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ORIGINAL RESEARCH ARTICLE

Community Acceptance of Indoor Residual Spraying for Malaria Control and Associated Factors

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Abstract

Introduction: Malaria remains a major global public health challenge despite substantial progress in control measures. In 2024, an estimated 282 million cases and 610,000 deaths were reported, with nearly 95% occurring in the WHO African Region. In India, malaria burden has declined considerably, although transmission persists in endemic regions. Indoor Residual Spraying (IRS) is an effective WHO-recommended intervention; however, its success depends largely on community acceptance, awareness, and participation.

Method: A community-based cross-sectional analytical study was conducted among 220 randomly selected adult household representatives from malaria-endemic rural villages of Palghar district, Maharashtra (2024–2025). Data were collected using a validated, interviewer-administered questionnaire assessing socio-demographic characteristics, housing conditions, malaria knowledge, perceptions, receipt of IEC messages, and acceptance of Indoor Residual Spraying (IRS). Associations were examined using Chi-square tests and logistic regression to estimate crude and adjusted odds ratios with 95% confidence intervals, considering $p<0.05$ statistically significant.

Result: The study found 56 (25.5%) households accepted IRS, whereas 164 (74.5%) refused. Acceptance was significantly higher among nuclear families (28.5% vs. 16.4%; p=0.004), residents of kuccha/semi-pucca houses (47.1% vs. 21.5%; p=0.001), lower socioeconomic groups (26.9% vs. 20.8%; p=0.042), and participants receiving malaria IEC messages (30.6% vs. 18.8%; p=0.031). Multivariable analysis identified kuccha/semi-pucca housing (AOR=3.86) and receipt of IEC messages (AOR=2.16) as the strongest independent predictors of IRS acceptance.

Conclusion: The study concluded that acceptance to IRS was very low, with 25.5% of the respondents accepting IRS and 74.5% refusing the intervention.

Key words: Malaria, Indoor Residual Spraying, Malaria Prevention, Community Acceptance, Vector Control.

1 | INTRODUCTION

Although there have been great strides in malaria prevention and control over the last 20 years, malaria remains one of the most important vector-borne infectious diseases in the world. The World Health Organization (WHO) reports that in 2023, the world experienced an estimated 263 million cases of malaria and roughly 597,000 deaths from the disease, which were slightly higher than the number of cases (249 million) and deaths (596,700) reported in 2022 (1). Almost 94-95% of malaria cases and deaths were in the WHO African Region, and children under 5 years of age and pregnant women were the most vulnerable groups. Nigeria, the Democratic Republic of the Congo, Uganda, Mozambique, and Niger still bear an undue burden of malaria. These fig-

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ures highlight the need for continuing and effective vector control programmes for the control of malaria transmission and deaths. Malaria remains a major global public health concern, with an estimated 282 million cases and 610,000 deaths reported across 80 endemic countries in 2024. Approximately 95% of global malaria cases and deaths occur in the WHO African Region, where children younger than five years account for nearly 75% of malaria-related deaths. The disease is transmitted by infected female Anopheles mosquitoes, with Plasmodium falciparum and Plasmodium vivax being the predominant causative species. Although intensified vector control, improved diagnosis, effective antimalarial therapy, and vaccination have substantially reduced disease burden since 2000, malaria continues to pose a significant epidemiological challenge in tropical and subtropical regions (1, 2) (Figure 1).

(Source: Syngenta, 2023)

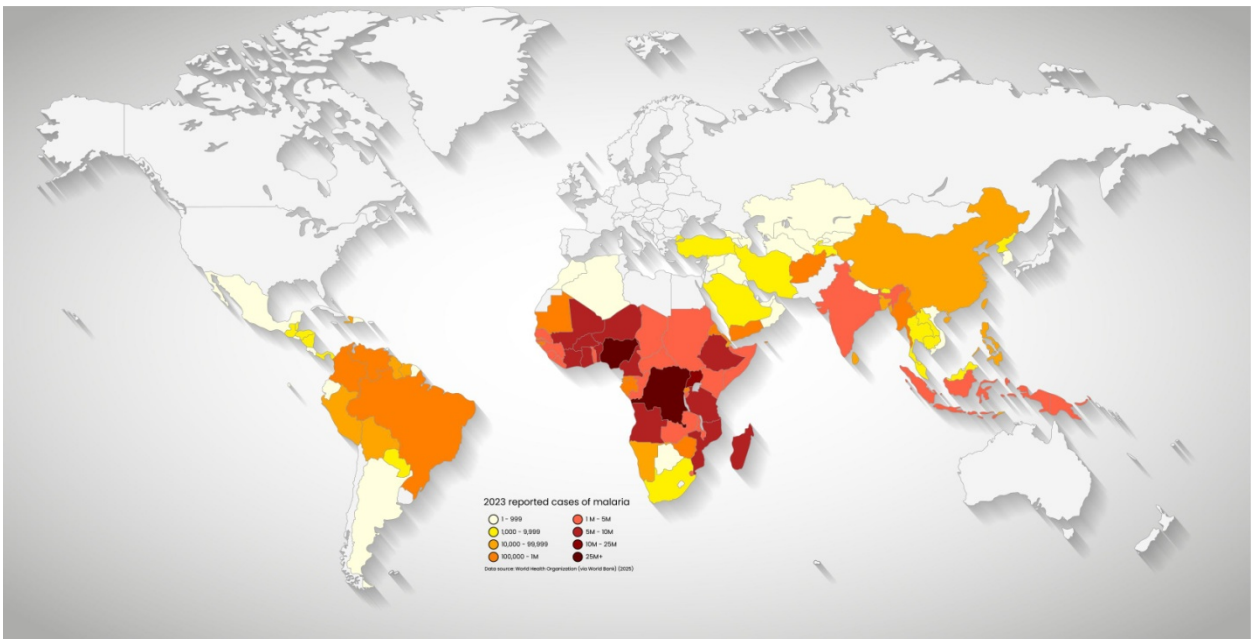

Fig. 1: Incidence of Malaria across the globe

Although the burden of malaria has declined substantially in the last decade, the disease continues to be a major public health challenge in India. In 2023, India recorded an estimated 234,000 malaria cases and 83 malaria-related deaths – a drop of more than 80% in cases and over 90% in deaths since 2015. Transmission is uneven with the highest burden in tribal, forested and hilly regions of states like Odisha, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra and north-eastern states. Plasmodium falciparum and Plasmodium vivax are the main species, with P. falciparum causing most severe disease and deaths from malaria. Continuous surveillance, vector control activities, prompt diagnosis and effective treatment have contributed significantly to the progress towards the national goal of malaria elimination in India (1–3) (Figure 2).

Indoor Residual Spraying (IRS) is one of the WHO-recommended core malaria vector control strategies. IRS is spraying the inside walls and ceiling of the houses using insecticides that last for a long period of time, which, when mosquitoes feed on them and then rest on these surfaces, will kill them. With high community coverage and the judicious use of insecticide, IRS can lead to a 30 to 60% decline in malaria incidence and a significant decrease in mosquito density and longevity. WHO's goal is to interrupt transmission effectively by reaching 80% coverage of households in targeted communities (2). IRS is used

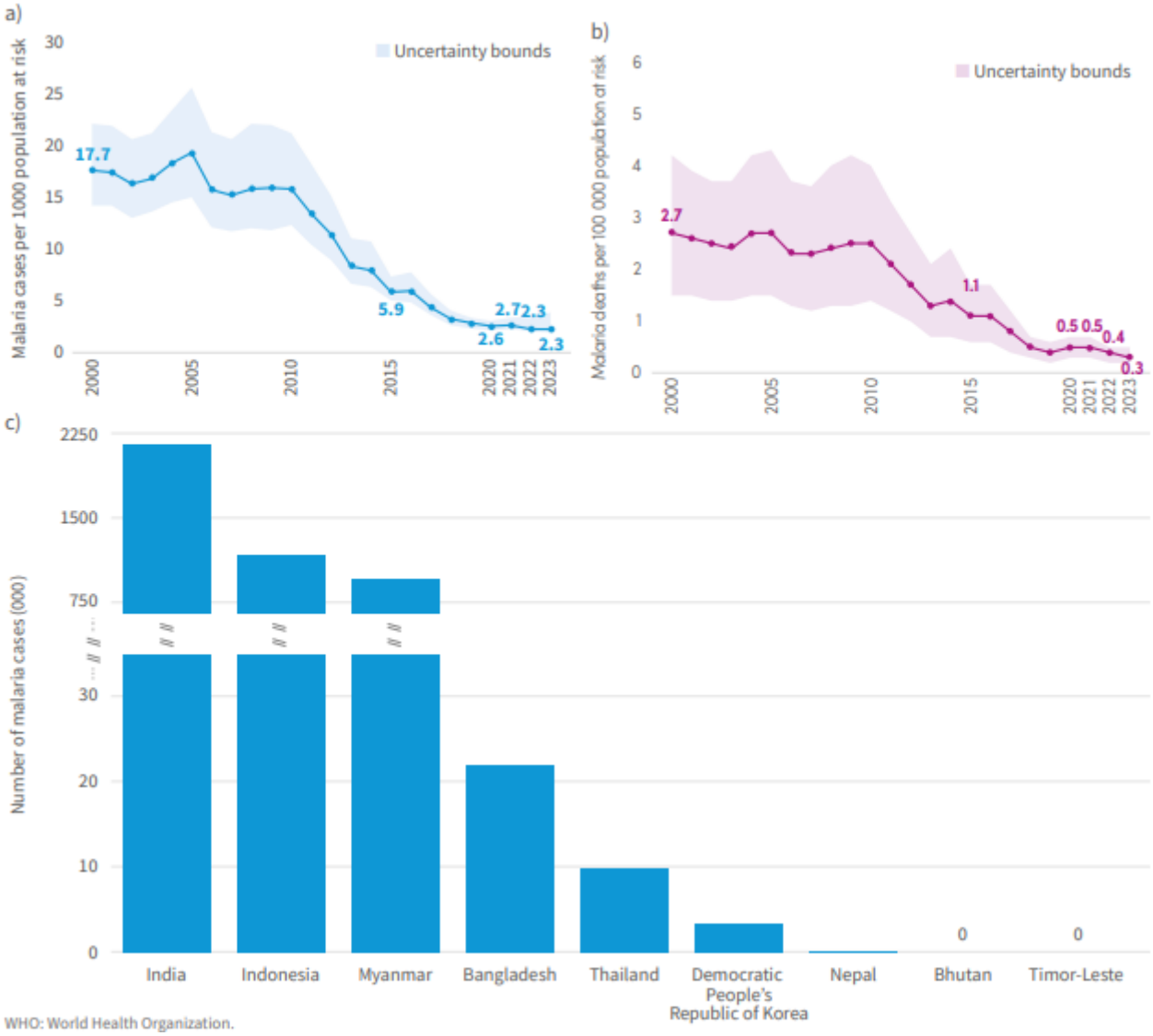

Fig. 2: Trends in (a) malaria case incidence (cases per 1,000 population at risk) and (b) malaria mortality rate (deaths per 100,000 population at risk) from 2000 to 2023, along with (c) the distribution of reported malaria cases by country in the WHO South-East Asia Region in 2023. [Source: World Health Organization, World Malaria Report 2024]

in combination with other malaria control interventions, such as insecticide-treated nets (ITNs), seasonal malaria chemoprevention, larval source management, and prompt diagnosis and treatment, to maximize malaria control.

While IRS has proven to be a very effective intervention in the fight against malaria transmission, community acceptance and participation are essential for success. Households will have to cooperate with trained spray operators if they want their homes to be sprayed and follow post-spraying guidelines, including staying out of sprayed homes for several months or refraining from repainting or washing sprayed walls (4). If there is not enough community acceptance, there will be inadequate coverage, which will decrease the effectiveness of IRS campaigns and continue to allow for the survival of mosquitoes and disease transmission.

Community acceptance of IRS is dependent on many socio-demographic, programmatic and behavioral factors. These cover educational status, knowledge about the transmission of malaria, perceived effectiveness of IRS, prior experiences with IRS campaigns, trust in health workers, cultural beliefs, concerns about the safety of insecticides, the unpleasant smell, fear of health risks, wall staining, noxious odours, moving household items, and the quality of community sensitization before IRS (5). Research

in malaria-endemic nations has repeatedly demonstrated that people who perceive themselves as having more knowledge about malaria prevention and public health authorities' trust in them are much more likely to accept IRS than those who have misconceptions or lack sufficient information.

The biological efficacy of insecticides is just one factor that determines IRS effectiveness; community participation is the other, and understanding factors that affect this is crucial to bolstering malaria control programmes (6). The results of this assessment will provide support for health education designers, malaria control programmes, and public health practitioners in designing community-focused health education activities, engaging communities, increasing coverage of IRS, and ultimately leading to a reduction of malaria transmission and the national and global malaria elimination goal.

2 | METHOD

Research design

A community-based cross-sectional analytical study was conducted in Palghar district (Maharastra) from 2024 to 2025, to assess the acceptance of Indoor Residual Spraying (IRS) for malaria prevention and to identify the socio-demographic, housing-related and behavioural factors associated with its acceptance among households living in a malaria endemic rural area. The cross-sectional design was chosen because it can measure exposure variables and the outcome of interest at the same time in a defined population at a specific point in time. The study also looked at the reasons for non-acceptance of IRS among households that refused indoor spraying. Data collection was carried out over a predefined period of study using a structured interviewer administered questionnaire after getting approval from appropriate institutional ethics committee. All participants provided written informed consent before being enrolled in the study and the confidentiality of collected data was maintained during the study.

Study Population and Sampling

The study population comprised adult household representatives residing in the selected rural villages under the study area. Individuals who had been permanent residents of the area for at least six months and were responsible for household decision-making regarding health-related practices were considered eligible for participation. The required sample size was estimated assuming a prevalence of 50% for acceptance of Indoor Residual Spraying, which provided the maximum sample size, with a 95% confidence level and an absolute precision of 5%. Based on these assumptions, the calculated minimum sample size was approximately 220 participants. Eligible households were selected using a simple random sampling technique from the household registers available at the respective health centres. Where more than one eligible adult was available in a household, one participant was selected through simple random selection to avoid clustering of responses. A total of 220 participants were successfully interviewed and included in the final analysis.

Inclusion Criteria

The study included adult household representatives aged 18 years or above who had been residing in the study area continuously for at least six months before the commencement of the survey. Participants were required to possess adequate knowledge regarding whether Indoor Residual Spraying had been conducted in their household during the previous spray cycle. Individuals who voluntarily agreed to participate and provided written informed consent were included in the study.

Exclusion Criteria

Individuals who were seriously ill, mentally incapacitated, or unable to participate in the interview at the time of data collection were excluded from the study. Temporary residents, visitors, and households that remained locked despite repeated visits were also excluded. Participants who declined to provide informed consent or who submitted incomplete responses during the interview were not considered for the final analysis.

Data Collection

Data were collected using a pre-tested, semi-structured interviewer-administered questionnaire developed after an extensive review of published literature, National Vector Borne Disease Control Programme (NVBDCP) guidelines, and relevant malaria prevention recommendations. The questionnaire comprised sections on socio-demographic

characteristics, educational status, religion, family type, socioeconomic status, housing characteristics, knowledge regarding malaria transmission, perception towards Indoor Residual Spraying, receipt of malaria-related Information, Education and Communication (IEC) messages, acceptance of IRS, and reasons for refusal wherever applicable.

The questionnaire underwent face and content validation by experts in Community Medicine and Public Health to ensure scientific accuracy and relevance. The instrument was translated into the local language and subsequently back-translated into English to ensure conceptual and semantic equivalence. Prior to the main survey, pilot testing was conducted among approximately 10% of the estimated sample in a comparable community not included in the final study. Based on the pilot observations, minor modifications were incorporated to improve clarity and comprehensibility. Data collected during pilot testing were excluded from the final analysis. Investigators received standardized training regarding interviewing techniques and questionnaire administration to minimize interviewer bias and maintain uniformity throughout the data collection process.

Operational Definitions

Acceptance of Indoor Residual Spraying (IRS): Acceptance was defined as households that permitted indoor residual spraying on the interior walls of their dwelling during the most recent IRS campaign conducted by the malaria control programme. Households that refused spraying or did not allow spraying inside the house were categorized as non-acceptors.

Knowledge regarding malaria transmission: Participants who correctly identified mosquito bites as the principal mode of malaria transmission were considered to possess adequate knowledge regarding malaria transmission, whereas incorrect or uncertain responses were classified as inadequate knowledge.

Perception regarding benefits of IRS: Participants were considered to have a favourable perception if they correctly acknowledged that Indoor Residual Spraying prevents malaria by eliminating mosquitoes resting on sprayed interior walls. Those who failed to identify this benefit or expressed misconceptions regarding IRS were categorized as having an unfavourable perception.

Receipt of malaria IEC message: Participants were classified as having received malaria IEC messages if they reported exposure to any malaria-related educational communication through health workers, community meetings, mass media, posters, or other official communication channels during the month preceding the survey.

Socioeconomic status: Socioeconomic status was assessed using the Modified B.G. Prasad Socioeconomic Classification based on the updated Consumer Price Index applicable during the study period. For statistical analysis, socioeconomic categories were grouped into lower and lower-middle classes versus middle and above classes.

Procedure

After obtaining ethical clearance and administrative permission from the concerned health authorities, a sampling frame of eligible households was prepared using local health records. Households were selected through simple random sampling, and trained investigators conducted face-to-face interviews during household visits. The objectives of the study were explained to all eligible participants before obtaining written informed consent.

Information regarding socio-demographic variables, knowledge, perceptions, housing characteristics, receipt of malaria IEC messages, and acceptance of IRS was collected through direct interviews. Whenever feasible, the reported acceptance of IRS was cross-verified by observing evidence of indoor spraying within the household, including visible insecticide marks or confirmation from household members. Participants who reported non-acceptance of IRS were further interviewed regarding the primary reasons for refusal using predetermined response categories. Completed questionnaires were reviewed daily by the principal investigator to ensure completeness, consistency, and accuracy of the collected information. Data were subsequently coded and entered into a computerized database after thorough verification.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using the Statistical Package for the Social Sciences (SPSS) version 27 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize

socio-demographic characteristics and study variables. Categorical variables were presented as frequencies and percentages. The association between IRS acceptance and independent variables including educational status, religion, family type, housing characteristics, socioeconomic status, knowledge regarding malaria transmission, perception towards IRS, and receipt of malaria IEC messages was assessed using the Chi-square test. Crude odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were calculated through univariate logistic regression. Variables demonstrating statistical significance during bivariate analysis or those considered epidemiologically relevant based on previous literature were entered into a multivariable binary logistic regression model to identify independent predictors of IRS acceptance. Adjusted odds ratios (AORs) with 95% confidence intervals were estimated after controlling for potential confounding variables. The goodness-of-fit of the final regression model was assessed before interpretation of results. A two-tailed p-value of less than 0.05 was considered statistically significant for all inferential analyses. Descriptive analysis was additionally performed to summarize the distribution of reasons for non-acceptance of Indoor Residual Spraying among participants who refused the intervention.

3 | RESULTS

Showed56 (25.5%) of the participants accepted the IRS while 164 (74.5%) did not accepted the IRS. IRS acceptance was high among the patients from nuclear families (28.5%) rather than those in joint families with 16.4%, showed significant association. Highest rate of acceptance was noted for the patients residing in the kuccha/semi-pucca houses, accounted to be as 47.1% rather than those living with in pucca houses, accounted to be as 21.5%. Acceptance showed high rate among those who belonged from low socioeconomic classes as 26.9% and those who had received with the malaria IEC messages accounted to be as 30.6%. Contrastingly, the education level, religion, knowledge regarding mosquito-borne transmission, and perception of IRS benefits were not related with the IRS rate of acceptance, which indicated the limited effect of the participants' acceptance behaviour.

Demonstrated the multivariable logistic regression analysis of the parameters associated with the IRS acceptance. Those who resided in thekuccha or semi-pucca houses showed highest likelihood for the acceptance of IRA, with approximately four-fold higher odds rather than those who residing in the pucca houses. The malaria IEC message enhanced the IRS acceptance by more than 2 times. The patients belonging from the nuclear families and lower socioeconomic groups, showed high rate of acceptance rather than those with respective reference categories. The education and religion showed no association with the acceptance of IRS, which suggested that the housing conditions and the health communication were strong predictors of the IRS acceptance compared to other demographic parameter.

Table 3 demonstrated that the most reported reason for the non-acceptance of IRS was the perception, that the IRS was not useful, accounted among 80 participants (48.8%), which accounted for about half of all non-acceptance responses. Belief is the second most common reason which demonstrated that the IRS should be sprayed in the washrooms and toilet areas, which is the breeding ground for mosquitos, noted among 58 patients, with 35.3%. About 84.2% of the participants were represented with misconceptions, which revealed the lack of knowledge and the misconceptions were the initial barriers of IRS acceptance. 12 participants (7.3%) showed the fear of insecticide staining walls. 4.9% of cases showed the usage of IRS in ditches instead of the inside houses.

Table 1. Association between Socio-demographic Characteristics, Knowledge, Perception, and Receipt of IEC Messages with Acceptance of Indoor Residual Spraying (IRS) Among Study Participants

Exposure Variable	IRS Accepted, n=56 (%)	IRS Not Accepted, n= 164 (%)	OR (95% CI)	Chi-square (df=1)	p-value
Level of Education					
Illiterate (n = 147)	39 (26.5)	108 (73.5)	1.18 (0.70–1.99)	0.62	0.431
Literate (n = 73)	17 (23.3)	56 (76.7)	Ref		
Religion					
Muslim (n = 165)	44 (26.7)	121 (73.3)	1.58 (0.88–2.84)	2.84	0.092
Hindu (n = 55)	12 (21.8)	43 (78.2)	Ref		
Type of Family					
Nuclear (n = 165)	47 (28.5)	118 (71.5)	2.42 (1.23–4.77)	8.24	0.004
Joint (n = 55)	9 (16.4)	46 (83.6)	Ref		
Type of House					
Kuccha & Semi-pucca (n = 34)	16 (47.1)	18 (52.9)	3.08 (1.47–6.42)	10.76	0.001
Pucca (n = 186)	40 (21.5)	146 (78.5)	Ref		
Socioeconomic Class					
Lower & Lower-middle (n = 167)	45 (26.9)	122 (73.1)	1.74 (0.95–3.18)	4.12	0.042
Middle & Above (n = 53)	11 (20.8)	42 (79.2)	Ref		
Knowledge: Mosquito Bite as Transmission Route					
Known (n = 202)	52 (25.7)	150 (74.3)	1.15 (0.39–3.01)	0.11	0.735
Not Known (n = 18)	4 (22.2)	14 (77.8)	Ref		
Perception: Benefits of IRS in Malaria Prevention					
Perceived (n = 19)	6 (31.6)	13 (68.4)	1.34 (0.46–3.87)	0.48	0.487
Not Perceived (n = 201)	50 (24.9)	151 (75.1)	Ref		
Received Malaria IEC Message in the Past Month					
Yes (n = 124)	38 (30.6)	86 (69.4)	1.81 (1.04–3.14)	4.63	0.031
No (n = 96)	18 (18.8)	78 (81.2)	Ref		

Table 2. Multivariable Logistic Regression Analysis of Factors Associated with Acceptance of Indoor Residual Spraying (IRS) among Study Participants

Variable	Category (Reference)	Adjusted Odds Ratio (AOR)	95% CI	p-value
Education	Illiterate vs Literate	0.89	0.53–1.50	0.648
Religion	Muslim vs Hindu	1.36	0.76–2.43	0.298
Type of Family	Nuclear vs Joint Family	1.95	1.04–3.66	0.037*
Socioeconomic Status	Lower & Lower-middle vs Middle & Above	1.68	1.01–2.98	0.046*
Received Malaria IEC Message in the Past Month	Yes vs No	2.16	1.29–3.61	0.003*
Type of House	Kuccha/Semi-pucca vs Pucca	3.86	2.12–7.05	<0.001*

Table 3. Distribution of Reasons for Non-acceptance of Indoor Residual Spraying (IRS) Among Study Participants

Sr. No.	Reason for Non-acceptance of IRS	No. of Participants (n=164)	Percentage (%)
1	IRS not useful	80	48.8
2	IRS sprayed only in toilets where mosquitoes breed	58	35.4
3	Fear of insecticide staining walls	12	7.3
4	Used IRS in ditches instead of inside houses	8	4.9
5	Concern about irritation or allergy due to insecticide	4	2.4
6	Sprayed over water sources outside the house	2	1.2
Total	—	164	100

4 | DISCUSSION

The results of the current study confirm the observations reported in the literature showing that one of the most significant factors affecting the effectiveness of an Indoor Residual Spraying (IRS) programme is community acceptance. IRS is a very effective malaria vector control measure, but coverage of households to be effective depends on the trust, positive perception, and active participation of the community (7). The results of previous studies have always shown that socio-demographic factors, knowledge about malaria, attitudes towards IRS, and programme quality of implementation are significant factors affecting IRS acceptance.

In a cross-sectional study among 790 households in Luangwa District, Zambia, by Aongola et al. (2022), the overall IRS acceptance rate was found to be 87%. The study found that individuals who had positive attitudes towards IRS were 29 times more likely to accept the spraying treatment (Adjusted Odds Ratio [AOR] = 29.34; 95% CI: 11.14–77.30) than individuals who had negative attitudes. The households that found the spraying schedule inappropriate had significantly less acceptance (AOR = 0.55); on the other hand, the acceptance of unemployed household heads was higher compared to the employed (8). Interestingly, there was no independent association of community information dissemination by the PA systems and door-to-door with acceptance after adjustment, which implies that more important factors than information alone were behavioural perceptions and personal experience. The results are similar to the present study, which showed that positive attitudes, trust in the spraying personnel and the perceived effectiveness of IRS were important factors affecting household acceptance.

Likewise, Suuron et al (2020) carried out an exploratory qualitative study in the Upper West Region of Ghana whereby 101 participants comprising household members, spray operators, community leaders and programme managers were involved. The study discovered that acceptance of IRS was encouraged by the reduction in malaria and nuisance insects, trust in health authorities, and effective community sensitisation before IRS campaigns (9). However, refusal was related to the fear of toxicity from insecticide, objectionable odours, problems with furniture removal, religious beliefs, lack of information, and negative actions of spray operators. The researchers finally came to the conclusion that health education, community communication with the programme staff, and the improvement of such communication were crucial to increase the uptake of IRS. The current results are similar to the ones described in the observations, which showed that community acceptance was limited due to notions of safety of insecticides and the inconvenience of their use.

Baltazar et al. (2019) conducted a qualitative study in Mozambique that included 61 in-depth interviews and 12 focus group discussions in eight malaria-endemic communities, to investigate community perceptions. While most respondents felt IRS was safe and beneficial, acceptance of IRS hinged on understanding the reason for IRS spraying, previous experience with IRS campaigns, confidence in government health services, and community support from community leaders (10). The malaria control programme would be able to save a significant amount of funds by implementing targeted IRS, which can be diverted to other potentially more efficient and life-saving malaria interventions, including improved malaria risk awareness among affected communities and health-care providers, and improved case management, surveillance and border screening. In this context, standard IRS (ICER $7845/DALY averted) would not be viewed as cost-

effective if targeted IRS is practiced as a standard practice (11).

These observations are supported by the findings of a recent systematic review published in 2026, which combined findings from 10 qualitative studies in seven sub-Saharan African countries. The overall malaria case fatality rate (first study year 0·79%, second study year 1·06%) was observed, and our cost-effectiveness estimates were calculated on the basis of the observed study CFR of 3·0% (12). At the targeted IRS clusters, some more structures were sprayed in year 2 following the protocol. This higher incidence led to some delays in reactive spraying, which may have led to onward transmission and higher numbers of cases. At the one-sided 5% significance level, targeted IRS was not inferior to standard IRS in year 2, but was at the 2·5% level. The result of additional non-inferiority was obtained at higher incidence levels, but should be interpreted accordingly due to the fact that the trial was not powered to show non-inferiority in individual study years (13).

On the other hand, negative previous experiences, incompatibility of spraying campaigns due to seasonal mismatch, adverse health impacts, and poor communication were frequent reasons for refusing (3). The review found that the effectiveness of the programmes in delivering the WHO target coverage for IRS depends not just on the insecticide itself, but also on the effectiveness of the programme implementation and community engagement (14).

Findings from the present study generally support those of other studies in highlighting that knowledge, positive attitudes, trust in health authorities and programme implementation are interlinked and influence community acceptance of IRS (15, 16)

Improved health education, increased community engagement, myths about the safety of insecticides and respectful, well-coordinated spray operations will likely increase IRS acceptance and contribute to better malaria control results.

5 | CONCLUSION

The study concluded that acceptance to IRS was very low, with 25.5% of the respondents accepting IRS and 74.5% refusing the intervention. Through multivariable analysis, it was found that the significant determinants of IRS acceptance included the kind of house, having received malaria IEC messages, family type, and socio-economic status. Respondents living in kuccha or semi-pucca houses and those having received malaria IEC messages accepted IRS. However, level of education, religion, knowledge about mosquito bites, and beliefs about benefits of IRS did not showed significant relationships. The most common reason for refusal of IRS were perceived uselessness of IRS and the wrong conception that IRS should be done only in toilets, with a combined rate of 84%. The findings revealed that misconceptions, lack of awareness, and household-related issues were the main issues to the acceptance of IRS. This showed the requirement for increased community-based health education and IEC campaigns.

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