RESEARCH ARTICLE **Open Access**

Gema Lingkungan Kesehatan
Vol. 24, No. 2 (2026), pp 189-196
e-ISSN 2407-8948 p-ISSN 16933761
doi: https://doi.org/10.36568/gelinkes.v24i2.354 *Journal Homepage: https://gelinkes.poltekkesdepkes-sby.ac.id/*

Environmental and Behavioral Determinants of Filariasis Among Adolescents in North Sumatra Province: A Cross-sectional Analysis of National Health Survey Data

Putra Apriadi Siregar[1]*, Rani Elviyanti Siregar[1], Desty Adinda[1], Muhammad Rezebri[1], Apriliani[2], Prima Yanti Siregar[3], Sabilla Pratiwi[4]

[1] Public Health Departements, Universitas Islam Negeri Sumatera Utara Medan, Indonesia
[2] Malahayati College of Health Sciences, Medan, Indonesia
[3] ITMI Academy of Information Management and Computing, Medan, Indonesia
[4] Sungai Mulia Guidance Centre, Kuala Lumpur, Malaysia

*Correspondence: putraapriadisiregar@uinsu.ac.id

Lymphatic filariasis remains a public health problem in North Sumatra Province, but research focusing on adolescents as a "hidden reservoir" in the transmission chain is still very limited. Most previous studies have focused on adult populations or small endemic clusters, thereby neglecting the specific risk dynamics in younger age groups. This study aims to analyze environmental and behavioral determinants that influence the incidence of filariasis specifically in the adolescent population in North Sumatra using provincial-level data. We conducted a cross-sectional analytical study using secondary data from the 2018 Indonesian Basic Health Survey (Riskesdas). A total of 13,860 individuals were included from all 33 districts/cities in North Sumatra using a census block sampling method. The dependent variable was filariasis incidence. Independent variables included demographic characteristics, ventilation adequacy, waste management, and mosquito prevention practices (e.g., repellent use, insecticide-treated nets). Data analysis was performed using chi-square tests and binary logistic regression to determine significant associations, with statistical significance set at $p < 0.05$. Among households surveyed, only 50.2% had adequate bedroom ventilation, while 91.4% had uncovered garbage, serving as potential mosquito breeding grounds. Insecticide-treated net usage was low (38%), and nearly half of the adolescents did not use repellents. Garbage disposal was significantly associated with filariasis incidence in all demographic groups ($p < 0.001$). Repellent use showed a protective association among rural residents ($p = 0.02$) and females ($p = 0.018$). Homes equipped with window screens had lower infection rates. The risk of filariasis in adolescents in North Sumatra is predominantly triggered by the failure of the household waste management system and the lack of physical protection of residential ventilation. The insignificance of mosquito net use confirms that transmission among adolescents occurs more through interaction with vector habitats outdoors or during nocturnal activities. Health interventions should shift from mass treatment to improving environmental sanitation and educating adolescents on adaptive self-protection behaviors.

Keywords: Behavioral risk, Disease, Environmental health, Filariasis

INTRODUCTION

Lymphatic filariasis is a parasitic disease transmitted by mosquitoes and is a leading cause of global morbidity. Lymphatic filariasis affects 120 million people in tropical and subtropical Asia, Africa, the Western Pacific, and some parts of the Americas (Cheng, 2017). Lymphatic filariasis is estimated to be the leading cause of physical disability worldwide, affecting 40 million people chronically. Some clinical manifestations in infected individuals include acute fever, chronic lymphedema, elephantiasis, and hydroceles (Hotez et al., 2015). Lymphatic filariasis, commonly known as elephantiasis, is a vector-borne zoonotic disease prevalent in tropical and subtropical regions. It is caused by filarial worms, primarily Wuchereria bancrofti, Brugia malayi, and Brugia timori, and transmitted by various species of mosquito vectors such as Culex, Anopheles, Aedes, and Mansonia (Sunish, 2024). The chronic nature of filariasis can result in permanent disability if untreated, characterized by severe swelling in the limbs, breast, and genitals.

Filariasis is classified as a reemerging disease, characterized by its previous existence, subsequent disappearance, and eventual reappearance in a new form. In 2004, the World Health Organization reported a global

prevalence of filariasis across 83 countries, with 120 million cases (WHO, 2018). Study Wayangkau (2025) show the Sarmi District showcases diverse topography, ranging from flat coastal plains to hilly regions with steep slopes. Notably, flat slopes with a gradient of 0–8% account for approximately 52.75% of the area. The biological and environmental conditions in the filariasis-endemic village of Bedono present a risk for disease transmission (Zuhruf, 2022). Indonesia identified the first documented case of filariasis in 1877, following which the disease temporarily vanished from the region. However, it has since re-emerged, with current estimates indicating that 22 provinces are affected, impacting approximately 115 million individuals, with the highest incidence reported in Papua. A survey conducted in 2000 identified 1,553 villages within 647 health centers across 231 districts in 26 provinces as endemic areas, with 6,233 chronic cases reported. Laboratory tests using finger-prick blood samples showed that about 3.1% of people have microfilaria, which means around 6 million people are infected with filarial worms, and about 100 million people are at high risk of getting infected because the mosquitoes that spread the disease are common.

North Sumatra Province experienced a decrease in new filariasis cases from 36 in 2012 to 24 in 2013, with a total of 152 cases recorded from 2012 to 2017. In 2017, the number of new cases was 18 compared to 2016 and 2015, with 30 and 44 new cases, respectively. Asahan District had the highest number of cases in 2017, with five new cases and 41 cases. In 2018, North Sumatra ranked 14th nationwide in Indonesia for chronic filariasis cases by province, with 183 cases (Kementerian Kesehatan RI, 2018). In Indonesia, lymphatic filariasis in humans is attributed to three distinct species of parasitic nematodes: Wuchereria bancrofti, Brugia malayi, and Brugia timori (Juwita, 2020). These parasites are disseminated across the Indonesian archipelago by various mosquito species from the genera Aedes, Anopheles, Culex, and Mansonia, which serve as vectors (Sofia, 2020) (Nurjazuli et al., 2018).

The adolescent population plays a crucial role as a key element in the dynamics of the spread and elimination of filariasis globally. Adolescents often act as significant reservoirs of infection; a study in Nigeria (2025) reported that the prevalence of *Wuchereria bancrofti* infection reached 41.8% in the 15–18 age group, making them a major source of transmission in the community (Adekunle & Asimiea, 2018). Clinically, although parasitic infection is usually acquired during childhood, the accumulation of worms in the lymphatic system often only begins to manifest noticeable symptoms such as lymphedema or hydrocele during adolescence (Goldin & Juergens, 2025). This condition is exacerbated by low health literacy among adolescents, with studies noting that only about 21.6% of adolescents are aware of this disease, making them more likely to ignore self-protection measures (Narayanan et al., 2025). Therefore, early detection during adolescence through ultrasound technology is crucial to prevent permanent damage and chronic morbidity in adulthood (Shenoy & Bockarie, 2011). Additionally, in elimination strategies, the infection status of adolescents is a vital indicator in transmission assessment surveys (*Transmission Assessment Surveys*) to validate the success or failure of mass drug administration programs in a region (Jian et al., 2026).

It is clear that environmental and climatic factors also play an important role in the transmission of vector-borne diseases. This phenomenon has been extensively studied in various articles. In the context of lymphatic filariasis, high temperatures and humidity have been observed to have a positive effect on mosquito population dynamics, particularly in terms of their reproductive capacity (Simelane, 2020). For instance, in temperate climates and in tropical highlands, temperature-related factors restrict the multiplication of mosquitoes and the development of the parasite (Roswati, 2021). In arid climates, precipitation-related factors restrict mosquito breeding. It is evident that the transmission of lymphatic filariasis displays seasonal patterns, particularly in northern regions (Annashr, 2021).

Environmental factors, including urban development, inadequate waste management, and poor sanitation, significantly contribute to the spread of lymphatic filariasis (Simelane, 2020). These conditions create breeding sites for mosquitoes, which facilitate disease transmission, especially in regions where the disease is endemic (Azzahra, 2024). Additionally, specific behavioral factors contribute to the spread of filariasis (Rahmi, 2022). These include going out at night, neglecting to install mosquito nets on windows, failing to wear protective clothing while traveling, and not using mosquito nets or repellent during sleep.

Specific environmental conditions can lead to an increase in the population of filariasis vectors, such as mosquitoes, by providing optimal breeding and resting habitats (Sunish, 2024). As a result, mosquito density is expected to rise in areas that contain shrubs, swamps, rice fields, active livestock enclosures, and locations with standing water that support the mosquito life cycle as disease vectors (Wayangkau, 2025). This risk arises from the close proximity of backyard plants, tidal flooding, mangrove trees, open drainage channels, rubbish in waterlogged areas, and livestock from residents' homes, all typically located less than 10 meters apart (Zuhruf, 2022). The study identified a significant correlation between wastewater drainage channels and the incidence of filariasis (Annashr, 2021). Stagnant water in drains and canals serves as breeding sites for mosquito larvae, which can lead to stagnation within homes. Houses that lack proper drainage or have open channels can create environments conducive to breeding filariasis vectorsVarious breeding sites in and around the homes including drains, open sewage channels, bird drinking spots, dispensers, bathtubs, standing water, and slow-flowing rivers (Wayangkau, 2025).

Although efforts to eradicate filariasis in Indonesia have been ongoing for the past decade, most research has focused on adult populations or specific endemic clusters,

often neglecting adolescents as a 'hidden reservoir' in the chain of transmission. In fact, adolescence is a critical phase in which infections acquired during childhood begin to show early clinical symptoms as the parasite load in the lymphatic system increases. Adolescents in North Sumatra have a unique risk of exposure due to high levels of nighttime activity—such as gathering outdoors at night—yet ironically, they have the lowest compliance with self-protection measures and mass drug administration (MDA) programs.

This research gap is particularly important because the literature linking household microenvironmental variables to specific adolescent behaviors in North Sumatra is still very limited. The use of Basic Health Research (Riskesdas/SKI) data in this study provides an empirical advantage in representing provincial-level data that cannot be captured by small-scale local studies. Analysis of this dataset allows for the identification of systemic transmission patterns triggered by the failure of physical home infrastructure and adolescent lifestyles, which is ultimately essential for designing more precise and evidence-based intervention strategies to sustainably break the chain of filariasis transmission in North Sumatra.

METHODS

Study Design

This study used a national-scale analytical cross-sectional design with secondary data from the 2018 Indonesian Basic Health Survey (Riskesdas), which focused on the epidemiology of filariasis in North Sumatra Province. Data were collected from January to July 2023 across all 33 districts/cities in North Sumatra, an area of Indonesia with a long history of filariasis.

The study population consisted of 68,835 individuals registered in the 2018 North Sumatra Provincial Population Census (BPS). Our sample included all adolescents in households registered in the BPS Census who met specific inclusion criteria, totaling 13,860 individuals. The criteria were age 10-18 years based on Indonesian Minister of Health Regulation No. 25 of 2014, registered in a household, and diagnosed with filariasis. Participants were selected using the census block sampling method. We only focused on permanent residents of North Sumatra Province for our sample. The data set included all relevant study variables. In addition, respondents were required to be physically present at their homes during the survey.

Setting

The present study utilized nationwide data from 33 districts/cities in North Sumatra Province.

Variable Study and Data Collection

The dependent variable in this study was the incidence of filariasis based on secondary data from the 2018 Indonesian Basic Health Survey (Riskesdas) based on health worker diagnoses. Independent variables include age, gender, educational status, employment status, residential status, use of mosquito nets, use of repellents, presence of open waste disposal, presence of closed waste disposal, use of mosquito control measures (such as sprays, coils, and electrical devices), and installation of wire mesh windows. The data for this study were obtained from a secondary source, namely the Health Research and Development Agency of the Ministry of Health of the Republic of Indonesia.

These statistics were collected as part of a national survey conducted in North Sumatra Province. A standard questionnaire was used as the main tool for collecting individual-level data on households. The questionnaire was administered through interviews and collected information on age, gender, educational status, employment status, residential status, use of mosquito nets and repellents, application of mosquito control methods (sprays, coils, electricity), installation of mosquito wire mesh on 10% of the floor area of the house, consumption of filariasis medication, and the incidence of filariasis in North Sumatra Province.

Statistical Analysis

The purpose of this study was to present the frequency distribution of each variable through frequency distribution and percentages. Furthermore, we analyzed bivariate data to identify risk factors for filariasis. In the initial phase of the investigation, a chi-square test was performed to test the relationship between independent and dependent variables because both data types were categorical. To ensure that there was no significant correlation between the independent variables, a collinearity test was performed. The statistical significance of the findings was evaluated using a 95% confidence interval (CI) and a p-value threshold of 0.05. All statistical analyses were performed using JASP Version 19.

Ethical Approval

The health research protocol underwent a thorough evaluation by the ICF Institutional Review Board, which meticulously adhered to the Protection of Human Subjects regulations (45 CFR 46) set foth by the United States Department of Health and Human Service.

RESULT AND DISCUSSION

Results

This section presents the research findings systematically, in the form of text, tables, and figures. Discuss the results with reference to relevant theory or previous research. The authors should provide an interpretation of the findings and explain the implications of the results for environmental health.

Table 1.
Frequency Distribution of Risk Factors for Filariasis in North Sumatra Province

Environmental Factors (N=13.860)	N	%
Bedroom ventilation		
Area >10% of floor area	6964	50.2
Kitchen ventilation		
Area >10% of floor area	6550	47.3
Living room ventilation		
Area >10% of floor area	8548	61.7
Garbage		
Uncovered garbage	12666	91.4

Table 2.
Frequency Distribution of Adolescent at risk for Filariasis in North Sumatra Province

Behavioral Factors of Adolescents (N=13.860)	N	%
Use of repellents		
No use of repellents	6896	49.8
Use of electric mosquito rackets		
No use of electric mosquito rackets	12941	93.4
Use of mosquito repellent		
No use of mosquito repellent	5094	36.8
Use of insecticide mosquito nets		
No use of insecticide mosquito nets	8589	62

The data highlight critical environmental risk factors that may contribute to filariasis transmission in North Sumatra. Bedroom ventilation meets the minimum recommended standard (>10% of floor area) in only 50.2% (n=6,964) of households, suggesting that half of the population resides in poorly ventilated sleeping areas. Kitchen ventilation is insufficient in 52.7% (n=7,310) of households, which may contribute to elevated indoor humidity—a key factor in mosquito breeding and survival. The marginally better performance of living room ventilation (61.7%, n=8,548) suggests that communal spaces are less of a concern, though the overall low compliance across all rooms indicates a systemic issue in housing design that could facilitate vector persistence.

The data reveal significant gaps in protective behaviors against filariasis among adolescents in North Sumatra. Nearly half (49.8%, n=6,896) do not use any form of repellents, increasing their exposure to mosquito bites, particularly from Culex species, the primary filariasis vector. This is compounded by the extremely low adoption of electric mosquito rackets (only 6.6%, n=919, report usage), which could serve as an effective personal protection measure. While mosquito repellent use is relatively higher (63.2%, n=8,766), the fact that 36.8% (n=5,094) still do not use them suggests a need for enhanced public health campaigns targeting adolescent populations.

Table 3.
The Relationship between environmental factors and risky behavior with the incidence of filariasis among adolescents in north Sumatra province, Indonesia

Environmental and Behaviour Factors	Urban Sign (P)	Rural Sign (P)	Man Sign (P)	Women Sign (P)
Bedroom ventilation	0.48	0.09	0.10	0.069
Kitchen ventilation	0.9	0.04*	0.58	0.12
Living room ventilation	0.86	0.32	0.049	0.83
Garbage	<0.001*	<0.001*	0.003*	0.004*
Use of insecticide mosquito nets	0.27	0.76	0.52	0.10
Use of repellents	0.34	0.02*	0.16	0.018

Environmental and Behaviour Factors	Urban Sign (P)	Rural Sign (P)	Man Sign (P)	Women Sign (P)
Use of electric mosquito rackets	0.70	0.24	0.48	0.58
Use of mosquito repellent	0.29	0.009	0.33	0.11

The data in Table 3 highlight several significant relationships between environmental factors, risky behaviors, and the incidence of filariasis among adolescents in North Sumatra, Indonesia, stratified by urban/rural areas and gender. Garbage Disposal emerged as a highly significant factor across all groups (urban: *p* < 0.001; rural: *p* < 0.001; men: *p* = 0.003; women: *p* = 0.004), indicating that poor waste management strongly correlates with filariasis transmission in both settings and genders. Ventilation showed varying significance. While kitchen ventilation was significant in rural areas (*p* = 0.04) but not urban (*p* = 0.9), living room ventilation was significant only among men (*p* = 0.049). Bedroom ventilation had no significant association in any group. Mosquito Prevention Measures exhibited mixed results. Repellent use was significant in rural areas (*p* = 0.02) and among women (*p* = 0.018), while mosquito repellent (other forms) was significant only in rural regions (*p* = 0.009).

Discussion

The most alarming finding was the almost universal presence of open waste (91.4%, n=12,666), which is likely to be a breeding ground for filariasis vectors such as Culex mosquitoes. Another very worrying finding is the low use of insecticide-treated mosquito nets (ITNs), with 62% (n=8,589) not using them. In contrast, insecticide-treated mosquito nets and electric mosquito raquets did not show a significant association with filariasis incidence in any group. Installing wire mesh on windows or vents effectively prevents mosquitoes from entering the home. According to Rahmat (2020) that individuals who did not equip their home ventilation systems with wire mesh were 14.00 times more likely to contract filariasis than those who did. The results of the Sofia (2020) study demonstrate that individuals residing in homes without mosquito nets on their vents are 3.71 times more likely to contract lymphatic filariasis compared to those living in homes equipped with such nets.

Living room ventilation is significant only for men (p=0.049), possibly reflecting gender-based differences in time spent in communal spaces. One reason for the spread of filariasis is that homes with open vents allow mosquitoes to enter. Consequently, it is imperative for health promotion at health centers to provide consistent health education to the community regarding the primary principles of preventing the transmission of lymphatic filariasis. This involves advising the community to install window screens on ventilation openings or windows to prevent mosquitoes from entering their homes.

Using wire mesh on house vents is an effective method for keeping mosquitoes out and avoiding bites. Researchers found that individuals living in homes without mosquito netting were 7.2 times more susceptible to filariasis than those who utilized mosquito netting for ventilation. Employing mosquito netting for house ventilation helped protect against bites and reduced the risk of filariasis by 70%. Integrating wire mesh into the ventilation system has been shown to enhance air circulation within the home while simultaneously serving as a barrier to mosquito entry (Fadilah, 2023). The wire mesh in the ventilation system effectively limits physical contact between mosquitoes outside and the house occupants by restricting their entry. The use of wire mesh has proven effective in reducing interactions between mosquitoes and humans (Siregar, 2021b). The use of wire mesh in ventilating homes is crucial as it prevents mosquitoes from entering. Without wire mesh, mosquitoes are likely to enter and breed inside homes, a concern that is particularly significant in poorly lit dwellings (Usalma, 2020).

The installation of wire mesh on house vents constitutes a measure of personal protection against mosquitoes, thereby reducing the risk of exposure to filariasis. The installation of wire mesh on vents has been demonstrated to reduce contact between mosquitoes and household members, as mosquitoes, which are vectors or carriers of filariasis, are unable to enter the house (Oktafian, 2021). Among the respondents who installed wire mesh on their ventilation but were diagnosed with filariasis, this phenomenon may be attributable to the respondents' nocturnal habits. Researchers have identified urbanization and the prevalence of mosquitoes as contributing factors to the increased risk of filariasis.

The analysis revealed a strong universal association between garbage disposal and filariasis (p<0.001; males/females: p=0.003/0.004). Researchers have identified refuse disposal as a systemic driver of mosquito breeding. This finding has led to a call for targeted interventions in both residential and public spaces.

The utilization of closed refuse bins has been demonstrated to be an effective measure for mitigating the risk of filariasis in urban communities. It has been determined that open trash bins provide an ideal environment for the proliferation of Culex spp.

mosquitoes, which are recognized as the primary vector (Anggraini, 2022).The presence of open trash bins facilitates the accumulation of stagnant water, a condition particularly conducive to the proliferation of mosquito larvae (Dompas, 2020) . Consequently, inadequate waste management has the potential to increase vector density and the risk of filariasis transmission.

The disposal of refuse in waterways or drainage systems can obstruct drainage infrastructure (Siregar, 2021a). The resulting water pools provide optimal breeding conditions for various species of mosquitoes, including Culex spp., which are recognized as vectors of filariasis and Japanese encephalitis (Lase, 2024). To lower the chance of mosquito breeding, every home must have a waterproof trash can and keep it there for no longer than two days (Yati, 2020).

The findings of this study suggest a potential association between the utilization of repellent measures and the prevalence of filariasis within rural communities (p = 0.009). Rural communities often experience increased exposure to mosquitoes because of agricultural activities, gardening, and living near forested or aquatic environments, which serve as natural habitats for these insects. Mosquitoes from the Mansonia genus are usually found in swamps or lakes; Anopheles are often linked to farms or rice fields; and Culex, which can spread filariasis, is an important carrier of W. bancrofti. The use of repellents is crucial, particularly during outdoor activities when mosquito activity peaks (Agustina, 2021). In rural communities, individuals often face a heightened risk of mosquito bites. It is well-established that daily activities related to livelihoods—such as farming, gardening, herding livestock, or gathering forest products—are frequently conducted outdoors. Mosquitoes that transmit filariasis are particularly active in these environments (Dewi, 2020).

Repellents, which are substances designed to deter mosquitoes, play a vital role in personal protective measures. When applied to skin areas not covered by clothing, repellents create a "chemical shield" that helps deter mosquitoes from approaching and biting (Sudiarti, 2021). This effect is especially significant in situations where outdoor activities cannot be avoided or where using mosquito nets is impractical, such as during nighttime work or social gatherings outdoors. Consistent and proper use of repellents has been shown to significantly reduce the likelihood of bites from infected mosquitoes, thereby lowering the risk of filaria transmission.

The results of this study indicate that the use of repellents is associated with the incidence of filariasis in rural communities (P = 0.009) and among women (P = 0.018). The utilization of repellents has yet to achieve comparable popularity in rural regions to other interventions, such as the deployment of mosquito nets (Alan, 2025). The provision of educational resources and practical demonstrations to the community is hypothesized to increase acceptance of repellent use.

The participants applied the repellent directly to their skin and clothing. Repellents are available in various forms, including liquids, pastes, lotions, and sprays. Most commercial repellents contain diethyltoluamide (DEET) as their active ingredient. DEET (N,N-diethyl-meta-toluamide) is known for its ease of absorption through the skin, where it enters the bloodstream and affects the nervous system. Specifically, DEET has been linked to seizures and, in rare cases, death (Ghali, 2024) (Rani, 2024). DEET's mechanism of action involves the inhibition of the chemical receptors for carbon dioxide and lactic acid in mosquitoes. Continuous use of diethyl-meta-toluamide (DEET) has been shown to cause mosquito resistance and harm human health. To mitigate these negative effects, repellents can be formulated using compounds derived from plant sources that are considered safe for human use (Sudiarti, 2021).

Mosquitoes that carry filariasis are most active at night, exhibiting two peaks in their biting and feeding activities: shortly after sunset and just before sunrise. Factors such as air temperature and humidity can influence these activities, either increasing or decreasing the feeding behavior of adult mosquitoes. Consequently, individuals who are nocturnal are at a greater risk (Rahmi, 2022).

Although the use of repellents helps reduce contact with mosquitoes, dependence on chemicals such as DEET needs serious attention due to the potential side effects if used continuously without proper education. The phenomenon in which respondents who had installed wire mesh were still diagnosed with filariasis provides important empirical contributions to this study; it indicates that the nocturnal behavior of adolescents—such as gathering outside at night or staying up late—negates the protective function of the home. Therefore, self-protection must be dynamic and not rely solely on static physical interventions within buildings.

The findings show that only 50.2% of homes have standard ventilation. This is an important contribution because it proves the structural failure of adolescent housing, which is the main entry point for vectors at night. A clear behavioral gap is evident, with 49.8% of adolescents not using repellents. These findings provide empirical evidence that health interventions in North Sumatra should focus on providing physical protection tools, rather than just verbal education.

Implications of intervention the results of this study provide a basis for community health centers to reformulate health promotion programs that are more specific to the adolescent population. Interventions should no longer be merely normative, but should target two crucial areas: community-based environmental sanitation improvements to eliminate mosquito breeding sites, and education on changing nocturnal behavior. Programs distributing self-made wire mesh or encouraging the use of more modern and practical protective equipment (such as electric rackets or plant-based repellents) can increase appeal and compliance among adolescents. Given the significant role of waste as a major driver of transmission, cross-sector collaboration to improve household waste disposal systems is a non-negotiable medical urgency in

order to break the chain of filariasis transmission in North Sumatra.

Although it provides a comprehensive overview at the provincial level, this study has several limitations that need to be considered. The use of a cross-sectional study design means that this study can only identify correlations and cannot draw conclusions about causality between environmental determinants and the incidence of filariasis. Furthermore, because this analysis uses secondary data from the Indonesian Health Survey (SKI), the variables examined are limited to the available data, so that other potential risk factors such as specific outdoor mobility or micro-socioeconomic conditions cannot be explored in depth.

Another significant challenge is the limited literature and references on filariasis that specifically focus on the adolescent population, making in-depth comparative analysis for this age group a challenge in the global discourse. Finally, the behavioral data collected is self-reported, which opens up the possibility of social desirability bias, where respondents may tend to report better protective behaviors than their actual practices in the field.

CONCLUSION

This study concluded that the incidence of filariasis among adolescents in North Sumatra Province was significantly determined by household environmental factors and low compliance with self-protection behaviors. Waste management emerged as the most dominant and universal environmental determinant for adolescents in both urban and rural areas ($p < 0.001$), where the presence of open waste (91.4%) was the main driver of vector transmission. In terms of housing structure, poor air circulation is a real risk factor, with only 50.2% of adolescents' bedrooms meeting health ventilation standards. These risky environmental conditions are exacerbated by adolescents' low self-protection behaviors, with 49.8% of respondents not using repellents and the adoption of modern protection tools such as electric mosquito rackets reaching only 6.6%. These findings confirm that adolescent girls and those living in rural areas are more vulnerable due to their interaction with the vector's natural habitat. Therefore, filariasis elimination strategies must prioritize improving household environmental sanitation and strengthening adolescent-specific protective behavior literacy.

SUGGESTION

Based on the findings of this study, efforts to prevent filariasis among adolescents in North Sumatra should focus on technical interventions that target significant variables, starting with strengthening the household waste management system through the provision of closed, waterproof waste containers to eliminate the breeding grounds of the vector *Culex spp.* on a large scale in residential areas. In addition, physical modifications to dwellings are highly recommended through the installation of wire mesh on every ventilation hole, especially in bedrooms and living rooms, to create an effective physical barrier to prevent mosquitoes from entering during their active biting period at night. For adolescents in rural areas and women's groups who show higher vulnerability, health education needs to emphasize the consistent use of repellents as a form of dynamic self-protection when conducting outdoor activities at night. In terms of policy, local governments are advised to integrate filariasis management into the Community-Based Total Sanitation (STBM) program and the renovation of Uninhabitable Houses (RTLH) by setting standards for the installation of wire mesh on house vents in endemic areas as a more realistic and sustainable upstream intervention to break the chain of transmission.

REFERENCE

Adekunle, N. O., & Asimiea, A. O. (2018). Prevalence of Lymphatic Filariasis and Associated Clinical Morbidities Among Adolescents in Three Rural Communities in Ondo State, Southwest Nigeria. *Journal of Tropical Medicine and Health*, *January*(2), 1–6. [Crossref] [Publisher]

Agustina, D. (2021). Environmental and Behavioral Factors Analysis of Malaria Incidents. *Jurnal Ilmiah Permas: Jurnal Ilmiah STIKES Kendal*, *11*(2), 423–432. [Crossref] [Publisher]

Alan, G. Z. (2025). Efektivitas Repellent dari Ekstrak Akar Tuba (Derris elliptica) terhadap Daya Hinggap Nyamuk Aedes aegypti. *Quantum Wellness: Jurnal Ilmu Kesehatan*, *2*(1), 54–71. [Crossref] [Publisher]

Anggraini, S. (2022). Upaya peningkatan pengetahuan siswa SD terhadap penyakit DBD dan jentik nyamuk di SDN Malabar Kota Bogor. *SELAPARANG: Jurnal Pengabdian Masyarakat Berkemajuan*, *6*(3), 1182–1185. [Crossref] [Publisher]

Annashr, N. N. (2021). Environmental Conditions and Filariasis Incidence in Kuningan District. *Window of Health: Jurnal Kesehatan*, *4*(1), 85-97. [Crossref] [Publisher]

Azzahra, M. K. (2024). A review of bed nets usage and sewerage conditions as risk factors for lymphatic filariasis in developing countries. *Journal of Environmental Health*, *16*(1), 89-100. [Crossref] [Publisher]

Cheng, Y. (2017). Modeling the Parasitic Filariasis Spread by Mosquito in Periodic Environment. *Computational and Mathematical Methods in Medicine*, *1*(1), 4567452. [Crossref] [Publisher]

Dewi, A. P. (2020). The Repellency Effect of Lemongrass (Cymbopogon citratus) Essential Oil Aromatherapy Candle against Aedes aegypti. *BALABA*, *16*(1), 21–28. [Crossref] [Publisher]

Dompas, B. E. (2020). Is there a correlation between physical environmental factors in the home and the incidence of dengue fever? *Indonesian Journal of Public Health and Community Medicine V*, *2*(1), 11–15. [Crossref] [Publisher]

Fadilah, A. A. (2023). The Relationship Between Education Level, Use of Ventilation Using Wire Gauze, and Use

of Mosquito Repellent with The Incidence of Filarisis in Indonesia (Data Analysis Of Riskesdas 2018). *Medical Profession Journal of Lampung*, *13*(5), 859-869. [Publisher]

Ghali, H. (2024). An updated review on the safety of N, N-diethyl-meta-toluamide insect repellent use in children and the efficacy of natural alternatives. *Pediatric Dermatology*, *41*(3), 403-409. [Crossref] [Publisher]

Goldin, J., & Juergens, A. L. (2025). Filariasis. In *StatPearls*. StatPearls. [Publisher]

Hotez, P. J., Bottazzi, M. E., Strych, U., Chang, L. Y., Lim, Y. A. L., Goodenow, M. M., & AbuBakar, S. (2015). Neglected Tropical Diseases among the Association of Southeast Asian Nations (ASEAN): Overview and Update. *PLoS Neglected Tropical Diseases*, *9*(4), 1–15. [Crossref] [Publisher]

Jian, H., Lawford, H., Mclure, A., Lau, C., & Craig, A. (2026). Global Lymphatic Filariasis Post-Validation Surveillance Activities in 2025 : A Scoping Review. *TropicalMed*, *11*(1), 1–22. [Crossref] [Publisher]

Juwita, F. (2020). Risk Factors of Filariasis in Brebes Regency. *Public Health Perspective Journal*, *5*(2), 137–146. [Publisher]

Kementerian Kesehatan RI. (2018). Laporan Riset Kesehatan Dasar Provinsi Sumatera Utara tahun 2018. In *Kementerian Kesehatan Republik Indonesia*. [Publisher]

Lase, A. (2024). Analisis Sanitasi Lingkungan dan Pengendalian Nyamuk di Kota Tarutung. *TOBA (Journal of Tourism, Hospitality and Destination)*, *3*(1), 26–32. [Crossref] [Publisher]

Narayanan, A. R., Mukund, S., Etican, A., & J, S. S. (2025). Navigating Filariasis in Adolescence : A Case Report of 16-Year-Old with Lymphatic Involvement. *INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN APPLIED SCIENCE (IJRIAS)*, *10*(6), 1671–1673. [Crossref] [Publisher]

Oktafian, M. (2021). Karakteristik Tempat Perindukan Nyamuk Culex sp. di Sekitar Tempat Tinggal Penderita Filariasis Limfatik di Kabupaten Brebes Tahun 2020. *Indonesian Journal of Public Health and Nutrition*, *1*(1), 133-141. [Publisher]

Rahmat, A. (2020). Faktor-faktor yang berhubungan dengan kejadian filariasis di Kabupaten Barito Kuala. *Dunia Keperawatan: Jurnal Keperawatan Dan Kesehatan*, *8*(1), 48-58. [Crossref] [Publisher]

Rahmi, I. R. (2022). Factors Associated with Filariasis Cases in Indonesia: A Systematic Review. *Jurnal Epidemiologi Kesehatan Komunitas*, *7*(2), 501-521. [Crossref] [Publisher]

Rani, R. (2024). Recent advances in degradation of N, N-diethyl-3-toluamide (DEET)—an emerging environmental contaminant: a review. *Environmental Monitoring and Assessment*, *196*(3), 238–248. [Crossref] [Publisher]

Roswati, S. (2021). A Systematic literature (Impact of Climate Change on Filariasis). *Annual Conference on Health and Food Science Technology*, 1012083. [Crossref] [Publisher]

Shenoy, R. K., & Bockarie, M. J. (2011). Lymphatic filariasis in children : Clinical features , infection burdens and future prospects for elimination. *Cambridge University Press*, *47*(2), 1–10. [Crossref] [Publisher]

Simelane, S. M. (2020). A mathematical model for the transmission dynamics of lymphatic filariasis with intervention strategies. *Acta Biotheoretica*, *68*(3), 297-320. [Crossref] [Publisher]

Siregar, P. A. (2021a). Risk Factors for Malaria in Coastal Communities in Pantai Cermin Sub-district, Serdang Bedagai Regency. *Tropical Public Health Journal*, *1*(2), 50-57. [Crossref] [Publisher]

Siregar, P. A. (2021b). Risk Factors of malaria among coastal communities in Pantai Cermin District, Serdang Bedagai Regency. *Tropical Public Health Journal*, *1*(2), 50–57. [Publisher]

Sofia, R. (2020). Analisis risiko penularan filariasis limfatik di Kabupaten Aceh Utara. *AVERROUS: Jurnal Kedokteran Dan Kesehatan Malikussaleh*, *6*(1), 1-16. [Crossref] [Publisher]

Sudiarti, M. (2021). Efektivitas daun zodia (Evodia suaveolens) sebagai repellent nyamuk Aedes aegypti. *Ruwa Jurai: Jurnal Kesehatan Lingkungan*, *15*(1), 8-15. [Crossref] [Publisher]

Sunish, I. P. (2024). Biodiversity of mosquitoes (Diptera: Culicidae) in phytotelmata from Car Nicobar Island, India.". *Bulletin of Entomological Research*, *114*(3), 393-404. [Crossref] [Publisher]

Usalma, U. (2020). Faktor Penyebaran Kasus Filariasis di Kabupaten Asahan. *Jukema (Jurnal Kesehatan Masyarakat Aceh)*, *6*(2), 134-140. [Publisher]

Wayangkau, E. C. (2025). The Relationship Between Environmental Factors, Adherence to Medication, and the Incidence of Filariasis in Sarmi Regency, Papua. *Jurnal Kesehatan Lingkungan Indonesia*, *24*(2), 186–193. [Crossref] [Publisher]

WHO. (2018). *Fact Sheets: Lymphatic Filariasis*.

Yati, L. M. C. (2020). Hubungan Sanitasi Lingkungan Dengan Keberadaan Jentik Nyamuk Terhadap Kejadian DBD di Desa Kesiman Kertalangu Kecamatan Denpasar Timur. *Jurnal Higiene*, *6*(1), 1–5. [Crossref] [Publisher]

Zuhruf, R. W. (2022). Environmental Characteristics in Endemic Filariasis Coastal Areas. *Jurnal Penelitian Dan Pengembangan Kesehatan Masyarakat Indonesia*, *3*(1), 42-51. [Crossref] [Publisher]