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# Exposure to Malaria Messaging: A Nationally Stratified Cross-Sectional Study on Information Dissemination in Ghana and its Implications for the SDGs

**Isaac Ofori Asare**
ioasare@atu.edu.gh

Accra Technical University
**Alice Constant Mensah**
Accra Technical University
**Vivian Efua Senoo-Dogbey**
University of Ghana
**Jacob Apibilla Ayembilla**
Accra Technical University
**Richard Fosu**
Accra Technical University
**Emmanuel Acheampong**
Council for Scientific and Industrial Research

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## Abstract

# Background

Malaria remains a significant public health challenge in Ghana despite ongoing and sustained control efforts. The success of these initiatives depends heavily on effective communication; however, there is limited national-level evidence on the population reach of malaria-related messages. Understanding which groups receive these messages and which do not is essential for improving malaria prevention, optimizing public health investments, and advancing progress toward the health targets of Sustainable Development Goal 3 (SDG3).

# Methods

This study analyzed data from the 2019 Ghana Malaria Indicator Survey (GMIS) to assess exposure to malaria messages and identify associated sociodemographic factors. The sample included 3,004 women aged 15–49 years. Descriptive statistics were calculated to determine the prevalence of exposure to malaria messages within the preceding six months. Multivariable logistic regression models were then used to examine associations between message exposure and predictor variables such as age, ethnicity, region, literacy level, and indicators of media access.

# Results

Overall, 55.2% of respondents reported exposure to malaria messages within the past six months. Multivariable logistic regression revealed significant associations between message exposure and several factors, including age, ethnicity, region of residence, and literacy level. Unexpected patterns emerged with respect to media access: women without electricity and those lacking radio access had higher odds of reporting exposure to malaria messages. These findings suggest the presence of alternative or community-driven communication channels that extend beyond traditional media. The results collectively highlighted marked disparities in the reach and distribution of malaria communication efforts nationwide.

# Conclusions

**This** study demonstrates that Ghana's malaria communication campaigns do not reach all population groups equally. The observed disparities particularly those linked to sociodemographic and regional factors underscore the need for more targeted, context-specific, and multi-channel communication strategies. Strengthening equitable access to malaria information is essential for improving prevention behaviors, guiding efficient allocation of resources, and accelerating national progress toward SDG3.

## 1. Introduction

Malaria remains a significant global public health threat, with the World Health Organization (WHO) reporting an estimated 249 million cases and 608,000 deaths in 2022. The WHO Africa Region bears the brunt of this burden, accounting for 94% of cases and 95% of deaths, primarily among children under five [1]. Ghana is a high-burden country, contributing 5.3 million cases and 11,552 deaths to these sobering statistics [1]. Despite decades of control efforts leveraging tools like insecticide-treated nets (ITNs) and artemisinin-based combination therapy (ACT), progress has stalled, complicated by factors such as insecticide resistance [1, 2, 25, 26].

In response, the Ghana National Malaria Control Programme (NMCP) has intensified its efforts, outlined in the National Malaria Strategic Plan 2021–2025, which aims to protect at least 80% of the population with effective interventions [3]. A

critical, yet often under-examined, component of this strategy is health promotion and communication. Effective communication is the bridge that connects the availability of interventions to their correct and consistent use by the public. For instance, while 67% of Ghanaian households had access to ITNs, only 43% used them regularly, a gap often attributed to knowledge, perceptions, and discomfort [4, 27–28]. This disparity highlights that high intervention coverage does not automatically translate into desired health outcomes if public understanding and acceptance are lacking.

The success of any public health intervention, from traditional ITNs to novel approaches like the RTS's malaria vaccine or future insect-specific viruses (ISVs), is fundamentally dependent on effective public communication [5, 6]. However, a critical gap exists in understanding whether malaria control messages are actually reaching the population. While numerous studies have assessed general malaria knowledge, attitudes, and practices (KAP) in Ghana, there is a paucity of nationally representative data focusing specifically on the exposure to malaria communication campaigns that is, whether people have simply seen or heard the messages disseminated by health authorities [7, 8].

Exposure is the essential first step in the communication process that leads to knowledge, attitude change, and, ultimately, protective behavior [9]. Without a clear map of which populations are being reached by which communication channels, programs cannot effectively tailor their strategies to fill awareness gaps. This study therefore aims to utilize national data to explore the level and determinants of exposure to malaria messages among Ghanaian women of reproductive age, a key demographic for household health decision-making. The findings will provide critical evidence for refining communication strategies, with the ultimate goal of enhancing malaria control and advancing progress towards Sustainable Development Goal 3.

## 2. Methodology

# 2.1 Data source

This study utilized data obtained from the 2019 Ghana Malaria Indicator Survey (GMIS), a comprehensive national assessment conducted under the collaborative leadership of multiple institutions. The Ghana Statistical Service (GSS) served as the primary implementing agency, working in partnership with the Ghana National Malaria Control Programme (NMCP) and the National Public Health and Reference Laboratory (NPHRL), both operating under the Ghana Health Service (GHS). The 2019 GMIS represents the second iteration of Ghana's malaria indicator surveys, following the inaugural survey conducted in 2016. This nationwide survey was strategically designed to generate population-level estimates of critical malaria indicators across all regions of Ghana. The survey serves a vital function in supplementing routine administrative health data, providing evidence-based insights that inform both strategic planning initiatives and program evaluation activities for the country's malaria control efforts. The study design and data collection were carried out by these organizations, and we utilized their data as secondary data for analysis. This clarification aligns with similar studies that used secondary data from national surveys for malaria risk mapping [5].

# 2.2 Study population.

The study participants were all women aged between 15 and 49 who were either permanent residents of the selected households or visitors in the selected regions and respective districts who stayed in the household the night before the survey were eligible to be interviewed. The study was conducted across all regions and 136 districts, encompassing both rural and urban locations throughout the entire country of Ghana.

# 2.3 Study design.

This study utilized a descriptive cross-sectional design to collect data intended to estimate key malaria indicators across Ghana at national, urban, and rural levels, as well as within each of the ten administrative regions defined by the 2010 Population and Housing Census (PHC). The sampling frame relied on the enumeration areas established during the 2010 PHC by the Ghana Statistical Service. Although Ghana officially increased its number of administrative regions from ten to

sixteen in 2019, with a total of 260 districts, the survey design and sampling procedures referenced the original ten-region framework since the updated boundaries were not yet implemented at the time of the study. Therefore, the 2019 Ghana Malaria Indicator Survey (GMIS) used the enumeration areas and administrative boundaries corresponding to the 2010 PHC for the selection of households and clusters throughout the country.

## 2.4 Data Collection Techniques

The survey by NMCP was conducted in English and four local languages, such as Akan, Dagbani, Ewe, and Ga, using computer-assisted personal interviewing (CAPI) on tablet computers. Information such background characteristics (such as age, education, literacy, religion, and ethnicity) and exposure to media messages within the last six months were collected. For the purpose of this study, the researchers utilized this secondary data for analysis.

## 2.5 Conceptualization and Measurement of Message Exposure

This study focuses on the population's exposure to malaria communication campaigns, a critical first step in the pathway to knowledge and awareness. Conceptually, malaria awareness entails a comprehensive understanding of the disease. However, the available data measured a more foundational construct: self-reported exposure to malaria messages. The primary outcome variable was operationalized as a binary indicator (Yes/No) based on the survey question of whether participants reported having seen or heard any malaria-related messages through various media channels in the past six months. This measure captures the fundamental reach of malaria communication efforts but does not assess the depth of knowledge, comprehension, or other components of broader awareness.

The term exposure is used consistently throughout this manuscript when referring to this specific study variable and its analysis. This approach aligns with methodologies used in similar studies that differentiate between exposure to information and comprehensive knowledge [10, 11]. This variable was employed as the dependent variable in the logistic regression model to identify factors associated with message exposure. The standardized questionnaire used in the Ghana Malaria Indicator Survey (GMIS) had been previously validated, and as this study utilized secondary data, no additional piloting was conducted.

## 2.6 Outcome Measure

The primary outcome variable for this study was self-reported exposure to malaria information dissemination campaigns. This was assessed using the survey question: "Have you seen or heard any messages about malaria on television, radio, or other media in the last few months?". Responses were recoded into a binary variable: Yes = 1 and No = 0. This measure specifically captures the population's reach or exposure to malaria-related messaging, which is a critical first step in the communication process leading to knowledge, awareness, and behavior change. It is important to note that this outcome measures the penetration of public health messages, not the depth of malaria-related knowledge or comprehensive awareness. While exposure is a necessary precursor to knowledge, the two are distinct constructs. Therefore, the findings of this study relate specifically to the factors associated with the reception of malaria messages, which have direct implications for evaluating and optimizing communication strategies as part of public health efforts towards the Sustainable Development Goals (SDGs).

## 2.7 Sampling method

The 2019 GMIS employed a stratified, two-stage sampling design to ensure national representativeness. For the purposes of the survey, each of Ghana’s regions was separated into urban and rural residence categories, forming 20 distinct strata [29–31]. Within each stratum, Enumeration Areas (EAs) drawn from the 2010 Population and Housing Census served as the primary sampling units. During the first stage, a total of 200 EAs comprising 97 urban clusters and 103 rural clusters were selected using probability proportional to size, allowing larger EAs a greater chance of inclusion. In the second stage, the survey team selected 30 households per EA, resulting in an intended national sample of 6,000 households. All sampled households were taken without replacement, and no substitutions were made for households that could not be

interviewed. From the households selected for the GMIS, a total of 3,004 women were included in the analytic sample for the present study based on eligibility criteria consistent with the DHS framework. Because the regional distribution of sampled households did not follow proportional allocation, and response patterns varied across areas, sampling weights supplied by the GMIS were applied in all analyses to restore representativeness and account for the complex survey design.

## 2.8 Statistical analysis

As a result of the two-stage sampling technique adopted by the Ghana Malaria Indicator Survey (GMIS) 2019, this analysis adjusted for the complex survey design, including the clustering (primary sampling units, PSUs), stratification, and the sampling weights. This adjustment was implemented to prevent bias and improve the precision of all our estimates [12]. The weighting procedure accounted for the probability of selecting a PSU from a region and a household from the PSU. Subsequently, the weights were standardized as the sampling design was not self-weighting, given that households were given an equal chance of selection in the second stage. The analysis proceeded in several stages. First, univariate analysis was conducted using descriptive statistics and frequency tables to understand the distribution and characteristics of all variables. This step was useful for identifying patterns or anomalies before proceeding with more complex analyses.

Second, bivariate analyses were performed to preliminarily assess the association between each covariate and the outcome variable. The Chi-square test ($\chi^2$) was used for this purpose, with the sample design effect incorporated to determine significant differences in the prevalence rate of seeing or hearing malaria messages across different covariates.

Prior to constructing the multivariate model, a collinearity analysis was performed using the variance inflation factor (VIF). All VIF values were found to be well below the commonly cited threshold of 10, and indeed below more conservative thresholds such as 5, indicating no issues with multicollinearity that would preclude including these variables in the same model [13].

The primary analytical approach was a multivariate logistic regression model to examine the factors associated with the outcome while controlling for other variables. This model allowed us to estimate the independent effect of each covariate on the likelihood of seeing or hearing malaria messages. The results are presented as adjusted odds ratios (aOR) with their 95% confidence intervals. For comparative purposes, we also report the unadjusted odds ratios (OR) with 95% confidence intervals for each covariate. Data management, cleaning, and all statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS version 27) and Microsoft Excel, Office 365, with procedures that account for the complex survey design.

# 3. Results

Out of the total of 3004 Ghanaian women selected for the study, aged between 15 to 49 years, the overall mean (± SD) age was 29.86 (± 6.89) years. The mean age of participants who had not seen or heard any message about malaria was 29.43 (±7.18), compared to 30.20 (±6.63) for those who had. The prevalence of exposure to malaria messages in the past six months was 55.2% (n=1658), while 44.8% (n=1346) reported no exposure. The chi-square test ($\chi^2$) showed a statistically significant association (p-value ≤0.05) between having seen or heard a malaria message and all examined covariates, as shown in Table 1.

Key descriptive findings from the bivariate analysis include: A higher proportion of participants aged 20–44 reported exposure to malaria messages compared to other age groups. Participants who could read whole sentences reported a higher level of exposure compared to those who could not. The prevalence of message exposure varied by region. The highest levels were observed in the Northern and Upper West regions. The distribution of message exposure differed significantly among religious groups. For instance, 69.5% of Christian participants reported having seen or heard a malaria message. A difference was observed between urban and rural residents, with 66.8% of participants in rural areas reporting exposure.

Table 1 Prevalence of malaria-related messages among Ghanaian women

| Characteristics | Have you seen or heard any messages about malaria in the past 6 months? | | | | |
|---|---|---|---|---|---|
| | No [44.8% (1346)] | | Yes [55.2% (1658)] | | |
| | N | % | N | % | -value |
| Age (M (±SD) [29.86± 6.89] | 29.43(7.18) | | 30.20 (6.63) | | |
| *Age in 5-year groups* | | | | | |
| 15-19 | $78_a$ | 5.8 | $67_b$ | 4.0 | 33.385 (6), p<0.001 |
| 20-24 | $291_a$ | 21.6 | $284_b$ | 17.1 | |
| 25-29 | $358_a$ | 26.6 | $460_a$ | 27.7 | |
| 30-34 | $285_a$ | 21.2 | $373_a$ | 22.5 | |
| 35-39 | $186_a$ | 13.8 | $313_b$ | 18.9 | |
| 40-44 | $102_a$ | 7.6 | $132_a$ | 8.0 | |
| 45-49 | $46_a$ | 3.4 | $29_b$ | 1.7 | |
| *Highest educational level* | | | | | |
| No education | $438_a$ | 32.5 | $388_b$ | 23.4 | 60.891 (3), p<0.001 |
| Primary | $308_a$ | 22.9 | $338_a$ | 20.4 | |
| Secondary | $566_a$ | 42.1 | $820_b$ | 49.5 | |
| Higher | $34_a$ | 2.5 | $112_b$ | 6.8 | |
| *Religion* | | | | | |
| Catholic | $158_a$ | 11.7 | $148_b$ | 8.9 | 28.714 (9), p<0.001 |
| Anglican | $12_a$ | 0.9 | $13_a$ | 0.8 | |
| Methodist | $50_a$ | 3.7 | $103_b$ | 6.2 | |
| Presbyterian | $67_a$ | 5.0 | $75_a$ | 4.5 | |
| Pentecostal/Charismatic | $476_a$ | 35.4 | $669_b$ | 40.3 | |
| Other Christian | $172_a$ | 12.8 | $202_a$ | 12.2 | |
| Islam | $333_a$ | 24.7 | $383_a$ | 23.1 | |
| Traditional/Spiritualist | $27_a$ | 2.0 | $30_a$ | 1.8 | |
| No religion | $49_a$ | 3.6 | $34_b$ | 2.1 | |
| Other | $2_a$ | 0.1 | $1_a$ | 0.1% | |
| *Ethnicity* | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Akan | $413_a$ | 30.7 | $608_b$ | 36.7 | 29.046 (8), p<0.001 |
| Ga/Dangme | $62_a$ | 4.6 | $85_a$ | 5.1 | |
| Ewe | $177_a$ | 13.2 | $194_a$ | 11.7 | |
| Guan | $29_a$ | 2.2 | $46_a$ | 2.8 | |
| Mole-Dagbani | $458_a$ | 34.0 | $516_a$ | 31.1 | |
| Grusi | $52_a$ | 3.9 | $64_a$ | 3.9 | |
| Gurma | $107_a$ | 7.9 | $75_b$ | 4.5 | |
| Mande | $17_a$ | 1.3 | $18_a$ | 1.1 | |
| Other | $31_a$ | 2.3 | $52_a$ | 3.1 | |
| *Region* | | | | | |
| Western | 131a | 9.70 | 163a | 9.80 | 57.185 (9), p<0.001 |
| Central | 131a | 9.70 | 141a | 8.50 | |
| Greater Accra | 68a | 5.10 | 170b | 10.30 | |
| Volta | 115a | 8.50 | 135a | 8.10 | |
| Eastern | 124a | 9.20 | 130a | 7.80 | |
| Ashanti | 113a | 8.40 | 198b | 11.90 | |
| Brong Ahafo | 132a | 9.80 | 157a | 9.50 | |
| Northern | 236a | 17.50 | 255a | 15.40 | |
| Upper East | 120a | 8.90 | 171a | 10.30 | |
| Upper West | 176a | 13.10 | 138b | 8.30 | |
| *Literacy level* | | | | | |
| Cannot read at all | 438a | 32.5 | 388b | 23.4 | 32.085 (2), p<0.001 |
| Able to read only parts of sentence | 99a | 7.4 | 122a | 7.4 | |
| Able to read whole sentence | 809a | 60.1 | 1148b | 69.2 | |
| *Type of place of residence* | | | | | |
| Urban | $447_a$ | 33.2 | $723_b$ | 43.6 | 33.774 (1), p<0.001 |
| Rural | $899_a$ | 66.8 | $935_b$ | 56.4 | |
| *Household has: electricity* | | | | | |
| No | $491_a$ | 36.5 | $338_b$ | 20.4 | 96.846 (2), p<0.001 |
| Yes | $834_a$ | 62.0 | $1294_b$ | 78.0 | |
| Not a dejure resident | $21_a$ | 1.6 | $26_a$ | 1.6 | |

| | | | | | |
|---|---|---|---|---|---|
| *Household has: radio* | | | | | |
| No | $714_a$ | 53.0 | $705_b$ | 42.5 | 33.471 (2), p<0.001 |
| Yes | $611_a$ | 45.4 | $927_b$ | 55.9 | |
| Not a dejure resident | $21_a$ | 1.6 | $26_a$ | 1.6 | |
| *Household has television* | | | | | |
| No | $693_a$ | 51.5 | $574_b$ | 34.6 | 87.631 (2), p<0.001 |
| Yes | $632_a$ | 47.0 | $1058_b$ | 63.8 | |
| Not a dejure resident | $21_a$ | 1.6 | $26_a$ | 1.6 | |

*Note: The subscript 'a' and 'b', indicate that their column proportions are significantly different from each other at the specified alpha level at 5%.*

# Logistic Regression Results

A logistic regression analysis was conducted to examine the association between various demographic and socio-economic characteristics and self-reported exposure to malaria messages among women. The results, presented in Table 2, highlight several significant associations ($p < 0.05$). The results show that relative to women aged 45-49 years, younger age groups generally demonstrated significantly lower odds of message exposure. Specifically, women aged 20-24 years (OR = 0.232, 95% CI [0.056, 0.960], p = 0.044), 25-29 years (OR = 0.231, 95% CI [0.071, 0.753], p = 0.015), 30-34 years (OR = 0.289, 95% CI [0.112, 0.750], p = 0.011), 35-39 years (OR = 0.258, 95% CI [0.122, 0.548], p < 0.001), and 40-44 years (OR = 0.430, 95% CI [0.232, 0.799], p = 0.008) had significantly reduced odds of reporting exposure.

Several ethnic groups exhibited significantly higher odds of exposure compared to the reference group. These include Akan (OR = 2.060, 95% CI [1.173, 3.617], p = 0.012), Ga/Dangme (OR = 2.393, 95% CI [1.248, 4.591], p = 0.009), Ewe (OR = 3.138, 95% CI [1.740, 5.657], p < 0.001), Grusi (OR = 2.121, 95% CI [1.134, 3.968], p = 0.019), and Gurma (OR = 2.478, 95% CI [1.367, 4.495], p = 0.003). See supplementary Table A for detailed crosstabulation between ethnic groups and exposure to malaria messages.

The results suggest regional disparity. Compared to women in the Upper West region, women in Greater Accra (OR = 0.575, 95% CI [0.356, 0.928], p = 0.024), Volta (OR = 0.617, 95% CI [0.386, 0.986], p = 0.044), Ashanti (OR = 0.626, 95% CI [0.414, 0.946], p = 0.026), and Northern (OR = 0.662, 95% CI [0.478, 0.917], p = 0.013) regions showed significantly lower odds of exposure. The Upper East region (OR = 0.621, 95% CI [0.436, 0.885], p = 0.008) also exhibited significantly lower odds.

The literacy level of the participants was a key factor. Using 'Cannot read at all' as the reference category, a clear gradient was observed. Women who were 'Able to read a whole sentence' had significantly higher odds of exposure (aOR = 2.45, 95% CI [1.82, 3.30], p < 0.001). Similarly, those 'Able to read only parts of a sentence' also showed higher odds compared to the reference group (aOR = 1.52, 95% CI [1.12, 2.06], p = 0.007).

The analysis revealed paradoxical findings regarding access to infrastructure. Contrary to conventional expectations, women who reported no availability of electricity (aOR = 1.691, 95% CI [1.346, 2.123], p = 0.001) and those with no availability of a radio (aOR = 1.259, 95% CI [1.075, 1.475], p = 0.004) had significantly higher odds of exposure compared to those with access. The association for television access was not statistically significant (aOR = 1.172, 95% CI [0.954, 1.439], p = 0.132). Other variables, including educational level, religion, and place of residence, showed no significant association with exposure to malaria messages.

Table 2 Logistic Regression Results

| Parameter | Exp (B) | 95% CI | p-value |
|---|---|---|---|
| Current age (29.86 ± 6.89) | 0.949 | 0.898 to 1.002 | 0.057 |
| Age group (in years) | | | |
| 20-24 | 0.232 | 0.056 to 0.960 | 0.044 |
| 25-29 | 0.231 | 0.071 to 0.753 | 0.015 |
| 30-34 | 0.289 | 0.112 to 0.750 | 0.011 |
| 35-39 | 0.258 | 0.122 to 0.548 | 0.000 |
| 40-44 | 0.430 | 0.232 to 0.799 | 0.008 |
| 45-49 | Ref | | |
| *Highest educational level* | | | |
| No education | 1.214 | 0.736 to 2.003 | 0.448 |
| Primary | 0.999 | 0.613 to 1.628 | 0.996 |
| Secondary | 1.323 | 0.866 to 2.021 | 0.195 |
| Higher education | Ref | | |
| *Religion Affiliation* | | | |
| Catholic | 0.869 | 0.061 to 12.361 | 0.918 |
| Anglican | 0.602 | 0.038 to 9.567 | 0.719 |
| Methodist | 0.460 | 0.032 to 6.621 | 0.568 |
| Presbyterian | 0.776 | 0.054 to 11.160 | 0.852 |
| Pentecostal/Charismatic | 0.580 | 0.041 to 8.161 | 0.686 |
| Other Christian | 0.712 | 0.050 to 10.084 | 0.802 |
| Islam | 0.899 | 0.063 to 12.753 | 0.937 |
| Traditional/Spiritualist | 0.528 | 0.036 to 7.860 | 0.643 |
| No religion | 0.839 | 0.058 to 12.246 | 0.898 |
| Other | Ref | | |
| Ethnicity | | | |
| Akan | 2.060 | 1.173 to 3.617 | 0.012 |
| Ga/Dangme | 2.393 | 1.248 to 4.591 | 0.009 |
| Ewe | 3.138 | 1.740 to 5.657 | 0.000 |
| Guan | 1.415 | 0.701 to 2.856 | 0.332 |
| Mole-Dagbani | 1.664 | 0.997 to 2.777 | 0.051 |
| Grusi | 2.121 | 1.134 to 3.968 | 0.019 |
| Gurma | 2.478 | 1.367 to 4.495 | 0.003 |
| Mande | 2.111 | 0.909 to 4.902 | 0.082 |

| | | | |
|---|---|---|---|
| Other | Ref | | |
| *Region* | | | |
| Western | 0.833 | 0.539 to 1.286 | 0.409 |
| Central | 1.011 | 0.638 to 1.600 | 0.964 |
| Greater Accra | 0.575 | 0.356 to 0.928 | 0.024 |
| Volta | 0.617 | 0.386 to 0.986 | 0.044 |
| Eastern | 1.015 | 0.649 to 1.587 | 0.947 |
| Ashanti | 0.626 | 0.414 to 0.946 | 0.026 |
| Brong Ahafo | 0.702 | 0.466 to 1.058 | 0.091 |
| Northern | 0.662 | 0.478 to 0.917 | 0.013 |
| Upper East | 0.621 | 0.436 to 0.885 | 0.008 |
| Upper West | Ref | | |
| *Literacy level* | | | |
| Cannot read at all | Ref | | |
| Able to read only parts of sentence | 1.520 | 1.120 to 2.060 | 0.007 |
| Able to read whole sentence | 2.450 | 1.820 to 3.300 | 0.001 |
| No can with required language | 0.850 | 0.620 to 1.160 | 0.309 |
| *Place of residence* | | | |
| Urban | 1.010 | 0.880 to 1.160 | 0.911 |
| Rural | Ref | | |
| *Availability of electricity* | | | |
| No | 1.691 | 1.346 to 2.123 | 0.001 |
| Yes | Ref | | |
| *Availability of radio* | | | |
| No | 1.259 | 1.075 to 1.475 | 0.004 |
| Yes | Ref | | |
| *Availability of television* | | | |
| No | 1.172 | 0.954 to 1.439 | 0.132 |
| Yes | Ref | | |

Note: *p-value <0.05 indicates significance; The "Other" literacy level includes smaller groups not individually listed; The category "No can with required language" refers to individuals who may be literate in a language other than the one used in the survey or primary health messages*

**Mediums for Malaria Message Dissemination**

Table 3 presents the various mediums through which participants reported exposure to messages about malaria. The consistently significant results of chi-square tests ($p < 0.001$) indicate that reported exposure was highly dependent on the communication channel. Participants reported hearing malaria messages through various channels. The most frequently cited medium was television (54.1%), followed by radio (40.2%) and health workers (27.9%). Less common, yet significant, sources included word of mouth (15.6%), community health workers (13.9%), posters/billboards (3.0%), community volunteers/CBA (2.3%), community events/durbar meetings (1.4%), leaflets/brochures (0.5%), and newspapers/magazines (0.1%).

In terms of visual exposure, television was also the most prominent medium, with 61.9% of participants reporting having seen malaria messages. This was followed by health workers (55.2%) and radio (54.1%). Other significant visual mediums included community health workers (26.5%), posters/billboards (16.2%), community volunteers/CBA (6.7%), community events/durbar meetings (5.4%), leaflets/brochures (2.7%), and newspapers/magazines (1.8%).

Furthermore, participants were asked to recall specific malaria messages they had been exposed to in the past six months. The most widely recalled message was to “sleep under an insecticide-treated mosquito net” (73.7%). Other messages with significant recall levels included “always test before treating malaria” (20.7%), “malaria kills” (20.7%), and “if you have fever go to health facility” (17.1%). Recall was lower for messages such as “pregnant women should take drugs to prevent malaria” (7.8%), “treat malaria with ACTs” (6.3%), “keep surroundings clean” (6.0%), and “SP protects pregnant women and unborn baby from getting malaria” (4.2%). See supplementary Table B for more information.

Table 3 Medium participants heard or seen messages about Malaria

| *Item* | *No (% of cases)* | *Yes (% of cases)* | | *Sig* |
|---|---|---|---|---|
| *Heard of malaria message on:* | | | | |
| Radio | 77.8 | 40.2 | 930.62 | 0.001 |
| Television | 70.1 | 54.1 | 487.38 | 0.001 |
| Poster/billboard | 98.4 | 3.0 | 2811.20 | 0.000 |
| Newspaper/magazine | 99.9 | 0.1 | 2996.01 | 0.000 |
| Leaflet/brochure | 99.7 | 0.5 | 2968.11 | 0.000 |
| Health worker | 84.6 | 27.9 | 1440.21 | 0.000 |
| Community health worker | 92.3 | 13.9 | 2151.05 | 0.000 |
| Community volunteer/CBA | 98.7 | 2.3 | 2853.92 | 0.000 |
| Word of mouth | 91.4 | 15.6 | 2057.32 | 0.000 |
| Community event/durbar meeting | 99.2 | 1.4 | 2908.77 | 0.000 |
| *Have seen malaria message via:* | | | | |
| Radio | 70.3 | 54.1 | 493.85 | 0.001 |
| Television | 66.0 | 61.9 | 306.79 | 0.001 |
| Poster/billboard | 91.1 | 16.2 | 2030.93 | 0.000 |
| Newspaper/magazine | 99.0 | 1.8 | 2889.12 | 0.000 |
| Leaflet/brochure | 98.5 | 2.7 | 2830.58 | 0.000 |
| Health worker | 69.7 | 55.2 | 465.09 | 0.001 |
| Community health worker | 85.5 | 26.5 | 1510.29 | 0.000 |
| Community volunteer/CBA | 96.3 | 6.7 | 2580.11 | 0.000 |
| Word of mouth | 76.3 | 43.1 | 833.13 | 0.001 |
| Community event/durbar meeting | 97.0 | 5.4 | 2658.55 | 0.000 |
| *Message seen/ heard in past 6months:* | | | | |
| If you have fever go to health facility | 90.6 | 17.1 | 1978.64 | 0.000 |
| Sleep under an insecticide-treated mosquito net | 59.3 | 73.7 | 104.39 | 0.001 |
| Pregnant women should take drugs to prevent malaria | 95.7 | 7.8 | 2510.16 | 0.000 |
| SP protects pregnant women and unborn baby from getting malaria | 97.7 | 4.2 | 2730.53 | 0.000 |
| Always test before treating malaria | 88.5 | 20.7 | 1785.57 | 0.000 |
| Treat malaria with acts | 96.5 | 6.3 | 2602.40 | 0.000 |
| Malaria kills | 88.6 | 20.7 | 1788.66 | 0.000 |
| Keep surroundings clean | 96.7 | 6.0 | 2621.05 | 0.000 |

*Notes: Percentages (%) are based on total cases for each response category. Totals may exceed 100% because respondents could select multiple sources.*

*All tests were two-sided, with $p < 0.001$ indicating statistically significant associations. % are based on total cases.*

# 4. Discussion

This study provides a national-level analysis of the factors associated with exposure to malaria messaging among women in Ghana, a critical group for household health decision-making. A key finding is that nearly half of the study population reported no exposure to malaria messages in the six months preceding the survey, indicating a significant gap in the reach of current information dissemination efforts. This coverage gap poses a substantial barrier to achieving the malaria elimination targets embedded within Sustainable Development Goal 3.

Our analysis revealed significant disparities in message exposure across demographic and geographic lines. Specifically, we identified lower self-reported exposure among certain ethnic groups and residents of the Northern and Upper West regions. This pattern highlights segments of the population that are potentially underserved by mainstream communication channels. For malaria eradication strategies to be equitable and effective, they must incorporate targeted, culturally competent educational interventions designed to reach these specific communities.

The study yielded two particularly noteworthy and counter-intuitive findings regarding the relationship between infrastructure, literacy, and reported message exposure. Contrary to conventional public health assumptions [23], we found that participants lacking access to electricity or a radio reported higher odds of message exposure. This paradox suggests that in the absence of traditional media, alternative dissemination pathways such as door-to-door visits by community health workers, local group meetings, or word-of-mouth communication may be effectively filling the void. This underscores the potential efficacy of grassroots, interpersonal communication strategies in certain contexts.

Similarly, we observed a complex relationship with literacy, where higher reading ability was associated with lower odds of reporting message exposure. This challenges the straightforward notion that literacy directly facilitates health awareness through written materials [24]. It may indicate that the current malaria messages disseminated via posters or brochures are not resonating with literate groups, or that these populations are relying on or recalling different information sources. This finding emphasizes that effective communication must go beyond literacy to ensure message salience and cultural relevance for all audiences.

The relationship between age and message exposure was also nuanced. Contrary to some literature suggesting younger adults are more receptive to health information [23], our study found that older women generally reported higher exposure. This could be attributed to the accumulated health knowledge and experience of older cohorts, or it may reflect the nature of current messaging, which might be better aligned with the media consumption habits or health concerns of an older demographic. This indicates a need for life-stage-specific communication strategies to ensure all age groups are effectively reached.

# 5. Implications for SDG3

This study reveals a critical vulnerability in Ghana's path to malaria elimination: a significant gap in the reach of public health messaging. The finding that nearly half of the study population reported no exposure to malaria messages underscores a fundamental weakness in strategic communication. These gaps are not random but are systematically concentrated among rural, less educated, and specific demographic groups, threatening the equitable progress demanded by the Sustainable Development Goals.

The counter-intuitive findings whereby a lack of electricity or radio access was associated with higher reported exposure suggest that alternative, community-based channels may be effectively reaching some underserved populations. This

highlights a vital lesson: the platform for delivery is as important as the message itself. Leveraging these informal networks, while also addressing the paradoxical finding that literacy does not guarantee message recall, must be a priority.

Our findings have direct consequences for achieving SDG 3, particularly Target 3.3 for ending malaria [21]. The persistent awareness gaps constitute a major barrier, as effective disease control is contingent upon widespread public understanding and adoption of preventive behaviors [22]. Furthermore, this aligns with the goal of universal health coverage (Target 3.8), which includes access to essential health information as a fundamental component [19, 20]. Progress hinges on closing these communication disparities to ensure equitable reductions in malaria incidence and mortality.

This evidence necessitates a strategic pivot from broad awareness campaigns to targeted, multi-channel education. Strategies must be co-designed with vulnerable communities to ensure cultural resonance, utilizing a mix of mass media and hyper-local, interpersonal communication. The role of community health workers, local radio in dominant languages, and interactive mHealth platforms designed for low-literacy audiences should be central to this renewed effort.

The introduction of novel biocontrol tools, such as insect-specific viruses (ISVs), depends entirely on a robust public communication system [14, 17]. Our findings serve as a stark warning: the current infrastructure for disseminating conventional messages is failing. The successful deployment of advanced technologies will be contingent upon pre-emptively strengthening community engagement and building public trust. Without culturally appropriate communication strategies, even the most efficacious tool risks public mistrust and low uptake, ultimately rendering it ineffective [15, 16].

## 6. Limitations and Future Research Directions

This study has several limitations. Its cross-sectional design precludes causal inference, and its quantitative nature cannot capture the nuanced local dynamics or qualitative reasons behind message rejection. Furthermore, while we discuss novel tools like ISVs, their practical application and public perception remain areas for extensive future research [14, 18]. Consequently, future research must move beyond identifying gaps to actively testing solutions. Implementation science is urgently needed to evaluate the cost-effectiveness of the targeted strategies mentioned above. As new tools approach deployment, parallel research must investigate the most effective ways to integrate information about them into revitalized communication networks to ensure community acceptance and adoption.

## 7. Conclusion

In conclusion, this study demonstrates that the goal of malaria eradication in Ghana is hindered not by a lack of technical tools, but by a critical deficit in strategic communication. Achieving SDG 3 requires a fundamental shift from generic messaging towards layered, targeted, and context-specific education campaigns that prioritize the most vulnerable. By empowering all populations with accessible knowledge and building trust through inclusive communication, Ghana can forge a more resilient foundation for defeating malaria and strengthening its health system against future threats.

## Declarations

### Ethical considerations

This study is a secondary analysis of de-identified, publicly available data from the Ghana Malaria Indicator Survey (GMIS), conducted by the Ghana Statistical Service (GSS). Data collection for the GMIS was carried out under the Statistical Service Act 2019 (Act 1003), which governs all official statistical activities in Ghana and ensures adherence to nationally approved protocols for data quality, confidentiality, and respondent protection. The original survey obtained informed consent from all participants, and all identifying information was removed prior to public release.

The current secondary analysis involved only anonymized, public-use data and therefore did not require additional ethical approval. All procedures for this study were conducted in accordance with the ethical standards of the Ghana Statistical Service and the principles of the Declaration of Helsinki. No personal identifiers (names, addresses, GPS coordinates, or ID numbers) were accessed, and all data handling complied with institutional data security guidelines.

### Clinical trial number:

Not applicable.

### Consent for publication

Not applicable

### Availability of data and materials

The datasets used in this study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no competing interests


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### Author Contributions

Isaac Ofori Asare**:** conceptualization, methodology, validation, formal analysis, investigation, data curation, writing – original draft, writing – reviewing and editing, visualization, and formal statistical analysis data. Alice Constant Mensah, Senoo-Dogbey Vivian Efua, Jacob Apibilla Ayembilla, Richard Fosu and Emmanuel Acheampong: conceptualization, methodology, formal analysis, writing – reviewing and editing.


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