toddler marked by a solid red color (Figure 1-4). After scoring the cases of diarrhea toddler by considering the factors of healthy latrines, open defecation free, drinking water facilities, and complete basic immunizations, the priority areas for handling toddler diarrhea were obtained. Based on Figure 5, it can be seen that 8 areas were priority areas for intervention for toddler diarrhea cases in Surabaya, namely Kenjeran District, Pakal District, Wiyung District, Tandes District, Jambangan District, Wonokromo District,

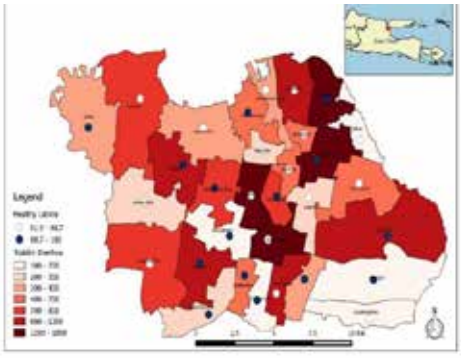

Figure 1. Distribution Map of Toddler Diarrhea Cases and Healthy Latrines in Surabaya in 2019

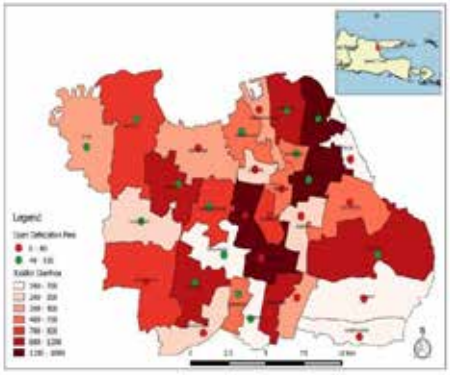

Figure 2. Distribution Map of Toddler Diarrhea Cases and Open Defecation Free in Surabaya in 2019

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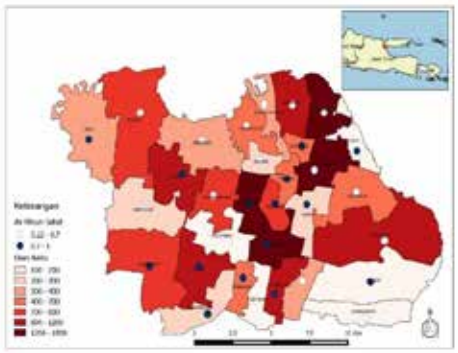

Figure 3. Distribution Map of Toddler Diarrhea Cases and Eligible Drinking Water in Surabaya in 2019

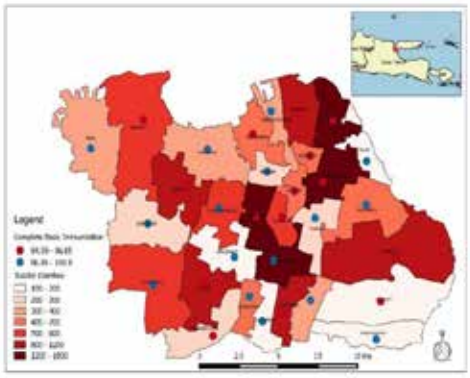

Figure 4. Distribution Map of Toddler Diarrhea Cases and Complete Basic Immunization in Surabaya in 2019

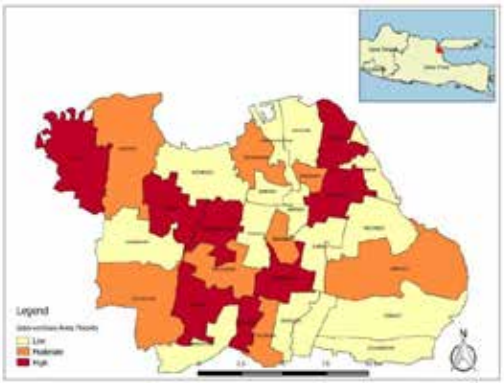

Figure 5. Map of Priority Areas Interventions for Toddler Diarrhea in Surabaya in 2019

Sukomanunggal District, and Tambak Sari District.

DISCUSSION

Diarrhea is a disease that is transmitted through contaminated food or drink. Eligible drinking water facilities were one of the efforts to prevent diarrhea in toddlers. Previous studies have found that eligible drinking water was significantly related to the incidence of diarrhea in toddlers, including types of drinking water, namely Municipal Waterworks and Non-Municipal Waterworks (Pertiwi & Widayani, 2019; Syaputra & Syamsir, 2020). Households that got water from ineligible sources were more at risk for diarrhea in toddlers (Alemayehu et al., 2020). The results of this study indicate that areas with very high cases of diarrhea were caused by the lack of adequate drinking

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water facilities. Similar to the previous study which described areas with a moderate risk of diarrhea in toddlers also had a moderate risk of drinking water facilities that met the requirements (Dyah Nurmarastri Sasabil Sidqi, Novia Anasta, 2021).

Spatial analysis is very important in mapping the spread of disease and assisting in policymaking. Targeting diarrhea transmission hotspots was one potential strategy to reduce diarrhea cases. The spatial pattern of the percentage of children with persistent diarrhea was related to households with sanitation facilities (Mahendra et al., 2021).

Increasing latrine coverage is generally believed to reduce exposure to fecal pathogens and prevent disease (Clasen et al., 2014), especially diarrhea in toddlers (Nilima et al., 2018). Previous studies have shown that houses with unhealthy latrines were three times more likely to have diarrhea in toddlers than those with healthy latrines (Kurniawati et al., 2021). Healthy latrines are latrines that animal vectors cannot enter, were made of waterproof floors, and do not cause unpleasant odors (in enclosed spaces), the distance between the latrine and the source of clean water must be > 10 meters from a septic tank. In principle, healthy latrines did not lead to the direct distribution of materials that were harmful to humans due to the disposal of human waste and preventing the spread of disease vectors to users and the surrounding environment (Peraturan Menteri Kesehatan RI Nomor 3 Tahun 2014 Tentang Sanitasi Total Berbasis Masyarakat, 2014). However, the results of this study showed a weak and insignificant positive correlation between the availability of healthy latrines and diarrhea in toddler. This is shown in Figure 1, which tends to have no difference in the distribution between districts with low or high cases of diarrhea in toddler on the percentage of healthy latrine availability. This finding is in line with the results of a meta-analysis study which stated that there was no effect of sanitation, availability of latrines, on the incidence of diarrhea in toddler. The study stated that to overcome the problem of diarrhea, it was not enough to intervene in sanitation alone but also at the same time as improving access to clean water and waste water management (Contreras & Eisenberg, 2020). Likewise with the research in India, they cannot assume that promoting targeted latrine coverage alone is effective for reducing exposure to fecal pathogens and preventing disease, there need to be interventions on exposure and health promotion (Clasen et al., 2014).

Diarrhea is an environment-based disease. Diarrhea in Indonesia has the potential to cause an outbreak because diarrhea is endemic and environment-based, which is often accompanied by death. The results of the previous study concluded that there was a very strong relationship between the CBTS program and the coverage of diarrhea services in NTB and there was a strong relationship between the open defecation-free program and the coverage of diarrhea services in NTB. (Saprudin & Syahrul, 2021).

ODF is a condition when every individual in a community no longer had open defecation that has the potential to spread disease (Peraturan Menteri Kesehatan RI Nomor 3 Tahun 2014 Tentang Sanitasi Total Berbasis Masyarakat, 2014). Areas that were already ODF will reduce the risk of diarrhea in toddlers (Ayalew et al., 2018). The results of this study indicate the opposite. ODF status was known to have an insignificant positive correlation with the incidence of diarrhea in toddler in Surabaya City. The distribution of districts with ODF coverage of more or less than 40% did not look different in districts with high and low cases of diarrhea in toddler. The range of ODF coverage in the Surabaya City was quite varied

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with a fairly high standard deviation value. In fact, the coverage of healthy latrine ownership in households was more than 90 percent in all districts. Further studies need to be carried out to understand this phenomenon. Therefore, several previous studies have shown that there was a relationship between the CBTS Program and the incidence of diarrhea in people who did not have latrines so people were obliged to have healthy latrines that are effective as sanitary ware (Sinum, 2021).

Complete basic immunization is a government program for compulsory health services for toddler (Dinkes Jawa Timur, 2020). Some of the causes of completeness of basic immunization were maternal education, place of delivery, distance to health facilities (Jama, 2020). Maternal factors significantly affected the completeness of basic immunization in terms of knowledge, attitudes, and perceptions (Dillyana, 2019). Meanwhile, complete basic immunization coverage is correlated with poor population, neonatal visits, and *posyandu* activity (Devi et al., 2021).

Complete basic immunization can protect toddlers' immunity so it was useful for preventing toddlers from diseases, one of which was diarrhea (Santoso & Kasman, 2018). Previous studies have shown that most toddler had a complete history of basic immunization and did not experience diarrhea, this had a significant impact on the nutritional status of toddler (Sartika et al., 2021). Even so, there were studies that state that there was no significant relationship between complete basic immunization and the incidence of diarrhea in toddler (Himawati & Fitria, 2020). Complete basic immunization in Indonesia did not include rotavirus vaccination because it was still the immunization of choice or not mandatory (Kementerian Kesehatan RI, 2015), even though rotavirus vaccination had an impact on preventing diarrhea in toddlers (Chissaque et al., 2018; Vinandyanata et al., 2021). A Cochrane review found that rotavirus vaccination can prevent diarrhea (Soares-Weiser et al., 2019). IDAI stated that rotavirus vaccination can be given to children three times, at the ages of 2 months, 4 months, and 6 months (Soedjatmiko et al., 2020).

A country had experienced a major decline in child deaths from diarrheal diseases in recent decades. The factors that had the most impact on the DSMR (Diarrhea specific mortality rate) were the coordinated efforts of the government with non-governmental organizations and the private sector to enable rapid implementation and interventions such as oral rehydration solutions and zinc, promotion of breastfeeding, handwashing and latrine sanitation, and improvement of women's education and nutrition (Billah et al., 2019; Devi et al., 2022).

However, previous studies showed that improved sanitation did not directly affect water treatment and was not associated with the incidence of diarrhea. At the community level, increased water coverage had no direct effect, but increased sanitation coverage was associated with lower diarrhea prevalence. The interaction analysis of this study shows that the protective effect of better sanitation at the community level is enhanced by better drinking water at the community level. This illustrates the importance of simultaneously improving drinking water and sanitation (Komarulzaman et al., 2017).

CONCLUSION

Based on the mapping results, it can be seen that the high cases of diarrhea toddlers in the Sawahan and Wonokromo districts were caused by the relatively low percentage of households with healthy latrines and villages with open defecation free. Meanwhile, the high cases of diarrhea in a toddler in Tambak Sari and Kenjeran districts were predicted to be caused by the low percentage of eligible drinking water facilities. However, the internal

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factors of toddler diarrhea were not included in this study such as hygiene habituation of family include habit of washing hands in running water, rotavirus vaccination, allergy factor, and other infection with chronic diarrhea. Mapping cases of diarrhea toddler based on the four risk factors (healthy latrines, ODF, drinking water facilities, and complete basic immunization) obtained 8 of 31 districts that were priority areas for handling toddler diarrhea in Surabaya, namely Kenjeran, Pakal, Wiyung, Tandes, Jambangan, Wonokromo, Sukomanunggal, and Tambak Sari. The districts of Sawahan, Tambak Sari, and Kenjeran also have relatively low complete basic immunization coverage. Therefore, it is necessary to prevent diarrhea through optimizing the CBTS program and increasing the coverage of basic immunization for toddler.

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