BAREKENG: Journal of Mathematics and Its Applications
December 2025 Volume 19 Issue 4 Page 2495–2506
P-ISSN: 1978-7227 E-ISSN: 2615-3017
https://doi.org/10.30598/barekengvol19iss4pp2495-2506

STRATEGY FOR ELIMINATING NEGLECTED TROPICAL DISEASES THROUGH INDIVIDUAL AND AREA ASPECTS USING THE HIERARCHICAL LOGISTIC REGRESSION METHOD

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Article History:

Received: 10th January 2025
Revised: 20th March 2025
Accepted: 13th June 2025
Available online: 1st September 2025

Keywords:

Binary Logistic Regression;
Filariasis;
Hierarchical Method;
NTDs;
Poverty.

ABSTRACT

Filariasis is one of the Neglected Tropical Diseases (NTDs) that is often associated with poverty and marginalized community groups. Papua is the province with the highest number of chronic filariasis cases and has the largest number of endemic districts/municipalities compared to other provinces in Indonesia. Papua is also the province with the highest poverty rate in Indonesia. To support the government's filariasis elimination program, this study aims to determine variables that influence the incidence of filariasis in Papua at the individual and area levels. This study uses 2018 Indonesia Basic Health Research data from the Ministry of Health and regional data from BPS-Statistics Indonesia. The results using Hierarchical Binary Logistic Regression concluded that defecation behavior in latrines, prevention behavior against mosquito bites, participation in mass preventive drug administration, number of poor people, and number of health workers have a significant effect on the incidence of filariasis. In contrast, the variables age, gender, type of work, and level of education do not have a significant effect.

How to cite this article:

S. I. Oktora, D. Matualage, A. A. Pasaribu, N. F. Sahamony and A. Kurnia., "STRATEGY FOR ELIMINATING NEGLECTED TROPICAL DISEASES THROUGH INDIVIDUAL AND AREA ASPECTS USING THE HIERARCHICAL LOGISTIC REGRESSION METHOD," *BAREKENG: J. Math. & App.*, vol. 19, NO. 4, pp. 2495-2506, December, 2025.

Journal homepage: *https://ojs3.unpatti.ac.id/index.php/barekeng/*
Journal e-mail: *barekeng.math@yahoo.com; barekeng.journal@mail.unpatti.ac.id*

Research Article · Open Access

1. INTRODUCTION

Neglected Tropical Diseases (NTDs) represent a group of diseases that remain a global issue to this day. NTDs are caused by various pathogens, including viruses, bacteria, parasites, fungi, and toxins, and are associated with devastating health, social, and economic consequences. According to World Health Organization [1], diseases categorized under NTDs include Buruli ulcer, Chagas disease, dengue and chikungunya, dracunculiasis, echinococcosis, foodborne trematodiasis, human African trypanosomiasis, leishmaniasis, leprosy, lymphatic filariasis, mycetoma, chromoblastomycosis and other deep mycoses, noma, onchocerciasis, rabies, scabies and other ectoparasitoses, schistosomiasis, soil-transmitted helminthiasis, snakebite envenoming, taeniasis/cysticercosis, trachoma, and yaws. NTDs are often associated with diseases that predominantly affect populations in the most vulnerable and marginalized regions, particularly among impoverished communities. These diseases are considered neglected because they have largely disappeared from the global health agenda, receive minimal funding, and are frequently linked to stigma and social exclusion. NTDs predominantly impact neglected populations with low levels of education and limited employment opportunities. Furthermore, these diseases are widely distributed in some of the poorest regions of the world, where access to safe and clean water, sanitation, and healthcare services remains below standard [2].

Addressing NTDs aligns with the vision of universal health coverage, which is the aim of SDG Target 3.8: Achieve universal health coverage, including financial risk protection, access to quality essential healthcare services, and access to safe, effective, quality, and affordable essential medicines and vaccines for all. This goal can be realized if individuals at risk for or suffering from NTDs have equitable access to high-quality healthcare services, in other words, if all individuals and communities receive the healthcare, they need without facing financial hardship. Investments in tackling NTDs can yield significant benefits, not only in terms of health outcomes but also in economic gains [3]. Lymphatic Filariasis, commonly known as elephantiasis, is one of the diseases categorized under Neglected Tropical Diseases (NTDs) and is most prevalent in tropical regions, particularly in Africa and Southeast Asia. This disease damages the lymphatic system and can lead to abnormal swelling of body parts, causing pain, severe disability, and social stigma. In 2021, the World Health Organization (WHO) launched the Neglected Tropical Diseases Roadmap 2021–2030, with one of its objectives being the elimination of Lymphatic Filariasis as a global public health concern [4].

In Indonesia, the government has designated five NTDs as priority programs for elimination: filariasis, intestinal worms, schistosomiasis, leprosy, and yaws. Filariasis has the highest number of endemic areas in Indonesia, affecting 236 districts/cities across 28 provinces. Only six provinces do not have endemic districts or cities, and these are classified as non-endemic provinces. These provinces are Jakarta Capital Special Region, Yogyakarta Special Region, East Java, Bali, West Nusa Tenggara, and North Sulawesi. Papua Province is an endemic area with the highest number of chronic filariasis cases in Indonesia, reaching 3,615 cases in 2022. The number of chronic cases in Papua is the most dominant among other provinces in Indonesia, accounting for 41.35 percent. In relation to poverty, Papua ranks the highest in Indonesia with a poverty rate of 26.56 percent as of March 2022. This figure is significantly higher than the national poverty rate of 9.54 percent [5].

Logistic regression analysis has been widely employed in research to examine complex associations involving a categorical response variable. When logistic regression analysis accounts for regional variation, it evolves into a multilevel/hierarchical logistic regression model to properly address the nested data structure. The hierarchical logistic regression method was selected in this study due to the hierarchical structure of the data, in which individuals are grouped based on geographic regions (areas). This structure leads to observations within the same area being more similar (i.e., dependent on one another) compared to observations across different areas. If this dependency is ignored, it may result in biased parameter estimates, underestimated standard errors, and inaccurate statistical inferences. Hierarchical logistic regression addresses these issues by accounting for random variation between areas while modeling fixed effects of predictors at both the individual and area levels. Moreover, this method allows for the simultaneous estimation of effects at these two levels, yielding a more accurate interpretation of the factors influencing the incidence of filariasis. Consequently, the analytical results become more reliable and statistically valid to support recommendations for targeted elimination strategies.

Merlo, et al. [20] applied multilevel logistic regression to explore contextual phenomena in social epidemiology, by integrating individual and area data to identify factors influencing consultations with private physicians. Tolera and Sebu [21] conducted multilevel logistic regression to analyze factors associated with early marriage in Ethiopia, which showed significant variations between regions. In addition, Al-Alwan, et al. [22] compared classical logistic regression with a Bayesian model for assessing hepatitis awareness, showing that the Bayesian approach yielded more precise estimates. Ariansyah and Siagian [33] used multilevel logistic regression in the exploitation status of working school-age children. In addition, Lesnussa et al [34] used binary logistic regression to identify factors associated with low birth weight. Makhalli [35] explored logistic regression modeling of reductant herbicide in Pagalaram. Other research by George, et al. [23] utilized logistic regression to analyze heart disease risk, with the finding that logit standardization provided better interpretation for predictor variables. Meanwhile, Cotler, et al. [24] showed that hierarchical logistic regression was effective in predicting tachypnea based on post-exercise malaise. Masriadi [7] also used logistic regression to identify risk factors for lymphatic filariasis in Indonesia and found that work had a significant influence. Austin and Merlo [25] explored multilevel logistic regression with random intercepts to predict patient mortality, demonstrating the importance of considering patient and hospital characteristics in the model. These methods demonstrate the flexibility of logistic regression in a variety of research contexts, for both individual and hierarchical analysis, as well as in increasing the precision of estimates and interpretation of results.

Several studies related to filariasis in Papua have been conducted. Aisyah, et al. [6] found that Papua consistently exhibits higher prevalence rates over time compared to other regions in Indonesia. Masriadi [7] investigated the risk factors for the occurrence of filariasis cases in North Mamuju, West Sulawesi. Puspaningrum and Sunarsih [8] conducted research on filariasis specifically in Banyuasin Regency, Sumatera Selatan; Santoso, et al. [9] in Belitung Regency, Bangka Belitung; and Ramadhani, et al. [10] in Pekalongan City, Central Java. Research related to filariasis that has been conducted in the Papua region includes studies conducted by Sandy [11] in Merauke Regency; and Puhili, et al. [12] in Yahukimo Regency. Research specifically conducted in Papua Province has been carried out by Simangunsong and Oktora [13]. Still, this research has not specifically examined the territorial factors that also influence the high incidence of filariasis in Papua Province. Territorial factors need to be studied because individual behaviors and environmental conditions cause filariasis. This study is important because filariasis can lead to permanent disabilities, reduce quality of life, and increase economic burdens. Consequently, populations suffering from filariasis, who are predominantly living below the poverty line, will not be able to escape the trap of poverty. Based on the explanation, the aims of this study are: (i) Providing an overview of the incidence of Lymphatic Filariasis in Papua Province; and (2) Identifying individual and area variables that influence the filariasis status of the population in Papua Province using the Hierarchical Logistic Regression Method

2. RESEARCH METHODS

2.1 Lymphatic Filariasis (LF)

Lymphatic Filariasis (LF) is one of the NTDs diseases caused by filarial nematodes transmitted through infected mosquitoes' bites [14]. This parasitic disease, which is transmitted through mosquito bites, causes disability and has a negative impact on the economies of developing countries. Therefore, this disease is endemic. The effects of LF on sufferers are discomfort, body deformity, severe disability, social stigma, and financial difficulties [15]. LF is caused by 3 species of filarial nematodes, namely Wuchereria bancrofti, Brugia malayi, and Brugia timori, which are transmitted through human hosts by several mosquito vectors (Culex, Anopheles, Aedes, and Mansonia). Transmission of LF disease can be stopped through mass drug administration [16]. According to [17], the international medical aid organization (Médecins Sans Frontières-MSF) has carried out a mass drug administration program in the Asmat District, Papua. However, this program faces quite big challenges, because the locations with high prevalence are in remote areas. This remote location causes a lack of public access to health workers and makes it difficult to persuade patients to take antifilaria drugs.

The spread of LF disease is caused by filarial worm infection and is transmitted through the bites of various types of mosquitoes. The filarial worm species in Indonesia, Wuchereria bancrofti, causes LF (filariasis bancrofti), while Brugia malayi and Brugia timori cause brugia filariasis. Sipayung, et al. [18] conducted research on filariasis which is influenced by the biological environment and health service efforts in Sarmi Regency. Based on the research results, it was concluded that promotive and preventive health service efforts as well as the biological environment had an influence on the incidence of LF in Sarmi Regency.

Paiting, et al. [19] explained that environmental risk factors and population habits were related to the incidence of filariasis in Yapen Islands Regency, Papua Province. According to WHO, filariasis can be influenced by several variables such as access to clean, safe water, adequate sanitation, low education (percentage of population from junior high school or below), and HDI level (health, education, and welfare).

2.2 Research Coverage

This research uses secondary data, namely raw data from the 2018 Indonesia Basic Health Research and regional data from BPS-Statistics Indonesia. Indonesia Basic Health Research is a national survey conducted by the Ministry of Health of the Republic of Indonesia through the Health Research and Development Agency (Balitbangkes). This survey aims to collect comprehensive data regarding the health status and health determinants of the Indonesia population. The unit of analysis for this research is the population aged 10 years and over in endemic areas in Papua Province.

The dependent variable used in this study was the filariasis diagnosis status of individuals in Papua Province. The diagnosis status of filariasis is divided into two categories, namely diagnosed and undiagnosed. Individuals diagnosed with filariasis are based on the results of blood tests carried out by health workers. The independent variables used in this study are individual and area variables which are thought to influence the filariasis status of communities in endemic areas of Papua. The dependent and independent variables used in this study can be seen in Table 1. The area of coverage in this study is regencies/cities which are included in filariasis endemic areas in Papua Province as shown in Table 2.

Table 1. Variables of Individual and Area Levels

Variable	Category/Unit
INDIVIDUAL LEVEL	
Dependent Variable	
Filariasis diagnosed status (Y)	1 = Yes 0 = No*
Independent Variable	
Age (X_1)	Years
Sex (X_2)	1 = Male 0 = Female*
Employment status (X_3)	1 = Farmer 0 = Not Farmers*
Education levels (X_4)	1 = Junior high school and below 0 = Senior high school and above*
Preventive behavior against mosquito bites (X_5)	1 = Do not do 0 = Do*
The behavior of defecating in the latrine (X_6)	1 = Not in the latrine 0 = In the latrine*
Participation in mass preventive drug administration (X_7)	1 = Do not participate 0 = Participate*
AREA LEVEL	
Number of poor people (Z_1)	Thousand people
Health workers (Z_2)	Person

Note: *) reference category

Table 2. Study Area

Regency/City	Regency/City	Regency/City
1. Merauke	9. Mimika	17. Keerom
2. Jayawijaya	10. Boven Digoel	18. Waropen
3. Jayapura	11. Mappi	19. Supiori
4. Nabire	12. Asmat	20. Greater Mamberamo
5. Yapen Islands	13. Yahukimo	21. Nduga
6. Biak Numfor	14. Bintang Mountains	22. Central Mamberamo
7. Puncak Jaya	15. Sarmi	23. Puncak
8. Intan Jaya	16. Jayapura City	

2.3 Analysis Method

The analytical methods used are descriptive analysis and inferential methods. Descriptive analysis is used to present a general description of the incidence of LF in Papua Province, while inferential analysis uses the Hierarchical Binary Logistic Regression method to examine individual and regional/area variables that influence the filariasis diagnosis status of people in Papua Province.

Logistic regression is a widely used statistical method for modeling the relationship between one or more independent variables and a categorical dependent variable, particularly binary outcomes (e.g., success/failure, yes/no). The model employs the logit link function to estimate the probability of the occurrence of an event as a function of the predictor variables. The basic form of binary logistic regression is

$$log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ \ldots\ + \beta_K X_K$$

where:
π : the probability of the event occurring
X_k : the k-th predictor
β_k : the k-th regression coefficient
k : $1, 2, \ldots, K$.

However, in real-world data, observations are often not independent. For instance, students are nested within schools, patients within hospitals, or repeated measures within subjects. Such data exhibit a hierarchical structure, where observations are grouped at higher levels. To address this dependency structure, hierarchical logistic regression (also known as multilevel logistic regression) extends the standard logistic model by incorporating random effects that account for between-group variability. This allows the model to appropriately handle clustered or grouped data and to estimate both fixed effects (shared across all groups) and random effects (specific to each group). The expansion into hierarchical logistic regression can be explained by the following two models.

The model that will be used in this research consists of 2 models, namely model 1 in **Equation (1)** which only uses random intercepts to detect the presence of area random effects while model 2 uses individual-level variables and area-level variables. Model 2 in **Equation (2)** this study was created to detect the influence of certain area characteristics on the phenomenon of the presence of filariasis cases.

Model 1 in Hierarchical Binary Logistic Regression can be stated as follows:

$$Logit(\pi_{ij}) = log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_0 + u_{0j} \quad (1)$$

where:
π_{ij} : the probability that the i-th individual in the j-th area will be diagnosed with Lymphatic Filariasis

β_0 : intercept

u_{0j} : residual level area with $u_j \sim Normal(0, \sigma^2_{u_0})$.

i : observations 1, 2, …., N

j : area 1, 2, …., 23

By introducing the group-specific random effect u_{0j}, the model captures the intra-class correlation and accounts for the dependence within clusters, resulting in more accurate parameter estimates and valid statistical inference for nested data structures.

Model 2 in Hierarchical Binary Logistic Regression can be stated as follows:

$$Logit(\pi_{ij}) = \log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \gamma_{00} + \sum_{h=1}^{p} \gamma_{h0} x_{hij} + \sum_{k=1}^{q} \gamma_{0k} z_{kj} + u_{0j} \quad (2)$$

where:
γ_{00} : fixed intercept

γ_{h0} : fixed effect of the h-th individual-level predictor variable, $h = 1, 2, \ldots, 7$
γ_{0k} : fixed effect of the k-th area-level predictor variable, $k = 1, 2$
x_{hij} : the h-th predictor variable for the i-th individual in the j-th area
z_{kj} : the k-th predictor variable of the j-th area
u_{0j} : random intercept of the j-th area

In this research, two levels were used, namely the individual level and the regional/area level. The stages of research are as follows:

1. Carry out a descriptive analysis of the incidence of filariasis in endemic areas of Papua Province. The descriptive analysis uses pie chart to show the percentage of diagnosed population with filariasis in endemic areas in Papua Province.
2. Carry out Hierarchical Binary Logistic Regression analysis with the following stages.
   a. Carry out modeling 1 using the Maximum Likelihood method to get the intercept value and area level variance ($\sigma_{u_0}^2$).
   b. Calculate the ICC (Intraclass Correlation Coefficient) value, namely the proportion of variance explained by the area grouping structure in the population with the formula:

$$ICC = \frac{\sigma_{u_0}^2}{\sigma_{u_0}^2 + \sigma_e^2} \tag{3}$$

   where:

$$\sigma_e^2 = individual\ variety$$
$$= \frac{\pi^3}{3} \approx 3.29$$

   c. The ICC value can also be interpreted as the correlation between two randomly selected individuals from the same group. An ICC value greater than 5 percent indicates that the hierarchical structure of the data has an impact on individual responses, suggesting the need for structured or multilevel regression modeling.
   d. Carry out modeling 2 by adding individual level and area level variables. The method used is Maximum Likelihood.
   e. Carry out significance testing for each parameter in model 2. Partial parameter testing is conducted at the individual level and the area level using Wald test (W).

   Partial parameter testing at the individual level is:

   $H_0 : \gamma_{h0} = 0$

   $H_1 : \gamma_{h0} \neq 0 \,; k = 1, 2, 3, \ldots, 7.$

   Test statistics:

$$W = \frac{\hat{\gamma}_{h0}}{se(\hat{\gamma}_{h0})} \sim N(0,1) \tag{4}$$

   The decision to reject H_0 when $p - value < \alpha$, with those used in this research is 5%.

   Partial parameter testing at the area level is:

   $H_0 : \gamma_{0k} = 0$

   $H_1 : \gamma_{0k} \neq 0 \,; k = 1, 2$

   Test statistics:

$$W = \frac{\hat{\gamma}_{0k}}{se(\hat{\gamma}_{0k})} \sim N(0,1) \tag{5}$$

   The decision to reject H_0 when $p - value < \alpha$, with those used in this research is 5%.

f. Calculated the odds ratio (OR) for each independent variable with the formula: $OR = e^{\beta_k}$.

The odds ratio indicates how much more likely an event is to occur when $x = 1$ compared to when $x = 0$.

g. Interpreted the data.

3. RESULTS AND DISCUSSION

3.1 General Description of The Incidence of Filariasis in Endemic Areas of Papua Province

Filariasis is spread across 23 districts/cities in Papua Province. Based on 2018 Indonesia Basic Health Research data it can be seen in **Figure 1**, It is known that 2.42 percent of the Papua population is diagnosed with filariasis. This percentage is still relatively very high compared to the national target, which is below 1 percent. If divided by region, the 23 endemic areas in Papua consist of lowlands, highlands and mountains.

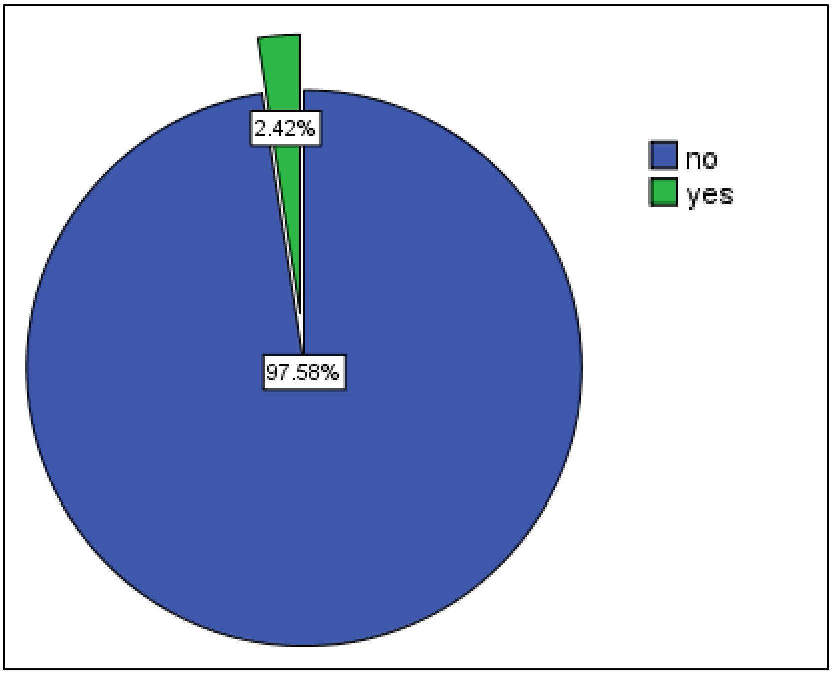

Figure 1. **Percentage of Diagnosed Population with Filariasis in Endemic Areas in Papua Province**

The lowland area consists of Asmat Regency, Nabire Regency, Waropen Regency, Yapen Regency, Mappi Regency, Biak Numfor Regency, Supiori Regency, Boven Digol Regency, Mamberamo Raya Regency, Keerom Regency, Mimika Regency, Yahukimo Regency, Jayapura City, Sarmi Regency, and Jayapura Regency. The highland region consists of Nduga Regency and Central Mamberamo Regency. The mountainous region consists of Bintang Mountains Regency, Jayawijaya Regency, Intan Jaya Regency, Puncak Jaya Regency, Puncak Regency, and Merauke Regency. If we look at the regional classification, most of the regions with a percentage of filariasis sufferers more than 1 percent are in the lowlands. This is in line with **[26]** who found that altitude is negatively correlated with filariasis transmission because the vector that carries filariasis lives and breeds well in lower areas.

3.2 The Influence of Varying District/City Characteristics on the Incidence of Filariasis

To determine the magnitude of the variation in filariasis incidence caused by differences in district/city characteristics, the ICC was calculated. Based on the error variance value at level two, it is equal to 0.7429 ($\sigma^2_{u_0}$), then the ICC value obtained is

$$ICC = \frac{0.7429}{0.7429 + 3.29} = 0.1842$$

This can be interpreted that there is a diversity of filariasis incidence in endemic areas of Papua of 18.42 percent which is caused by differences in district/city characteristics. The ICC value can also be interpreted as the magnitude of the correlation between individuals in the same district/city, which is 0.1842. The ICC value obtained is more than 5 percent, thus Hierarchical Logistic Regression modeling needs to be carried out to capture the variation caused by differences in regional characteristics. [27]

According to **Table 3**, it is known that there are three independent variables at the individual level that have a significant influence on the incidence of filariasis among residents in endemic areas of Papua, namely the behavior of defecating without being in a latrine, the behavior of not taking precautions against mosquito bites, and not participating in the administration of Mass Preventive Medication (MPM). The variables, such as age, gender, employment status and education level have no effect on the incidence of filariasis in endemic areas of Papua.

The estimation equation formed is

$$Logit(\hat{\pi}_{ij}) = log\left(\frac{\hat{\pi}_{ij}}{1-\hat{\pi}_{ij}}\right) = -2.7231 - 0.0037X_1 - 0.1481X_2 - 0.2677X_3 - 0.1179X_4 - 0.4487X_5 + 0.7437X_6 - 1.8671X_7 - 0.0261Z_1 + 0.0015Z_2$$

Table 3. Parameter Estimation Results of the Two-Level Hierarchical Binary Logistic Regression Model

Variable	Category	Coefficient	*Standard Error*	*z-value*	*p-value*
Constant		-2.7231	0.3875	-7.027	2.11e-12*
Age (X_1)		-0.0037	0.0038	-0.979	0.3278
Sex (X_2)	Male	-0.1481	0.1103	-1.342	0.1795
	Female**				
Employment Status (X_3)	Farmers	-0.2677	0.1662	-1.611	0.1073
	Not farmers**				
Education Levels (X_4)	Junior high school and below	-0.1179	0.1308	-0.901	0.3676
	Senior high school and above**				
Preventive behavior against mosquito bites (X_5)	Do not do	-0.4487	0.1707	-2.628	0.0086*
	Do**				
The behavior of defecating in the latrine (X_6)	Not in the latrines	0.7437	0.1514	4.911	9.06e-07*
	In the latrine**				
Mass Preventive Medication (MPM) (X_7)	Do not participate	-1.8671	0.1359	-13.738	< 2e-16*
	Participate**				
Number of poor people (Z_1)		-0.0261	0.0105	-2.491	0.0128*
Number of health workers (Z_2)		0.0015	0.0006	2.366	0.0180*

Data Source: 2018 Indonesia Basic Health Research (processed)
Notes: *) significant at alpha = 5%
**) = reference category

The behavioral variable of defecating not in a latrine has an odds ratio of exp(0.7437) = 2.1037. This means that residents with the habit of defecating not in toilets tend to suffer from filariasis which is 2.1037 times greater than residents who have the habit of defecating in toilets. Research by Eneanya, et al. [28] found that access to a private latrine in the household was associated with a lower risk of contracting filariasis. A private latrine owned by a household can be interpreted as a sign of better housing quality, better sanitation and hygiene, and higher socio-economic status. All of these things are associated with a lower risk of contracting filariasis.

Residents who do not take precautions against mosquito bites have an *odds ratio* exp(-0.4487) = 0.6384. This means that residents who do not take precautions against mosquito bites have a lower tendency to suffer from filariasis compared to residents who do prevent them, or in other words, residents who take precautions against mosquito bites actually have a greater tendency to suffer from filariasis. Preventive measures against mosquito bites that cause filariasis include cleanliness of the home environment, use of mosquito nets or anti-mosquito medication when leaving the house. Based on the results of data exploration, in general a greater percentage of individuals who take preventive measures suffer from filariasis. This shows that the use of mosquito nets and anti-mosquitoes cannot protect individuals from transmitting filariasis.

Conditions like this have also been found in previous research which examined the incidence of malaria in Jayapura Regency. Even though mosquito nets have been distributed by the health department and used by the community at night, people are still infected with malaria. Research conducted by Abas, et al. [29] found that after ten washes, the mosquito nets were no longer effective at killing mosquitoes. Thus, the use of insecticide-treated bed nets will be ineffective in preventing disease transmission if it is not accompanied by proper maintenance, including the frequency of washing the bed nets.

Odds ratio for the variable participation in mass preventive drug administration is equal to exp(-1.8671) = 0.1546. This shows that residents who do not participate in mass preventive drug administration have a lower tendency to suffer from filariasis compared to residents who participate. In addition, residents who participate in mass preventive drug administration are actually more likely to suffer from filariasis. This is in line with the results of data exploration where the percentage of individuals who participated in MPM had a higher percentage of filariasis incidents. MPM coverage in endemic areas of Papua is still far below the target. Mass treatment is long and carried out every year, causing several complaints and boredom among the people involved. This causes low treatment coverage in an area [30]. In addition, there are still many areas in endemic areas of Papua that have a fairly high percentage of cases, namely more than two percent. This increases the possibility of exposure to mosquitoes infected with filarial worms, especially if it is associated with MPM coverage which is still very low. In addition, areas with a high infection burden may experience microfilaria persistence even after MPM is implemented [31].

The number of poor people has a significant effect on the incidence of filariasis. This is in line with the theory that the incidence of filariasis is closely related to poverty. Papua is the region with the highest poverty rate in Indonesia. In fact, on average, the poverty rate in 23 endemic areas of Papua reaches 27.54 percent. The value of the *odds ratio* is exp(-0.0261) = 0.9743. This can be interpreted that when the number of poor people increases, the tendency for the incidence of filariasis to increase by 0.9743. When we examined in more detail, the poor population in endemic areas of Papua is mostly in mountainous areas such as Jayawijaya Regency and Puncak Jaya Regency. On the other hand, the percentage of filariasis sufferers in this area is relatively low. The percentage of filariasis sufferers that reaches more than 1 percent actually occurs mostly in lowland areas such as Supiori Regency and Jayapura City. The number of poor people in these two regions is also relatively lower than the previous two mountainous regions. It is shown in Table 4. This is in line with Salim's research [32] which concluded that the incidence of filariasis tends to increase when the geographical conditions of an area are lowland.

Table 4. Filariasis Sufferers, Poor People, and Regional Classification in Endemic Areas in Papua

Regency/City	Filariasis Sufferers (%)	Poor People (thousand people)	Regional Classification
Asmat	1.94	26.02	Lowland
Nabire	2.79	37.06	Lowland
Waropen	0.8	9.26	Lowland
Yapen	1.69	26.3	Lowland
Mappi	2.06	25.21	Lowland
Biak Numfor	2.96	37.93	Lowland
Supiori	7.47	7.76	Lowland
Boven Digoel	2.43	13.7	Lowland
Mamberamo Raya	0.96	6.94	Lowland
Keerom	1.02	9.4	Lowland
Mimika	2.05	31.18	Lowland
Yahukimo	0	74.02	Lowland
Jayapura City	4.93	33.75	Lowland
Sarmi	2.04	5.67	Lowland
Jayapura	1.75	17.19	Lowland
Nduga	1.06	37.14	Highland
Central Mamberamo	11	17.75	Highland
Pegunungan Bintang	2.9	22.81	Mountainous
Jayawijaya	0.54	82.9	Mountainous
Intan Jaya	0	20.8	Mountainous
Puncak Jaya	0.57	45.51	Mountainous
Puncak	3.1	42.1	Mountainous
Merauke	0.8	23.72	Mountainous

Data Source: BPS-Statistics Indonesia and 2018 Indonesia Basic Health Research (processed)

The number of health workers in endemic areas of Papua has a positive effect on the incidence of filariasis with an odds ratio value of exp(0.0015) = 1.002. This means that for every additional 1 health worker, the incidence of filariasis in endemic areas of Papua tends to increase by 1.002 times. A resident is categorized as diagnosed with filariasis when he or she has been diagnosed with filariasis based on the results of a blood test by a health worker. Increasing the number of health workers in Papua, especially those reaching endemic areas, will certainly have a positive effect on increasing the number of people suffering from filariasis. The greater the number of health workers in an endemic area, the more massive the examination of the population will be, which does not rule out the possibility that many cases of filariasis will be found in the community.

4. CONCLUSION

In general, the percentage of population in endemic areas of Papua who are diagnosed with filariasis is still relatively very high compared to the national target, which is below 1 percent. If we look at the regional classification, most of the regions with a percentage of filariasis sufferers of more than 1 percent are in the lowlands. The diversity of filariasis incidence in endemic areas of Papua caused by differences in district/city characteristics is quite high, reaching 18.42 percent. Independent variables at the individual level that have a significant influence on the incidence of filariasis among residents in endemic areas of Papua are the behavior of not defecating in a latrine, the behavior of not taking precautions against mosquito bites, and not participating in the administration of mass preventive medicine. The variables age, gender, employment status, and education level do not have a significant effect on the incidence of filariasis in endemic areas of Papua. All regional/area variables (number of poor people and number of health workers) have a significant effect on the incidence of filariasis in endemic areas of Papua.

Based on the research results, future research can interact regional types (lowland, highland, and mountain) with regional variables in endemic areas of Papua. This is based on research findings that filariasis is closely related to poverty and the availability of health workers, but poverty and the availability of health workers are also closely related to the type of region in Papua Province.

AUTHOR CONTRIBUTIONS

Siskarossa Ika Oktora: Conceptualization, Data Curation, Formal analysis, Methodology, Software, Visualization, Writing - Original Draft. Dariani Matualage: Conceptualization, Data Curation, Formal Analysis, Methodology, Software, Visualization, Writing - Original Draft. Asysta Amalia Pasaribu: Conceptualization, Data Curation, Formal Analysis, Methodology, Software, Visualization, Writing - Original Draft. Nur Fitriyani Sahamony: Conceptualization, Data Curation, Formal Analysis, Methodology, Software, Visualization, Writing - Original Draft. Anang Kurnia: Supervision, Writing - Review and Editing. All authors discussed the results and contributed to the final manuscript.

FUNDING STATEMENT

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ACKNOWLEDGMENT

The authors thank IPB University, Politeknik Statistika STIS, Universitas Papua, Binus University, and Universitas Binawan for the support.

CONFLICT OF INTEREST

The authors declare no conflicts of interest to report study.

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