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ENVIRONMENTAL FACTORS INFLUENCING MALARIA TRANSMISSION IN PAYNESVILLE CITY- LIBERIA

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ABSTRACT

Malaria continues to be a leading cause of morbidity and mortality in Liberia, with urban areas like Paynesville experiencing significant transmission rates due to various environmental factors. This study investigates the key environmental determinants influencing malaria transmission among the residents of Paynesville, Montserrado County. Specific factors examined include stagnant water, inadequate drainage systems, poor waste management, and urban agricultural practices (small farms or gardens), all of which create breeding grounds for malaria vectors (female anopheles mosquitoes). Additionally, the study explores how socio-economic conditions, urban overcrowding, and climate-related factors (favorable to the malaria transmission vectors), such as rainfall and temperature, contribute to increased malaria transmission risk. Using a mixed-methods approach, this research collected data through field observations, surveys, and interviews with community dwellers, alongside a review of local malaria prevalence records. Results indicate that poorly managed drainage systems and the proximity of residential areas to stagnant water sources are the primary contributors to malaria transmission. These findings underscore the importance of addressing environmental management in malaria control efforts. This study offers critical insights into the relationship between environmental conditions and malaria transmission in

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urban Liberia. By identifying specific risk factors, it provides a foundation for implementing targeted interventions such as improved sanitation infrastructure, public health education, and sustainable urban planning to reduce malaria incidence in Paynesville-Liberia and similar settings across sub-Saharan Africa.

KEYWORDS

Malaria transmission, Environmental Factors, Mosquito Breeding, Public Health, Stagnant Water, Waste Management.

INTRODUCTION

Malaria remains one of the most significant public health challenges worldwide, particularly in sub-Saharan Africa. It is a life-threatening disease transmitted through the bites of infected *Anopheles* mosquitoes, which serve as vectors for *Plasmodium* parasites [1].

Despite global efforts to reduce the incidence of malaria, the disease continues to be endemic in many African nations, including Liberia. In Liberia, malaria accounts for a considerable proportion of morbidity and mortality, particularly among vulnerable populations such as children and pregnant women [2]. Paynesville, a populous urban district in Montserrado County, Liberia, is notably affected by malaria transmission. The environmental conditions and socio-economic circumstances within this region create ideal breeding grounds for mosquito vectors, contributing to sustained malaria transmission. Factors such as inadequate drainage systems, the presence of stagnant water, poor waste management practices, and substandard housing conditions exacerbate the situation. These environmental determinants, combined with limited access to healthcare, insufficient malaria prevention measures, and climate factors such as rainfall and temperature, have a profound impact on the spread of malaria in this community [3][4]. Understanding the environmental factors influencing malaria transmission in Paynesville is crucial for the design and implementation of effective control strategies. Recent studies indicate that urban malaria transmission, while

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different from rural areas, remains a significant issue due to urbanization patterns that lead to overcrowded living conditions and insufficient infrastructure [5]. Furthermore, urban agriculture, which often involves irrigation, provides mosquito breeding habitats close to human dwellings (Keiser et al., 2004). The purpose of this study is to identify and analyze the key environmental factors contributing to malaria transmission in Paynesville and provide recommendations for targeted interventions to reduce the disease burden. This research aims to contribute to the broader understanding of how environmental factors interact with malaria transmission in urban settings, with a specific focus on Liberia. By highlighting the unique challenges faced by the community dwellers of Paynesville, this paper seeks to provide evidence-based recommendations that could inform public health policies and community-based interventions aimed at mitigating malaria transmission in similar urban areas across sub-Saharan Africa.

LITERATURE REVIEW

Malaria transmission is strongly influenced by environmental conditions, which directly affect the breeding and survival of *Anopheles* mosquitoes, the vectors responsible for transmitting the *Plasmodium* parasites. Factors such as poor sanitation, stagnant water, and inadequate drainage systems create favorable breeding grounds for mosquitoes in urban settings (Keiser et al., 2004). Additionally, Paynesville's urban overcrowding exacerbates these risks, leading to increased malaria transmission rates.

Socio-economic factors such as poverty, low education levels, and inadequate access to healthcare are crucial determinants of malaria risk. In communities like Paynesville, lower-income households often reside in areas with inadequate infrastructure, where environmental management is poor, and residents have limited access to malaria prevention measures such as insecticide-treated nets and indoor spraying. These conditions increase exposure to mosquitoes and the likelihood of malaria transmission (Tusting et al., 2013).

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Climate variables, particularly temperature, rainfall, and humidity, play significant roles in the lifecycle of malaria vectors and the transmission of the disease. Higher temperatures can accelerate mosquito breeding cycles and parasite development. Rainfall, particularly in tropical regions like Liberia, contributes to the formation of stagnant water bodies, which serve as ideal mosquito breeding habitats (Caminade et al., 2014).

Understanding these climate-related dynamics is essential for effective malaria control in regions like Paynesville, where seasonal rainfall patterns can intensify transmission risks.

Urbanization trends in Africa are associated with increased malaria risks in many cities, including Paynesville. While urban areas traditionally have lower malaria prevalence compared to rural regions, the rapid pace of urbanization in many African cities has led to the creation of slum-like conditions with poor waste management and insufficient access to clean water.

These environmental conditions contribute to higher malaria transmission rates in cities (Klinkenberg et al., 2020).

Effective malaria control strategies must integrate environmental management, particularly in urban areas. Measures such as improving drainage systems, removing stagnant water sources, and ensuring proper waste disposal are critical to reducing mosquito breeding grounds. Additionally, urban planning that focuses on reducing overcrowding and improving housing conditions can further limit the exposure of residents to malaria vectors (WHO, 2015).

METHODOLOGY

This study employed a descriptive cross-sectional design, aimed at gathering data from participants as well as reviewing local malaria prevalence records. To explore the relationship between environmental factors and malaria transmission within the

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community [6], structured questionnaires were distributed to residents of Paynesville. These questionnaires sought to capture information on socio-economic conditions, malaria prevention strategies, and household-level environmental risks, such as drainage systems and stagnant water presence. Field visits were conducted to assess environmental conditions in selected areas. Variables such as drainage quality, waste management practices, and the proximity of stagnant water sources to residences were recorded [7]. The study population included all residents of Paynesville City, which, according to the 2014 census, had an estimated population of approximately 400,000 males and females.

SAMPLE SIZE AND SAMPLING TECHNIQUES

According to the 2014 census data, the population of Paynesville City was approximately 400,000.

The researcher therefore used the accepted scientific formula below to come up with the sample size. Formula: ($n=Z^2_{X2}$ P (1-P)/$(SE)^2$), where n= unknown sample size, Z^2=1.96, P=probability of selection, 1-P= q or probability of not selecting, SE^2=standard error and 0.5 was used as margin of error.

However, the sample size for this study was 400 respondents (male and female) between ages of 18-55years which the researcher used for the study that cut across all streets in the study area of Paynesville.

The research employed a multi-stage sampling approach. Stratified sampling technique was adopted to select the number of houses in each street selected for this study. A purposive sampling technique was used to select 400 respondents, (180 male and 220 females) who are volunteers. Proportionate sampling technique was used to select 50% married respondents in Paynesville City and used for the study.

RESEARCH INSTRUMENT

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The sample for this study comprised of 400 respondents ranging from age 18-55 years randomly selected from Paynesville City. A self-structured questionnaire was designed tagged (ESQ) Environmental Sanitation Questionnaire and used for this study. The survey was organized into three distinct parts: (**Section A, Section B, and Section C**).

Section A contained information relevant to the demographic data of the respondents while section B sought information on the research questions while section C focus on the variables under study.

DESCRIPTION OF THE STUDY AREA

Liberia is officially **Republic of Liberia,** Republic, Western Africa. Area: 37,466 sq mi (97,036 sq km). Population: (2023 est.) 5,209,000. Capital: Monrovia. In Liberia, the population includes Americo-Liberians, who are descendants of freed African American slaves that resettled from the United States in the 19th century, alongside 16 native ethnic groups from the Mande, Kwa, and Mel language families. Languages: English (official), indigenous languages. Religions: traditional beliefs, Christianity, Islam. Currency: Liberian dollar Liberia features a stretch of coastal plains that run 350 miles (560 kilometers) along the Atlantic Ocean, which transitions into hilly terrain and modest mountains further inland. Africa's oldest republic, Liberia was established on land acquired for freed U.S. The American Colonization Society established a colony at Cape Mesurado in 1821, which was primarily populated by freed slaves.

In 1822 Jehudi Ashmun, a Methodist minister, became the director of the settlement and Liberia's real founder. In 1824, the area was christened Liberia, with Monrovia designated as its principal city.. Joseph Jenkins Roberts proclaimed Liberian independence in 1847 and expanded its boundaries. Border disputes with the French and British lasted until 1892, when its boundaries were officially established.

Liberia has 15 counties. Monserrado is one of the counties, which host Paynesville City. The city is a suburb of the capital Monrovia that has several neighborhoods, *called* "*communities*" by residents, which are notable for their unique

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names. It has seen rapid population growth in recent years, creating significant demands for public health services, such as the control of malaria [8] [9]

PROCEDURE FOR DATA COLLECTION

The researcher signed a letter of introduction from the Head of Department, of Environmental Health at the International Academic Management Association (IAMA) University for Identification Purpose to the Paynesville City Major and made advance familiarization tour and enlightenment visit to all the community selected for the study and sought the consent of household heads for their absolute support. The instrument was distributed in the morning before setting to work and market places and the evening especially weekends and during relaxation hours by the researcher and assistant researchers and collection was made on the spot to ensure a high rate of returns of accurate data.

PROCEDURE FOR DATA ANALYSIS

The instruments collected were analyzed using frequency counts and percentage, pie and bar chart for the demographic data, while correlation matrix was used for the research question and the analysis of the hypotheses was conducted at a 0.05 significance level.

RESULTS

The result revealed that poorly managed drainage systems and the proximity of residential areas to stagnant water sources created by the people living in Paynesville are the primary contributors to malaria transmission among the people of Paynesville City. These findings underscore the importance of addressing environmental management in malaria control efforts.

Below is the inter-co relational matrix of the relationship between poorly managed drainage systems and the proximity of residential areas to stagnant water sources components in the control of malaria transmission among Paynesville residence.

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The table revealed that frequency of cleaning the surrounding bushes and grasses of the respondents (r=-0.6120, N=400,P<0.05), frequency of cleaning the drainage system (r=-0.7605, N400, P<0.05), availability of the drainage system around the house (r=-0.8999, N400, P<0.05), frequency of cleaning the toilet facilities (r=-0.0370, N400, P<0.05), presence of small farmland in areas of residence (r=-0.0692, N400, P<0.05).

This implies that frequency of cleaning the surrounding bushes and grasses, frequency of cleaning the drainage system, availability of the drainage system around the house, frequency of cleaning the toilet facilities, presence of small farmland in areas of residence had positive relationship in the control of malaria and other diseases among the people of Paynesville City- Liberia.

This below table indicates the frequency of cleaning the toilet facilities, presence of small farmland in areas of residence as environmental sanitation practice by the people of Paynesville City.

FREQUENCY OF CLEANING THE SURROUNDINGS OF BUSHES AND GRASSES	Frequency	Percent	Cum. Percent	Wilson 95% LCL	Wilson 95% UCL
Every 2-3 months	90	23%	23%	19%	27%
Every six months	8	2%	25%	1%	4%
Monthly	138	35%	59%	30%	39%
Weekly	106	27%	86%	22%	31%
Whenever I like/except visitors	58	15%	100%	11%	18%
TOTAL	**400**	**100.00%**	**100.00%**		

This table indicates that **138** respondents, accounting for 35% are cleaning the surrounding bushes and grasses on the monthly bases, **106** respondents, representing 27% clean on the weekly bases, **90** respondents representing 23% do clean every 2-3 months, **58** respondents, representing 15% can only do so whenever they like or expect guest/strangers, and **8** respondents, representing just 2% do so every six months.

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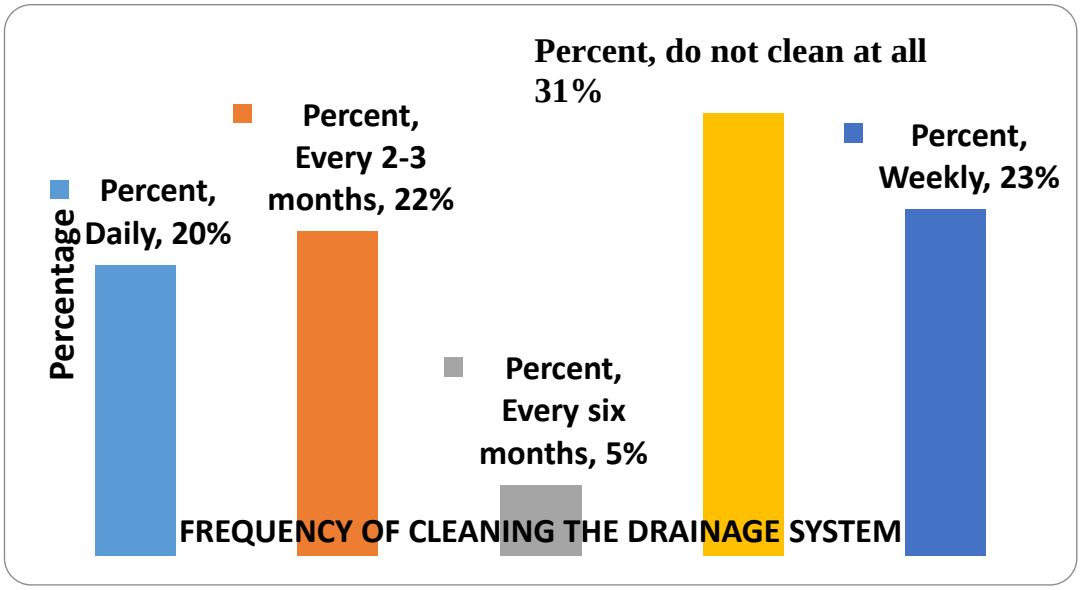
Frequency of Cleaning the Drainage System of the Respondents



This above table presents **123** respondents, accounting for 31% are not cleaning the drainages around their houses at all, **93** respondents, representing 23% do clean the drainages weekly, **87** respondents, representing 22% clean the drainages every 2-3 months, **78** respondents, representing 20% do clean on the daily basis and **19** respondents, representing 5% do clean the drainage every six months. From the above projection, the researcher discovered that in addition to other influencing factors, failure by the majority of the residence of Paynesville City to clean the drainage system in and around their houses have resulted to increasing the mosquito population; thereby escalating the malaria transmission rate in the selected community.

Correlation matrix showing perceived environmental sanitation components in the control of malaria and other diseases among the people of Paynesville City.

	Malaria	Frequency of Cleaning the Surrounding Bushes and Grasses of the Respondents	Frequency of Cleaning the Drainage System of the Respondents	Availability of the drainage system around the house of the respondents	Frequency of cleaning the toilet facilities	Presence of small farmland in areas of residence
Malaria	1					

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Frequency of Cleaning the Surrounding Bushes and Grasses of the Respondents	-0.6120	1				
Frequency of Cleaning the Drainage System	-0.7605	0.1993	1			
Availability of the drainage system around the house	-0.8999	0.2396	0.7750	1		
Frequency of cleaning the toilet facilities	0.0370	0.0689	0.0086	-0.0107	1	
Presence of small farmland in areas of residence	-0.0692	-0.0338	0.0086	-0.0299	-0.0181	1

Correlation is significant at 0.05 (2-tailed); N=400

Summary of joint contribution of perceived environmental sanitation 'components' in the control of malaria and other disease among the people of Paynesville City.

Model	Sum of Square	Df	Mean square	F	Sig. P. value	Remark
Regression Residual	685.836 387.460	4 395	186.459 1.806	98.409	.000	Sig
Total	1073.296	399				

Also as indicated in table above, it was found that the linear contribution of perceived environmental sanitation component was tested significance on Distribution of

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insecticides treated nets, Wearing protective clothing, Residual house spraying, Door to door sensitization, frequency of cleaning the drainage system, in the control of malaria among the people of Paynesville . Indicating that about 61.7% of the variance was accounted for by the independent variables.

DISCUSSION/CONCLUSION OF RESULTS

The findings were discussed in line with the research question and hypotheses, which implies that frequency of cleaning the surrounding bushes and grasses, frequency of cleaning the drainage system, availability of the drainage system around the house, frequency of cleaning the toilet facilities, presence of small farmland in areas of residence the people of Paynesville were positively correlated in the environmental factors influencing the transmission of malaria.

This is according to the study conducted in Sierra Leone; which focused on understanding the impact of environmental factors on malaria transmission and explored interventions like long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS) in mitigating transmission rates. The research was particularly significant in examining how socio-environmental variables contribute to malaria risks in endemic regions like sub-Saharan Africa [10].

Another study was conducted in the Niger Delta region of Nigeria, specifically pointing to the challenges associated with pollution, land degradation, and how these factors influence the health and livelihoods of local communities. The study highlighted the adverse environmental effects resulting from oil spills and gas flaring, which contribute to the degradation of ecosystems and increase health risks, including diseases such as malaria, due to stagnant water from oil blockages, which can create breeding grounds for mosquitoes [11].

Also according to study done in Accra, Ghana, it was observe that about 60-70 per cent of solid waste generated in the markets and other public places often find their way into

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an open drains and create a breeding ground for mosquitoes and insects; thereby increasing the transmission rate of malaria. [12][13].

Furthermore, the researcher wanted to establish the link between sanitation and the risks of malaria transmission rate. He therefore used regression analysis and correlation analysis to have this achieved. The result from the above analysis indicates that poor sanitary activities practiced by the community dweller, has increased the malaria transmission rate in the community under review.

Therefore based on the research findings or result of the study, it can be concluded that there are environmental factors influencing the transmission of malaria among the people of Paynesville, evidence by the all variables in the study that showed significantly positive.

CONCLUSION

In conclusion, this study has highlighted the significant environmental factors influencing malaria transmission in Paynesville City, Liberia. The findings reveal that poorly managed drainage systems and the close proximity of residential areas to stagnant water sources play a pivotal role in driving the high incidence of malaria within the community. These environmental conditions, largely influenced by human activity, create ideal breeding grounds for mosquitoes, which are the primary vectors of malaria.

Addressing these challenges requires a multifaceted approach, including improving drainage infrastructure, enhancing community awareness, and promoting sustainable sanitation practices.

Effective interventions targeting these environmental factors could significantly reduce malaria transmission and improve the health outcomes of residents in Paynesville City. Collaborative efforts between local authorities, healthcare providers, and the community are essential in mitigating the risks and fostering a healthier, malaria-free environment for future generations.

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