

Factors Leading to Acceptability of Indoor Residual Spraying Coverage in Urban Areas of Luwingu District, Zambia

Moses Mukosha*

Department Of Public Health And Environmental Sciences,
Levy Mwanawasa Medical University in Zambia.

Corresponding Author: Moses Mukosha, Department Of Public Health And Environmental Sciences, Levy Mwanawasa Medical University in Zambia.

Received: 📅 2025 Aug 19

Accepted: 📅 2025 Sep 18

Published: 📅 2025 Sep 23

Abstract

Introduction

Indoor Residual Spraying (IRS) is a crucial intervention for malaria control, yet its acceptability in urban areas remains understudied, particularly in Luwingu District, Zambia. This research aimed to identify the factors influencing the acceptability of IRS coverage in Luwingu urban setting and to provide insights for improving malaria control strategies and elimination by 2030.

Methods

A cross-sectional study was conducted using a structured questionnaire administered to 344 households in the urban area of Luwingu District. The questionnaire encompassed variables such as age, sex, religion, marital status, occupation, and IRS coverage status. Data was analysed using statistical package for the social sciences (SPSS. 28.0) included descriptive statistics and logistic regression to identify factors associated with IRS acceptability.

Results

Among the surveyed households, 53.3% reported being sprayed with IRS, while 46.8% were not. The analysis revealed several key factors influencing IRS acceptability. Age was found to be significant, with younger individuals more likely to accept IRS. Gender also played a role, with females more likely to accept IRS compared to males. Additionally, marital status was associated with acceptability, with married individuals showing higher acceptance rates. Occupation and religious affiliation were not significant predictors of IRS acceptability in this context. The findings suggest that targeted strategies should be developed to address the diverse needs and preferences of different demographic groups within the urban population. These may include tailored communication campaigns, community engagement initiatives, and incentives to improve IRS uptake among specific demographics.

Conclusion

The study underscores the importance of understanding local contexts and Socio-demographic factors in designing effective malaria control programs. Targeted interventions informed by the identified factors can enhance IRS acceptability and coverage in urban areas, contributing to the overall goal of malaria elimination in Luwingu District and similar settings.

Keywords: Indoor Residual Spraying, Malaria Control, Urban Health, Acceptability, Luwingu District, Zambia

1. Introduction

1.1 Background

Indoor Residual Spraying (IRS) is a prominent vector control strategy extensively utilized to combat malaria transmission, particularly in endemic regions. According to the World Health Organization (WHO), in 2020, there were an estimated 229 million cases of malaria globally, with a staggering 94% of these cases occurring in Africa (WHO, 2021). Zambia, located in southern Africa, has been significantly impacted by malaria, prompting the adoption of various control measures, including IRS. Indoor Residual Spraying involves the application of insecticides to the

interior walls of houses. This strategy is designed to kill and repel adult malaria mosquitoes, thereby controlling the mosquito population and reducing the incidence of malaria. The process is effective in reducing the density of vector mosquitoes, which directly contributes to a decrease in malaria cases. Studies have consistently shown that IRS is a crucial tool in malaria control. For example, Hilton et al. (2023) demonstrated the effectiveness of IRS in reducing malaria transmission in various regions, highlighting its importance in integrated malaria control strategies. The development and utilization of residual insecticides have significantly influenced malaria control efforts, particularly

from the late 20th century onwards. The discovery of these insecticides and their efficacy in controlling malaria transmission led to the widespread adoption of IRS in areas severely affected by malaria epidemics. Residual insecticides remain effective over extended periods, ensuring continued protection against malaria vectors and contributing to sustained reductions in malaria incidence [1-4].

In Zambia, the National Malaria Elimination Center (NMEC) of the Ministry of Health has embraced IRS as a fundamental component of its malaria control strategy. This approach aligns with the national policy outlined in the National Malaria Communication Strategy Plan (2022-2026), which emphasizes IRS as a major means of malaria vector control (NMEC, 2022). The implementation of IRS in Zambia reflects a commitment to leveraging proven interventions to reduce malaria transmission and ultimately achieve malaria elimination. The integration of IRS into Zambia's malaria control efforts underscores its effectiveness as part of a broader strategy that includes other preventive measures, such as insecticide-treated nets and antimalarial medications. By continuing to utilize IRS alongside these complementary interventions, Zambia aims to make significant progress in reducing malaria morbidity and mortality, ultimately working towards the goal of malaria elimination.

1.2 Statement of the Problem

Malaria remains a critical public health issue in Luwingu District, especially during the rainy season from November to April, which creates optimal conditions for mosquito breeding. According to the Luwingu District Health Management Information System (HMIS) Reports for 2021, malaria is the leading cause of illness, with an estimated incidence rate exceeding 400 cases per 1,000 population (Luwingu DHMT, 2021). Despite robust Information, Education, and Communication (IEC) campaigns advocating for IRS and substantial financial support from partners for malaria prevention, IRS coverage in Luwingu urban areas remain insufficient. This discrepancy is inconsistent with the coverage targets outlined in the NMEC Strategy Plan for 2022-2026 (NMEC, 2022). Research by Williams et al. (2022) and Jones et al. (2023) highlights that barriers to effective IRS implementation include logistical challenges and community engagement issues. Understanding these factors is crucial for enhancing malaria control efforts and improving health outcomes in Luwingu urban communities [5].

1.3 Study Justification

Indoor Residual Spraying is a vital vector control strategy for combating malaria, especially in high-risk areas like urban settings. Effective IRS implementation requires high coverage rates to reduce mosquito populations and interrupt malaria transmission. However, achieving this in urban areas can be challenging due to community acceptance issues. The success of IRS programs depends heavily on local cooperation and acceptance, which can be difficult in densely populated areas. In Luwingu District, Northern Zambia, despite various vector control measures, including IRS, challenges such as inadequate community

acceptance and misconceptions may hinder effectiveness. Limited research exists on factors affecting IRS acceptability in Luwingu's urban settings, making it essential to explore these factors to improve IRS coverage and reduce malaria incidence and related morbidity. Understanding community perceptions through cross-sectional and qualitative methods can guide the development of targeted interventions, such as community engagement strategies and tailored communication campaigns. This research will inform local and national health policies, contributing to Zambia's malaria elimination goals and aligning with global health objectives set by the World Health Organization (WHO, 2019).

1.4 Research Question

- What is the level of awareness among urban residents in Luwingu District regarding Indoor Residual Spraying (IRS) as a malaria prevention method?
- What are the perceptions of urban residents in Luwingu District regarding the effectiveness of IRS in reducing malaria transmission?
- What are the attitudes of urban residents in Luwingu District towards the safety and potential health risks associated with IRS?

1.5 Objectives

1.5.1. General Objective

To assess the associated factors influencing Indoor Residual Spraying (IRS) coverage in urban areas of Luwingu District, Zambia.

1.5.2. Specific Objectives

- To assess the level of awareness among urban residents in Luwingu District regarding Indoor Residual Spraying (IRS).
- To explore the perceptions of urban residents in Luwingu District regarding the effectiveness of IRS in reducing malaria transmission.
- To examine the attitudes of urban residents in Luwingu District towards IRS.

2. Overview

Indoor residual spraying (IRS) is widely used intervention for vector control in malaria-endemic areas. According to WHO, IRS involves the application of insecticides to the interior surfaces of houses to kill mosquitoes that transmit malaria. Several studies have emphasized the importance of IRS in reducing malaria transmission rates and improving public health outcomes (WHO 2019). Indoor Residual Spraying is a critical component of malaria control strategies globally. It involves applying long-lasting insecticides to the walls and ceilings of homes to kill mosquitoes that come into contact with these surfaces. The World Health Organization has identified IRS as one of the most effective measures for rapidly reducing malaria transmission in endemic regions (WHO, 2019) [6].

2.1 Awareness of Indoor Residue Spraying

Globally, awareness of Indoor Residual Spraying (IRS) and its benefits is fundamental to achieving high coverage rates and ensuring effective malaria control. IRS is a critical vector control measure that involves applying insecticides

to the interior walls of homes to kill and repel malaria-carrying mosquitoes. Research by O'Brien et al. (2024) underscores the importance of increased awareness in boosting participation in health programs like IRS. The study reveals that comprehensive awareness campaigns are pivotal in enhancing engagement and adherence to IRS protocols. These campaigns educate communities about the efficacy and safety of IRS, thereby increasing acceptance and participation. Green et al. (2021) further supports this view, showing that targeted awareness efforts, which make information about IRS more accessible and understandable, lead to improved participation rates and better health outcomes. The researchers highlight that effective communication strategies can bridge knowledge gaps and foster a more informed public, ultimately leading to more successful IRS implementation.

In Africa, where the malaria burden is disproportionately high, awareness is crucial for improving IRS coverage. Hilton et al. (2023) demonstrate that in numerous African countries, the success of IRS programs is closely tied to community awareness and understanding of the intervention's benefits. The study found that regions with robust awareness campaigns experienced better IRS coverage and a reduction in malaria incidence. This correlation highlights the critical role of public education in enhancing the effectiveness of IRS. Rajatileka et al. (2018) add that in urban settings across Africa, addressing awareness gaps and misconceptions is essential for improving IRS uptake. They emphasize that misconceptions about IRS safety and efficacy can hinder program success, suggesting that overcoming these barriers through targeted education can significantly enhance IRS coverage and impact [7,8].

In Zambia, awareness has a direct influence on IRS coverage and effectiveness. According to Chanda et al. (2020), inadequate community awareness has been a significant barrier to achieving the desired IRS coverage in Zambia. The study points out that many communities lack sufficient knowledge about the benefits and safety of IRS, which affects their willingness to participate. To address this issue, Chanda et al. (2020) recommend increased efforts in community education and engagement. They stress the need for tailored communication strategies that effectively convey the importance of IRS and address any misconceptions. This approach is crucial for improving IRS coverage and ensuring that the intervention reaches its intended impact. The National Malaria Elimination Centre (NMEC) of Zambia aligns with these findings by emphasizing the need for effective communication strategies to enhance public understanding and acceptance of IRS. The NMEC's National Malaria Strategic Plan 2022-2026 highlights the importance of addressing awareness and knowledge gaps as part of its broader strategy to control and eliminate malaria. By focusing on improving community awareness and engagement, Zambia aims to achieve higher IRS coverage rates and reduce malaria transmission.

2.2. Perception of Indoor Residue Spraying

Globally, community perceptions of Indoor Residual Spraying

(IRS) play a critical role in the success of malaria control programs. As noted by Roberts et al. (2023), favorable perceptions of IRS often lead to higher participation rates and better adherence to spraying protocols. This is essential in achieving the widespread coverage needed to disrupt malaria transmission. Positive views on IRS, such as beliefs in its effectiveness in reducing mosquito populations and preventing malaria, are pivotal for program success. However, negative perceptions, often fueled by concerns over health risks, distrust in public health authorities, or previous adverse experiences, can significantly deter participation.

A study by Smith et al. (2021) in Southeast Asia found that communities with a strong belief in the efficacy of IRS were more likely to engage actively with the program. Conversely, a lack of understanding about IRS and its benefits often leads to skepticism and resistance. For example, in some regions of South America, misinformation about the health impacts of insecticides used in IRS led to a decline in community participation (Garcia et al., 2020). Further, Khosla et al. (2022) highlighted that in India, fears regarding the chemical components of IRS sprays contributed to a 20% drop in household participation in some districts, demonstrating the need for robust educational campaigns [9].

Educational initiatives that clearly communicate the benefits and safety of IRS have proven effective in changing perceptions. In a study conducted in Papua New Guinea, Harris et al. (2019) found that door-to-door visits by healthcare workers who explained the importance and safety of IRS significantly increased acceptance rates. Similarly, Thompson and Rivers (2020) reported that community-based education programs in rural Nepal improved knowledge and acceptance of IRS, particularly when local health workers were involved in the dissemination of information. Furthermore, involving community leaders in planning and executing IRS programs has shown to be effective. For instance, Wright et al. (2018) observed in a study in Haiti that when local leaders endorsed the IRS program, the community's trust and participation significantly increased.

In the African context, similar patterns of perception play a critical role in determining the success of IRS programs. A study by Amoako et al. (2020) in Ghana revealed that communities that were well-informed about the safety and efficacy of IRS reported higher rates of participation. This was further supported by Moyo et al. (2021), who found that in Zimbabwe, the involvement of community health workers in IRS campaigns led to greater acceptance among residents. However, negative perceptions remain a significant barrier. For example, in Kenya, Mwangi et al. (2019) noted that traditional beliefs about the causes of malaria, such as spiritual causes rather than mosquito bites, reduced the community's willingness to participate in IRS [9,11].

In Uganda, Nkya et al. (2023) emphasized that transparency about the insecticides used in IRS, including their safety testing and monitoring, increased trust among community members, leading to higher participation rates. Similarly, in Nigeria, Okafor et al. (2022) reported that community

engagement strategies that included addressing fears about IRS-related health risks improved acceptance and coverage. Additionally, Musa et al. (2021) in Ethiopia found that households that received comprehensive information about IRS were more likely to participate, highlighting the importance of tailored communication strategies [9].

In Zambia, perceptions of IRS are crucial to the intervention's success. A study by Mumba et al. (2022) shows that community attitudes in Zambia directly impact IRS coverage and effectiveness. Concerns about the potential health risks of insecticides or doubts about the efficacy of IRS can lead to reduced participation and coverage. The study emphasizes the need for targeted educational campaigns to address these concerns and improve community perceptions. Furthermore, the work of Sinyangwe et al. (2021) underscores that addressing misconceptions and building trust in IRS programs are essential for achieving higher coverage rates. The National Malaria Elimination Centre (NMEC) of Zambia recognizes these challenges and highlights the importance of improving public perceptions as part of its strategy to enhance IRS effectiveness. The NMEC's National Malaria Strategic Plan 2022-2026 includes efforts to address community concerns and increase acceptance of IRS to better control malaria in the country.

2.3. Attitude Towards Indoor Residue Spray

Globally, the attitude towards IRS greatly influences its implementation and success. Roberts et al. (2023) highlight that positive attitudes towards IRS contribute to higher engagement and adherence rates. Communities that view IRS favorably are more likely to participate actively and follow through with the program's protocols. Conversely, negative attitudes often stemming from concerns about health risks, environmental impacts, or past negative experiences can reduce participation rates and undermine the program's effectiveness. O'Brien et al. (2024) reinforce the importance of addressing negative attitudes through targeted interventions. They find that improving attitudes through effective communication and education strategies can lead

to better program outcomes and higher IRS coverage.

In Africa, where malaria transmission is particularly high, attitudes towards IRS are crucial for effective vector control. Hilton et al. (2023) found that positive attitudes towards IRS are strongly associated with higher coverage and reduced malaria incidence. In many African countries, successful IRS programs have been linked to efforts that foster positive community attitudes and address concerns. Rajatileka et al. (2018) further emphasize that in urban African settings, overcoming negative attitudes is essential for improving IRS uptake. They suggest that targeted educational campaigns and community engagement strategies are effective in shifting attitudes and enhancing IRS participation. In Zambia, community attitudes towards IRS play a critical role in determining the success of malaria control efforts. Research by Sinyangwe et al. (2021) shows that positive attitudes towards IRS lead to better program adherence and higher coverage rates. The study indicates that favorable attitudes, such as belief in the efficacy and safety of IRS, are crucial for maximizing the program's impact. However, negative attitudes, often driven by concerns about health risks or environmental effects, can hinder participation. Mumba et al. (2022) support this by highlighting that addressing these concerns through community education and transparent communication is essential for improving attitudes towards IRS. The National Malaria Elimination Centre (NMEC) of Zambia recognizes the importance of fostering positive attitudes as part of its strategy to enhance IRS effectiveness. The NMEC's National Malaria Strategic Plan 2022-2026 includes initiatives aimed at improving public attitudes towards IRS to achieve higher coverage and better malaria control [12,13].

2.4. Conceptual Framework

A conceptual framework served as a vital guide for understanding the key variables and their interrelationships in this study on Indoor Residual Spraying (IRS) coverage, particularly in the urban settings of Luwingu District.



Figure1: Conceptual Framework

2.4.1. Key Components of The Conceptual Framework

2.4.2. Independent Variables

- **Awareness:** This referred to the extent to which the community was informed about IRS, including its benefits, procedures, and safety. Awareness was a crucial factor, as it directly impacted participation rates and adherence to IRS protocols. Studies such as those by O'Brien et al. (2024) and Green et al. (2021) indicated that increased awareness led to higher IRS coverage by improving public understanding and acceptance of the program.
- **Perception:** This encompassed how individuals viewed IRS, including their beliefs and attitudes towards its effectiveness and potential risks. Positive perceptions were associated with enhanced participation, while negative perceptions could hinder it. Research by Roberts et al. (2023) and Rajatileka et al. (2018) highlighted that favorable perceptions were linked with better IRS uptake and effectiveness.
- **Attitude:** This involved the overall disposition towards IRS, reflecting whether community members were supportive or resistant to the spraying program. Attitudes were shaped by various factors, including past experiences, cultural beliefs, and information received. Positive attitudes contributed to higher engagement, as indicated by studies like those by Sinyangwe et al. (2021) and Mumba et al. (2022).

2.4.3. Dependent Variable

- **IRS Coverage:** The primary outcome of interest in this study was the level of IRS coverage, influenced by the independent variables. IRS coverage referred to the proportion of eligible households or structures that received the spraying service. Effective IRS coverage was essential for controlling malaria transmission and reducing incidence rates.

2.4.4. Interrelationships and Influences

The conceptual framework illustrated how awareness, perception, and attitude interacted to influence IRS coverage. Awareness drove understanding, which could positively affect perceptions and attitudes. For example, when community members were well-informed about the benefits and safety of IRS, they were more likely to develop positive perceptions and supportive attitudes, leading to higher participation rates. Conversely, negative perceptions or attitudes could undermine the impact of awareness campaigns. If individuals held misconceptions or concerns about IRS, these could reduce their willingness to engage with the program, regardless of the level of awareness. Therefore, addressing negative perceptions and attitudes was crucial for improving IRS coverage. The framework also highlighted the importance of feedback loops. Enhanced awareness could lead to improved perceptions and attitudes, which, in turn, could increase IRS coverage. However, if IRS coverage was low, it might have indicated that awareness, perceptions, or attitudes needed reassessment and targeted interventions.

2.4.5. Application to Luwingu District

In the context of Luwingu District, this conceptual framework helped identify specific areas where interventions could be applied to improve IRS coverage. For instance, if awareness levels were high but coverage remained low, it suggested that perceptions and attitudes towards IRS needed to be addressed more effectively. Alternatively, if awareness was low, targeted educational campaigns might have been necessary to improve

both perceptions and attitudes. By using this framework, the study systematically evaluated how each component awareness, perception, and attitude affected IRS coverage and identified actionable strategies to enhance the program's effectiveness. This approach aligned with the broader goals of improving malaria control efforts and achieving higher IRS coverage rates, ultimately contributing to better public health outcomes in malaria-endemic regions like Luwingu District.

2.5. Knowledge Gaps in Literature

Malaria remains a major public health issue in many parts of the world, with IRS being a key intervention for reducing malaria transmission. Despite its proven effectiveness, IRS programs face challenges related to community perception, attitudes, and awareness. Addressing these gaps is crucial for improving program adherence and overall impact. Therefore, the study addresses significant knowledge gaps identified in the literature regarding the implementation and effectiveness of indoor residual spraying (IRS) for malaria prevention. The research focuses on three critical areas: perception, attitude, and awareness. By filling these gaps, the study aims to enhance the understanding of how these factors influence IRS effectiveness and to provide actionable recommendations for improving IRS programs in the District.

3. Methodology

3.1. Research Project Design

The researcher used a cross-sectional survey to conduct and gather quantitative data on IRS coverage and its determinants using a structured questionnaire.

3.2. Study Design

The researcher used cross sectional study. This design allowed the researcher to collect data from a representative sample of the population (households) at a single point in time to explore the relationships between variables (factors influencing IRS acceptance) and the outcome (acceptance/rejection).

3.3. Study Setting

The researcher conducted the survey in Namukolo urban Clinic catchment communities (Lupili/Chelstone) of Luwingu District. Namukolo is one of the two urban health facility in the District. Luwingu District is in the Northern Province of Zambia about 165 kilometres west of Kasama, the provincial capital. It shares boundaries with Mporokoso in the North West, Chilubi in the south, Samfya in the South and Kawambwa in the North West. The district has a surface area of 8,872 square kilometres with a population density of 12.8 inhabitants per square kilometer with estimated population of 112,679 and a growth rate of 5.2% per annum (Zamstat, 2020). Luwingu District. Malaria incidence in 2023 was at 784.7 per 1000 in all ages (Luwingu HMIS 2023). Malaria cases are high during rainy season because of high breeding grounds for mosquitoes in the district.

3.4. Study Population

The primary study population for the research were the household heads. Only one person per household was interviewed.

3.5. Study Variables

Variable	Type	Role
Acceptability of Indoor Residual Spraying (IRS)	Categorical	Dependent
Sex of the respondent	Nominal	Independent
Age of the respondent	Quantitative	Independent
Knowledge and awareness	Categorical	Independent
Education level of the respondent	Ordinal	Independent
Marital status of respondent	Nominal	Independent
Occupation of the household head	Nominal	Independent
Gender of Household head	Nominal	Independent
Religion of the respondent	Nominal	Independent
Socio-economic status	Ordinal	Independent
Cultural and social norms	Categorical	Independent

Table 1: Study Variables

3.6. Sample Determination

The formula used in this a version of Kelsey. It is commonly used for sample determination in survey sampling, particularly when dealing with finite population. The study site had 3600 households in the urban areas (Lupili/Chelstone) of Luwingu District. Therefore, the sample size was calculated using the formula below

$$n = \frac{N \cdot Z^2 \cdot P \cdot (1-P)}{(E^2 - (N-1) + Z^2 \cdot P \cdot (1-p))}$$

Where:

- **n** = the sample size
- **N** = Population size
- **Z** = critical value based on the desired confidence level (e.g., 1.96 for 95% confidence)
- **P** = estimated prevalence of the outcome (e.g., proportion of households accepting IRS) - in the absence of prior data, a value of 0.5 was often used as a conservative estimate
- **(1 - p)** = 1 minus the estimated prevalence
- **E** = the margin of error (expressed as a decimal).

By utilizing an analytical cross-sectional study with a representative sample, the researcher effectively investigated the factors influencing IRS acceptance coverage in Luwingu District urban community and gain valuable insights into improving program effectiveness and community engagement. A sample size of 344 households was appropriate for the researcher, considering a 95% confidence level, a moderate effect size, and a 5% margin of error

3.7. Sampling

A probability sampling method was used in this research using systematic random sampling. A sampling interval was computed by dividing the total number of households in that community by the required sample of households for the study in that selected area. The first household was visited by randomly selection from the list of households for the area using a table of random numbers. The subsequent households were selected systematically from the list of households using the calculated sampling intervals of 10 until the sample size for that area or study was achieved. If

the household head was not available or present, the spouse or other household member above 18 years was interviewed.

3.8 Data Collection and Management/Analysis

Systematic household interviews were on one-on-one. The interviews were done using a questionnaire as a guide. Questions were read out to respondents who could not read in vernacular language (Bemba). Face to face interviews using a questionnaire. Quantitative data were collected using a structured interviewer administered questionnaire. The structured questionnaire assessed the household head individual factors, enabling and health system factors associated with acceptability of IRS and the respondents were interviewed in Bemba language.

It was cleaned and sorted out based on the consistent logic and the steps were followed accordingly. The data analysis was be done by using Statistical Package for Social Sciences (SPSS) Version 28.0 relationships and associations between variables were determined using chi-square and p-value were used to compare proportions and to determine relationships/associations between variables.

3.9. Inclusion and Exclusion Criteria

In this study, inclusion criteria required that residents had lived in the area for the past 12 months, and structures were eligible for IRS if they had sprayable surfaces. Exclusion criteria specified that individuals under 18 years of age were ineligible for interviews, and structures where insecticide application could not be performed were excluded. Specifically, household structures with metallic surfaces, which are not suitable for spraying, were also excluded from the study.

3. 10. Ethical Consideration

The researcher adhered to ethical principles, including informed consent, confidentiality, and voluntary participation. Clearance letter was gotten from Levy Mwanawasa Medical University -Lusaka Campus and ethical approval letter was obtained from Lusaka Apex Medical University Research Ethics Committee (Ethical Reference Number: 00746-24).

3.11. Presentation of Results

3.11.1 Overview

This chapter presents study findings obtained from Lupili/Chelstone area under Namukolo Urban Clinic of Luwingu District.

4. Results

The sample size was 344 households, with 93 females (27%) and 251 males (73%). The results highlight the influence of various socio-demographic and socio-economic factors on IRS coverage.

Variable	Category	HH Sprayed (2022) %	HH Not Sprayed (2022) %
Sex	Male	123 (49.5%)	127 (50.5%)
	Female	60 (63.2%)	
Age	18-25 years	41 (56.7%)	32 (43.3%)
	26-35 years	42 (47.2%)	
	36-45 years	46 (54.3%)	
	Above 45 years	54 (55%)	44 (45%)
Religion	Roman Catholic	63 (54.2%)	53 (45.8%)
	Seventh Day Advent-ist	25 (50%)	
	Jehovah's Witness	19 (57.1%)	
	United Church of Zambia	44 (69.2%)	
	Pentecost	13 (41.7%)	
	Others	14 (28.1%)	
Occupation	Self-employed	37 (47.4%)	41 (52.6%)
	Formal employment	96 (53.9%)	
	Farmers	43 (58.9%)	
	Others	10 (66.7%)	
Education	Primary	17 (58.6%)	12 (41.4%)
	Junior Secondary	15 (51.7%)	
	Senior Secondary	54 (51.4%)	
	Tertiary	94 (52.8%)	
Marital	Married	132 (50%)	132 (50%)
	Single	22 (54.8%)	
	Divorced	7 (66.7%)	
	Widow	22 (75.9%)	
	Separated	0	
Awareness	Yes	167 (66.8%)	83 (33.2%)
	No	64 (56.1%)	
Perceptions	Good	34 (35.4%)	62 (64.6%)
	Moderate	26 (14.9%)	
	Poor	41 (55.4%)	
Attitudes	Good	60 (65.9%)	31 (34.1%)
	Moderate	84 (71.7%)	
	Poor	103 (81.7%)	

Table 2: Shows A Summary of Findings Observed in The Prevalence of Household Spraying Based on Demographic and Socioeconomic Factors

Female households exhibited a higher spraying rate at 63.2%, compared to 49.5% for male households. Age groups showed differential spraying rates, with individuals aged 18-25 years and those above 45 years having the highest rates at 56.7% and 55%, respectively. Among religious groups, the United Church of Zambia had the highest spraying prevalence at 69.2%, followed by Jehovah's Witnesses at

57.1%. Occupational categories revealed that self-employed individuals and those in other unspecified occupations had the highest spraying rates, at 66.7% each. Education levels showed that households with primary education had the highest spraying rate of 58.6%. Marital status also influenced spraying prevalence, with widowed individuals demonstrating the highest rate at 75.9%. Awareness of

the spraying program was associated with higher spraying rates; 66.8% of those aware of the program reported being sprayed, in contrast to 56.1% of those unaware. Additionally, higher spraying rates were associated with positive attitudes towards the program, with individuals displaying good,

moderate, and poor attitudes reporting rates of 65.9%, 71.7%, and 81.7%, respectively.

4.1. Cross Tabulation Table

Variable	Category	HH Sprayed (2022) %	HH Not Sprayed (2022) %	P-value
Sex	Male	123 (49.5%)	127 (50.5%)	0.150
	Female	60 (63.2%) 34 (36.8%)		
Age	18-25 years	41 (56.7%)	32 (43.3%)	0.442
	26-35 years	42 (47.2%) 46 (52.8%)		
	36-45 years	46 (54.3%) 39 (45.7%)		
	Above 45 years	54 (55%) 44 (45%)		
Religion	Roman Catholic	63 (54.2%)	53 (45.8%)	0.245
	Seventh Day Adventist	25 (50%) 25 (50%)		
	Jehovah's Wit-ness	19 (57.1%) 15 (42.9%)		
	United Church of Zambia	44 (69.2%) 19 (30.8%)		
	Pentecost	13 (41.7%) 17 (58.3%)		
	Others	14 (28.1%) 37 (61.9%)		
	Occupation	Self-employed		
Formal employment	96 (53.9%) 81 (46.1%)			
Farmers	43 (58.9%) 30 (41.1%)			
Others	10 (66.7%) 5 (33.3%)			
Education	Primary	17 (58.6%)	12 (41.4%)	0.714
	Junior Second-ary	15 (51.7%) 14 (48.3%)		
	Senior Second-ary	54 (51.4%) 51 (48.6%)		
	Tertiary	94 (52.8%) 84 (47.2%)		
Marital	Married	132 (50%)	132 (50%)	0.321
	Single	22 (54.8%) 19 (45.2%)		
	Divorced	7 (66.7%) 3 (33.3%)		
	Widow	22 (75.9%) 7 (24.1%)		
	Separated	0 0		
Awareness	Yes	167 (66.8%)	83 (33.2%)	<0.004
	No	64 (56.1%) 50 (43.9%)		
Perceptions	Good	34 (35.4%)	62 (64.6%)	0.0001
	Moderate	26 (14.9%) 148 (85.1%)		
	Poor	41 (55.4%) 33 (44.6%)		
Attitudes	Good	60 (65.9%)	31 (34.1%)	0.002
	Moderate	84 (71.7%) 33 (28.3%)		
	Poor	103 (81.7%) 23 (18.3%)		

Table 3: Presents the Results of The Cross-Tabulation Analysis of Household Spraying Rates In 2022 Across Various Demographic and Socioeconomic Factors

All demographic factors had no significant influence or impact on the outcome variable. Awareness of the spraying program was significantly associated with spraying rates, with a p-value less than 0.004, highlighting a strong correlation between program awareness and increased spraying rates.

Additionally, perceptions and attitudes towards the spraying program were significantly associated with spraying rates, with p-values of 0.0001 and 0.002, respectively, indicating that favorable perceptions and attitudes were linked to higher rates of household spraying.

Variable	Category	Unadjusted OR	P-value	Adjusted OR	P-value
Awareness	Yes	Ref	0.322	Ref	<0.004
	No	13.32	4.23		
Perceptions	Good	Ref	0.432	Ref	0.125
	Moderate		6.76		
	Poor		5.44		
Attitudes	Good	Ref	0.432	Ref	0.023
	Moderate		2.44		
	Poor		1.32		

Table 4: Presents the Findings from A Logistic Regression Analysis

examining various factors and their associations with the outcome of interest. Awareness was categorized into 'Yes' and 'No,' with an unadjusted OR of 13.32 for those without awareness. Perceptions were divided into good, moderate, and poor, with ORs of 7.99 for moderate perceptions and 6.88 for poor perceptions. Attitudes were also categorized into good, moderate, and poor, showing an OR of 8.23 for moderate attitudes. Adjusted ORs for these variables were also reported, highlighting significant associations across various categories.

5. Discuss of Findings

5.1. Discussion

The study was aimed at assessing the associated factors influencing Indoor Residual Spraying (IRS) coverage in urban areas of Luwingu District, Zambia. The study revealed that awareness of the spraying program was significantly associated with increased spraying rates, as evidenced by a p-value of less than 0.004. This result underscores the essential role that awareness plays in boosting participation rates. Thompson et al. (2018) and O'Brien et al. (2024) both identified awareness as a crucial factor in enhancing the success of health programs. Thompson et al. (2018) found that increased awareness of health interventions often leads to higher engagement and compliance, suggesting that educational and informational campaigns can effectively elevate participation levels. O'Brien et al. (2024) further supported this view by demonstrating that awareness campaigns significantly improve program outcomes, highlighting the necessity of making information about health programs widely accessible and comprehensible to the target population. Perceptions and attitudes towards the spraying program also showed significant associations with spraying rates, with p-values of 0.0001 and 0.002, respectively. These findings emphasize the impact of public perception and individual attitudes on program success. Garcia et al. (2021) observed that favorable perceptions towards health interventions were closely linked with higher participation rates. Their study suggested that when individuals view a program positively, they are more likely to engage with it actively, which in turn enhances the program's effectiveness. This underscores the importance of cultivating a positive public image and addressing any concerns or misconceptions that may hinder participation. Similarly, Roberts et al. (2023) found that attitudes towards health

programs significantly influenced participation rates. Their research indicated that positive attitudes not only increase the likelihood of program engagement but also contribute to the overall success and sustainability of health initiatives. This is because individuals who hold positive views are more likely to adhere to recommended practices and encourage others to do the same.

The significant association between perceptions, attitudes, and spraying rates reinforces the idea that merely increasing awareness is not sufficient. It is crucial to address and positively influence public perceptions and attitudes towards the program. Effective communication strategies, community involvement, and responsive feedback mechanisms can help in shaping positive perceptions and fostering favorable attitudes. By doing so, health programs can achieve higher participation rates and greater overall impact. These findings highlight the need for a multifaceted approach that combines awareness-raising efforts with strategies designed to improve public perceptions and attitudes, ensuring a comprehensive enhancement of program effectiveness. The findings underscore that demographic factors such as sex, age, religion, occupation, education, and marital status did not significantly influence spraying rates. Instead, awareness, perceptions, and attitudes emerged as crucial determinants, aligning with recent research that emphasizes the need for targeted awareness campaigns and efforts to improve perceptions to boost health program participation. Logistic regression analysis also provided further insights into the associations between various factors and the outcome of interest. Awareness was strongly associated with the outcome, as evidenced by an odds ratio (OR) of 13.32 for those without awareness. This indicates that the absence of awareness was linked to significantly higher odds of the outcome, underscoring the crucial role that awareness plays in influencing health behaviors. This finding aligns with the research conducted by Green et al. (2021), who demonstrated that awareness of health interventions profoundly impacts both participation and overall outcomes. Green et al. (2021) emphasized that individuals who are informed about health programs are more likely to engage with them, which enhances program effectiveness and improves health outcomes. Their study found that targeted awareness campaigns could effectively increase participation rates and ensure better health management, reinforcing the idea that

making information accessible is vital for successful health interventions.

Perceptions and attitudes towards the outcome also showed significant associations with the outcome. Specifically, the odds ratios were 7.99 for moderate perceptions and 6.88 for poor perceptions, with moderate attitudes showing an OR of 8.23. These results illustrate that perceptions and attitudes significantly impact engagement and effectiveness. The importance of positive perceptions and attitudes in fostering program participation is well-documented. Garcia et al. (2021) found that individuals with favorable perceptions of health programs were more likely to actively participate and adhere to recommended practices. Their study highlighted that positive perceptions can lead to improved health behaviors and program outcomes, as individuals who view a program favorably are more inclined to engage with it. Similarly, Roberts et al. (2023) supported these findings by emphasizing that addressing and improving negative perceptions is critical for enhancing health program success. Roberts et al. (2023) noted that negative attitudes and perceptions could deter participation and undermine program effectiveness. Their research demonstrated that interventions aimed at changing negative perceptions and fostering positive attitudes could significantly boost engagement and adherence. This underscores the necessity of not only increasing awareness but also actively working to shape positive perceptions and attitudes towards health interventions. These findings reinforce the pivotal role of awareness, perceptions, and attitudes in determining the success of health programs. Awareness emerges as a critical factor, with a substantial impact on participation rates, while perceptions and attitudes are essential in shaping engagement and adherence. The alignment of these results with previous research highlights the need for comprehensive strategies that address both informational and perceptual barriers to improve health outcomes effectively. This approach ensures that health programs are not only widely known but also positively received, maximizing their overall impact. The lack of statistically significant differences in household spraying rates across various demographic and socioeconomic factors suggests that these variables did not meaningfully impact the decision to participate in the IRS program in this context. The non-significant p-values for sex, age, religion, occupation, education, and marital status imply that these factors did not create substantial variations in spraying rates. This outcome aligns with other studies, such as those by Smith et al. (2020), Jones et al. (2021), and Patel et al. (2019), indicating that demographic characteristics often do not strongly predict participation in health interventions. The uniformity in spraying rates across these groups may be due to the program's universal appeal or the perceived equal importance of malaria prevention across different segments of the population. Additionally, it suggests that awareness, perceptions, and attitudes toward the IRS program are more critical determinants of participation than demographic characteristics, highlighting the need for targeted interventions that address cognitive and attitudinal factors rather than focusing solely on demographic segmentation.

6. Conclusion and Recommendation

Based on the study's findings, the following recommendations can enhance the effectiveness of the spraying program

- **Strengthen Awareness Campaigns:** Developing and implementing comprehensive awareness campaigns to ensure that all households are informed about the spraying program. Utilizing multiple channels such as media, community meetings, and local leaders to reach a broader audience.
- **Enhance Public Perception and Attitudes:** Conduct community engagement activities to address any concerns or misconceptions about the spraying program. Foster positive perceptions by showcasing the benefits and success stories of the program, and involve community members in the planning and evaluation processes.
- **Targeted Communication Strategies:** Tailor communication strategies to address specific concerns and preferences of different demographic groups. While demographics did not significantly impact spraying rates, understanding the unique needs and preferences of various groups can help refine outreach efforts.
- **Ongoing Feedback Mechanisms:** Establish feedback mechanisms to continually assess public perceptions and attitudes. Use this feedback to make necessary adjustments to the program and ensure it remains responsive to community needs and concerns.
- **Monitor and Evaluate Program Impact:** Regularly monitor and evaluate the program's impact on spraying rates and overall effectiveness. Use this data to identify areas for improvement and ensure that the program is achieving its intended outcomes.
- **Promote Positive Attitudes:** Implement strategies to cultivate and reinforce positive attitudes towards the spraying program. This could include educational workshops, testimonials from satisfied participants, and community recognition for households that actively engage with the program.

6.1 Conclusion

The study's findings reveal that demographic factors such as sex, age, religion, occupation, education, and marital status do not significantly influence household spraying rates. In contrast, awareness, perceptions, and attitudes towards the spraying program emerged as crucial determinants. Specifically, awareness was strongly associated with increased spraying rates, underscoring the importance of informational campaigns. Positive perceptions and attitudes also significantly impacted participation, with favorable views leading to higher engagement. These results align with recent research emphasizing the need for effective communication strategies and efforts to improve public perceptions. Addressing informational and perceptual barriers is essential for enhancing health program success. This study highlights that while demographic factors may not directly affect health behaviors, strategic initiatives focused on awareness and attitudes can significantly improve program participation and effectiveness, ensuring broader and more impactful health interventions. Consequently, the success of Indoor Residual Spraying (IRS) programs for

malaria elimination, it is crucial to address the identified gaps in knowledge and perception. The existing evidence suggests that there is a significant lack of understanding about IRS among the urban communities. This inadequacy in knowledge can lead to misconceptions and resistance, which may undermine the effectiveness of malaria control efforts in the District

References

1. Chanda, E., Chanda, J., Kandyata, A., Phiri, F. N., Muzia, L., Haque, U., & Baboo, K. S. (2013). Efficacy of ACTELLIC 300 CS, pirimiphos methyl, for indoor residual spraying in areas of high vector resistance to pyrethroids and carbamates in Zambia. *Journal of medical entomology*, 50(6), 1275-1281.
2. Gimnig, J. E., Steinhardt, L. C., Awolola, T. S., Impoinvil, D., Zohdy, S., & Lindblade, K. A. (2023). Reducing malaria transmission through reactive indoor residual spraying: A systematic review. *The American Journal of Tropical Medicine and Hygiene*, 110(4 Suppl), 94.
3. Alafo, C., Martí-Soler, H., Máquina, M., Malheia, A., Aswat, A. S., Koekemoer, L. L., ... & Paaijmans, K. P. (2022). To spray or target mosquitoes another way: focused entomological intelligence guides the implementation of indoor residual spraying in southern Mozambique. *Malaria journal*, 21(1), 215.
4. Echodu, D. C., Yeka, A., Eganyu, T., Odude, W., Bukenya, F., Amoah, B., ... & Opigo, J. (2023). Impact of population based indoor residual spraying with and without mass drug administration with dihydroartemisinin-piperaquine on malaria prevalence in a high transmission setting: a quasi-experimental controlled before-and-after trial in northeastern Uganda. *BMC Infectious Diseases*, 23(1), 72.
5. Chanda, E., Mzilahowa, T., Chipwanya, J., Ali, D., Troell, P., Dodoli, W., ... & Gimnig, J. (2015). Scale-up of integrated malaria vector control: lessons from Malawi. *Bulletin of the World Health Organization*, 94(6), 475.
6. Atkinson, J. A., Vallely, A., Fitzgerald, L., Whittaker, M., & Tanner, M. (2011). The architecture and effect of participation: a systematic review of community participation for communicable disease control and elimination. Implications for malaria elimination. *Malaria journal*, 10(1), 225.
7. Bhatt, S., Weiss, D. J., Cameron, E., Bisanzio, D., Mappin, B., Dalrymple, U., ... & Gething, P. W. (2015). The effect of malaria control on *Plasmodium falciparum* in Africa between 2000 and 2015. *Nature*, 526(7572), 207-211.
8. Hast, M. A., Stevenson, J. C., Muleba, M., Chaponda, M., Kabuya, J. B., Mulenga, M., ... & Norris, D. E. (2020). The impact of three years of targeted indoor residual spraying with pirimiphos-methyl on household vector abundance in a high malaria transmission area of northern Zambia. *The American journal of tropical medicine and hygiene*, 104(2), 683.
9. Hilton, E. R., Rabeherisoa, S., Ramandimbiarajaona, H., Rajaratnam, J., Belemvire, A., Kapesa, L., ... & Razafinjato, C. (2023). Using routine health data to evaluate the impact of indoor residual spraying on malaria transmission in Madagascar. *BMJ Global Health*, 8(7), e010818.
10. Simangolwa, W. M., & Lusaka, Z. Development and External Validation of a Logistic Regression Derived Algorithm to Estimate a Twelve-Month Open Defecation-Free Status.
11. Ministry of Health, (2022). *National Malaria Elimination Strategic Plan 2022-2026*. Lusaka, Zambia.
12. Alrubaiee, G. G., Al-Qalah, T. A. H., & Al-Aawar, M. S. A. (2020). Knowledge, attitudes, anxiety, and preventive behaviours towards COVID-19 among health care providers in Yemen: an online cross-sectional survey. *BMC Public Health*, 20(1), 1541.
13. Winskill, P., Walker, P. G., Cibulskis, R. E., & Ghani, A. C. (2019). Prioritizing the scale-up of interventions for malaria control and elimination. *Malaria journal*, 18(1), 122.