Clustering of Communicable Diseases in Indonesia and the Factors that Affect Them: 2018 Basic Health Research Data Statistical Review

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Abstract

The prevalence of communicable diseases in Indonesia is still high and causes morbidity and mortality in several Indonesian provinces. This cross-sectional study classified provinces based on the prevalence of seven communicable diseases: acute respiratory infections (ARI), pneumonia, diarrhea, filariasis, malaria, hepatitis, and tuberculosis (TB). The study analyzed the 2018 Indonesian Basic Health Research data. It is essential to categorize these diseases to identify regions with low, moderate, and high prevalence and the factors that affect them to facilitate the treatment of these diseases. Grouping provinces and influenced factors were analyzed using K-means, ANOVA, and stepwise regression. The results revealed that Group 1 shows a high prevalence, except for hepatitis and diarrhea. Group 2 demonstrates a moderate prevalence, excluding hepatitis and diarrhea, while Group 3 has a low prevalence. Improved access to primary healthcare services reduced the prevalence of pneumonia and TB, while using insecticide-treated mosquito nets for less than three years increased the prevalence of ARI and pneumonia. Adequate bedroom lighting reduced the prevalence of ARI, whereas being underweight in individuals over 18 increased it. In individuals aged 16–18 with short stature, there was an increase in the prevalence of hepatitis and malaria. Regularly draining the bathtub once a week and ensuring proper bedroom ventilation reduced the incidence of diarrhea. Using improved long-lasting insecticidal nets (LLINs) for mosquitos led to a decrease in filariasis cases. Specific factors influence each communicable disease and necessitate a multisectoral approach for effective treatment.

Keywords

ARI; clustering communicable diseases; diarrhea; filariasis; hepatitis; malaria; pneumonia; tuberculosis

Introduction

Infectious diseases significantly cause morbidity and mortality worldwide (Straif-Bourgeois et al., 2014; World Health Organization [WHO], 2020). Controlling infectious diseases is one of the priorities for health officials. These include tuberculosis (TB), malaria, HIV/AIDS, diseases that can be prevented by immunization, neglected diseases (leprosy, filariasis, schistosomiasis), and new diseases that cause public health emergencies. Understanding the dynamics of transmission and also correct, accurate, and timely diagnosis are the first steps in disease treatment and control (Ministry of Health [Indonesia], 2023).

Indonesia is a large country with an area of 1.9 million km^2 and a population of 275 million in 2022 (BPS-Statistics Indonesia, 2023b), an increase from 270 million individuals in the previous census 2020 (BPS-Statistics Indonesia, 2021). With this very high population, the potential for transmission of infectious diseases in Indonesia is also very high. Infectious diseases with a high prevalence in Indonesia are acute respiratory infections (ARI), pneumonia, TB, hepatitis, diarrhea, malaria, and filariasis.

The most directly infectious disease in Indonesia is ARI with a prevalence in 2018 was 9.3% (Ministry of Health [Indonesia], 2019), TB with 677,464 cases, hepatitis especially hepatitis B with 49,639 (1.6%) cases among pregnant women, and pneumonia and also diarrhea (caused 12.5% and 5.8% of deaths among children under five years) in 2022, while malaria with an Annual Parasite Incidence is 1.6 per 1,000 population and filariasis with 8,742 cases are the most of indirect infectious diseases in Indonesia (Ministry of Health [Indonesia], 2023). The study offers fundamental data for assessing the suitability of inter-provincial infectious disease control programs in Indonesia. With this study, a more appropriate and comprehensive approach to controlling infectious diseases can be identified.

Methods

Sampling

The data analyzed in this study is secondary data from the 2018 Riskesdas National Report (Ministry of Health [Indonesia], 2019). Riskesdas is a national-scale survey with a cross-sectional and non-intervention design. The population is all households in Indonesia. The number of samples included was 300,000 households from 30,000 Susenas Census Blocks (BS) conducted by the Central Bureau of Statistics (BPS) using the PPS (probability proportional to size) method using linear systematic sampling, with two-stage sampling. Individuals who are sampled from Riskesdas and to be interviewed are all household members in the selected household. Respondents for the study included all age groups, with a total of more than 1 million respondents spread across 33 provinces in Indonesia (Ministry of Health [Indonesia], 2019).

Indonesia conducts the Indonesian Health Survey (Riskesdas) every five years. The 2023 Indonesian Health Survey uses a cross-sectional design using the Indonesian Central Statistics Agency's sample frame of 34,500 census blocks, each consisting of 10 households, and there are 345,000 households specifically for entire households for the extensive survey. Meanwhile, to measure the health status and nutritional status of toddlers, specifically toddlers, the

Indonesian Central Statistics Agency's sample was added to include under-five households, including 345,000 under-five households. With the intersection, it is estimated that the total number of households visited will be 586,000. The population is all households in Indonesia covering provinces and districts/cities, namely 38 provinces and 514 districts/cities. That implementation is carried out jointly with regional government and is supervised and monitored across ministries and institutions. The 2023 Indonesian Health Survey (Riskesdas) results have not yet been published. In 2023, Indonesia published research results with the title 2023 Indonesian Health Statistics Profile published by the Indonesian Central Statistics Agency with different analysis variables from the 2023 Indonesian Health Survey by the Ministry of Health of Indonesia. Thus, the use of the 2018 Riskesdas National Report is appropriate.

Cross-sectional data regression is a statistical method used to analyze the relationship between one or more independent (explanatory) variables and one dependent variable (which you want to predict) at a certain point in time. This model is relatively simple and easy to understand, can help in understanding the influence of the independent variable on the dependent variable, can make predictions on the value of the dependent variable based on the value of the independent variable given, and identify the significant influence of the independent variable on the dependent variable. Its weakness is that it does not consider changes that occur over time, so it is less suitable for analyzing trends or changes over a certain period.

Variables

The dependent variables are the prevalence of ARI, pneumonia, diarrhea, filariasis, malaria, hepatitis, and TB. The independent variables are ease of access to hospitals, health centers, and clinics/doctors; methods to dispose of bathroom waste and kitchen waste, collect organic waste, deal with mosquitoes, dispose of toddler feces; good household waste management; the frequency of draining the bathroom tub, bed, family and living room ventilation and lighting; correct behavior for defecating (in the toilet); handwashing behavior, smoking habit; use of artemisinin combination treatment (ACT) for malaria; management of diarrhea and filariasis and; toddler nutritional status, nutritional status of children aged 5–18 years and aged > 18 years.

The prevalence per province is calculated as follows:

$$\text{Prevalence of communicable disease} \frac{\text{Sufferers of communicable disease}}{\text{Number of respondents}}$$

Data analysis

This study clustered provinces based on the prevalence of seven infectious diseases (ARI, pneumonia, TB, hepatitis, diarrhea, malaria, and filariasis) and identified causal factors related to the burden of these diseases. Clustering is categorized into three groups due to Indonesia’s three zones: western, eastern, and central Indonesia. Each zone exhibits unique behavioral characteristics and habits.

The first stage was grouping provinces into three groups using seven prevalence of seven infectious diseases, using the K-means method. K-means clustering is a popular unsupervised machine-learning algorithm for clustering data points into groups or clusters based on their similarities (Hornik & the R Core Team, 2023). The number of groups of three determines grouping to obtain provincial groups that have low, medium, and high prevalence values (Johnson & Wichern, 2007; Rencher, 2012). To check the perfection of the grouping, an evaluation is carried out by measuring the distance of all components in a group as small and the distances between the groups as large or by size

$$\text{Lambda} = \frac{\text{distance between groups}}{\text{distance within groups}} > 1$$

The clustering method was carried out by multivariate K-means cluster analysis (Johnson & Wichern, 2007; Rencher, 2012), which was followed by a mean difference test using a single factor ANOVA and proceeded with the Duncan Multiple Range tests (DMRT) (Kirk, 2013; Montgomery, 2019; Oehlert, 2010).

Factors causing infectious diseases can be grouped into several factors, namely a) health service factors, b) environmental factors, c) behavioral factors, d) health status, and e) inheritance factors. To determine the factors that influence the prevalence of infectious diseases and selection, it is using the stepwise regression method (Reimann et al., 2008; Wang & Chen, 2016). Stepwise regression is the step-by-step iterative construction of a regression model that involves selecting independent variables for a final model (Draper & Smith, 1998).

Results

Grouping of provinces based on communicable diseases

The results of grouping provinces based on the prevalence of infectious diseases in Indonesia and comparing distances between groups and distances within groups are presented in Table 1.

Table 1: Comparison of Distances Between Groups and Distances Within Groups with Three Groupings

Distance within Group		Distance Between Group	1 vs 2	1 vs 3	Lambda 1	Lambda 2
West Papua	1.993	West Papua	8.658	10.145	4.344	5.090
Papua	1.993	Papua	12.235	13.879	6.139	6.964
Average	**1.993**	**Average**	**10.447**	**12.012**	**5.241**	**6.027**

Distance within Group		Distance Between Group	2 vs 1	2 vs 3	Lambda 3	Lambda 4
Aceh	1.408	Aceh	11.040	3.527	7.841	2.505
West Sumatera	1.743	West Sumatera	11.267	3.748	6.465	2.151
Bengkulu	2.061	Bengkulu	9.002	5.867	4.368	2.847
West Java	1.075	West Java	10.594	4.728	9.851	4.396
Central Java	2.273	Central Java	11.607	2.429	5.107	1.069
East Java	1.978	East Java	11.347	2.672	5.737	1.351
Banten	1.736	Banten	10.469	5.656	6.030	3.257
Bali	1.670	Bali	11.285	3.238	6.758	1.939
West Nusa Tenggara	1.977	West Nusa Tenggara	10.114	5.994	5.115	3.031

East Nusa Tenggara	6.208	East Nusa Tenggara	9.058	9.004	1.459	1.450
West Kalimantan	1.927	West Kalimantan	11.096	2.693	5.758	1.397
Central Sulawesi	2.160	Central Sulawesi	10.354	5.022	4.793	2.325
South Sulawesi	2.119	South Sulawesi	11.282	3.351	5.325	1.581
Gorontalo	1.713	Gorontalo	10.775	4.154	6.291	2.425
Average	**2.146**	**Average**	**10.664**	**4.434**	**5.778**	**2.266**

Distance within Group		Distance Between Group	3 vs 1	3 vs 2	Lambda 5	Lambda 6
North Sumatera	2.722	North Sumatera	12.045	3.582	4.426	1.316
Riau	1.324	Riau	12.279	3.856	9.277	2.913
Jambi	2.766	Jambi	13.668	6.787	4.941	2.454
South Sumatera	1.000	South Sumatera	12.406	4.870	12.402	4.869
Lampung	1.663	Lampung	12.508	5.132	7.519	3.085
Bangka Belitung	2.229	Bangka Belitung	12.212	5.797	5.479	2.601
Riau Islands	2.533	Riau Islands	13.170	6.300	5.199	2.487
Jakarta	1.625	Jakarta	11.586	2.611	7.130	1.607
Yogyakarta	2.147	Yogyakarta	12.183	3.578	5.675	1.666
Central Kalimantan	1.987	Central Kalimantan	11.664	3.751	5.871	1.888
South Kalimantan	0.334	South Kalimantan	12.259	4.137	36.702	12.386
East Kalimantan	1.063	East Kalimantan	11.877	3.732	11.173	3.511
North Kalimantan	1.391	North Kalimantan	12.103	3.750	8.702	2.696
North Sulawesi	1.117	North Sulawesi	12.287	4.673	11.000	4.184
Southeast Sulawesi	1.315	Southeast Sulawesi	11.486	3.013	8.732	2.291
West Sulawesi	2.352	West Sulawesi	11.819	3.453	5.025	1.468
Maluku	1.924	Maluku	10.539	3.192	5.478	1.659
North Maluku	2.133	North Maluku	12.072	5.827	5.659	2.732
Average	**1.757**	**Average**	**12.120**	**4.336**	**8.911**	**3.101**

The center of Group 1 is the average prevalence of ARI, pneumonia, TB, hepatitis, diarrhea, malaria, and filariasis from two provinces, namely 12.70%, 6.55%, 0.65%, 0.54%, 8.60%, 10.36%, and 1.40%, respectively. The Euclidean distance of West Papua Province to the center of Group 1 is 1.993, which is smaller than the distance of West Papua Province to the center of Groups 2 and 3, 8.658 and 10.145, respectively, which means that West Papua is a member of Group 1. Lambda 1 of West Papua is compared to the distance between West Papua and the center of Group 2 and Group 1. If Lambda 1 is greater than Group 1, then West Papua is a member of Group 1 and not Group 2. Lambda 2 of West Papua is a comparison of the distance between West Papua to the center of Group 3 and the center of Group 1. If Lambda 2 is greater than Group 1, then West Papua is a member of Group 1 and not Group 3. Lambda 1 for West Papua to Group 2 is $\frac{8,658}{1,993}$ = 4.344, Lambda 2 for West Papua against Group 3 is $\frac{0,145}{1,993} = 5.090$, which shows that West Papua Province is a member of Group 1, not Group 2 or 3. The same calculation applies to the Papua Province, and we found that it is a member of Group 1, not Group 2 or 3, because Lambda 1 and Lambda 2 are more than Group 1. On average, Lambda 1 = 5.241, Lambda 2 = 6.027, which shows that the provinces of West Papua and Papua are members of Group 1, not Group 2 or 3.

The average for Lambda 3 and 4 are 5.778 and 2.266, where each is greater than Lambda 1, which means the provinces of Aceh, West Sumatra, Bengkulu, West Java, Central Java, East Java, Banten, Bali, West Nusa Tenggara, East Nusa Tenggara, West Kalimantan, Central Sulawesi, South Sulawesi, and Gorontalo are members of Group 2, not Group 1 or 3. Likewise, the averages for Lambda 5 and 6 are 8.911 and 3.101, respectively, each of which is greater than Group 1, which means the provinces of North Sumatera, Riau, Jambi, South Sumatera, Lampung, Bangka Belitung, Riau Islands, Jakarta, Yogyakarta, Central Kalimantan, South Kalimantan, East Kalimantan, North Kalimantan, North Sulawesi, Southeast Sulawesi, West Sulawesi, Maluku, and North Maluku are members of Group 3, not Group 1 or 2. Thus, the results of the grouping are as follows: a). The first group comprises the Province of West Papua and Papua; b). The second group consists of the provinces Aceh, West Sumatera, Bengkulu, West Java, Central Java, East Java, Banten, Bali, West Nusa Tenggara, East Nusa Tenggara, West Kalimantan, Central Sulawesi South Sulawesi, and Gorontalo; c). The third group consists of the provinces North Sumatera, Riau, Jambi, South Sumatera, Lampung, Bangka Belitung, Riau Islands, Jakarta, Yogyakarta, Central Kalimantan, South Kalimantan, East Kalimantan, North Kalimantan, North Sulawesi, Southeast Sulawesi, West Sulawesi, Maluku, and North Maluku (Table 1). Table 1 shows that all provinces have a lambda value greater than 1 (>1), meaning the grouping with these three groups is perfect. Not a single province is in the wrong group.

ANOVA analysis on the prevalence of ARI, pneumonia, TB, hepatitis, diarrhea, malaria, and filariasis between the three groups obtained F values of 26.83, 12.16, 4.70, 3.656, 14.936, 214.173, and 4.765, respectively, with a significant p value < 5% (< .001, < .001, .017, .038, < .001, < .001, and .016, respectively), which means that the average prevalence of all communicable diseases among groups are different or in another sense that the provinces in Indonesia can be grouped into three groups based on the prevalence of ARI, pneumonia, TB, hepatitis, diarrhea, malaria, and filariasis.

The results of the ANOVA can be continued with the Duncan Multiple Range Tests (DMRT) (Table 2). The average prevalence of ARI in Groups 1, 2, and 3 were 12.700%, 10.300%, and 7.156%, respectively. The average percentage of ARI is significantly different between these groups. Group 1 is a group with a high prevalence of ARI, Group 2 is a group with a moderate ARI prevalence, and Group 3 is a group with a low ARI prevalence. Groups 2 and 3 with DMRT can be said to have an average prevalence of pneumonia, TB, malaria, and filariasis that is not different but significantly different from Group 1. Group 1 has the highest pneumonia, TB, malaria, and filariasis prevalence, and Groups 2 and 3 have a low prevalence. Regarding hepatitis, Groups 1 and 2 can say that the average prevalence of hepatitis is not different, and so is Group 2. With Group 3, it can be said that the average prevalence of hepatitis is not different. Still, in Group 1 with Group 3, it can be said that the average prevalence of hepatitis was different. Group 1 is a group with a high percentage of hepatitis, and Group 3 is a group with low hepatitis. On the other hand, the average prevalence of diarrhea in Groups 1 and 2 did not have a significant difference in the prevalence of diarrhea. Still, Group 3 had a significant difference in the average prevalence of diarrhea compared to Group 1 and Group 2. Group 3 can be said to be the group with a low prevalence of diarrhea. While Groups 2 and 1 are groups with a higher average prevalence of diarrhea (Table 2).

Table 2: Duncan's Multiple Range Test Average Percentage of Communicable Diseases in Indonesia

Communicable disease	Source	Sum Square	df	Mean Square	F	Sig	Group	N	Mean 1	Mean 2
ARI	Between Groups	74.201	2	37.101	13.873	.000**	3	6	6.767	
	Within Groups	50.813	19	2.674			2	14		10.300
	Total	125.015	21				1	2		12.700

Communicable disease	Source	Sum Square	df	Mean Square	F	Sig	Group	N	Mean 1	Mean 2
Pneumonia	Between Groups	17.507	2	8.753	8.787	.002**	3	6	3.283	
	Within Groups	18.928	19	0.996			2	14	4.643	
	Total	36.435	21				1	2		6.550
TB	Between Groups	0.195	2	0.098	4.167	.032*	3	6	0.290	
	Within Groups	0.445	19	0.023			2	14	0.393	
	Total	0.64	21				1	2		0.650
Hepatitis	Between Groups	0.077	2	0.039	3.916	.038*	3	6	0.327	
	Within Groups	0.188	19	0.01			2	14	0.422	0.422
	Total	0.265	21				1	2		0.540
Diarrhea	Between Groups	34.87	2	17.435	10.563	.001**	3	6	5.983	
	Within Groups	31.36	19	1.651			1	2		8.600
	Total	66.231	21				2	14		8.836
Malaria	Between Groups	179.76	2	89.88	149.94	.000**	3	6	0.357	
	Within Groups	11.389	19	0.599			2	14	0.436	
	Total	191.149	21				1	2		10.355
Filariasis	Between Groups	0.806	2	0.403	9.297	.002**	2	14	0.729	
	Within Groups	0.824	19	0.043			3	6	0.750	
	Total	1.63	21				1	2		1.400

*Note: Duncan's Multiple Range Test was used to identify subsets of means at an alpha level of .05; *p value < .05 is considered statistically significant and pvalue < .01 is very significant.*
ARI=Acute Respiratory Infections ,TB=Tuberculosis

Factors influencing the occurrence of communicable diseases

Factors that influence the prevalence of infectious diseases are presented in Table 3. The stepwise regression equation obtained is the prevalence of ARI = 17.013–0.147 in bedrooms with sufficient lighting + 0.066 sleeping using mosquito nets with insecticides < 3 years + 0.259% thin at Age > 18 years (BMI) + error. An increase of 1% in bedrooms with sufficient lighting per province will reduce an average of 0.147% of ARI per province, assuming the other independent variables are constant. An increase of 1% in sleep using mosquito nets with insecticides < 3 years and thin at age > 18 years (BMI) will increase the prevalence of ARI per province on an average of 0.066% and 0.259%, respectively (Table 3).

Table 3: Factors Influencing the Incidence of Communicable Diseases

Disease	Influencing Factor	Coefficient	*p* value
ARI	Intercept	17.013	.000**
	Percent of bedrooms with adequate lighting	-0.147	.003**
	Percent of sleeping using mosquito nets with	0.066	.003**

Disease	Influencing Factor	Coefficient	*p* value
	insecticides < 3 years		
	Percent of thin at age > 18 years (BMI)	0.259	.037*
Pneumonia	Intercept	5.717	.000**
	Percent of ease of access to primary health center	-0.043	.012*
	Percent of sleeping using mosquito nets with insecticides < 3 years	0.032	.018*
TB	Intercept	0.786	.000**
	Percent of ease of access to primary health center	-0.007	.000**
	Percent of burial of toddler feces in soil	-0.029	.008**
Hepatitis	Intercept	0.305	.000**
	Percent of very short for age 16–18 years (Height/Age)	0.019	.003**
Diarrhea	Intercept	16.111	.000**
	Percent of bedrooms with adequate ventilation	-0.084	.020*
	Percent of cleaning bathtub once a week	-0.120	.044*
Malaria	Intercept	-0.114	.884^{ns}
	Percent of using long-lasting insecticidal nets (LLINs)	0.076	.003**
	Percent of very short for age 16–18 years (Height/Age)	0.843	.001**
	Percent of very short for age 5–12 years (Height/Age)	-0.552	.017*
Filariasis	Intercept	0.826	.000**
	Percent of ease of access to primary health center	-0.008	.069^{ns}
	Percent of taking filariasis medication	0.013	.000**
	Percent of using LLINs	-0.003	.01**

Note: ARI=Acute Respiratory Infections ,TB=Tuberculosis

The regression equation of pneumonia prevalence = 5.717 – 0.043 ease of access to health centers + 0.032 dealing with mosquitoes by sleeping using mosquito nets with insecticides < 3 years. An increase of 1% in the ease of access to primary health centers will reduce pneumonia by 0.043%, assuming the other independent variables are constant. Meanwhile, an increase of 1% from dealing with mosquitoes by sleeping using mosquito nets with insecticides < 3 years will increase the prevalence of pneumonia each by 0.032%, with the condition of the other independent variables remaining constant (Table 3).

Regression equation prevalence of TB = 0.786 – 0.007 ease of access to health centers – 0.029 feces of toddlers planted into the ground + Error. Increasing 1% easy access to health centers and toddler feces planted into the ground will reduce TB disease by 0.007% and 0.029%, assuming other variables are constant (Table 3).

The regression of the prevalence of hepatitis is 0.305 + 0.019, with a very short lifespan of 16–18 years (height for age indicator) + Error. An increase of 1% in short stature in individuals aged 16–18 will increase the prevalence of hepatitis by 0.019%.

Regression of diarrhea prevalence =16.111–0.084 bedrooms with adequate ventilation – 0.120 draining the bathroom tub one time in 1 week + Error. The increase of 1% of bedrooms with sufficient ventilation and habits of draining the bathroom tub at least one time in a week will be able to reduce diarrhea by 0.084% and 0.120%, respectively, with the assumption other variables are constant (Table 3).

Prevalence of malaria = -0.114 + 0.076 use of long-lasting insecticidal nets (LLINs) + 0.843 underweight in individuals at the age group of 16–18 years (weight for age indicator) -0.552 short stature in the age groups of 5–12 years (height for age indicator) + Error. An increase of 1% in the use of LLINs and underweight status in individuals aged 16–18 will increase malaria by 0.076% and 0.843%, respectively, assuming other variables are constant. An increase of 1%

in short stature status of individuals aged 5–12 years will reduce malaria by 0.552%, assuming other variables are constant (Table 3).

Prevalence of filariasis = 0.826–0.008 ease of access to community health centers + 0.013 taking filariasis drugs according to health workers -0.003 using LLINs + error. An increase of 1% in the ease of access to primary health centers and the use of LLINs will reduce filariasis prevalence by 0.008% and 0.003%, respectively. Conversely, according to health workers, an increase of 1% in taking filariasis medication will increase the prevalence of filariasis disease, assuming other variables are constant (Table 3).

Discussion

Acute Respiratory Infections (ARI)

Poor lighting in bedrooms will increase the incidence of ARI. Adequate bedroom lighting will negatively affect the virulence of pathogenic microorganisms because air humidity is lower due to exposure to sunlight (Hobday & Dancer, 2013). Reduced virulence of pathogenic microorganisms that can cause ARI in the bedroom can reduce the likelihood of ARI (Leung, 2021).

Inadequate lighting can extend the life span of germs in airborne droplets. This study's findings align with research by Syam and Ronny (2016), which showed that 66.0% of toddlers living in homes that do not meet the lighting requirements would develop ARI, while only 26% of toddlers living in homes with adequate lighting suffer from ARI.

Before the discovery of antibiotics, sunlight played an essential role in controlling infection and preventing the spread of disease in buildings (Hobday & Dancer, 2013). Even today, forms of artificial light are effectively used in hospital settings to reduce infection transmission (Anderson et al., 2017, 2013). In addition to the lighting factor, the nutritional status factor, especially malnutrition, is closely related to the incidence of ARI (Okiro et al., 2008; Paynter et al., 2014; Tazinya et al., 2018). Many experimental studies on influenza infection show that protein and energy deficiencies increase the risk of more severe infections (Ritz et al., 2008; Taylor et al., 2013) and reduce virus-specific antibodies and CD8+ T-cell responses (Taylor et al., 2013). Experimental studies show that malnutrition can facilitate the emergence of viral variants that are more virulent than the original strains (Beck et al., 2004).

In addition, inadequate nutritional intake can interfere with the immune system as the immune system requires adequate nutritional intake. If the immune system does not work optimally, the body is easily infected by viruses or bacteria, specifically the microorganisms that cause ARI. This study’s findings align with the findings of Sunarni et al. (2017), which showed that 97.9% of toddlers with undernourished status experience ARI, while only 28.2% of toddlers with good nutrition experience ARI. Nutritional status is the most critical risk factor for the incidence of ARI in toddlers.

Poor nutritional status will increase susceptibility to ARI, and toddlers suffering from ARI can cause them to experience nutritional status disorders due to body metabolism disorders. The severity of ARI dramatically affects the occurrence of impaired nutritional status in toddlers: the more severe the ARI that toddlers suffer, the poorer the nutritional status in toddlers, and vice versa (Carr & Maggini, 2017; Gombart et al., 2020; Martineau et al., 2017; Sunarni et al., 2017; Wang et al., 2019; Widia, 2017).

The insecticide-treated nets should be less than three years old, meaning many insecticides are still attached to them. The insecticide used contains deltamethrin. Among the side effects of deltamethrin are allergic skin reactions and respiratory tract irritation. The relationship between the use of mosquito nets and the incidence of ARI is the effect of the chemicals used on the mosquito nets (Akyeampong et al., 2022).

In the study of Dicko et al. (2011), four out of 150 people who received insecticide-treated nets experienced ARI at the time of the first dose of Intermittent Preventive TreatmenT(IPT.) This is considered a reaction to drugs. A case study on subjects exposed to indoor pyrethrin-based insecticides at unknown concentrations showed symptoms of anosmia, which was preceded by transient nasal irritation and short-term phantosmia and torqosmia (Gobba & Abbacchini, 2012; Lessenger, 1992).

Pneumonia

According to the World Health Organization (WHO) (2022b), Pneumonia accounts for 14% of all deaths of children under the age of 5, killing 740,180 children in 2019. One of the actions taken is that every child with pneumonia should have access to appropriate care – either from community-based health workers or in health facilities if their illness is severe – and can adequately get the antibiotics and oxygen they need (WHO, 2022b). Research by Oldenburg et al. (2021) also showed that increasing the distance (median distance between the community and primary health facilities was 5.0 km Interquartile Range (IQR) 2.6 to 6.9 km) to the Primary Health Centre would decreasing the number of Primary Health Centre visits despite the policy of eliminating treatment costs for children under five years (Spearman's rho − 0.42, 95% Confidence Interval(CI) [-0.54, -0.31], p value < .0001). A study by Root et al. (2017) in Bohol, Philippines, showed a significant effect of distance from Bohol Regional Hospital and vaccination with Pneumococcal conjugate **vaccine(**PCV)11 on the risk of pneumonia.

Viruses, bacteria, or fungi can cause pneumonia. Pneumonia can be prevented by immunization, adequate nutritional intake, and by overcoming environmental factors. The mortality rate will increase in children who are malnourished at the time of hospitalization. Survival depends more on nutritional status than hypoxemia (West et al., 1999). Research by Kaboré et al. (2020) for 10 years using a discontinuous series design shows that pneumonia vaccination in children under five years effectively reduces pneumonia in children, including severe pneumonia and deaths caused by pneumonia. Vaccine effectiveness rates were 34%, 24%, and 50% for all causes of pneumonia in children < 5 years, < 2 years, and 2–4 years, respectively.

In October 2018, the introduction of PCV13 in children under five years resulted in an absolute reduction in the pneumonia hospitalization rate of 348 cases per 100,000 person-years. Yeimo et. Al. (2018) conducted research in Yigi and Mbua Sub-districts, Nduga District, Papua, Indonesia, from December 2017 to February 2018 with a sample of 184 children under five years of age with 88 children with pneumonia and 96 without pneumonia as control. It was found that the risk of pneumonia in toddlers increased in the absence of Bacille Calmette-Gueri (BCG) immunization, with harmful household air pollution and poor.

The results of this study also revealed that an increase of 1% in sleep using mosquito nets with insecticides < 3 years would increase the prevalence of pneumonia by 0.032%, with the other independent variables remaining constant. The insecticide used contains deltamethrin. One of the side effects of deltamethrin is irritation of the respiratory tract. Therefore, the relationship between mosquito nets and the incidence of pneumonia is in the effect of the chemicals used on the mosquito nets. This aligns with Akyeampong et al. (2022), who found that exposure to chemical pesticides is associated with respiratory infections in children under five.

Tuberculosis (TB)

Provinces in Group 1 have the highest prevalence of TB among other groups. Meanwhile, the provinces in Groups 2 and 3 have the same prevalence of TB. The determinants of the incidence of TB are poverty, malnutrition, HIV infection, smoking, diabetes (WHO, 2022a), stress, and the number of TB cases (Chanda-Kapata et al., 2020). The provinces of Papua and West Papua have the highest prevalence of TB (0.65%). These two provinces have the lowest income level compared to other provinces based on the indicator of average per capita expenditure per year (BPS-Statistics Indonesia, 2023b). The Ministry of Health of Indonesia (2022) reported that Papua is the province with the fifth highest cumulative cases of HIV, with a total of 41,286 cases from 2010 to March 2022, and with the highest number of AIDS cases, numbering 24,873 cases. Meanwhile, West Papua has the 15th highest HIV and AIDS cases in a row, with 6,531 and 2,656 cases.

The research results of Nidoi et al. (2021) supported this finding as it was found that there is a close relationship between TB infection and socioeconomic status among Karamoja in North-Eastern Uganda people. This study confirmed that low socioeconomic status is associated with poor TB treatment outcomes, emphasizing the need for multi- and cross-sectoral approaches and socioeconomic enablers to optimize TB care. The high TB infection rate reflects ignorance, absence of medical care, poor hygiene, poor nutritional status, economic pressure, and lack of proper health facilities and knowledge about TB treatment (to diagnose latent TB infection). Hence, education and socioeconomic status remain the most crucial factors in reducing the risk of developing TB among the general population in a region. This is because TB is a disease that requires long-term treatment, so easy access to health services such as primary health centers is needed. Currently, TB treatment takes 4–6 months, with a successful cure of up to 85% (WHO, 2022a). Thus, ease of access and health services will significantly reduce the prevalence of this disease. The approach should be based on the basic health system (Primary Health Centre) so that success can be sustained in the long term (WHO, 2022a).

Research conducted by Chanda-Kapata et al. (2020) in sub-Saharan Africa reported that the COVID-19 pandemic had disrupted routine health services and diverted resources, disrupting the prevention and treatment of diseases such as TB, malaria, and HIV so that they cannot meet global targets. Lockdowns during COVID-19 led to reduced access to critical health services such as TB diagnosis and treatment. Survey results in 13 countries with the highest TB burden showed only a 29% reduction in TB detection rates globally due to COVID-19 in 2020 (The Global Fund, 2021). Reporting of new TB diagnoses and screening programs has declined in part due to reduced numbers of health workers, limited access to facilities, and erroneous reporting of data that affect access to treatment. It was reported that there was a decrease in the reporting of TB diagnoses in countries with a high TB burden, from 41% in South Africa to 25% in India (McQuaid et al., 2021).

The WHO (2021) stated that in 2020, out of 10 million people who developed TB, only 5.8 million cases were detected globally. The remaining 4.2 million were not detected and became a source of further transmission in the community. In Jayapura, the causes of non-adherence to TB medication are problematic accessing health services related to distance and travel costs, lack of knowledge about transmission and causes of TB, lack of education associated with TB provided by TB nurses, and the effect of incomplete TB treatment (Ruru et al., 2018; Ulfah et al., 2017).

Feces can be a medium for transmitting Mycobacterium tuberculosis (MTB). The feces of TB sufferers contain the bacteria MTB. The bacteria originate from swallowed sputum, and TB DNA remains intact after passing through the intestine (Nicol & Zar, 2020). It was reported that children with prolonged cough may have a positive fecal polymerase chain reaction (PCR) test due to the possibility of higher sputum production with increased bronchial infection when swallowed by children (Wolf et al., 2008). Several studies have established that the diagnosis of TB can be made by examining feces, especially in children (Agarwal et al., 2022; Rajendran et al., 2022). Therefore, burying children's feces in the ground correlates with a decrease in TB disease due to limited exposure to the source of transmission. However, epidemiological studies on this relationship are not yet available, so further research is needed. TB can be reduced through multisectoral actions by addressing the determinants of TB, such as poverty, malnutrition, HIV infection, smoking and diabetes, stress, and the number of TB cases (Chanda-Kapata et al., 2020; WHO, 2022a).

Hepatitis

Based on correlation tests between infectious diseases, it is known that the prevalence of hepatitis has a genuine positive relationship with diarrhea. Complications of hepatitis may cause this condition due to the use of certain drugs in people living with hepatitis. The use of certain drugs causes the thickening of the walls of the ascending colon and terminal ileum of the digestive tract, as well as opportunistic infections that lead to diarrhea (Patel et al., 2020). Hepatitis virus infection varies greatly between islands (Mulyanto, 2016). This study found that the highest percentage of hepatitis occurred in Group 1, namely West Papua Province and Papua Province (Table 2). This happens because the common hepatitis in Indonesia is hepatitis B, where the hepatitis B virus in endemic areas like Indonesia generally occurs vertically from positive mothers to newly born children (Ministry of Health [Indonesia], 2021; Mulyanto, 2016).

Early detection of hepatitis B (DDHB) using the rapid diagnostic test (RDT) hepatitis B surface antigen (HBsAg) up to the district/city level is an Indonesian government program to eliminate and prevent vertical transmission of hepatitis. In 2021, coverage of this program in West Papua and Papua was the lowest among other provinces (Ministry of Health [Indonesia], 2021). As a result, new hepatitis B cases continue to occur in early childhood in these two provinces. This is in line with the findings of Dakl and Alnuaimy (2017) and Mulyanto (2016), who stated that transmission of hepatitis B virus (HBV) from mother to child is still high in several remote areas of eastern Indonesia, with the highest prevalence in Sorong Papua (17%).

The prevalence of hepatitis significantly correlates with ease of access to health facilities, hospitals, health centers, and clinics/doctors (Table 4). This finding is consistent with the findings of Kwadzokpui et al. (2020), who stated that hepatitis B infection in pregnant women in the Ningo-Prampram district, Ghana, is significantly associated with access to health facilities.

Table 4: Correlation Percentage of Hepatitis with Independent Variables

No	Independent Variable	Correlation	% Hepatitis	No	Independent Variable	Correlation	% Hepatitis
1	Percent of ease to hospital	Pearson Correlation	-0.377	**7**	Percent of family rooms with adequate lighting	Pearson Correlation	-0.51
		Sig (2 tailed)	0.028*			Sig (2 tailed)	0.002**
		N	34			*N*	34
2	Percent of ease to community public health	Pearson Correlation	-0.414	**8**	Percent of correct behavior on how to defecate in the latrine	Pearson Correlation	-0.421
		Sig (2 tailed)	0.015*			Sig (2 tailed)	0.013*
		N	34			*N*	34
3	Percent of ease to doctor	Pearson Correlation	-0.419	**9**	Percent of very short aged 13 to 15 years based on height per age	Pearson Correlation	0.38
		Sig (2 tailed)	0.014*			Sig (2 tailed)	0.027*
		N	34			*N*	34
4	Percent of bedrooms with adequate ventilation	Pearson Correlation	-0.396	**10**	Percent of very short aged 16 to 18 years based on height per age	Pearson Correlation	0.499
		Sig (2 tailed)	0.02*			Sig (2 tailed)	0.003**
		N	34			*N*	34
5	Percent of bedrooms with adequate lighting	Pearson Correlation	-0.504	**11**	Percent of short aged 16 to 18 years based on height per age	Pearson Correlation	0.37
		Sig (2 tailed)	0.002**			Sig (2 tailed)	0.031*
		N	34			*N*	34
6	Percent of family rooms with adequate ventilation	Pearson Correlation	-0.38	**12**	Percent of toddler feces in the latrine	Pearson Correlation	-0.396
		Sig (2 tailed)	0.027*			Sig (2 tailed)	0.02*
		N	34			*N*	34
				13	Percent of toddler feces anywhere	Pearson Correlation	0.468
						Sig (2 tailed)	0.005**
						N	34

Apart from that, hepatitis B, which occurs in Indonesia, is generally hepatitis B, which is transmitted from positive mothers to their babies. Ease of access to health facilities, especially for carrying out DDHB, has a significant influence on hepatitis cases. This also happens in Cameroon, where free vaccination for pregnant women who test negative for HBsAg in hospital antenatal care units affects HBV transmission (Nlinwe & Lungle, 2021).

There is a very significant correlation between the prevalence of hepatitis and stunting. It was found that an increase in very short stature by 1% in the 16–18-year-old group would increase the incidence of hepatitis by 0.019%. This may be due to the close relationship between malnutrition and acute and chronic diseases. It has been demonstrated that the disease can cause malnutrition, and poor nutrition is one of the causes. Risk factors such as reduced caloric intake, malabsorption of nutrients, the effects of chronic liver disease on hepatic IGF production, or inflammatory mediators may contribute to impaired growth in children with hepatitis B or C. Hepatitis B or C may impact growth through their effect on inflammation heart. Duration of infection may be a factor in determining height at a given age. A study evaluating the impact of chronic hepatitis B or C on the growth of children and adolescents found that, on average, children with chronic hepatitis B or C showed impaired growth due to high ALT enzymes (Gerner et al., 2012).

Diarrhea

Widhanar et al. (2021) stated that three main pathogenic groups cause diarrhea: viruses, bacteria, and parasites. The viruses most commonly found to cause diarrhea are Rotavirus, Escherichia coli (the most common bacteria), and Cryptosporidium, the parasite. A trial conducted by Sattar et al. (1986) in hospitals, nursing homes, and childcare centers found that low temperature and humidity cause transmission of infections caused by rotavirus, such as diarrhea, to be higher. It is known that bedrooms with adequate ventilation will increase the light entering the room, raise the temperature and humidity, and reduce transmission of infections caused by rotavirus. These conditions apply to other causes of diarrhea because both Escherichia coli bacteria and the Cryptosporidium reproduce quickly in low temperature and humidity. An increase in relative humidity of up to 80% impacts decreasing the infectivity rate of some rotavirus agents, thus indirectly explaining why relative humidity has a negative linear relationship with the number of diarrhea cases (Gao et al., 2014). Rainfall, humidity (lag 1–3), wind speed (lag 2–3), and availability of clean water were correlated with the incidence of diarrhea in Kupang City from the years of 2011 to 2015 (Padji & Sudarmadji, 2017).

Diarrhea is an environment-based disease. Many factors directly or indirectly drive the occurrence of diarrhea, namely agent, host, environment, and behavioral factors. Inadequate provision of clean water, water contaminated with feces, unhygienic disposal of feces, poor personal and environmental hygiene, and undercooked food preparation and storage all affect the incidence of diarrhea. Environmental factors are the most dominant factors. If environmental factors are unhealthy, diarrhea can easily occur (Zara & Fitriany, 2021). The environment includes drinking water, waste disposal, feces, and waste management.

Poor environmental sanitation can reduce the quality of the community's living environment, contaminate drinking water sources, and increase disease transmission. Therefore, a healthy environment is essential in reducing the incidence of diarrhea in children (Aisiyah et al., 2022). An unhealthy environment allows diarrhea-causing pathogens to spread more quickly. The bedroom conditions can cause children under five to get diarrhea because toddlers and children who use the bedroom for resting do not clean themselves before going to bed. The pathogenic bacteria that stick to the body of children under five after doing activities outside the home are transferred to mattresses, sheets, pillows, bolsters, used blankets, and also in the bedroom air and eventually are ingested and cause diarrhea (Bitew et al., 2017).

Research by Farrow and Farrow (1999) showed a relationship between indoor nitrogen dioxide (NO2) and the incidence of diarrhea in children. The study found a relationship between bedrooms with sufficient ventilation and reduced incidence of diarrhea, possibly related to NO2 levels in the bedroom. The NO2 levels can be generated from exhaust fumes or burning waste and enter the bedroom. The study also found that draining the bath once a week would reduce the incidence of diarrhea (Cairncross et al., 2010).

Malaria

Based on the correlation test between infectious diseases, it was found that the prevalence of malaria had a very significant positive correlation with the prevalence of filariasis (Pearson Correlation = 0.458, Sig (2-tailed) = 0.006). This condition is likely because mosquito vectors transmit these two diseases, and the density of mosquitoes in an environment affects both diseases (Liu et al., 2011).

Group 1, consisting of West Papua and Papua provinces, had a high average malaria prevalence. This was per the Ministry of Health of Indonesia (2018), which stated that West Papua and Papua are malaria-endemic provinces. In these two provinces, no districts/cities had become malaria-free areas (elimination areas). It was reported that 4 out of 13 total districts/cities in West Papua province were with Annual Parasite Incidence(API) > 5 (high malaria endemic), seven districts/cities with API > 1 and < 5 (moderate malaria endemic), and two districts/cities with API < 1 (mild malaria endemic). Meanwhile, in Papua, 16 out of 29 districts/cities are areas with high endemic, with seven and six districts/cities being moderately and mildly endemic (Ministry of Health [Indonesia], 2018).

Groups 2 and 3 had a lower average prevalence of malaria. In these groups, the presentation of malaria is already low because the prevention program to gradually eliminate malaria until 2030 in Indonesia has been quite successful. The Ministry of Health of Indonesia (2018) stated that 285 out of 514 districts throughout Indonesia have eliminated malaria. However, only three provinces have eliminated malaria in all districts: Bali, East Java, and Jakarta.

Variables that affect the prevalence of malaria are the percentage of individuals who used LLINs, the percentage of individuals in the age groups 16–18 years with short stature, and the percentage of individuals in the age groups 5–12 years who were very short (Table 3). This condition indicates that using LLINs is not practical in preventing malaria. This contradicts Asingizwe et al. (2019), who stated that using LLINs is one of the steps to prevent malaria besides controlling mosquito breeding sites. This contradiction may be because the respondents in this study did not use the LLINs correctly.

In this study, research was conducted by answering questions from questionnaires through interviews and observations. It is not guaranteed that the answers given by respondents are carried out. The same thing applies to observational data. Even though the LLINs for mosquitos were installed at the time of observation, it was not certain that the respondents used them every time they slept. The lack of public knowledge about the benefits of LLINs in eliminating malaria transmission has resulted in people not using LLINs regularly. There are side effects of using LLINs, such as an odor that sometimes causes coughing, which is why not use these nets. Therefore, the public must be educated about the benefits of using LLINs for malaria prevention. This is consistent with Asingizwe et al. (2019), who agreed that the knowledge, attitudes, and respondents' perceptions about malaria, vector (mosquito) bites, and using LLINs must be increased.

This study also found a relationship between the incidence of malaria and stunting. The incidence of malaria was significantly different between the stunting groups of adolescents and children. This study found that when other variables remained constant, an increase of 1% of individuals in the 16–18 age group who were very short would increase malaria by 0.843%, but would reduce in the children aged 5–12 group by 0.552%.

The reduced incidence of malaria in stunted children aged 5–12 years may be related to protection from sickle cells (HbS). It is known that HbS is a mutation of hemoglobin that reduces the risk of manifestations of severe and mild malaria. Furthermore, Kreuels et al. (2009) stated that the risk of chronic malnutrition is lower for those who carry or have the HbS genotype in early childhood. This happens because HbAS protects against recurrent malaria. It is known that recurrent malaria in early childhood can interfere with child development and cause chronic malnutrition as indicated by height for age z score < -2 standard deviation (*SD*). Stunting is an indicator of chronic malnutrition. Furthermore, Kreuels et al. (2009) also stated that children carrying the HbAS genotype showed a lower risk of stunting during the first two years of life. Malaria itself was positively associated with stunting in the past: 1% of the increasing of individuals with very short stature in the age group 16–18 years will increase the prevalence of malaria by 0.843%.

Filariasis

Indonesia is one of the filarial endemic countries where all (three) species of filarial worms can be found (Ministry of Health [Indonesia], 2020). The filarial worms are Wuchereria bancrofti, Brugia malayi, and Brugia timori (Ministry of Health [Indonesia], 2005). Filariasis can be transmitted by mosquitoes, including Anopheles, Culex, Mansonia, Aedes, and Armigeres (Arsin, 2016), and can be transmitted anytime due to mosquito bionomics. The life cycle of filarial worms requires mating in lymph nodes, leading to slow infection progression. Clinical symptoms of filariasis require multiple bites from infected mosquitoes over a long time.

Filariasis or elephantiasis is a vector-borne disease caused by filarial worms attacking the lymph nodes and ducts. Even though it is not fatal, this disease can cause lifelong disability, so it is still a health problem in Indonesia (Ministry of Health [Indonesia], 2022). Filariasis elimination in Indonesia is targeted to be completed in 2020 by reducing the microfilaria rate to <1% in each district and preventing and limiting disability due to filariasis. The elimination strategy is carried out by (1) breaking the chain of transmission through mass medication in endemic areas, (2) preventing and limiting defects through clinical case management, (3) integrated vector control, (4) strengthening cooperation across regions and nation, and (5) strengthen surveillance and research development (Ministry of Health [Indonesia], 2014).

The first step in the filariasis elimination program is mapping endemic areas, with the smallest units being districts/cities. The mapping results in 2017 found that Papua Province is the province with the most significant number of filariasis endemic districts/cities, with 23 districts/cities endemic to filariasis, followed by East Nusa Tenggara Province (18 filariasis endemic districts/cities), and then by Aceh, Southeast Sulawesi and West Papua Provinces (12 filariasis endemic districts/cities). Overall, it was found that 236 out of 514 districts in Indonesia were filariasis endemic areas, and there were 10,681 cases of filariasis recorded in 2018 (Ministry of Health [Indonesia], 2018b).

The analysis results show that the factors influencing the incidence of filariasis in Indonesia are the prevalence of taking filariasis medication, according to health workers, and the prevalence of using LLINs for mosquitos. The filariasis elimination program is carried out by administering mass prevention drugs to people in endemic districts once a year for five consecutive years (Meliyanie & Andiarsa, 2017; Ministry of Health [Indonesia], 2005; WHO, 2017). The worldwide administration of filariasis mass drug administration (MDA) aims to eliminate filariasis by eliminating the incidence of transmission from sufferers to potential filariasis sufferers. Transmission will decrease or not even occur if the number of microfilariae circulating in the community is deficient, so even if a mosquito is a vector, its bite cannot transmit filariasis. The MDA coverage is set at > 65% of the population (Ministry of Health [Indonesia], 2014). Increasing the use of LLINs in filariasis-endemic areas has significantly reduced filariasis prevalence. This is per the 3rd elimination strategy, which is integrated vector control that includes the administration of LLINs (WHO, 2017).

The limitations of the study are: (1) the design of the study was cross-sectional; therefore, there was no causal relationship of the study; (2) the dataset was already six years old at the time of analysis; therefore, further studies are needed to update the result using the recent dataset; and (3) the variables that influence the prevalence of infectious diseases were only based on the 2018 Riskesdas National Report. This study did not examine other variables that may influence the prevalence of infectious diseases in Indonesia.

Conclusion

Provinces in Indonesia can be significantly grouped based on the incidence of infectious diseases: Group 1 has a high prevalence of infectious diseases, except for hepatitis and diarrhea; Group 2 has a moderate prevalence of infectious diseases, except for hepatitis and diarrhea; and Group 3 has a low average prevalence of infectious diseases. Therefore, infectious diseases require specific treatment per province.

Direct infectious diseases (ARI, pneumonia, hepatitis, diarrhea) are correlated, as are indirect infectious diseases (filariasis and malaria). Meanwhile, direct infectious diseases are not correlated with indirect infectious diseases. Therefore, if one type of direct infectious disease occurs, one must watch out for the emergence of other direct infectious diseases; the same goes for indirect infectious diseases.

Ease of access to public health centers significantly reduces the prevalence of pneumonia and TB. The prevalence of TB is also significantly decreased with an increase in the prevalence of toddler fecal burial in the soil. Using insecticide-treated nets for less than three years significantly increases the prevalence of ARI and pneumonia. The prevalence of bedrooms with sufficient lighting and thin nutritional status at the age of > 18 years respectively decreases and increases the prevalence of ARI. Very short stature status at the age of 16–18 years significantly increases the prevalence of hepatitis and malaria. Diarrhea disease substantially decreases with the behavior of draining the bath once a week and adequate bedroom ventilation. The increase in LLINs significantly increases and decreases the prevalence of malaria and filariasis, respectively. Very short stature status at the age of 5–12 years reduces the incidence of malaria prevalence. An increase in LLINs significantly reduces the prevalence of filariasis, and an increase in taking filariasis medication, according to the health center, indicates a significant rise in filariasis cases. Thus, each infectious disease has specific determinant factors, and multisectoral management is needed to overcome them.

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