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PREVALENCE OF RISK FACTORS FOR DIPHTHERIA: CLTS AND DPT-HB-HIB3 IMMUNIZATION COVERAGE IN EAST JAVA (PERIODE 2018-2020)

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Abstract

Introduction: *Diphtheria is an acute disease that is transmitted through air, saliva, and direct contact with patients. In the Community Lead Total Sanitation (CLTS) targets, air quality in the house is an indicator leading to diphtheria incidence as its bacteria can spread through the air. Efforts can be made to overcome diphtheria by providing DPT-HB-HiB3 immunization to increase body immunity and enforcing the CLTS program to improve air quality. Meanwhile, East Java experienced a decrease in CLTS and DPT-HB-HiB3 coverage in 2020. This study aimed to map the distribution of the disease and describe the correlation between diphtheria and its factors.* ***Methods:*** *This study evaluated diphtheria incidence in 38 regencies/cities in East Java. It used the Spearman correlation test to analyze secondary data from the Health Profile of East Java in 2018-2020. Data processing was done using Health Mapper and SPSS.* ***Results and Discussion:*** *No correlation was found between CLTS coverage and the incidence of diphtheria in 2018 ($p = 0.207$; $OR = 0.201$) while there was a correlation between DPT-HB-HiB3 immunization coverage and the incidence of diphtheria in 2018 ($p = 0.006$; $OR = 0.441$).* ***Conclusion:*** *CLTS coverage was not associated with the incidence of diphtheria in the province rather DPT-HB-HiB3 immunization coverage was. Education for public about the importance of DPT-HB-HiB3 immunization is required and maintaining a clean environment to prevent transmission of diphtheria.*

INTRODUCTION

Diphtheria is one of the diseases caused by the pathogenic bacterium, *Corynebacterium*. It previously became an old public health concern, but it is now reappearing as a re-emerging disease (1). This toxic strain of gram-positive bacillus *C. diphtheriae* causes diphtheria. It gives some effects on the body. Infection on the skin is one of the symptoms caused by diphtheria. It also infects the upper respiratory tract which can cause serious complications and even deaths. *Corynebacterium diphtheria* which invades local body organs and produces very dangerous exotoxins may cause heart muscle and nervous system disorders (2). This diphtheria disease is transmitted through the air, splashes of saliva when talking, and direct contact with diphtheria sufferers. Besides, they generally attack the pharynx, nose, larynx, and tonsils. The appearance of a grey asymmetrical membrane surrounded by redness of the throat and enlarged lymph nodes is another symptom of diphtheria.

In Indonesia, 944 cases of suspected diphtheria spread across 25 provinces in 2019, while until May 2020, 129 suspected diphtheria cases were found across 16 provinces. From December 2019 to May 2020, the highest number of diphtheria cases was reported in the East Java, West Java, DKI Jakarta, East Kalimantan, and Aceh Provinces. Case Fatality Rate (CFR) or the death rate for diphtheria cases in Indonesia was 4.62%, still below the world average mortality rate at 5 -10% (3). In 2018, the number of diphtheria cases in East Java Province was 695 cases with an IR of 0.017 per 10,000 population. In 2019, it decreased to 358 cases, with an IR of 0.09 per 10,000 population. In 2020, it decreased again to 94 cases with an IR of 0.002 per 10,000 cases and the attack rate at 0.2% (4). The low coverage of Community Lead Total Sanitation (CLTS) and DPT-HB-HiB3 immunization is one of the factors contributing to diphtheria. A bad environment with poor sanitation can lead to the presence of diphtheria germs, which are easily transmitted to other people through the air, droplets, and close contact (5).

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Poor sanitation is measured by overcrowding situation, humidity in the house, type of floor, inadequate ventilation, and sources of infection. Low air quality that comes from poor home environmental conditions or poor sanitation may increase diphtheria incidence. Apart from the low Community Lead Total Sanitation CLTS coverage, high diphtheria cases can also be caused by the low DPT-HB-HiB3 immunization coverage. These vaccines especially DPT, are useful to form strong antibodies. With immunization, health interventions become effective in reducing infant and under-five mortality because of diphtheria as people have formed their herd immunity (6).

The immunization program offers a very cost-effective intervention to prevent infectious diseases. The Indonesian government has targeted to achieve immunization coverage up to 80% or above (7). Previous research mentions that based on the Spearman Rho correlation test, the significance value obtained was 0.03, and the correlation coefficient was -0.411. These values indicated a relationship between the completeness of diphtheria immunization status and the incidence of diphtheria in the Surabaya areas. Moreover, the incidence of diphtheria was more common in respondents who did not receive immunizations compared to those who received immunizations (8). If one has not received immunization, the titter of protective antibody against diphtheria has not yet been produced.

To facilitate the public with immunization services, fast and accurate information on disease distribution in the local contexts can facilitate decision-making to take immunization. The pattern of disease distribution and its risk can be identified from the mapping process through a Geographic Information System (GIS), a system capable of processing data related to geographic location or conditions (9). In the health sector, the spread of a disease can also be used to measure the risk of disease. The mapping and analysis processes will provide attribute data and spatial data. Having more accurate data on disease distribution support health offices to find countermeasures against the disease incidence (10). Therefore, this study aimed to map diphtheria spread and describe the correlation between diphtheria incidence and coverage of Community Lead Total Sanitation (CLTS) and DPT-HB-HiB3 immunization in 2018-2020.

METHODS

This study is a population correlation study conducted in 38 regencies/cities in East Java as the unit of analysis. It includes the incidence of diphtheria as the determining variable and Community Lead Total Sanitation (CLTS) and DPT-HB-HiB3 immunization coverage as independent variables. The secondary data used were collected from 38 regencies/cities accessible freely in the East Java Province's Health Profile Book in 2018, 2019, and 2020 which states all variables needed. In the East Java Province's Health Profile Book in 2018, 2019, and 2020 there is very detailed information from 38 districts/cities in East Java Regarding Community Lead Total Sanitation (CLTS) coverage data, DPT-HB-HiB3 coverage data, and Diphtheria Incidence coverage so that it can support the secondary data needed in this study.

Descriptive data analysis was done using a health mapper version 4.3.0.0 with product version 4.03. This application was developed by the World Health Organization (WHO) to meet the need for information on infectious disease surveillance in all programs at national and global levels. The data on the variables were presented in a regional distribution map. They were tested for normality before the Kolmogorov-Smirnov tests were performed.

The Kolmogorov-Smirnov test can be used to test whether sample data were normally distributed or not. Before identifying the relationship between the incidence of diphtheria with Community Lead Total Sanitation (CLTS) and DPT-HB-HiB3 immunization coverage in each regency/city in East Java Province, the normality test was performed. It is normally distributed if the error has a significance value more than 0.05 (Table 1). Furthermore, for decision making on correlation between the variables, the Spearmen correlation test was performed.

Table 1. Results of Normality Test Data for Diphtheria Cases, Coverage of Community Lead Total Sanitation (CLTS), and Coverage of DPT-HB-HiB3 Immunization in 2018-2020

Results	Category		
	Diphtheria	DPT-HB-HiB3 Immunization	CLTS
2018			
N	38	38	38
Asymp. Sig (2-tailed)	0.229	0.501	0.640
2019			
N	38	38	38
Asymp. Sig (2-tailed)	0.188	0.455	0.804
2020			
N	38	38	38
Asymp. Sig (2-tailed)	0.065	0.569	0.658

RESULTS

Correlation of DPT-HB-HiB3 Immunization and Community Lead Total Sanitation (CLTS) Coverage in 2018-2020 with Diphtheria Incidence

Figure 8 shows that the DPT-HB-HiB3 immunization coverage in 2018-2020 was fluctuating.

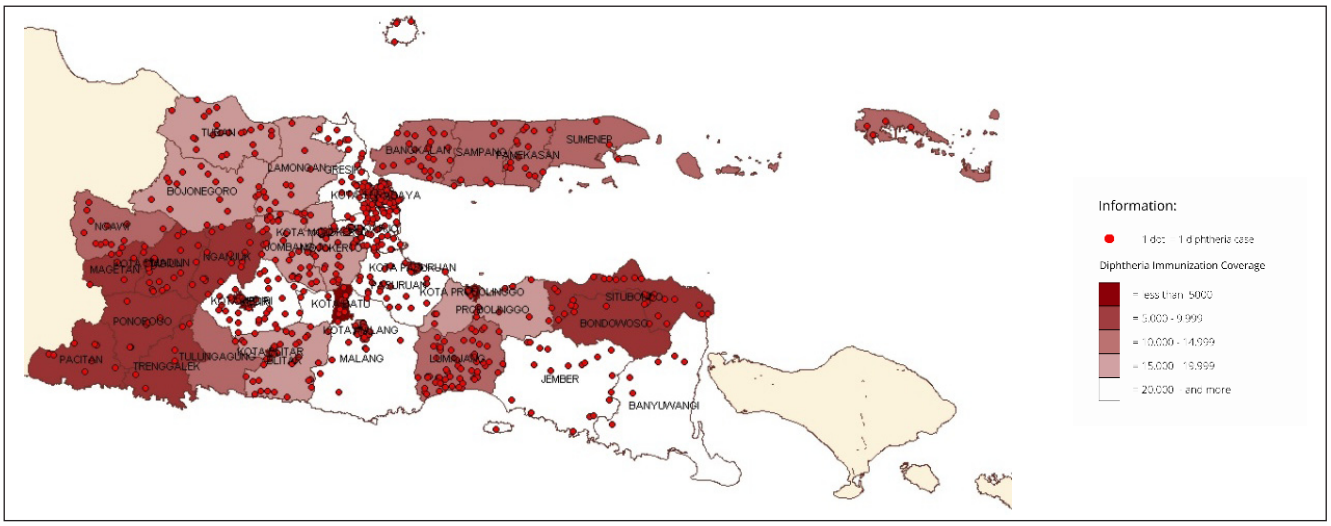


Figure 1. Diphtheria Incidence Distribution Map and DPT-Hb-HiB3 Immunization Coverage in 2018

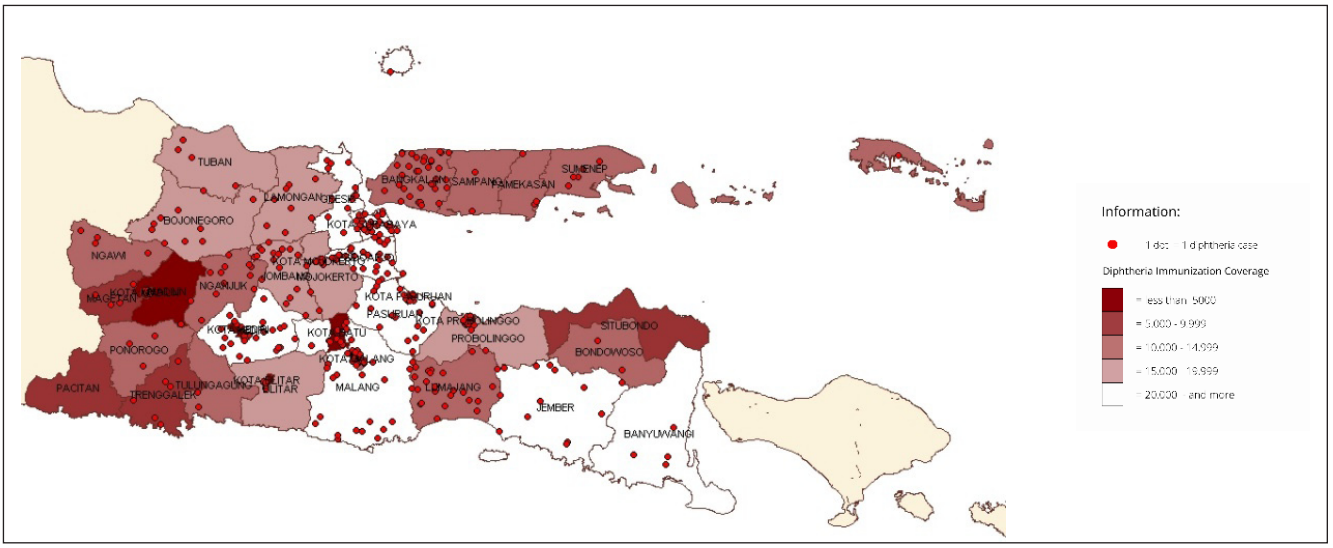


Figure 2. Diphtheria Incidence Distribution Map and DPT-Hb-HiB3 Immunization Coverage in 2019

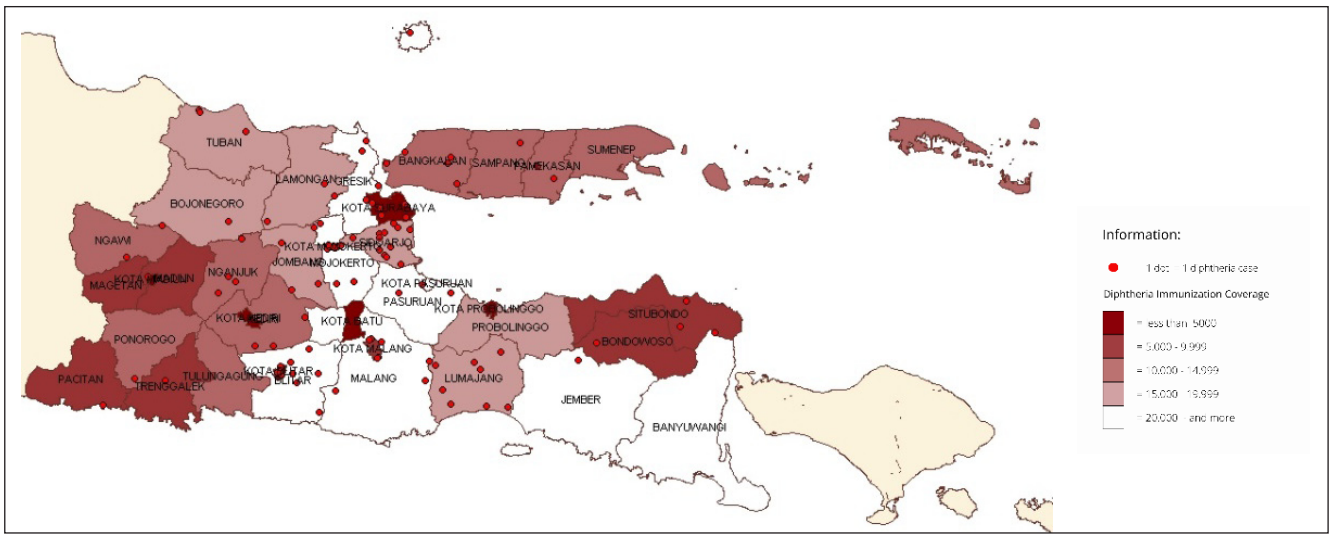


Figure 3. Diphtheria Incidence Distribution Map and DPT-Hb-HiB3 Immunization Coverage in 2020

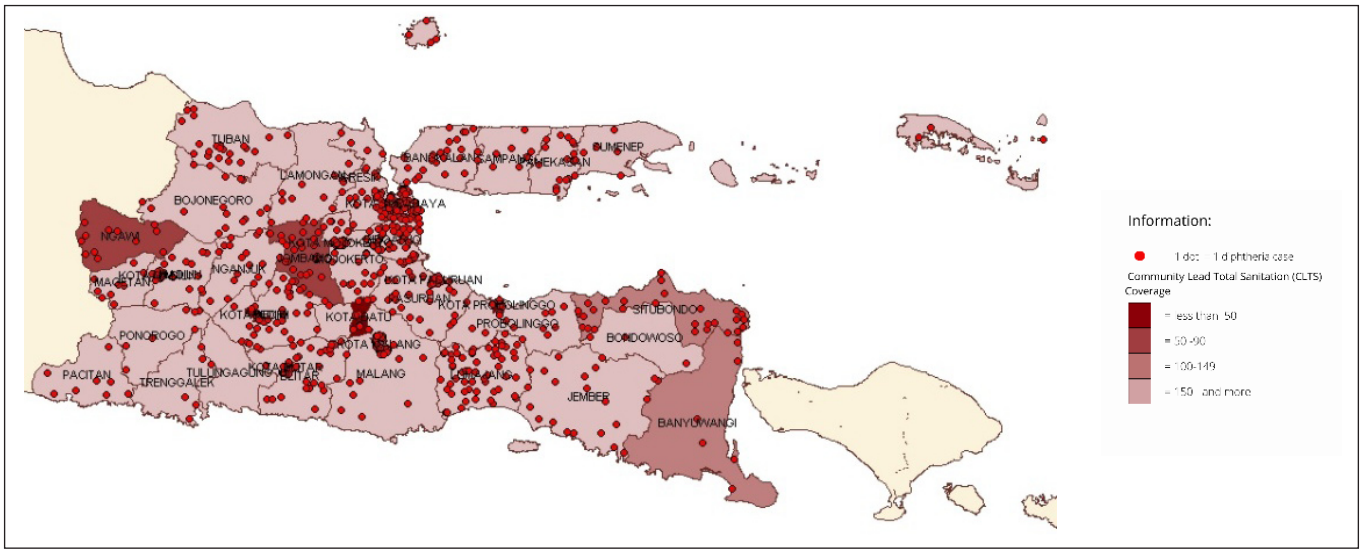


Figure 4. Diphtheria Incidence Distribution Map and Community Lead Total Sanitation (CLTS) Coverage in 2018

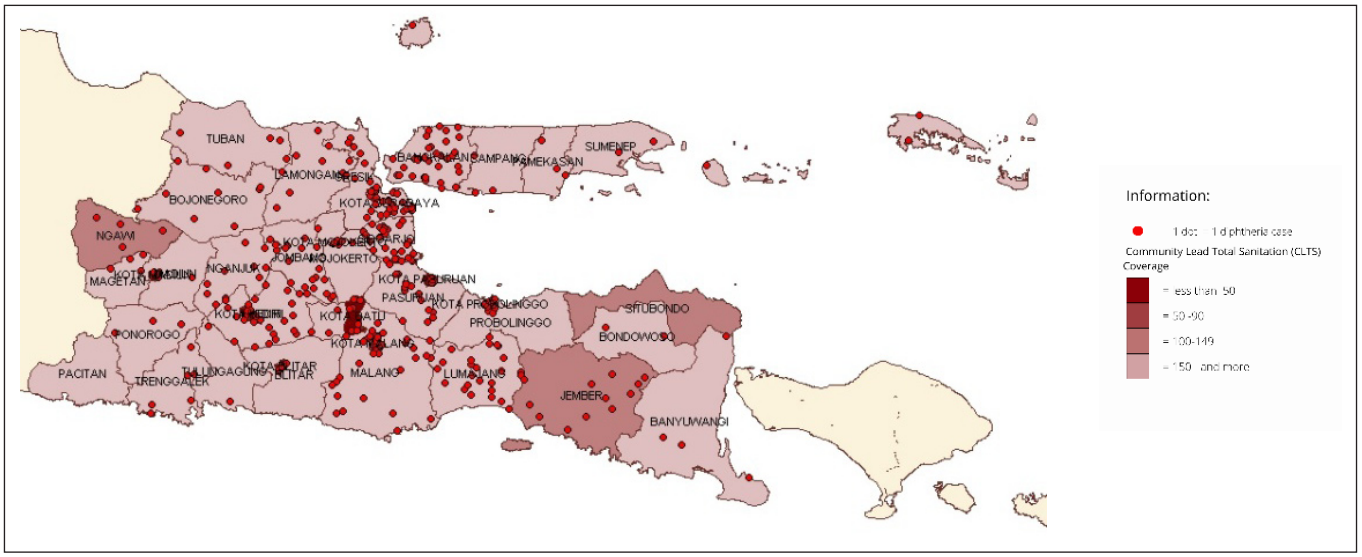


Figure 5. Diphtheria Incidence Distribution Map and Community Lead Total Sanitation (CLTS) Coverage in 2019

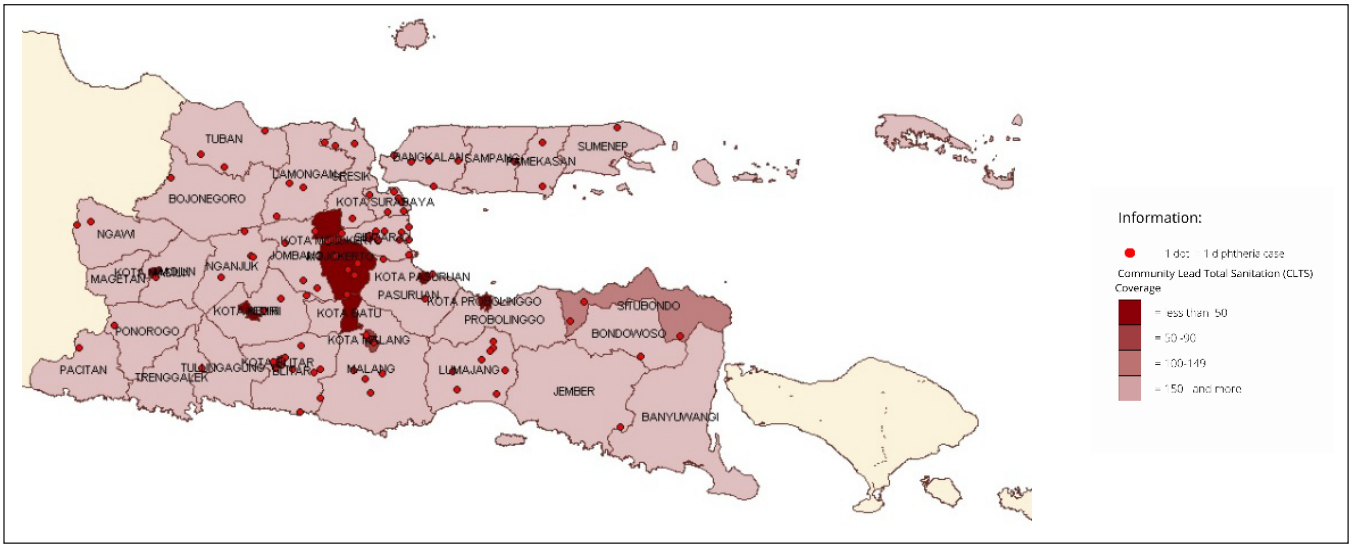


Figure 6. Diphtheria Incidence Distribution Map and Community Lead Total Sanitation (CLTS) Coverage in 2020

There was an increase in immunization coverage in 2019 and a decrease in 2020. Similarly, the coverage of Community Lead Total Sanitation (CLTS) increased in 2019, but decreased in 2020.

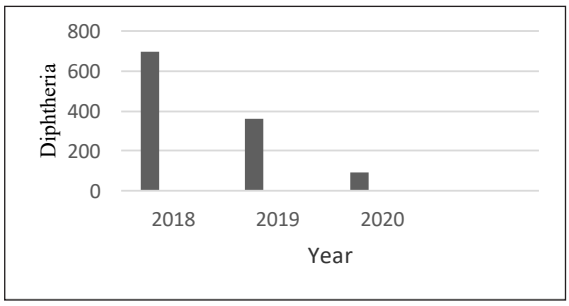


Figure 7. Diphtheria Incidence in East Java Province in 2018-2020

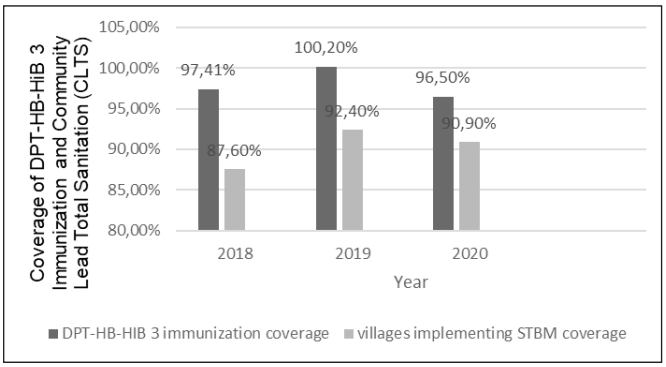


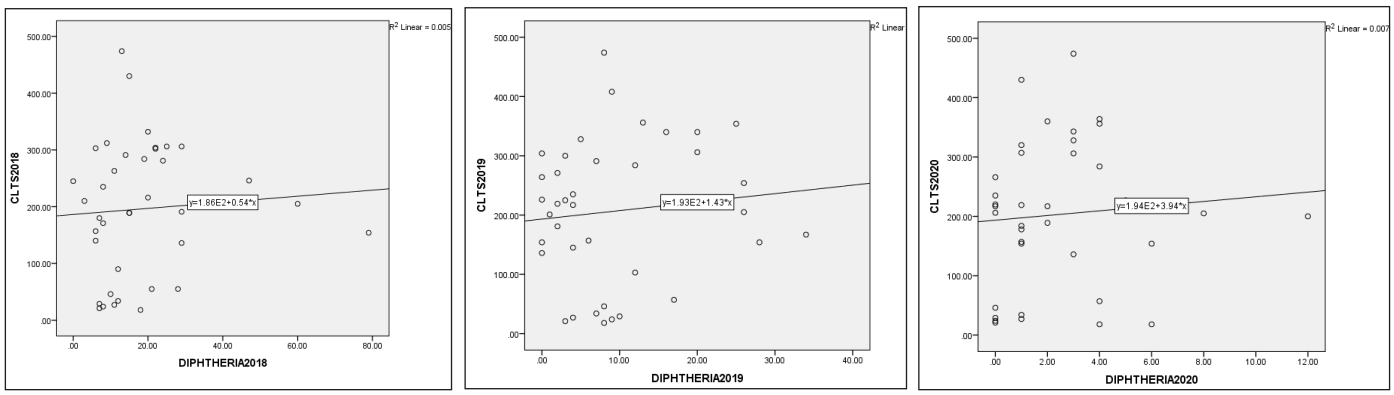
Figure 8. Community Lead Total Sanitation (CLTS) and DPT-HB-HiB3 Immunization Coverage in 2018-2020

Distribution and The Correlation Between Community Lead Total Sanitation (CLTS) Coverage with The Diphtheria Incidence 2018-2020

In 2018 East Java Province faced 695 cases diphtheria with CLTS coverage of 7.451 or 87.6%. In 2019, three regencies/cities (7.8%) of 38 regencies/ cities in East Java had high CLTS coverage followed by increasing diphtheria cases, and one district (2.6%) had low CLTS coverage followed by high diphtheria cases. Diphtheria cases also occurred in Pamekasan Regency with the highest CLTS coverage consecutively from 2018-2020. It had 15 cases in 2018, three cases in 2019, and two cases in 2020 with 100% CLTS coverage. In 2018, it was the only regency/city in East Java Province that did not have diphtheria cases with 90.4% CLTS coverage. While Jombang Regency and Ngawi Regency had relatively low CLTS coverage compared to other regencies. In Jombang Regency there were 28 cases with 18% CLTS coverage, while Ngawi Regency had 12 cases with 41.5% CLTS coverage.

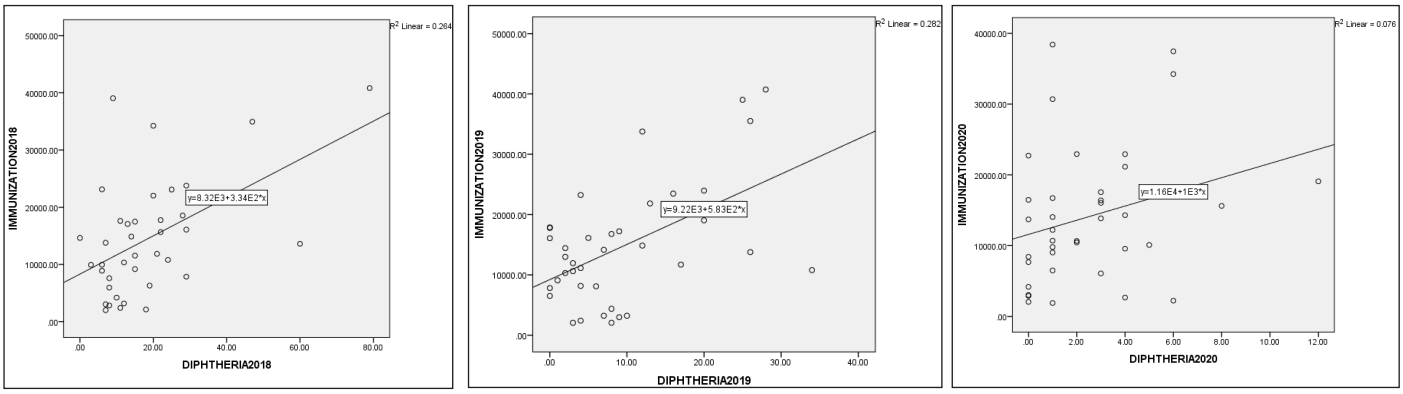
Seen from Figure 5, in 2019 the incidence of diphtheria decreased, but CLTS coverage increased from 87.6% to 92.4%. Sixteen regencies/cities in East Java Province experienced increased CLTS coverage in 2019. Sixteen regencies/cities had stable CLTS coverage, and six regencies/cities experienced lower CLTS coverage in 2019. Bangkalan Regency among the other five faced 34 cases with 59.4% CLTS coverage in 2019. In 2019, Pamekasan Regency only had three cases and 100% CLTS coverage. Five regencies did not have diphtheria cases in the same year. Some include Probolinggo Regency and Pacitan Regency, which also faced a decrease in CLTS coverage; two others i.e., Situbondo Regency and Mojokerto Regency encountered stable CLTS coverage. Meanwhile, the other, Blitar Regency, had increased CLTS coverage.

In 2020 the coverage of CLTS decreased from the previous year from 92.4% to 90.9% along with a decrease in diphtheria cases. In 2020, CLTS coverage plummeted in 12 regencies/cities, while it decreased in five regencies/cities, and the rest remained stable. Batu City and Probolinggo City had 100% CLTS coverage without diphtheria cases in 2020. Two regencies with the lowest CLTS were Mojokerto Regency (5.9%) and Sidoarjo Regency (56.7%). Mojokerto Regency had six cases, and Sidoarjo Regency faced 12 cases of diphtheria.



(a) *(b)* *(c)*

Figure 9. Graph of Correlation of CLTS Coverage with Diphtheria Cases 2018 *(a)* , 2019 *(b)*, 2020 *(c)*



(a) *(b)* *(c)*

Figure 10. Graph of Correlation of DPT-HB-HiB3 Coverage with Diphtheria Cases 2018 2018 *(a)* , 2019 *(b)*, 2020 *(c)*

The results of the Spearman population correlation test stated that the coverage of CLTS in 2018-2020 with diphtheria cases in 2018-2020 was sig (2-tailed) > 0.05, greater than 0.05, meaning that there was no significant relationship between CLTS coverage in 2018-2020 and diphtheria cases in 2018-2020. In 2018 a correlation coefficient of 0.210 was obtained, which means the relationship is very weak and a positive correlation coefficient means that the higher the CLTS coverage, the healthier the population. In 2019 a correlation coefficient of 0.115 was obtained, meaning that the relationship is very weak and the correlation coefficient is positive, meaning that the higher the CLTS coverage, the healthier the person is. In 2020, a correlation coefficient of 0.126 was obtained, meaning that the relationship was very weak and the correlation coefficient was positive. In other words, the higher the CLTS coverage, the healthier the babies.

Distribution and Correlation of DPT-HB-HiB3 Immunization Coverage with Diphtheria Incidence in 2018-2020

In 2018, 695 the incidence of diphtheria cases occurred in East Java Province with 97.27% immunization coverage. Diphtheria cases also occurred in areas with high immunization coverage, including Gresik and Tulungagung Regencies. Twenty cases were also found in Gresik Regency which had high immunization coverage (109.28%). Tulungagung Regency is the only diphtheria-free regency with 98.95% immunization coverage. Meanwhile, Nganjuk Regency and Bangkalan Regency had lower DPT-HB-HiB3 immunization coverage than others. Nganjuk Regency had 19 cases with 41.34% immunization coverage, and Bangkalan Regency had 24 cases with 73.57% immunization coverage.

In 2019 the incidence of diphtheria in East Java Province decreased from 695 cases to 358 cases accompanied by rising immunization coverage from 97.41% to 100.2%. The immunization coverage swelled in 29 out of 38 regencies/cities in 2019. Meanwhile, 33 of 38 regencies/cities had shrinking diphtheria cases in 2019. Five regencies/cities, namely Tulungagung Regency, Malang Regency, Bangkalan Regency, Probolinggo City, and Batu City, had increased cases accompanied by reduced immunization coverage in 2019. Two regencies i.e., Mojokerto Regency and Probolinggo Regency, had no cases and immunization coverage above 100%, 105.2%, and 104.1%, respectively.

The incidence of diphtheria then decreased from 358 cases in 2019 to 94 cases in 2020. However, DPT-HB-HiB3 immunization coverage went down from 100.2% to 96.5%. In 2020, only eight regencies/cities, i.e., Ponorogo Regency, Trenggalek Regency, Blitar Regency, Kediri Regency, Pasuruan Regency, Jombang Regency, Blitar City, and Batu City, experienced rising immunization coverage. Eight others had lower immunization coverage in 2020 than in 2018. Four others i.e., Pacitan Regency, Blitar Regency, Situbondo Regency, and Mojokerto Regency had swelling diphtheria incidence. Only two regencies/cities, i.e., Banyuwangi Regency and Batu City had no cases and immunization coverage above 100%, at 107.9% and 101.1%, respectively.

The results of the Spearman population correlation test stated that the coverage of DPT-HB-HiB3 immunization in 2018 with diphtheria cases in 2018 was 0.006 < 0.05, smaller than 0.05, meaning that there was a significant relationship between the coverage of DPT-HB-HiB3 immunization in 2018 and cases diphtheria in 2018. The correlation coefficient is 0.441, meaning that the correlation strength between the diphtheria case variables in 2018 and the 2018 DPT-HB-HiB3 immunization coverage is 0.441 or sufficient. The value of the correlation coefficient is positive, meaning that the relationship between the two variables is unidirectional, namely the higher the immunization coverage, the healthier the baby.

The results of the Spearman population correlation test stated that the coverage of DPT-HB-HiB3 immunization in 2019 with diphtheria cases in 2019 was 0.020 <0.05, less than 0.05, meaning that there was a significant relationship between the coverage of DPT-HB-HiB3 immunization in 2019 and diphtheria cases. in 2019. The correlation coefficient is 0.376, meaning that the strength of the correlation between the diphtheria case variables in 2019 and the 2019 DPT-HB-HiB3 immunization coverage is 0.376 or sufficient. The value of the correlation coefficient is positive, meaning that the relationship between the two variables is unidirectional, namely the higher the immunization coverage, the healthier the baby.

The results of the Spearman population correlation test stated that the coverage of DPT-HB-HiB3 immunization in 2020 with diphtheria cases in 2020 was 0.052 > 0.05, greater than 0.05, meaning that there was no significant relationship between DPT-HB-HiB3 immunization coverage in 2020 and diphtheria cases in 2020.

Table 2. Spearman Population Correlation Test between Community Lead Total Sanitation (CLTS) Coverage and DPT-HB-HiB3 Immunization Coverage with Diphtheria Incidence in 2018-2020

Factors	Sig. (2-tailed)	Correlation Coefficient	
2018			
CLTS	0.207	0.210	Insignificant
DPT-HB-HiB3 Immunization	0.006	0.441	Significant-Moderate
2019			
CLTS	0.492	0.115	insignificant
DPT-HB-HiB3 Immunization	0.020	0.376	Significant-Moderate
2020			
CLTS	0.450	0.126	insignificant
DPT-HB-HiB3 Immunization	0.052	0.318	insignificant

DISCUSSION

Distribution of Diphtheria Incidence and Community Lead Total Sanitation (CLTS) Coverage

The incidence of diphtheria tends to decrease as CLTS coverage fluctuates every year during 2018-2020. Table 2 shows the correlation of CLTS with the incidence of diphtheria in 2018-2020. The current results are different from previous studies where the Poisson regression modeling tests indicate a significant value for CLTS coverage, the results of Poisson regression modeling indicate that CLTS has a significant value and is at a significance level of 0.05 (11). Research in Bojonegoro, the transmission of diphtheria can also be influenced by several factors, including poor sanitation and hygiene, thus facilitating the transmission of diphtheria. One of the factors that facilitate the process of disease is sanitation and hygiene (12).

Research in 2018 has revealed households with proper sanitation tend to have 0.93 times the chance to facilitate diphtheria transmission (13). Every one percent of reduced sanitation may result in a new diphtheria case. This is because sanitation plays a very important role in increasing diphtheria cases, one of which is air sanitation which causes the proliferation of diphtheria-causing bacteria in the house. Based on research conducted in Situbondo, dense housing and poor environment with low sanitation are other causes of diphtheria (14). The excessive population in an area may cause a slum environment that may become breeding site for *Corynebacterium diphtheria*. Others include low vaccination coverage, crowding, migration or population movement, environmental factors, nutritional status, parental behavior, and personal hygiene of children (15). Research conducted in Yemen, diphtheria cases were mostly found in areas with massive population displacement, non-functioning services, lack of food, poor clean water, and poor sanitation (16).

One of the diseases that easily becomes a pandemic is diphtheria. Direct contact with diphtheria sufferers and the baby's weak immunity are the main causes of diphtheria outbreaks. Sanitation could be assessed by whether the house has enough spaces to allow sunlight to enter, the level of humidity, and ventilation/windows available (17). Population density can cause environmental sanitation to be low. This is because the increase in population that is not matched by the availability of sufficient land will have an impact on the emergence of a slum environment. In terms of health, the environment is closely related to the breeding ground for several types of diseases, both diseases caused by bacteria, including diphtheria. In addition, population density can also cause a high number of diphtheria cases because the higher the number of diphtheria sufferers in healthy people, so that more and more people are affected by diphtheria disease. The presence of the floor of the house, humidity, ventilation/windows of the house, and the density of the dwelling are components of the physical environmental conditions that are associated with high cases of diphtheria in children (18). The OR value is 4.18, which means that if the respondent has a physical environmental condition of the house that does not meet the requirements, it will be 4.18 times at risk of getting diphtheria compared to those who have a house that meets the requirements. *Corynebacterium diphtheria* can grow when the humidity exceeds the specified threshold. Therefore, Community Lead Total

Sanitation should be reinforced to improve the degree of human health against diphtheria. Environmental factors warrant attention from health officers who pursue tackling measures of diphtheria cases. This is in line with research conducted in East Java that the variables of complete basic immunization and population density have a significant effect on the prevalence of diphtheria in East Java (19).

According to the Regulation of Ministry of Health Republic Indonesia No.3/MENKES/2014 concerning Community Based Total Sanitation, Community Lead Total Sanitation (CLTS) includes three strategic components i.e., creating a conducive environment, increasing sanitation needs, and increasing access to sanitation. Degraded quality in one of the components yields unsuccessful implementation (20). To achieve the components, assessments should begin with the house, its sanitation, and the community's behavior (21). For example, the house can be measured from its location, air quality, noise from vibration, soil quality, groundwater quality, environmental facilities and infrastructure, disease-transmitting animals, and reforestation.

Distribution of Diphtheria Incidence with DPT-HB-HiB3 Immunization Coverage

The incidence of diphtheria tends to decrease as DPT-HB-HiB3 immunization coverage fluctuates every year during 2018-2020. Age, gender, parental education, socioeconomic status, immunization status, and close contact are considered to contribute to the incidence of bacteria (22). Other research mentions it happens due to a lack of parental knowledge, family support for immunization, and immunization status (23). From the two studies, immunization status had the most significant value associated with the incidence of diphtheria.

According to Law Number 36/2009 Concerning Health, immunization is deemed able to suppress and reduce mortality because of infectious diseases in children (24). One's immune system may increase through immunization (25). DPT immunization along with diphtheria toxoid vaccination has been used in Padang to induce immunity against diphtheria, pertussis, and tetanus (26). Immunization is considered to prevent disease transmission through air or contaminated foods. This is quite helpful because the transmission is quite fast and the method of transmission is easy, namely through the air, contact with diphtheria patients, or through eating utensils and food contaminated with the patient's saliva.

Research in 2017 for recipients of the Family Hope Program has discovered age, marital status, education, occupation, internet access, and area of residence contribute to low immunization coverage among the recipients of the Family Hope Program. Of the several factors mentioned, age and marital status have a significant effect on immunization coverage (27). Besides, research conducted in Pekanbaru reported that time constraints, family support, information, and vaccine composition influence basic immunization coverage (28). These things are closely related to immunization coverage because the obstacle for people to get health services is time constraints, for example, the person is busy working so he cannot take his child to get immunizations. Lack of family support may reduce one's possibility to get assistance to access immunization. Meanwhile, the family who knows the benefits, goals, schedule, and place of immunization may be helpful to give immunizations to children.

High immunization coverage does not guarantee the abolition of diphtheria diseases as the immune system will decline with age (29). As people get older, their immune system also decreases. Therefore, it is necessary to take a diphtheria vaccine booster along with aging, especially for children under two years old, school-aged children, and women of childbearing age including pregnant women. The purpose of booster or advanced immunization is to ensure that the level of immunity is maintained. A person who has complete immunization status has fewer chances five times of experiencing diphtheria disease compared to those with incomplete immunization status. The first vaccination could be given when a child is under two years old. Then, the second DPT-HB-HiB3 immunization according to the policy of the Indonesian Ministry of Health is given three times, and measles immunization is administered once at the age of 18-24 months which is useful for maintaining and increasing antibody titers in children who decrease in cases of diphtheria and measles (30).

The effectiveness of vaccination that works against diseases is determined by immunization status (31). Research has figured out antibody titter could be 20.13%-29.96% effective in school-age children who have not received further diphtheria immunization and could be 92.01%-98.11% after diphtheria immunization. This is in line with research conducted in Saudi Arabia in 2017 that absent or incomplete immunization status, young age, lack of nutrition, and delays in treatment may cause severe diphtheria which later leads to death (32). The vaccine's effectiveness is influenced by patient, logistics, and epidemiological factors (33). Patient factors include the patient's age, susceptibility to diphtheria disease, previous exposure to antigens, and history of vaccination with the administration of other drugs. Compliance with the vaccination schedule is a logistic factor, while the epidemiological factor

refers to one's immunity. Based on the previous study, this study concludes the importance of complete basic immunization to reduce the incidence of diphtheria. Due to the higher DPT-HB-HIB3 immunization coverage, the lower the number of cases of diphtheria.

ACKNOWLEDGMENTS

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CONCLUSION

A significant relationship existed between the incidence of diphtheria cases and DPT-Hb-HiB3 immunization coverage in East Java Province 2018-2020. However, Community Lead Total Sanitation (CLTS) coverage did not give any significant relationship with the incidence of diphtheria within the period. The incidence of diphtheria tends to occur in areas with low immunization coverage every consecutive year. Few areas or villages (13%) with low coverage of Community Lead Total Sanitation (CLTS) faced shrinking diphtheria cases. Education for public about the importance of DPT-HB-HiB3 immunization is required, and maintaining a clean environment is another important effort to prevent diphtheria transmission.

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