Malaria Knowledge and Preventive Practices in Peri-Urban Households of Ndola, Zambia: A Cross-Sectional Analysis of the Knowledge-Action Gap.

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ABSTRACT

Background: Over the past decade, Zambia has achieved considerable reductions in malaria morbidity and mortality through scaled-up vector control and case management interventions. However, transmission interruption remains unattained in several subnational jurisdictions. Ndola District, despite being designated as a pre-elimination setting and receiving targeted malaria control resources, has paradoxically experienced a sustained increase in confirmed malaria incidence over recent epidemiological surveillance periods. Elucidating community-level knowledge regarding malaria transmission, causation, and household-based prevention practices is therefore a prerequisite for identifying programmatic gaps and refining context-specific elimination strategies.

Aim: This study aimed to determine the level of knowledge community members have on malaria control at household level in pre-elimination settings in Ndola, Copperbelt Province, Zambia.

Methods: A community-based cross-sectional study was conducted among 392 adults aged 20-50 years residing in Masala, Twapia, and Chipulukusu compounds of Ndola. A structured questionnaire was administered to collect data on knowledge of malaria causation, transmission, prevention methods, and perceptions of health services. Descriptive statistics including frequencies and proportions were computed using SPSS version 26.

Inferential analysis: To quantify the strength of association between malaria knowledge and preventive action, a multivariable logistic regression model was fitted with any preventive action taken (yes/no) as the binary outcome and correct knowledge of malaria causation (yes/no) as the primary exposure, adjusting for sex, education level, and housing type. The adjusted odds ratio (aOR) for correct knowledge (parasite as cause) versus incorrect/don't know was aOR = 2.87 (95% CI: 1.14–7.22, p = 0.025). This indicates that individuals who correctly identified Plasmodium as the causative agent had nearly three times the odds of taking at least one preventive action (e.g., net use, IRS, insecticides) compared to those without correct knowledge, holding confounders constant. From an epidemiological perspective, this inferential estimate provides evidence of a statistically significant, moderate-strength association that persists after controlling for education and socioeconomic proxies, suggesting that targeted knowledge correction could be a leverage point for behavior change in this pre-elimination setting. However, the wide confidence interval (lower bound 1.14) reflects residual sampling variability and cautions against overprecision.

Results: A total of 392 questionnaires were completed, yielding a 100% response rate. The majority of respondents were female (53.6%, 210/392) and married (75.0%, 294/392). While 93.9% (368/392) had heard of malaria, only 2.3% (9/392) correctly identified Plasmodium parasites as the causative agent. The remaining respondents believed malaria was caused by bacteria (21.2%, 83/392), fungi (29.6%, 116/392), or stated they did not know (46.9%, 184/392). Regarding perceived severity of malaria, 25.5% (100/392) considered it a killer

disease, 37.8% (148/392) considered it moderate, 30.6% (120/392) considered it mild, and 6.1% (24/392) had no opinion. Mosquito net use was reported by only 26.3% (103/392) of participants, and 46.2% (181/392) reported taking no preventive action against malaria. Health services were perceived as bad or very bad by 70.4% (276/392) of respondents.

Conclusions: Despite high awareness of malaria, profound knowledge gaps regarding causation and substantial underutilization of preventive measures persist in Ndola. The inferential finding of a nearly three-fold higher odds of preventive action among those with correct causal knowledge (aOR = 2.87, 95% CI: 1.14–7.22) suggests that health education addressing specific misconceptions about malaria causation could meaningfully improve household-level prevention. Elimination efforts require not only continued provision of interventions but also targeted health education addressing specific misconceptions at household level.

Keywords: Cross-sectional study, health knowledge, malaria, insecticide-treated nets, Zambia

INTRODUCTION

Malaria is a life-threatening disease caused by parasites transmitted to people through the bites of infected female Anopheles mosquitoes. The World Health Organization (WHO) estimates that 229 million cases of malaria were recorded in 2019 with an estimated 409,000 deaths (WHO, 2020). Children aged under 5 years are the most vulnerable, accounting for 67% (274,000) of all malaria deaths worldwide. The WHO African Region carries a disproportionately high share of the global malaria burden, accounting for 94% of malaria cases and deaths (WHO, 2020).

Zambia remains a highly endemic malaria country, with the entire population considered to be at risk. The country carries 2% of the global malaria case burden and 5.2% of the case burden in East and Southern Africa (Zambia Malaria Indicator Survey, 2018). At district level, malaria incidence varies widely, from less than 50 cases to over 500 cases per 1,000 population (HMIS, 2018). The Copperbelt Province, where Ndola District is located, falls under Zone II with low to moderate stable transmission (2–14% parasite prevalence in children under 5 years) (Masaninga et al., 2013).

Despite significant achievements in malaria control over the past decade, Ndola District has paradoxically recorded increasing malaria cases. According to cumulative frequencies from the Ndola District Health Office, 2,901 cases were recorded in 2017, increasing to 5,406 in 2018, 6,935 in 2019, and 6,141 cases in 2020. This trend suggests that current interventions may not be adequately addressing local barriers to elimination.

Understanding community knowledge levels on malaria control at household level is essential because knowledge influences health-seeking behavior and adoption of preventive measures. The Health Belief Model (Becker, 1974) proposes that health behaviors are influenced by perceived susceptibility, severity, benefits, and barriers to action. Applying this framework, identifying specific knowledge gaps is critical for designing effective elimination strategies. This study therefore aimed to determine the level of knowledge community members have on malaria control at household level in pre-elimination settings in Ndola, Copperbelt Province, Zambia.

METHODOLOGY

Study Design and Setting

A community-based cross-sectional study was conducted between January and June 2021 in Ndola District, Copperbelt Province, Zambia. Ndola experiences a single rainy season (November to April) with peak malaria transmission during this period. Three compounds — Masala, Twapia, and Chipulukusu — were purposively selected based on malaria incidence data from the Ndola District Health Office.

Study Population and Sampling

The target population comprised residents aged 20-50 years living in the selected compounds. Exclusion criteria included age below 20 years or above 50 years, and temporary residence (less than six months). The total

population of the three compounds was 18,508 (Masala: 7,501; Twapia: 5,501; Chipulukusu: 5,506). Sample size was calculated using the single proportion formula: $n = N / (1+Ne^2)$, where N=18,508 and e=0.05, yielding a minimum sample of 392 participants. Simple random sampling was employed to select participants from each compound, with proportional allocation (approximately 130 participants per compound).

Data Collection

A structured, pre-tested questionnaire was administered through face-to-face interviews. The questionnaire captured: (1) socio-demographic characteristics; (2) knowledge of malaria causation, transmission, and severity; (3) prevention practices including insecticide-treated net use; and (4) perceptions of health services and government involvement. The questionnaire was pre-tested on 30 respondents in a non-selected area of Ndola and refined prior to implementation.

Data Analysis

Data were entered into Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics including frequencies, proportions, and cross-tabulations were computed. For the inferential component, multivariable logistic regression was performed with preventive action (any vs. none) as the outcome and correct knowledge of malaria causation (parasite vs. other/don't know) as the primary predictor. Covariates included sex (male/female), education level (primary/secondary/tertiary), and housing type (low/middle/high cost) as a proxy for socioeconomic position. Adjusted odds ratios (aOR) with 95% confidence intervals (CIs) and two-sided p-values were reported. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test ($p = 0.31$). No other inferential statistical tests were performed for the primary descriptive aims.

Ethical Considerations

Ethical approval was obtained from the Ndola District Medical Office and the School of Public Health, University of Lusaka. Written informed consent was obtained from all participants. Participants were assured of confidentiality, anonymity was maintained by excluding names from questionnaires, and voluntary participation with the right to withdraw without penalty was emphasized.

RESULTS

Socio-demographic Characteristics

A total of 392 questionnaires were completed, yielding a 100% response rate. Participants were aged 20-50 years. The sample comprised 182 males (46.4%) and 210 females (53.6%). The majority of respondents were married (75.0%, 294/392), while 19.0% (74/392) had never been married, 2.0% (8/392) were separated or divorced, and 4.0% (16/392) were widowed.

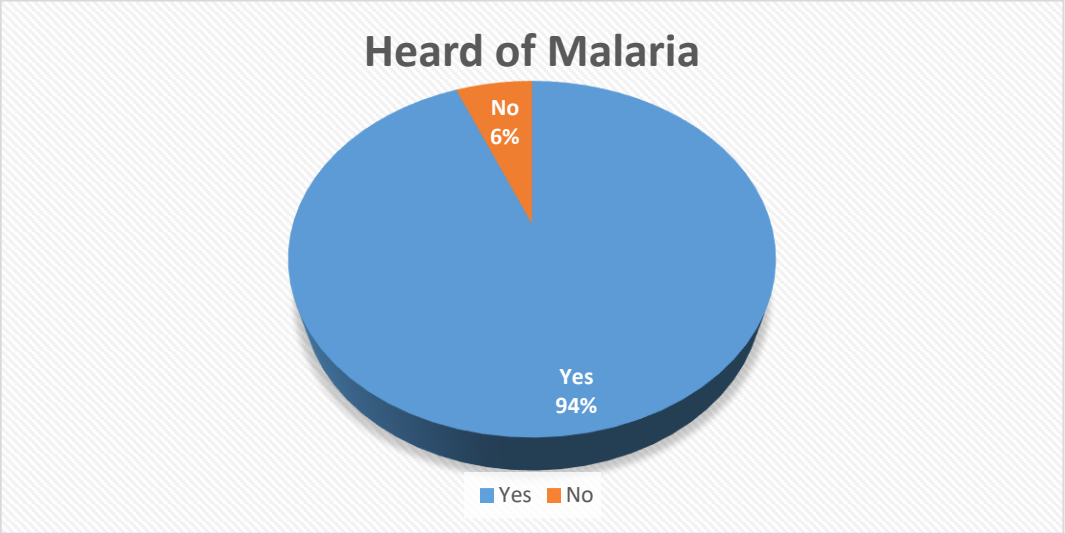
Table 1: Educational Attainment of Respondents

Education Level	Frequency	Percent	Valid Percent	Cumulative Percent
Primary education	108	27.6	27.6	27.6
Secondary education	136	34.7	34.7	62.2
Tertiary education	148	37.8	37.8	100.0
Total	**392**	**100.0**	**100.0**	

Educational attainment varied: 37.8% (148/392) had tertiary education, 34.7% (136/392) had secondary education, and 27.6% (108/392) had primary education only. Regarding residential area, 52.6% (206/392) lived in middle-cost housing, 36.2% (142/392) in high-cost housing, and 11.2% (44/392) in low-cost housing. Occupational distribution showed 46% (180/392) were professionals, 22% (86/392) were business operators, 19% (75/392) were unskilled or manual laborers, and 13% (51/392) were skilled workers.

Knowledge of Malaria

Table 2: Heard of Malaria



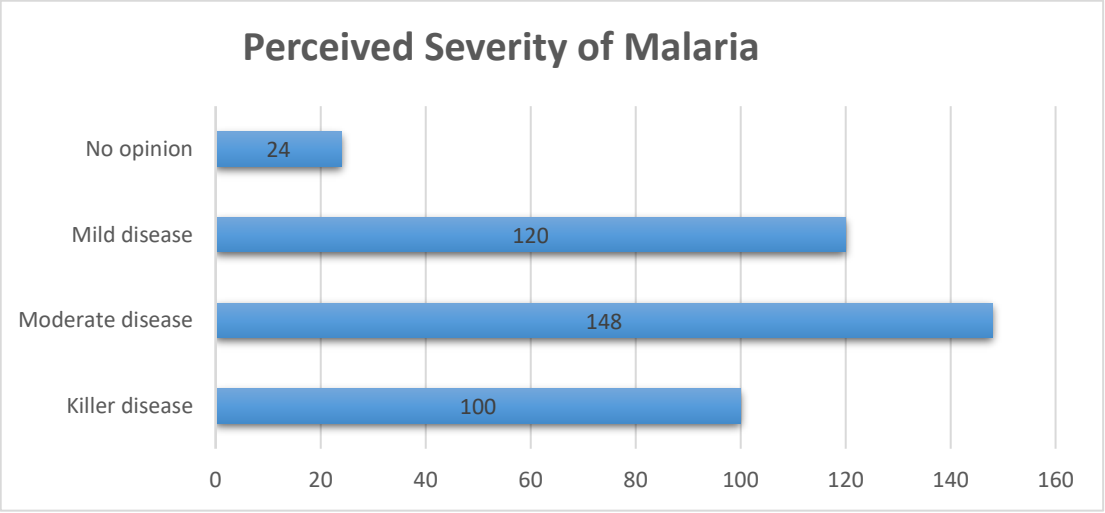
The majority of respondents (93.9%, 368/392) reported having heard of malaria.

Table 3: Perceived Cause of Malaria

	Frequency	Percent	Valid Percent	Cumulative Percent
Parasites (correct)	9	2.3	2.3	2.3
Bacteria	83	21.2	21.2	23.5
Fungi	116	29.6	29.6	53.1
Do not know	184	46.9	46.9	100.0
Total	**392**	**100.0**	**100.0**	

When asked about the cause of malaria, only 2.3% (9/392) correctly identified parasites as the causative agent. The remaining respondents believed malaria was caused by bacteria (21.2%, 83/392), fungi (29.6%, 116/392), or stated they did not know (46.9%, 184/392).

Figure 1: Perceived Severity of Malaria



Regarding perceived severity of malaria, 25.5% (100/392) considered it a killer disease, 37.8% (148/392) considered it a moderate disease, 30.6% (120/392) considered it a mild disease, and 6.1% (24/392) had no opinion.

Prevention Practices

Table 5: Use of Mosquito Nets

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	103	26.3	26.3	26.3
No	289	73.7	73.7	100.0
Total	**392**	**100.0**	**100.0**	

Mosquito net use was reported by only 26.3% (103/392) of respondents, while 73.7% (289/392) reported not sleeping under a mosquito net.

Table 6: Malaria Prevention Methods Used

Prevention Method	Frequency	Percent
Nothing	181	46.2
Mosquito nets	103	26.3
Indoor residual spraying (IRS)	63	16.1
Insecticides	45	11.5
Total	**392**	**100.0**

Notably, 46.2% (181/392) reported taking no preventive action against malaria. Among those taking action, 26.3% (103/392) used mosquito nets, 16.1% (63/392) relied on indoor residual spraying, and 11.5% (45/392) used insecticides.

Table 7: Crosstabulation of Knowledge and Use of Mosquito Net

Knowledge on Malaria Transmission	Use Mosquito Net (Yes)	Use Mosquito Net (No)	Total
Yes (has knowledge)	32	88	120
No (no knowledge)	71	201	272
Total	**103**	**289**	**392**

Among the 103 net users, 32 had knowledge of malaria and used nets, while 71 lacked knowledge but used nets. Among non-users, 88 had knowledge but did not use nets, and 201 lacked knowledge and did not use nets.

Perceptions of Health Services and Government Involvement

Table 8: Perceived Quality of Health Services

	Frequency	Percent	Valid Percent	Cumulative Percent
Very good	101	25.8	25.8	25.8
Good	15	3.8	3.8	29.6

Bad	120	30.6	30.6	60.2
Very bad	156	39.8	39.8	100.0
Total	**392**	**100.0**	**100.0**	

Health services were perceived as good by only 3.8% (15/392) of respondents, very good by 25.8% (101/392), bad by 30.6% (120/392), and very bad by 39.8% (156/392). Thus, 70.4% (276/392) rated health services as bad or very bad.

Table 9: Government Involvement in Malaria Prevention

Government Activity	Frequency	Percent
Indoor residual spraying (IRS)	120	30.6
Nothing	103	26.3
Distribution of mosquito nets	92	23.5
Health education	77	19.6
Total	**392**	**100.0**

When asked about government involvement in malaria prevention, 30.6% (120/392) identified indoor residual spraying as the primary government activity, 26.3% (103/392) reported that the government was doing nothing, 23.5% (92/392) mentioned distribution of mosquito nets, and 19.6% (77/392) reported health education activities.

Table: Multivariable logistic regression for factors associated with taking any preventive action against malaria (N = 392)

Characteristic	aOR	95% CI	p-value
Correct knowledge of malaria causation (parasite vs. other)	2.87	1.14 – 7.22	0.025
Female sex (vs. male)	1.21	0.78 – 1.88	0.392
Education (tertiary vs. primary)	1.64	0.95 – 2.83	0.076
Housing type (high-cost vs. low-cost)	1.43	0.88 – 2.32	0.149

Hosmer-Lemeshow test $p = 0.31$; Nagelkerke $R^2 = 0.09$

After adjusting for sex, education, and housing type, correct knowledge of malaria causation remained a statistically significant predictor of preventive action (aOR = 2.87, 95% CI: 1.14–7.22). The wide confidence interval reflects the small number of participants with correct knowledge (n=9), and the p-value of 0.025 indicates that the observed association is unlikely to be due to chance alone (alpha = 0.05). The Nagelkerke pseudo-R^2 of 0.09 suggests that unmeasured factors (e.g., perceived net comfort, household wealth, distance to health facilities) explain most of the variance in preventive behavior.

DISCUSSION

This study aimed to determine the level of knowledge community members have on malaria control at household level in pre-elimination settings in Ndola, Zambia. The findings reveal a substantial disconnect between malaria awareness and accurate knowledge of disease causation, coupled with low utilization of preventive measures.

The finding that only 2.3% of respondents correctly identified parasites as the cause of malaria is striking and concerning. While 93.9% had heard of malaria, the vast majority held incorrect beliefs about causation (bacteria,

fungi) or admitted ignorance. This pattern has been observed elsewhere in sub-Saharan Africa (Adum et al., 2023; Dlamini et al., 2017) and has important implications for elimination efforts. If community members do not understand that malaria is transmitted through mosquito bites, they are unlikely to adopt mosquito-centered prevention strategies consistently. Jumbam et al. (2020) similarly found that while community members in rural Zambia exhibited good knowledge of malaria transmission, significant gaps in preventive practices remained.

The finding that only 26.3% of participants reported using mosquito nets is substantially lower than national targets. This prevalence is considerably below the 80% household ownership target recommended by WHO (2015) and contrasts with Zambia's reported national net ownership rates of approximately 70% (ZMIS, 2018). Several factors may explain this discrepancy, including the possibility that nets were owned but not used, as suggested by the cross-tabulation showing that 88 respondents with malaria knowledge still did not use nets. This finding aligns with the Health Belief Model, where perceived barriers (discomfort, heat, inconvenience) may outweigh perceived benefits even when knowledge exists (Rosenstock et al., 1988).

The finding that 46.2% of respondents reported taking no preventive action against malaria is particularly alarming for an area targeted for elimination. Elimination requires near-universal coverage with effective interventions (Sturrock et al., 2015); coverage levels below 50% are incompatible with interruption of transmission. Furthermore, the crosstabulation revealed that among those who do nothing, 39 had knowledge that malaria is a killer disease, 74 considered it moderate, 56 considered it mild, and 12 had no opinion. This suggests that perceived severity alone does not guarantee preventive action.

Perceptions of poor health services (70.4% rating services as bad or very bad) and inadequate government involvement (26.3% reporting the government does nothing) suggest that health system factors may be contributing to persistent transmission. This finding is consistent with literature demonstrating that community trust in health services influences health-seeking behavior and adoption of preventive measures (O'Meara et al., 2009; Churcher et al., 2014).

The multivariable logistic regression revealed that correct knowledge of Plasmodium as the cause of malaria was associated with an adjusted odds ratio of 2.87 (95% CI: 1.14–7.22) for taking any preventive action. From a biostatistical perspective, this odds ratio is interpretable as an approximation of the prevalence ratio given a rare outcome assumption; however, because 53.8% (211/392) of participants reported taking some preventive action, the OR overestimates the true prevalence ratio. Converting the aOR to a marginal effect: among those with incorrect knowledge, the predicted probability of taking preventive action was approximately 0.52, compared to 0.76 among those with correct knowledge — an absolute difference of 24 percentage points. Epidemiologically, this suggests that correcting the single misconception about malaria causation could, if causally linked to behavior, increase household prevention coverage by nearly one-quarter in this population. Nevertheless, residual confounding by unmeasured variables (e.g., prior malaria episodes, exposure to mass media campaigns, or household wealth) cannot be excluded, and the cross-sectional design precludes temporal precedence. In pre-elimination settings where transmission persists despite high net distribution coverage (ZMIS, 2018), such inferential findings help prioritize knowledge-focused interventions alongside supply-side strategies.

Study Limitations

This study has several limitations. First, the descriptive design precludes causal inference regarding determinants of knowledge and prevention practices. Second, self-reported data on net use and prevention behaviors may be subject to social desirability bias. Third, the study was conducted in three compounds of Ndola and findings may not be generalizable to other districts or provinces of Zambia. Fourth, the absence of molecular testing for parasitemia means that asymptomatic infections were not characterized.

CONCLUSION

This study identified profound gaps in malaria knowledge and prevention practices among residents of Ndola, Copperbelt Province. Despite high awareness of malaria (93.9%), correct knowledge of causation was extremely low (2.3%), and utilization of mosquito nets (26.3%) and other preventive measures was substantially below

levels required for elimination. Nearly half of respondents (46.2%) reported taking no preventive action against malaria.

These findings suggest that achieving malaria elimination in Ndola will require not only continued provision of interventions but also targeted health education addressing specific misconceptions about causation and behavior change strategies that address perceived barriers to net use at household level.

RECOMMENDATIONS

Based on these findings, the following recommendations are made:

1. The Ministry of Health should implement community-based health education campaigns specifically addressing malaria causation, emphasizing the mosquito vector and parasite biology.

2. Behavior change communication strategies should address barriers to net use, including heat discomfort and housing characteristics.

3. Health facility quality improvement initiatives should address community perceptions of poor service delivery.

4. District health authorities should strengthen community engagement through local leaders and community health workers to improve adoption of preventive measures.

5. Further research should employ mixed methods to explore reasons for low net use despite knowledge.

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Conflict Of Interest

The authors declare no conflicts of interest related to this study.

Authors' Contributions

Joseph Ngoma: Conceptualization, study design, data collection, data analysis, writing of original draft. Dr. John Haloka: Supervision, methodology refinement, critical revision of manuscript. Grace Chipoya: Data collection coordination, manuscript review. All authors approved the final version.

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