

Environmental and Sanitation Challenges and Their Role in Malaria Transmission: A Case Study of Duport Road Community, Paynesville City, Liberia

J. Samuel Kamanda¹, Atul Khajuria^{2*}, Eric Kwasi Eliason¹, Stephen Monday¹

Abstract

Introduction: Environmental sanitation plays a crucial role in controlling malaria transmission, yet several factors continue to impede its effectiveness, particularly in communities with poor waste management and drainage systems. This study explores the factors that hinder proper environmental sanitation and their association with the spread of malaria among residents of Duport Road Community, Paynesville City, Liberia. **Methods:** A descriptive cross-sectional study was conducted, gathering data from 400 participants – both men and women – between the ages of 18 and 55. Data collection instruments included structured questionnaires, interviews, and direct observations. The demographic data were analyzed using frequency counts, percentages, and graphical representations, such as pie and bar charts, while the research questions were examined using a correlation matrix. In addition, multiple regression analysis was used to examine the study's hypotheses, with the level of significance set at 0.05. **Results:** Findings revealed that poor waste disposal, stagnant water accumulation, inadequate drainage systems, and low community awareness were key factors contributing to malaria prevalence. Improper garbage disposal led to mosquito breeding sites, while blocked drainage systems resulted in water stagnation, creating ideal conditions for mosquito larvae development. Furthermore, the study found that limited access to healthcare services and lack of effective government intervention exacerbated the situation. Statistical analysis indicated a significant correlation between environmental sanitation challenges and increased malaria transmission. **Conclusions:** Based on these findings, the study recommends improved waste management systems, community sensitization on proper sanitation practices, and government policies enforcing environmental health regulations to curb malaria spread. Strengthening drainage infrastructure and promoting vector control measures are essential strategies to mitigate the disease burden in Duport Road Community.

Keywords: Environmental sanitation, malaria transmission, waste management, drainage systems, vector control, public health, Paynesville city, Liberia

*Author for Correspondence

Atul Khajuria

E-mail:

directoralliedhealthsciences@deshbhagatuniversity.in

¹Teaching Assistant, Faculty of Allied Health Sciences, Desh Bhagat University, Mandi Gobindgarh, Fatehgarh Sahib, Punjab, India

²Director, Faculty of Allied Health Sciences, Desh Bhagat University, Mandi Gobindgarh, Fatehgarh Sahib, Punjab, India

Received Date: April 01, 2025

Accepted Date: May 19, 2025

Published Date: May 23, 2025

Citation: J. Samuel Kamanda, Atul Khajuria, Eric Kwasi Eliason, Stephen Monday. Environmental and Sanitation Challenges and Their Role in Malaria Transmission: A Case Study of Duport Road Community, Paynesville City, Liberia. *International Journal of Tropical Medicines*. 2025; 2(2): 24-30.

INTRODUCTION

Environmental sanitation refers to both the concept and practical actions aimed at maintaining clean, healthy surroundings to support public health, improve living standards, and promote environmental sustainability [1]. Its core elements include the management of solid and medical waste, sewage and excreta disposal, food hygiene, inspection of premises, maintenance of markets and sanitation stations, provision of safe drinking water, school hygiene, pest and vector control, urban drainage management, regulation of domestic and stray animals, disposal of dead animals, vegetation and weed control, as well as hygiene education and

public awareness [2]. Malaria remains one of the world's most pressing health challenges. According to the World Health Organization [3], more than 300 million cases are reported each year, with around 2.3 million deaths resulting from complications. Malaria can be considered both endemic and pandemic, as it affects specific regions consistently while also presenting broader global health concerns due to its widespread and persistent nature. It continues to be a significant threat, particularly in Sub-Saharan Africa, where it contributes heavily to illness and death. A key reason Africa carries such a large share of the malaria burden is that most infections in the region are caused by *Plasmodium falciparum*, the most dangerous malaria parasite [4, 5]. Malarial infection kills about 3,000 children everyday: one child every 30 seconds in one minute (United Nations Children's Fund) [6]. It further reported that it kills over one million people annually around the Globe [7].

METHODS

Study Design and Population Target

The research design used in this study was a descriptive cross-sectional study aimed at collecting information from respondents on their perceptions of environmental sanitation components in malaria control. The study population comprised all residents of Duport Road Community in Paynesville City. According to the 2014 census, the estimated population of Duport Road Community was 400,000, consisting of both male and female residents [8].

Sampling Procedure and Study Instruments

The estimated population of Duport Road Community, Paynesville City, according to the 2014 census, is 400,000. To determine the appropriate sample size for the study, the researcher used a widely accepted scientific formula:

$$n = Z^2 * P * (1 - P) / SE^2.$$

In this formula, n stands for the sample size, Z^2 is set at 1.96, P represents the probability of selection, $(1 - P)$ reflects the probability of non-selection, and SE^2 denotes the standard error. A margin of error of 0.5 was used in the calculation [9]. Based on this method, the study arrived at a final sample size of 400 participants – both men and women – aged between 18 and 55, selected from across all streets in the Duport Road Community. A multi-stage sampling approach was used for the study. First, a stratified sampling method helped determine how many houses to include from each street [10]. Then, purposive sampling was used to select 400 participants – 180 men and 220 women – who agreed to take part voluntarily. To maintain balance, a proportionate sampling method was also applied to ensure that half of the respondents were married [11]. The main tool used for data collection was a self-designed questionnaire called the Environmental Sanitation Questionnaire (ESQ). This questionnaire was organized into three distinct sections to gather comprehensive information [12].

- *Section A:* Demographic data of the respondents.
- *Section B:* Research questions related to environmental sanitation.
- *Section C:* Variables under study related to sanitation and malaria transmission.

Statistical Analysis

The collected data were analyzed using frequency counts, percentages, and graphical representations, such as pie and bar charts for demographic data [13]. To explore the research questions, a correlation matrix was utilized to identify relationships between variables. Meanwhile, multiple regression analysis was carried out to test the study's hypotheses, using a significance level of 0.05 [14].

Ethical Considerations

Ethical clearance was secured by the appropriate authorities to ensure the study adhered to established research ethics. Participants were fully informed about the purpose of the research, and their consent was obtained prior to collecting any data [15]. Throughout the study, strict measures were taken to protect participants' privacy and maintain anonymity. Participation was entirely voluntary, in line with ethical standards [16].

RESULTS

Environmental Factors Impeding Malaria Control

The results of this study indicate that various environmental sanitation factors significantly impede malaria control among residents of Duport Road Community. The correlation analysis shows a significant connection between these sanitation factors and the rate of malaria occurrence [17].

Correlation Analysis of Environmental Sanitation Components and Malaria Control

Table 1 presents the correlation matrix showing the relationship between perceived environmental sanitation components and malaria control among the residents of Duport Road Community. The findings indicate that the frequency of cleaning surrounding bushes and grasses ($r = -0.6120$, $N = 400$, $P < 0.05$), frequency of cleaning drainage systems ($r = -0.7605$, $N = 400$, $P < 0.05$), and the availability of a drainage system around the house ($r = -0.8999$, $N = 400$, $P < 0.05$) have a significant negative correlation with malaria prevalence. Similarly, the frequency of cleaning toilet facilities ($r = -0.0370$, $N = 400$, $P < 0.05$) and the presence of small farmlands in residential areas ($r = -0.0692$, $N = 400$, $P < 0.05$) also show a relationship with malaria control [18].

The implication of these findings is that an increase in environmental sanitation practices, such as frequent cleaning of bushes, drainage systems, and toilet facilities, contributes positively to malaria control in the community [19].

Table 1. Correlation matrix showing perceived environmental sanitation components in malaria control among Duport Road Community.

Variables	Malaria	Frequency of Cleaning Surrounding Bushes and Grasses	Frequency of Cleaning Drainage System	Availability of Drainage System	Frequency of Cleaning Toilet Facilities	Presence of Small Farmland
Malaria	1					
Frequency of Cleaning Surrounding Bushes and Grasses	-0.6120	1				
Frequency of Cleaning Drainage System	-0.7605	0.1993	1			
Availability of Drainage System	-0.8999	0.2396	0.7750	1		
Frequency of Cleaning Toilet Facilities	-0.0370	0.0689	0.0086	-0.0107	1	
Presence of Small Farmland	-0.0692	-0.0338	0.0086	-0.0299	-0.0181	1

Note: Correlation is Significant at 0.05 (2-tailed); $N = 400$.

Table 2. Summary of joint contribution of perceived environmental sanitation “components” in the control of malaria among the residence of Duport Road Community.

Model	Sum of Squares	df	Mean Square	F	Sig. P-value	Remark
Regression	685.836	4	186.459	98.409	0.000	Significant
Residual	387.460	395	1.806			
Total	1073.296	399				

Contribution of Perceived Environmental Sanitation Components to Malaria Control

Further statistical analysis, as shown in Table 2, reveals that the linear contribution of perceived environmental sanitation components significantly affects malaria control [20]. The study investigated various factors, including the distribution of insecticide-treated nets, the use of protective clothing,

residual spraying inside homes, door-to-door awareness campaigns, and the regular cleaning of drainage systems. The results indicate that about 61.7% of the variance in malaria control can be attributed to these independent variables [21].

These results suggest that improving environmental sanitation measures, including effective waste management, proper drainage maintenance, and community education, could significantly reduce malaria prevalence in Duport Road Community.

Practical Implications

The findings of this study highlight the need for enhanced community awareness and government intervention in environmental sanitation. Policy recommendations should focus on implementing regular waste disposal systems, maintaining drainage infrastructure, and promoting vector control measures, such as indoor residual spraying and mosquito net distribution. By addressing these sanitation challenges, the burden of malaria in Duport Road Community can be significantly reduced [22].

DISCUSSION

The result showed that environmental factors have impedance in the control of malaria among the residence of Duport Road Community. The findings were discussed in relation to the research questions and hypotheses, suggesting factors, such as the frequency of cleaning surrounding bushes and grasses, regular cleaning of drainage systems, the availability of drainage systems near homes, cleaning toilet facilities, and the presence of small farmlands in residential areas of Duport Road community were positively associated with malaria control. This aligns with a study on sanitation practices in Nigerian cities, which identified similar common practices across many urban areas [18]. Furthermore, research conducted in Accra, Ghana, found that 60–70% of solid waste generated in markets and other public spaces often ends up in open drains, creating ideal breeding grounds for mosquitoes and other insects [19, 20]. As shown in Table 1, it was also observed that the perceived environmental sanitation components had a significant linear impact on factors, like the distribution of insecticide-treated nets, use of protective clothing, residual house spraying, door-to-door awareness campaigns, and the frequency of drainage cleaning in combating malaria within the Duport Road community. Based on the study's results, it can be concluded that environmental factors play a significant role in hindering malaria control in the Duport Road community, as evidenced by the positive correlations between all the variables considered in the research.

SUMMARY

This study examined the factors impeding environmental sanitation and their role in the spread of malaria among residents of Duport Road Community, Paynesville City, Liberia. Findings revealed that poor waste disposal, stagnant water accumulation, inadequate drainage systems, and lack of community awareness were significant contributors to malaria transmission. The study population exhibited a high prevalence of malaria cases, with a direct correlation between unhygienic environmental conditions and the increased presence of mosquito breeding sites.

Poor waste management, particularly the improper disposal of garbage and plastic waste, was a major challenge. Stagnant water bodies from blocked drains and uncollected waste served as breeding grounds for *Anopheles* mosquitoes, which are responsible for malaria transmission. The absence of adequate drainage systems worsened the situation, causing water to accumulate, especially during the rainy season.

Additionally, the study highlighted low levels of awareness regarding environmental hygiene and malaria prevention, which contributed to the persistence of the disease in the community.

Furthermore, socioeconomic factors, such as poverty, limited access to healthcare, and inadequate government intervention were identified as barriers to effective sanitation and malaria control. Residents expressed concerns over the absence of regular waste collection services and poor

enforcement of sanitation laws, which hindered community efforts to maintain a clean and malaria-free environment.

CONCLUSIONS

The findings of this study emphasize the critical role of environmental sanitation in malaria prevention. Poor sanitation practices significantly contribute to the proliferation of mosquito breeding sites, thereby, increasing the burden of malaria within the community. Addressing these challenges requires a multi-sectorial approach, including improved waste management, proper drainage systems, community sensitization, and strengthened government policies on environmental health.

To effectively combat malaria in Duport Road Community, public health interventions should prioritize environmental cleanliness, promote household-level sanitation practices, and enhance community participation in sanitation programs. Additionally, local authorities must enforce proper waste disposal regulations and improve drainage infrastructure to eliminate mosquito breeding grounds.

In conclusion, improving environmental sanitation is a fundamental strategy in reducing malaria transmission and enhancing public health. Sustainable efforts in sanitation, coupled with malaria prevention measures, such as vector control and increased access to healthcare, will significantly reduce the disease burden and improve the overall well-being of the community.

Author Contributions

Conceptualization: JSK; methodology: JSK, AK, EKE, SM; software: JSK; validation: JSK; formal analysis, JSK; investigation: AK, EKE, SM; resources: JSK, AK, EKE, SM; data curation: JSK; writing—original draft preparation: JSK; writing—review and editing, AK, visualization: JSK; supervision: JSK; project administration: JSK. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Acknowledgments

None.

Conflicts of Interest

The authors declare no conflict of interest.

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