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ORIGINAL ARTICLE

# The environmental determinants of disease transmission in Medan City

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**ABSTRACT**

Health issues, potentially triggered by environmental conditions and human behaviour, represent a complex challenge, particularly in Indonesia where environmentally related diseases remain a primary cause of mortality. This study aimed to ascertain the spatial distribution of Dengue Haemorrhagic Fever (DHF), Tuberculosis (TB), and diarrhoea in the city of Medan. The research employed a descriptive analysis of DHF and TB case data aggregated by sub-district, encompassing population, age group, and sex distribution. Acute diarrhoea case data were collected from various community health centres (puskesmas) in Medan City, categorized by puskesmas location, patient age, and dehydration status. The results revealed significant variations in the number of DHF cases across Medan's sub-districts, with Medan Helvetia recording the highest incidence. The distribution of TB cases also varied, with Medan Deli exhibiting the highest number of reported cases. For diarrhoea, Puskesmas Helvetia reported the highest number of cases. The discussion delves into the factors influencing the spatial distribution of these three diseases, including population density, environmental determinants, community behaviour, access to healthcare services, and sanitation conditions. In conclusion, the study highlights that the spread of infectious diseases in Medan City is influenced by a variety of interacting factors. Effective prevention and control efforts necessitate a comprehensive, multi-sectoral approach focusing on robust surveillance, community empowerment, improved access to healthcare, and the enhancement of environmental and sanitation conditions.

**Keywords:** dengue haemorrhagic fever, tuberculosis, diarrhoea, disease transmission

## Introduction

Health issues represent a complex challenge, potentially triggered by both environmental conditions and human behaviour. In Indonesia, environmentally related diseases remain a primary cause of mortality.[1] Environmentally related diseases are defined as pathological conditions involving functional impairment or structural changes in bodily organs resulting from human interaction with surrounding elements that have the potential to cause illness. More specifically, an environmentally related disease is one where the disease process or phenomenon within a community has a strong relationship, root, or connection to one or more environmental components within a specific geographical area where the community resides or engages in activities over a defined period. Reports from the World Health Organization (WHO) indicate that environmental factors contribute significantly to over 80% of disease cases.[2,3]

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The increasing incidence of environmentally related diseases is primarily attributed to unfavourable environmental factors and low levels of clean and healthy living behaviours (PHBS).[4] From a hygiene perspective, the prevalence of environment-related diseases is generally due to unmet community needs for clean water, low rates of sanitary latrine use, and soil, water, and air pollution from domestic, industrial, agricultural, and transportation waste, as well as physical environmental conditions that facilitate pollution.[5] Several environmentally related diseases remain significant public health problems in Indonesia, including dengue fever, diarrhoea, and tuberculosis (TB).[6]

The WHO has noted an over eight-fold increase in reported dengue fever cases in the last four years, rising from 505,000 cases to 4.2 million cases in 2019. Dengue fever-related deaths also increased from 960 to 4,032 during the period from 2015.[7,8] According to data from the Indonesian Ministry of Health (Kemenkes) in 2020, dengue haemorrhagic fever (DHF) cases in Indonesia reached 71,700 by July. The ten provinces with the highest number of cases were West Java (10,772 cases), Bali (8,930 cases), East Java (5,948 cases), East Nusa Tenggara (5,539 cases), Lampung (5,135 cases), Jakarta (4,227 cases), West Nusa Tenggara (3,796 cases), Central Java (2,846 cases), Yogyakarta Special Region (2,720 cases), and Riau (2,255 cases).[9]

Globally, the WHO estimated 10 million TB cases in 2019. Although there has been a decline in new TB cases, the rate is not in line with the 2020 targets of the END TB Strategy, which aimed for a 20% reduction in TB cases between 2015 and 2020. In the period 2015-2019, the cumulative reduction in TB cases was only 9%.[10,11] The estimated TB incidence in Indonesia in 2021 was 969,000 cases, or 354 per 100,000 population, with an estimated 144,000 deaths due to TB, or 52 per 100,000 population. Based on tuberculosis incidence data from 2000-2020, there was a decrease in TB incidence and mortality rates, although not significant. However, in the period 2020-2021, there was an 18% increase in TB incidence (from 819,000 cases in 2020 to 969,000 cases in 2021, or from 301 per 100,000 population to 354 per 100,000 population) and a 55% increase in TB-related deaths (from 93,000 deaths in 2020 to 144,000 deaths in 2021, or from 34 per 100,000 population to 52 per 100,000 population).[10] Of the estimated 969,000 TB cases per year, case notification in 2022 recorded 724,309 cases (75%), indicating that 25% of cases remain unreached, undetected, or unreported.[10,11]

Meanwhile, diarrhoea is a major health problem in developing countries, including Indonesia. Diarrhoea not only causes death but is also a leading cause of malnutrition, which can lead to mortality and other health problems. Several factors cause diarrhoea, including bacteria from faecal contamination of food or drink, or direct contact with infected individuals. Additionally, dominant factors contributing to diarrhoeal diseases are water quality, food hygiene and sanitation, the availability of household latrines, and water sanitation.[12] Data from the 2019 Indonesian Health Profile showed a diarrhoea prevalence based on healthcare professional diagnosis of 6.8% and based on healthcare professional diagnosis or reported symptoms of 8%. The age groups with the highest diarrhoea prevalence (based on healthcare professional diagnosis) were children aged 1-4 years (11.5%) and infants (9%). The lowest diarrhoea prevalence was recorded in Riau Islands Province (5.1%) and the highest in North Sumatra Province (14.2%).[13]

The primary objective of this research is to ascertain the spatial distribution of environmentally related diseases in the city of Medan. Specifically, this study aims to: (1) identify the spatial distribution of Dengue Haemorrhagic Fever (DHF) in Medan, (2) identify the spatial distribution of Tuberculosis (TB) in Medan, and (3) identify the spatial distribution of Diarrhoea in Medan.

## Method

This study employed a descriptive analysis of case data for Dengue Haemorrhagic Fever (DHF), tuberculosis (TB), and acute diarrhoea across various regions of Medan City. DHF and TB case data were aggregated by sub-district, encompassing information on the total population within each sub-district, the distribution of cases by age group (15-35 years, 36-56 years, and 57 years and above), and the distribution of cases by sex. Concurrently, acute diarrhoea case data were collected from multiple community health centres (puskesmas) within Medan City. Diarrhoea data were categorised by puskesmas location, patient age group (older children/adults and toddlers), and dehydration status (none, moderate, severe). The analysis aimed to observe and describe the patterns of case distribution for each disease across different geographical areas and population groups within Medan City.

## Results

Examining the data reveals significant variations in the number of DHF cases across Medan's sub-districts. Medan Helvetia recorded the highest number of cases with 90, despite having a total population of 12,190. In contrast, Medan Maimun, with a smaller population of 3,186, reported the lowest number of DHF cases at just 1. Several other sub-districts also experienced a notable number of DHF cases. Medan Tuntungan reported 33 cases out of a population of 8,487, while Medan Denai had 22 cases within its 13,546 residents. Medan Sunggal registered 21 cases among its 9,383 population, and both Medan Tembung (population 11,065) and Medan Deli (population 17,636) also reported 21 and 23 cases respectively. Medan Kota, with a population of 5,145, recorded 19 DHF cases.

On the lower end of the spectrum, besides Medan Maimun, several sub-districts reported very few DHF cases. Medan Johor (population 11,463) and Medan Baru (population 2,185) each had only 3 cases. Medan Amplas (population 11,144) reported 5 cases, and Medan Selayang (population 8,012) recorded 6 cases. Medan Area (population 7,600) and Medan Petisah (population 4,435) had slightly higher numbers with 8 and 9 cases respectively.

Table 1. Frequency distribution of DHF cases by sub-district in Medan City

| Sub-district | Total Population | Age Group (Years) | | | Gender | | Cases |
|---|---|---|---|---|---|---|---|
| | | 15-35 | 36-56 | 57+ (elderly | Male | Female | |
| Medan Tuntungan | 8.487 | 2.560 | 4.555 | 1.372 | 5.689 | 2.798 | 33 |
| Medan Johor | 11.463 | 5.781 | 2.891 | 2.791 | 4.765 | 6.698 | 3 |
| Medan Amplas | 11.144 | 3.894 | 1.988 | 5.262 | 3.990 | 7.154 | 5 |
| Medan Denai | 13.546 | 6.843 | 3.777 | 2.926 | 8.432 | 5.114 | 22 |
| Medan Area | 7.600 | 2.459 | 2.776 | 2.365 | 3.421 | 4.179 | 8 |
| Medan Kota | 5.145 | 1.488 | 1.032 | 2.625 | 2.411 | 2.734 | 19 |
| Medan Maimun | 3.186 | 1.604 | 531 | 1.051 | 1.313 | 1.873 | 1 |
| Medan Polonia | 4.812 | 1.311 | 1.541 | 1.960 | 1.922 | 2.890 | 2 |
| Medan Baru | 2.185 | 458 | 1.005 | 722 | 1.800 | 385 | 3 |
| Medan Selayang | 8.012 | 3.002 | 1.665 | 3.345 | 3.501 | 4.511 | 6 |
| Medan Sunggal | 9.383 | 4.503 | 2.005 | 2.875 | 3.781 | 5.602 | 21 |
| Medan Helvetia | 12.190 | 6.950 | 2.367 | 2.873 | 7.543 | 4.647 | 90 |
| Medan Petisah | 4.435 | 1.862 | 1.552 | 1.021 | 1.906 | 2.529 | 9 |
| Medan Barat | 5.615 | 2.780 | 1.003 | 1.832 | 2.076 | 3.539 | 14 |
| Medan Timur | 8.598 | 4.588 | 2.054 | 1.956 | 2.303 | 6.295 | 26 |
| Medan Perjuangan | 7.390 | 5.333 | 1.341 | 716 | 1.996 | 5.394 | 13 |
| Medan Tembung | 11.065 | 8.345 | 2.371 | 349 | 3.566 | 7.499 | 21 |
| Medan Deli | 17.636 | 6.554 | 8.853 | 2.229 | 6.991 | 10.645 | 23 |
| Medan Labuhan | 5.145 | 1.200 | 2.777 | 1.168 | 2.022 | 3.123 | 12 |
| Medan Marelan | 16.946 | 9.544 | 5.677 | 1.725 | 5.784 | 11.162 | 17 |
| Medan Belawan | 9.848 | 4.573 | 3.324 | 1.951 | 3.666 | 6.182 | 16 |

The distribution of DHF cases does not appear to be directly proportional to the total population of each sub-district. For instance, Medan Deli has a large population but a moderate number of cases, while Medan Helvetia, with a smaller population than Medan Deli, has a significantly higher number of cases. This suggests that other factors beyond just population size may be influencing the prevalence of DHF in these areas.

The data presented in Table 2 provides a detailed frequency distribution of tuberculosis (TB) cases across various sub-districts within Medan City. The first column identifies each of the 21 sub-districts included in the study. Subsequent columns detail the total population within each sub-district, followed by a breakdown of the population into three age groups: 15-35 years, 36-56 years, and 57 years and above (categorized as elderly). This age stratification allows for an examination of the potential age-specific prevalence of TB. Furthermore, the table presents the gender distribution within each sub-district, indicating the number of males and females residing in each area. The final column, and the primary focus of the table, reports the total number of TB cases identified in each respective sub-district.

A preliminary examination of the data reveals variability in the number of TB cases across Medan City's sub-districts. Medan Deli exhibits the highest number of reported cases (35), followed by Medan Labuhan (22) and Medan Marelan (18). Conversely, Medan Tuntungan and Medan Denai each reported 16 cases, while Medan Selayang and Medan Belawan also recorded 12 and 16 cases, respectively. Notably, Medan Polonia and Medan Baru reported zero TB cases during the period of data collection. The remaining sub-districts, including Medan Johor, Medan Amplas, Medan Area, Medan Kota, Medan Maimun, Medan

Sunggal, Medan Helvetia, Medan Petisah, Medan Barat, Medan Timur, Medan Perjuangan, and Medan Tembung, reported a relatively lower number of cases, ranging from one to eight.

Table 2. Frequency distribution of tuberculosis cases by sub-district in Medan City

| Sub-district | Total Population | Age Group (Years) | | | Gender | | Cases |
|---|---|---|---|---|---|---|---|
| | | 15-35 | 36-56 | 57+ (elderly | Male | Female | |
| Medan Tuntungan | 8.487 | 2.560 | 4.555 | 1.372 | 5.689 | 2.798 | 1 |
| Medan Johor | 11.463 | 5.781 | 2.891 | 2.791 | 4.765 | 6.698 | 4 |
| Medan Amplas | 11.144 | 3.894 | 1.988 | 5.262 | 3.990 | 7.154 | 2 |
| Medan Denai | 13.546 | 6.843 | 3.777 | 2.926 | 8.432 | 5.114 | 16 |
| Medan Area | 7.600 | 2.459 | 2.776 | 2.365 | 3.421 | 4.179 | 4 |
| Medan Kota | 5.145 | 1.488 | 1.032 | 2.625 | 2.411 | 2.734 | 4 |
| Medan Maimun | 3.186 | 1.604 | 531 | 1.051 | 1.313 | 1.873 | 3 |
| Medan Polonia | 4.812 | 1.311 | 1.541 | 1.960 | 1.922 | 2.890 | 0 |
| Medan Baru | 2.185 | 458 | 1.005 | 722 | 1.800 | 385 | 0 |
| Medan Selayang | 8.012 | 3.002 | 1.665 | 3.345 | 3.501 | 4.511 | 12 |
| Medan Sunggal | 9.383 | 4.503 | 2.005 | 2.875 | 3.781 | 5.602 | 7 |
| Medan Helvetia | 12.190 | 6.950 | 2.367 | 2.873 | 7.543 | 4.647 | 8 |
| Medan Petisah | 4.435 | 1.862 | 1.552 | 1.021 | 1.906 | 2.529 | 4 |
| Medan Barat | 5.615 | 2.780 | 1.003 | 1.832 | 2.076 | 3.539 | 5 |
| Medan Timur | 8.598 | 4.588 | 2.054 | 1.956 | 2.303 | 6.295 | 8 |
| Medan Perjuangan | 7.390 | 5.333 | 1.341 | 716 | 1.996 | 5.394 | 5 |
| Medan Tembung | 11.065 | 8.345 | 2.371 | 349 | 3.566 | 7.499 | 5 |
| Medan Deli | 17.636 | 6.554 | 8.853 | 2.229 | 6.991 | 10.645 | 35 |
| Medan Labuhan | 5.145 | 1.200 | 2.777 | 1.168 | 2.022 | 3.123 | 22 |
| Medan Marelan | 16.946 | 9.544 | 5.677 | 1.725 | 5.784 | 11.162 | 18 |
| Medan Belawan | 9.848 | 4.573 | 3.324 | 1.951 | 3.666 | 6.182 | 16 |

Table 3 presents a frequency distribution of reported acute diarrhoea cases across various primary healthcare centres (puskesmas) within Medan City. The data is categorized by the location of the puskesmas, the age group of the affected individuals (older children/adults and under five years), and the reported dehydration status (no, moderate, severe). Additionally, the total number of acute diarrhoea cases reported at each puskesmas is provided.

A notable variation in the number of reported diarrhoea cases is evident across the different puskesmas. For older children and adults, Puskesmas Helvetia recorded the highest number of cases (1446), followed by Puskesmas Glugur Darat Medan (1058) and Puskesmas Medan Johor (991). Conversely, several puskesmas reported considerably lower numbers, with Puskesmas M.A. Selatan and Puskesmas Teladan reporting no cases in this age group.

Table 3. Frequency distribution of diarrhoea cases by primary healthcare centre (puskesmas) in Medan City

| Location | Age group | | Dehydration status | | | Acute Diarrhoea |
|---|---|---|---|---|---|---|
| | Older Children/Adults | Under Five Years | No | Moderate | Severe | |
| Puskemas Amplas | 967 | 266 | 89 | 0 | 0 | 87 |
| Puskemas Belawan | 549 | 78 | 19 | 0 | 0 | 18 |
| Puskemas Bestari Medan | 222 | 26 | 0 | 0 | 0 | 0 |
| Puskemas Bromo | 222 | 34 | 90 | 0 | 0 | 87 |
| Puskemas Darussalam | 237 | 33 | 0 | 57 | 0 | 56 |
| Puskemas Desa Binjai | 432 | 76 | 33 | 28 | 0 | 60 |
| Puskemas Desa Lalang | 399 | 55 | 0 | 0 | 0 | 0 |
| Puskemas Desa Terjun | 638 | 109 | 0 | 0 | 0 | 0 |
| Puskemas Glugur Darat Medan | 1058 | 147 | 0 | 80 | 0 | 79 |
| Puskemas Glugur Kota | 104 | 14 | 14 | 0 | 0 | 14 |
| Puskemas Helvetia | 1446 | 191 | 181 | 0 | 0 | 177 |
| Puskemas Kampung Baru | 385 | 66 | 86 | 0 | 0 | 86 |
| Puskemas Kedai Durian | 440 | 72 | 15 | 0 | 0 | 15 |
| Puskemas Kota Matsum | 308 | 47 | 0 | 0 | 0 | 0 |
| Puskemas M.A. Selatan | 271 | 0 | 0 | 0 | 0 | 0 |
| Puskemas Mandala | 693 | 85 | 48 | 0 | 0 | 47 |
| Puskemas Martubung | 555 | 109 | 152 | 0 | 0 | 150 |
| Puskemas Medan Deli | 838 | 15 | 10 | 3 | 0 | 12 |
| Puskemas Medan Denai | 359 | 46 | 0 | 0 | 0 | 0 |
| Puskemas Medan Johor | 991 | 411 | 142 | 2 | 0 | 141 |

| Location | Age group | | Dehydration status | | | Acute Diarrhoea |
|---|---|---|---|---|---|---|
| | Older Children/Adults | Under Five Years | No | Moderate | Severe | |
| Puskemas Medan Labuhan | 311 | 26 | 152 | 0 | 0 | 151 |
| Puskemas P.Brayan Kota | 189 | 4 | 0 | 0 | 0 | 0 |
| Puskemas Padang Bulan | 375 | 49 | 43 | 0 | 0 | 41 |
| Puskemas Padang Bulan Selayang II | 1039 | 160 | 0 | 0 | 0 | 0 |
| Puskemas Pasar Merah | 244 | 25 | 29 | 0 | 0 | 28 |
| Puskemas Polonia | 555 | 22 | 11 | 0 | 0 | 10 |
| Puskemas Rantang | 224 | 16 | 22 | 0 | 0 | 22 |
| Puskemas Rengas Pulau | 993 | 244 | 59 | 0 | 0 | 58 |
| Puskemas Sei Agul | 391 | 55 | 60 | 0 | 0 | 58 |
| Puskemas Sentosa Baru | 963 | 105 | 0 | 0 | 0 | 0 |
| Puskemas Sering | 607 | 0 | 106 | 0 | 0 | 104 |
| Puskemas Sicanang | 377 | 58 | 55 | 0 | 0 | 55 |
| Puskemas Simalingkar | 546 | 67 | 107 | 0 | 0 | 106 |
| Puskemas Simpang Limun | 273 | 26 | 0 | 62 | 0 | 60 |
| Puskemas Sukaramai | 355 | 58 | 80 | 0 | 0 | 79 |
| Puskemas Sunggal | 690 | 123 | 38 | 0 | 0 | 38 |
| Puskemas Tegal Sari | 497 | 39 | 0 | 0 | 0 | 0 |
| Puskemas Teladan | 215 | 0 | 0 | 0 | 0 | 0 |
| Puskemas Titi Papan | 950 | 103 | 0 | 0 | 0 | 0 |
| Puskemas Tuntungan | 277 | 53 | 0 | 0 | 0 | 24 |

Regarding cases among under five-year-olds, Puskesmas Medan Johor also reported the highest frequency (411), significantly higher than other puskesmas. Puskesmas Amplas (266) and Puskesmas Rengas Pulau (244) also reported a substantial number of cases in this younger age group. In contrast, Puskesmas M.A. Selatan and Puskesmas Teladan again reported no cases in this demographic.

In terms of dehydration status, the majority of reported cases across all puskesmas were classified as having no dehydration. Instances of moderate dehydration were reported in a few puskesmas, including Puskesmas Darussalam (57 cases), Puskesmas Desa Binjai (28 cases), Puskesmas Glugur Darat Medan (80 cases), and Puskesmas Medan Deli (3 cases), as well as Puskesmas Simpang Limun (62 cases). Notably, no cases of severe dehydration were reported across any of the primary healthcare centres.

Finally, the total number of acute diarrhoea cases at each puskesmas reflects the summation of cases across both age groups. Puskesmas Helvetia recorded the highest total (177), primarily driven by cases in older children and adults. Puskesmas Medan Johor also reported a high total (141), with a significant contribution from cases in under five-year-olds. Conversely, Puskesmas Bestari Medan, Puskesmas Desa Lalang, Puskesmas Desa Terjun, Puskesmas Kota Matsum, Puskesmas M.A. Selatan, Puskesmas P.Brayan Kota, Puskesmas Padang Bulan Selayang II, Puskesmas Polonia, Puskesmas Sentosa Baru, Puskesmas Tegal Sari, and Puskesmas Teladan reported relatively low or zero total acute diarrhoea cases during the period of data collection.

This frequency distribution highlights the varying burden of acute diarrhoea across different geographical areas served by these primary healthcare centres in Medan City and underscores the importance of considering both age groups and dehydration status in understanding the epidemiology of diarrhoeal diseases within the region.

## Discussion

### *Dengue Haemorrhagic Fever*

Mapping of Dengue Haemorrhagic Fever (DHF) cases in Medan City in 2024 indicates a variation in incidence across sub-districts. Medan Helvetia sub-district recorded the highest number of cases with 90 occurrences, followed by Medan Tuntungan (33 cases) and Medan Timur (26 cases). Conversely, the lowest case numbers were found in Medan Maimun (1 case), Medan Polonia (2 cases), and Medan Baru (3 cases). A study by Girsang et al.[14] investigated the relationship between population density and DHF incidence in Medan City. Their findings suggest that areas with high population density tend to have a high number of DHF cases, identified in two sub-districts. Interestingly, seven sub-districts with high population density exhibited low DHF case numbers. Meanwhile, five sub-districts with sparse population density had high DHF case numbers. Another study conducted by Fauzan and Purwanti[15] analysed DHF prevalence in Jakarta Special Capital Region (DKI Jakarta Province) during the period 2016-2019. This study, undertaken at

Universitas Muhammadiyah Surakarta, revealed that the highest incidence of DHF occurred in 2016, reaching 198.8 per 100,000 population. In that year, almost all areas of DKI Jakarta were in the high DHF incidence category, with no areas classified as low. The Head of the DKI Jakarta Health Office at the time, Koesmedi Prihatno, reported a significant increase in DHF cases in 2016, nearly reaching outbreak status (Kejadian Luar Biasa – KLB).

Climatic factors and population density in Medan City were also examined by Mutiara[16] in a study covering the period 2018-2022. Analysis showed that air pressure had a significant correlation with DHF incidence (r=0.391) and was the most dominant climatic factor (p=0.02). Spatial mapping in this research identified Medan Tembung sub-district as an area with high population density and high DHF incidence during the study period. The climatic variable of air pressure was confirmed to play a role in DHF incidence in Medan City.

Furthermore, Musfadillah's research[17] investigated the association between climatic factors and DHF incidence in Medan City from 2015 to 2019. The findings indicated a significant relationship between temperature and wind speed with DHF incidence (p=0.008 and p<0.0001, respectively). Conversely, humidity and rainfall did not show a significant association with DHF incidence (p=0.654 and p=0.091). The characteristics of urban areas, which are generally densely populated, increase the potential for contact between mosquito vectors and humans. The Indonesian Health Profile notes DKI Jakarta as the region with the highest population density in Indonesia, which could amplify the risk of DHF transmission. Moreover, high accessibility in urban areas can also be a contributing factor to disease spread.[13]

DHF control requires the integration of programmes and intersectoral collaboration due to the complexity of influencing factors. Currently, DHF incidence is also linked to the impact of climate change, which indirectly affects the vector development cycle. Therefore, comprehensive DHF prevention and control programmes need to be implemented. Information from surveillance activities constitutes an important early warning system for detecting increases in vector populations and forms the basis for effective and efficient vector control policy decisions. This approach needs to be strengthened through intersectoral collaboration, community empowerment, and the reinforcement of health services. Strengthening disease and risk factor surveillance systems is a crucial step in DHF prevention and control.[18–20]

Proposed DHF prevention and control strategies include vector control with an emphasis on community empowerment through Mosquito Nest Eradication (Pemberantasan Sarang Nyamuk – PSN) using the 3M Plus method and the 1 House 1 Larvae Monitor Movement (Gerakan 1 Rumah 1 Jumantik – G1R1J). Additionally, enhancing early detection surveillance systems, prevention, and control of DHF cases and outbreaks, strengthening diagnosis and patient management in health facilities, as well as the development and utilisation of technology, are important components of the solution. The 2020-2024 Work Action Plan for DHF prevention and control adopts three main approaches: disease and vector surveillance, case management, and vector control.

### *Tuberculosis*

Based on the mapping of tuberculosis cases in Medan City in 2024, Medan Deli sub-district recorded the highest number of cases at 35, followed by Medan Labuhan (22 cases) and Medan Marelan (18 cases). Meanwhile, Medan Polonia and Medan Baru sub-districts reported no cases, and the lowest case numbers were found in Medan Tuntungan (1 case) and Medan Amplas (2 cases). A study in Medan City examined the role of private healthcare facilities in tuberculosis suspect identification and pulmonary tuberculosis treatment. The findings of this research identified several key themes, including the tuberculosis screening service pathway in hospitals, the screening methods used, hospital policies related to screening, the resources available for screening, the case recording and reporting system, the role of healthcare professionals in pulmonary tuberculosis education through various media, the hospital's role in pulmonary tuberculosis treatment, and the challenges faced by hospitals in managing pulmonary tuberculosis patients. These findings provide a comprehensive overview of tuberculosis control efforts within the hospital setting.

Research by Farsida and Kencana[21] at the Puskesmas Pamulang in South Tangerang investigated the characteristics of children with tuberculosis. The results showed a higher incidence of tuberculosis in male children (54.5%) compared to females. A study by Finny[22] in Padang City from 2020 to 2022 examined the relationship between climatic factors and tuberculosis cases. Correlation test results indicated a significant association between air humidity (p=0.019; r=0.401) and wind speed (p=0.017; r=0.408) with tuberculosis cases. In contrast, air temperature, rainfall, and duration of sunlight exposure did not show significant correlations. Multiple linear regression analysis suggested that air humidity and wind speed were associated

with tuberculosis cases in Padang City. Data from the Indonesian Ministry of Health[23] indicate that tuberculosis cases in male children are 1.3 times higher than in female children. This is thought to be related to greater outdoor activity in males and potentially lower adherence to medication.

Tuberculosis infection is differentiated into active tuberculosis, which causes symptoms and is transmissible, and latent tuberculosis, where the bacteria are dormant and do not cause symptoms. Clinical symptoms of tuberculosis in children are often non-specific, such as fever, weight loss, and recurrent acute respiratory infections, making clinical diagnosis challenging.[24] The role of the Directly Observed Treatment (DOT) supporter (Pengawas Minum Obat – PMO) is considered crucial for successful tuberculosis treatment. The DOT supporter assists patients, reminds them to take medication, provides motivation, and accompanies them to health facilities. Good knowledge of the DOT supporter can improve patient adherence to anti-tuberculosis medication.[25]

Proposed solutions include education by the DOT supporter to the patient's family regarding prevention, tuberculosis symptoms, and the importance of sputum examination if symptoms occur. Education for tuberculosis patients includes how to avoid transmission, the correct way to take medication, drug side effects and how to manage them, and the purpose of follow-up sputum examinations. Education about the risks of treatment failure, such as drug resistance, longer treatment duration, higher costs, and potential mortality, is expected to motivate patients to take their medication regularly.[26,27]

*Diarrhoea*

Mapping of diarrhoea cases in Medan City in 2024 shows that the Helvetia Public Health Centre (Puskesmas) recorded the highest number of cases (177 individuals), followed by the Medan Labuhan Public Health Centre (151 individuals) and the Martubung Public Health Centre (150 individuals). Conversely, several public health centres reported no cases of diarrhoea, including Bestari Medan Public Health Centre, Desa Lalang Public Health Centre, Desa Terjun Public Health Centre, Kota Matsum Public Health Centre, M.A. Selatan Public Health Centre, Medan Denai Public Health Centre, P. Brayan Kota Public Health Centre, Padang Bulan Selayang II Public Health Centre, Sentosa Baru Public Health Centre, Tegal Sari Public Health Centre, Teladan Public Health Centre, and Tuntungan Public Health Centre.

Research by Rahmadani et al.[28] analysed the factors influencing diarrhoea cases in 21 sub-districts of Medan City using a Spatial Auto Regressive (SAR) model. The results indicated that the SAR model was superior to the Ordinary Least Square (OLS) model, with an R-squared value of 35.82%. The significant variable influencing diarrhoea cases in Medan City was the number of residents without access to clean water from the Regional Water Company (Perusahaan Daerah Air Minum – PDAM). A study by Husna and Soviadi[29] mapped the distribution of diarrhoeal disease and its determinants in West Java Province. The research findings classified areas based on diarrhoea incidence levels into very low, low, moderate, high, and very high. The mapping suggests that factors other than population income, access to drinking water facilities, and households with Clean and Healthy Living Behaviours (Perilaku Hidup Bersih dan Sehat – PHBS) likely contribute to diarrhoea incidence. Research by Nuha et al.[30] investigated the relationship between weather as a risk factor for diarrhoea incidence in East Jakarta Administrative City from 2015 to 2019. Correlation test results showed no significant association between air temperature, air humidity, and rainfall with diarrhoea incidence.

Data on drinking water facilities indicate that some areas have achieved the target for access to qualified drinking water. Water quality plays a crucial role in public health, where contaminated water can be a medium for the spread of diarrhoea-causing bacteria and viruses, especially if not properly treated.[31] The problem of substandard drinking water quality is often characterised by unpleasant taste and odour, which can be caused by poor source water quality or inadequate distribution systems.[31] Healthy drinking water quality standards include physical, bacteriological, and chemical requirements. The availability of drinking water sources that meet quality and quantity standards can significantly reduce diarrhoea incidence.[32]

Public perception regarding the causes of diarrhoea is often limited to the consumption of spicy or unclean food, and the belief that diarrhoea is caused by "catching a cold". However, scientifically, the main cause of diarrhoea is the bacterium *Escherichia coli* (*E. coli*), which can proliferate in environments with poor sanitation (slums), unclean water (physically, biologically, and chemically), and a lack of Clean and Healthy Living Behaviours (PHBS) or hygiene practices. Observations in Medan City indicate a lack of awareness regarding food, beverage, and residential environment hygiene, as well as less active involvement of healthcare workers. Proposed solutions include the implementation of PHBS to improve household health

status and resilience to disease. Based on the national criteria of the Ministry of Health, households with PHBS practice 10 PHBS indicators. Environmental health aspects within PHBS, such as the use of clean water, healthy latrines, and proper waste management, are correlated with diarrhoea incidence. The higher the level of PHBS, the lower the risk of contracting diarrhoea.

## Conclusion

Based on a case study of infectious diseases in Medan City, distinct patterns of dissemination were observed for Dengue Haemorrhagic Fever (DHF), Tuberculosis (TB), and diarrhoea. The propagation of DHF exhibited inter-district variation, with certain districts displaying significantly higher case numbers compared to others. This pattern suggests that factors beyond population density directly correlate with DHF incidence rates. Other studies have highlighted the role of environmental determinants and community behaviour in DHF transmission, as well as the importance of surveillance and community empowerment in prevention efforts. TB cases also demonstrated a non-uniform distribution across Medan City. Several districts recorded the highest number of cases, while others reported very low or even zero cases. This underscores the complexity of TB transmission, which is influenced by a range of factors, including socio-economic conditions, access to healthcare services, and treatment adherence. The role of treatment supporters (TS) and patient and family education is crucial for successful TB management. Regarding diarrhoea, significant differences in incidence rates were evident among primary healthcare centres (puskesmas) in Medan City. Some puskesmas reported high case numbers, particularly within the paediatric age group, whereas others recorded very low or no cases. Access to clean water and adequate sanitation, alongside the adoption of healthy lifestyle behaviours (PHBS) at the household level, were identified as important factors influencing diarrhoea occurrence.

Overall, this study highlights that the spread of infectious diseases in Medan City is influenced by a variety of interacting factors, including environmental conditions, population density, community behaviour, access to and quality of healthcare services, and other factors such as climate. Effective prevention and control efforts necessitate a comprehensive, multi-sectoral approach, focusing on robust surveillance, community empowerment, improved access to healthcare, and the enhancement of environmental and sanitation conditions.

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