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DETERMINANTS OF ASSYMPTOMATIC MALARIA AMONG ADOLESCENTS IN WESTERN KENYA

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# DETERMINANTS OF ASYMPTOMATIC MALARIA AMONG ADOLESCENTS IN WESTERN KENYA

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## ABSTRACT

*Background:* **Asymptomatic malaria among adolescents has maintained malaria transmissions in malaria endemic areas contributing to lack of reduction in severe malaria incidences and mortalities. Despite universal health coverage interventions, adolescents do not consistently use Insecticide Treated Nets (ITNs) in malaria endemic settings.**

*Objectives:* **The general objective was to find out the determinants of asymptomatic malaria among adolescents in Bunyala and Ugenya Sub-Counties in Busia and Siaya Counties respectively in Kenya.**

*Setting:* **The study was carried out between 1/12/2023 and 31/01/2024 among adolescents aged 10 -19 years old in the two study sites.**

*Methods:* **Analytical cross-sectional study design among a sample size of 1367 adolescents who were screened for malaria and semi-structured questionnaires used. Data was analyzed using SPSS version 25. Chi-square and logistic regression models were used, p-value<0.05 was significant.**

*Results:* **Prevalence of asymptomatic malaria was 56.7%(n=776). 702(52%) used ITNs the previous night. Un-use of ITNs was 1.854 times more likely led to asymptomatic malaria {p=0.000, AOR 1.854, 95% CI 1.492 – 2.304)}. Factors that significantly affected use of ITNs included; gender(aOR =1.3, 95% CI 1.045-1.658, p = 0.005), site of study(aOR =2.6, 95%CI = 2.0 – 3.3, p = 0.000), age, sleeping place(OR = 1.56, 95% CI 1.2-1.95, p = 0.000), type of floor material(aOR = 1.3, 95% CI 1.0 – 1.7, p = 0.000), sleeping surface(Aor 2.5, 95%CI 1.9 -3.3, p-value 0.000) and whether they had seen bedbugs at home(AOR 1.689, 95% CI 1.3 – 2.1).**

*Conclusion:* **There was a high prevalence of malaria, higher than average for the lake endemic zone. Inconsistent use of ITNs and factors influencing their use were established to be determinants for asymptomatic malaria among the adolescents. This calls for prompt actions targeting this age-group who are little focused on in malaria interventions in malaria endemic settings like Ugenya and Bunyala.**

## INTRODUCTION

Malaria has persistently been a disease of public health importance especially across the sub-Saharan Africa where it contributes to considerably high mortalities and morbidities[1]. The world health report indicates that in 2022, it led to 569,000 mortalities in this region, which constitutes 95% of global malaria cases and five million cases which was 94% of global cases[2]. Some countries such as Cambodia and Vanuatu have managed to eliminate malaria, some are nearing elimination like Namibia and Botswana through using a combination of mass-testing and treating, use of ITNs and prophylactic medication against malaria parasites[3]. However, in countries like Nigeria, Congo, Tanzania and Kenya among others it has remained a challenge[2]. This could be attributed to a significant proportion of the population being asymptomatic as some studies highlight where adolescents aged 10 – 19 years are mostly incriminated[4–6]. In this state, they rarely seek treatment and seldom use insecticide treated nets(ITNs) as they don't show visible signs of sickness as in clinical malaria or severe malaria[7–9]. They have also been shown to contribute to highest amounts of human-mosquito transmissions compared to clinically ill patients[10]. Use of ITNs have been promoted particularly among children under five years and pregnant mothers and less focus on adolescents despite some reports indicating a shift in malaria morbidity to this age-group[8,10,11]. Factors scientists have found to affect use of ITNs include; sleeping arrangements within households, gender, age, house building materials influenced by socio-economic factors[5,12–17]. Sleeping surfaces such as foam mattresses on beds or reed mats on floor as well as myths and misconceptions such as mass distributed ITNs contribute to spread of bedbugs as noted in Ethiopia have also been cited to affect use of ITNs[14,16,18].

Bunyala Subcounty and Ugenya Sub-Counties in Western Kenya fall in the Lake Endemic Zone where prevalence of malaria is highest in the entire nation of Kenya[11]. This is despite Universal Health Coverage principles ensuring constant prioritization of these areas in distribution of ITNs as described in the Kenya Demographic Health Survey of 2022 which shows that at least 85% of households in this region own at least an ITN[19]. Adolescents who could be the culprits in harboring asymptomatic malaria which occasionally gets clinical leading to anemia, reduced cognitive ability and absenteeism from school among them have not been conclusively investigated in level of infection and use of ITNs[20].

This study highlights the prevalence of asymptomatic malaria among adolescents aged 10 – 19 years, their use of ITNs and factors that influence their use of ITNs. The information obtained will guide policies put in place to control negative outcomes of malaria in these settings. That way, it will contribute towards the strategy to eliminate malaria in Kenya by 2030.

## METHODOLOGY

**Study design:** We applied a cross-sectional survey using a semi-structured questionnaire among a sample size of 1367 adolescents. The study was carried out between December 1, 2023 and January 31,

2024 among adolescents aged 10 -19 years old. The study design was adopted in this study to measure association between exposure and factors associated to exposure, in this case failure to use ITNs and outcome, which is asymptomatic malaria among adolescents[21].

**Study site:** This study was carried out in Bunyala Central Location in Bunyala Sub-County in Busia County and East Ugenya location in Ugenya Sub County, in Siaya County in Kenya. Bunyala borders Lake Victoria and has an irrigation scheme while Ugenya is around 50 kilometres away from the shores of Lake Victoria and main economic activity is subsistence agriculture. The Kenya Demographic and Health Survey 2022 indicated that 93.5% of households in Busia County (including Bunyala sub-county) and 86.7% of households in Siaya County (including Ugenya sub-county) own at least one ITN.

**Study population:** Adolescent girls and boys from randomly selected primary schools in Bunyala Sub-County and Ugenya sub-county.

**Sampling strategy:** A list of primary schools in the two sub-counties was obtained from the Sub-County Education Offices. Simple random sampling was used to obtain the schools involved. Fisher's formula was used to obtain sample size obtained considering the prevalence of malaria in the study settings[22]. Since the public primary school's population of adolescents aged 10-19 ranges between 50 to 300 pupils, all pupils in the age-bracket were issued with consent forms to be signed by their parents authorizing them to take part in the study.

**Data Collection:** Data was collected using pre-tested questionnaires administered by trained research assistants and community health promoters from the sub-counties upon consent. The data collectors were trained to familiarize themselves with the data collection tool and the process. During the activity, body weights and body-temperature of all assenting/consenting adolescents was measured using an axillary thermometer and recorded. Tests for malaria was done using rapid diagnostic kits from drops of blood obtained through finger-pricking on each participant. Participants testing positive for malaria were treated at no cost with Artemisinin-based combination therapy (ACT) strictly following malaria management guidelines. A moderately structured questionnaire was then used to interview all the adolescents tested.

The questionnaire had information on adolescents age, sex, weight, temperature, Rapid diagnostic test result, sleeping arrangements, type of floor, whether they shared sleeping place with animals, how many adolescents shared a sleeping place, ITN access and use and bedbug infestation.

Validity and reliability of the tools used. The tools used were reviewed by the study supervisors and pilot test done in Bunyala East to ensure consistency of the results obtained. The data collectors were taken through trainings to ensure uniformity in

information that was obtained. The Cronbach alpha method was used to compute reliability of the tools. A value of 0.7 or greater was found which indicated high reliability index of the tools.

**Data Analysis:** Data was entered into excel sheets after which the data were analyzed using SPSS version 25. Descriptive data was presented in tables and charts while chi-square and logistic regressions were used to analyze associations. P-value below 0.05 was considered significant statistically

**Ethical consideration:** Approval was obtained from school management and parents before data collection. All adolescent pupils were issued with assent and consent forms describing the study to take home for the parents to provide informed consent. Only pupils whose parents agree to the information were involved in the study. Ethical clearance was secured from Maseno University Ethics and Review Committee (MUERC) approval number MUSERC/01274/23 on 23rd November 2023. The letters were presented to the county commissioners of Siaya and Busia Counties, and Directors of Medical services were approached who introduced study team to the Bunyala and Ugenya Sub County Commissioners. Confidentiality principles were adhered to and caregivers were adequately consented before assent was obtained from the adolescents. All ethical considerations were complied with according to the Helsinki Declaration, adopted 2013[23].

## RESULTS

### Demographics

A total of 1367 adolescents whose caregivers consented to the study were enrolled and surveyed. Females were 769(56.25%) and 598(43.74%) were males. From Ugenya in Siaya County, 654(47.8%) adolescents participated while 713(52.15%) were from Bunyala in Busia County(Table 1).

Table 1: Age and gender of sudy participants

| | Name of Primary School | Males | Females | 10-12 years | 13-15 years | 16-19 years | Total |
|---|---|---|---|---|---|---|---|
| **Siaya County Schools** | Bar Odar Pri | 86 | 138 | 119 | 98 | 8 | 224 |
| | Buranga Pri | 84 | 87 | 67 | 81 | 23 | 171 |
| | Inungo Pri | 119 | 140 | 126 | 118 | 15 | 259 |
| **Busia County** | Bubamba | 50 | 35 | 32 | 43 | 10 | 85 |
| | Mukhobola | 108 | 145 | 132 | 110 | 11 | 253 |
| | Mundika B | 99 | 134 | 92 | 114 | 27 | 233 |
| | Nanjomi | 52 | 90 | 45 | 73 | 24 | 142 |
| **Totals** | | **598** | **769** | **613** | **637** | **118** | **1367** |

### Prevalence of Assymptomatic malaria

The prevalence of asymptomatic malaria infection was 56.8%(n=776/1367). Male

adolescents (60%, n=358/598) had significantly higher prevalence than females 54%(n=418/769). The prevalence of asymptomatic malaria was significantly higher (p = 0.007) in Ugenya at 58.1% (380/713) than Bunyala where it was 53.3% (396/654). (Table 2)

**Table 2: Prevalence of asymptomatic malaria according to gender, age-group, and study site**

| Variable | Category | Proportion | | Crude p-value, 95% CI | Adjusted p-value and adjusted 95% CI |
|---|---|---|---|---|---|
| | | Malaria positive (%) | Malaria negative | | |
| **Gender** | Males | 358(59.9%) | 240 | 0.041, 0.8(0.64 – 0.991) | 0.039(0.64-0.989) |
| | Females | 418(54.4%) | 351 | | |
| **Age brackets** | 10-12 | 359(58.6%) | 253 | 0.404(ref) | 0.460(ref) |
| | 13-15 | 354(55.6%) | 283 | 0.289 1.24(0.83 – 1.8) | 0.32, 0.9(0.6 – 1.2) |
| | 16-19 | 63(53.4%) | 55 | 0.661 1.09(0.74 – 1.62) | 0.312, 0.81(0.55 – 1.213) |
| **Study site** | Ugenya | 396(60.1%) | 258 | 0.007, 1.35(1.085 – 1.67) | 0.009, 1.3(1.07 – 1.66) |
| | Bunyala | 380(53.3%) | 333 | | |
| **Overall prevalence** | | 776(56.8%) | 591 | | |

**Use of ITNs and prevalence of asymptomatic malaria**

805(58.8%) participants had ITNs fixed over their sleeping places while 702(49.6%) used ITNs the previous night (**Table 3**). Fixed ITNs above sleeping place protected against asymptomatic malaria by 1.7 times higher than those who did not fix ITNs. Use of ITNs prevented infection by 1.8 times compared to those who did not use ITNs.

**Table 3: Use of ITNs versus symptomatic malaria outcome**

| Variable | Category | | Proportions | | Crude p-value and 95% CI | Adjusted p-value and 95% CI |
|---|---|---|---|---|---|---|
| | | | Malaria positive | Malaria negative | | |
| **ITNs fixed over sleeping place** | **YES** | 805 | 414 | 391 | 0.000 1.709(1.37 -2.133) | 0.943 1.016(0.66 – 1.57) |
| | **NO** | 562 | 362 | 200 | | |
| **Used ITNs the previous night** | **Yes** | 712 | 353 | 359 | 0.000 1.854(1.462 – 2.304) | 0.003 1.92(1.25 – 2.9) |
| | **No** | 655 | 423 | 232 | | |

**Factors influencing use of ITNs**

Since use of ITNs significantly influenced the outcome of asymptomatic malaria among adolescents, factors that influenced use of ITNs were considered determinants of asymptomatic malaria (Table 6). The factors that significantly influenced use of ITNs included: gender where females were 1.3 times more likely to use ITNs than males. Younger adolescents aged 10 – 12 years were 1.5 times better users than those aged 13 – 15 years and twice better users than adolescents aged 16 – 19 years. Adolescents in Bunyala were 2.5 times better users of ITNs than adolescents in Ugenya while those who slept in the main house were 1.4 times more likely to use ITNs than those who slept in other buildings within the homestead. Among those who slept in another building of the homesteads, those who slept in own houses meant mainly for sleep by adolescents('simba') were 1.6 times more likely to use ITNs than adolescents who slept in a kitchen building at 5% significance level. The type of floor did not significantly influence use of ITNs. Adolescents who slept on foam mattresses were 2.6 times more likely to use ITNs than those who slept on reedmat alone; those who reported not to have seen bedbugs at home were 1.7 times more likely to use ITNs than those who had seen bedbugs at home at 5% significance.

**Table 4: Factors influencing use of ITNs**

| **Variable** | | **Proportions** | | **Crude p-value** | **Crude 95% CI** | **Adjusted p-value** | **Adjusted 95%CI** |
|---|---|---|---|---|---|---|---|
| | | **Used** | **Didn't use ITNs** | | | | |
| Gender | Male | 286 | 312 | 0.005 | 0.74(0.6 – 0.915) | 0.035 | 1.287(1.108 – 1.627) |
| | Female | 426 | 343 | | | | |
| Age of adolescent(years) | 10-12 | 346 | 266 | 0.006 | ref | 0.001 | Ref |
| | 13-15 | 315 | 322 | 0.012 | 1.33(1.06 – 1.66) | 0.004 | 1.44(1.13 – 1.84) |
| | 16-19 | 51 | 67 | 0.008 | 1.709(1.15 – 2.5) | 0.003 | 1.96(1.27 – 3.04) |
| Study site | Ugenya | 244 | 410 | 0.000 | 3.2(2.6 – 4.0) | 0.000 | 2.5(1.9 – 3.2) |
| | Bunyala | 468 | 245 | | | | |
| Sleeping place | Mainhouse | 407 | 283 | 0.000 | Ref | 0.024 | ref |
| | Another building of the homestead | 287 | 358 | 0.000 | 1.8(1.4 – 2.2) | 0.007 | 1.41(1.1 – 1.8) |
| | Other, outside homestead | 18 | 14 | 0.750 | 1.1(0.5 – 2.3) | 0.436 | 1.35(0.63 – 2.88) |
| | In own separate house/hut/simba | 102 | 90 | 0.000 | Ref | 0.076 | Ref |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| If Another building of homestead | In the kitchen building | 100 | 185 | 0.000 | 2.097(1.443 – 3.046) | 0.023 | 1.6(1.07 – 2.42) |
| | Other, specify | 83 | 81 | 0.636 | 1.106(0.729-1.679) | 0.266 | 1.28(0.83 – 1.97) |
| Type of floor | Earthen floor | 450 | 484 | 0.000 | 0.607(0.481 – 0.765) | 0.250 | 1.17(0.9 – 1.5) |
| | Concrete floor | 262 | 171 | | | | |
| Sleeping surface | Foam mattress | 583 | 376 | 0.000 | 3.421(2.672 – 4.380) | 0.000 | 2.6(1.95 – 3.34) |
| | Reedmat | 126 | 278 | | | | |
| Bedbug infestation of household | Yes | 428 | 477 | 0.000 | 0.562(0.448 – 0.707) | 0.000 | 1.675(1.31 – 2.12 |
| | No | 284 | 178 | | | | |

## DISCUSSION

Asymptomatic malaria has been found to be the most common type of malaria, accounting for up to 84.9% of all malaria cases in some studies and adolescents have been found to be the highest affected age-group[4–6]. Previous survey in the general population found prevalence of malaria in Busia to be 37% and 27% in Siaya County which was much lower than 56.8% in the current study[11]. Since asymptomatic malaria patients have been shown to be major contributors of human-mosquito transmissions, it is imperative to put adequate measures to control malaria among adolescents[8,10,24]. Additionally, they could lose the partial immunity and have clinical malaria rise thus absenteeism from school, impaired cognitive ability among other negative outcomes may be noticed[20].

Rate of net use was below recommended levels by World Health Organization of 80% as Bunyala adolescents recorded usage rate of 65.6% while in Ugenya, the adolescents registered only 37.3% use rate[2]. A survey in 2015 among adolescents in Western region found adolescents use rate at 67.9% in Busia and an average of 48% in the lake region counties[25]. The effect of ITN use on asymptomatic malaria has also been demonstrated by some studies in the Sub-African region that have shown prevalence of asymptomatic malaria to be associated with inconsistent use of ITNs[7–9].

Factors established to influence use of ITNs in the current study included; sleeping arrangement of the adolescents. More adolescents who slept in the Main house slept under ITNs compared to other houses within the homestead. These findings are consistent with a qualitative study in Madagascar which found that adolescents boys sleeping in other houses within the homesteads or outside the homesteads shied away from using ITNs due to fear of being considered married[13]. A quantitative study in Ghana also found that the number of bedrooms within the main house influenced

use of ITNs[12]. Sleeping under ITNs the previous night significantly influenced asymptomatic malaria outcome, but fixed ITNs did not have a significant effect. Studies have reiterated that use of ITNs reduces malaria incidences, however the outcome was contrary to some studies that have found that permanently hung ITNs over the sleeping place reduced prevalence of malaria[26]. Sleeping in children's own huts led to higher usage of ITNs than sleeping in separate kitchen structures, this result agrees with a study in Vietnam, which deduced that sleeping around the kitchen fire and poverty were associated with decreased use of ITNs[12].

In this study, female adolescents were better users of ITNs than male adolescents, this was similar to a finding in Kenyan Coast where despite adolescents showing lowest ITN use, girls were better users than boys[5]. This could be due to a perception among males' adolescents that associates use of ITNs to being feminine[13].

Younger adolescents were significantly better in use of ITNs than older adolescents, a finding congruent with findings by Tairou which found that adolescents aged 10 – 14 years were better at using ITNs than their counterparts between 15 – 19 years since the previous were more prone to clinical malaria[8].

Sleeping on foam mattress increased chances of using ITNs in the current study. This finding is similar to a study in Ghana which found that sleeping on mattresses was positively associated with use of ITNs rather than sleeping on the floor[14]. Type of floor, whether earthen or concrete did not influence use of ITNs. Contrary to findings in Ethiopia by Malede *et al* that earthen floors and incomplete constructed houses were associated with lower use of ITNs among adolescent than complete house structures[16]. Sleeping surface such as mattresses had higher usage of ITNs than adolescents who slept on reedmats alone. Use of reed mats alone to sleep implies a poor socio-economic status compared to sleeping on foam mattresses. This outcome therefore deduced that adolescents who from poorer households were not good users of ITNs compared to those from wealthier households. Other studies have also shown that higher wealth is more associated with more use of ITNs while others showed no difference[9,27]. Contrastingly, some studies have found that middle and higher quartile wealth had lower use of ITNs compared to lower wealth quantile households[14,28].

Bedbug infestation in households negatively influenced use of ITNs in this study. This is similar to some studies in Ethiopia which found that that bedbug infestation of bednets discourages use of ITNs[16,18]. Thus, even with continued distribution of ITNs, their efficacy towards eliminating bedbugs should equally be ascertained.

**Study limitation**

Since use of insecticide treated nets and outcome which was asymptomatic malaria were both assessed at the same time during the data collection, it is difficult to tell which factor preceded the other. Causality would possibly be established if a prospective cohort study were done where the variables examined are observed for some set period of time.

## CONCLUSION

Campaigns targeting the adolescents on use of insecticide treated nets should be intensified which may include inculcating prevention of malaria principles into their curriculum. Factors linked to socio-economic status of the households should be sorted by ensuring policies are in place to improve living standards of these households. Myths and misconceptions should be demystified by practically demonstrating to the adolescents the effectiveness of ITNs, not only to control mosquitoes but other nuisance insects such as bedbugs.

## RECOMMENDATION

The County Governments of Busia and Siaya should revamp campaigns targeting promotion of use of ITNs among adolescents and put in place policies that address the factors impeding use of ITNs. This may help greatly in strides towards attaining global goal of reduction of malaria incidence and mortality by 90% by 203028.

Further research needs to be carried out to establish the reasons for poorer use of ITNs among residents of Ugenya Sub-County compared to residents of Bunyala since previous research have shown that areas with irrigation schemes have higher prevalence of malaria, but it was otherwise in the current study. Additionally, it should be established if use of ITNs vary with month or seasons of the year among the adolescents.

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No potential conflict of interest was reported by the authors.

### Declaration of Generative AI and AI assisted technologies in the writing process

The authors hereby declare that Artificial Intelligence (AI) or AI assisted technologies were not used the writing process of this manuscript.

### Authors contributions

Morvan Omollo contributed to the concept of the study, acquisition of data, analysis, interpretation of data and preparing of the manuscript drafts. Peter Omemo contributed in the design of the study, interpretation of data, revising the information critically for intellectual content and finally approval of the final version submitted.

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**References**


1. Abdulraheem MA, Ernest M, Ugwuanyi I, et al. High prevalence of Plasmodium malariae and Plasmodium ovale in co-infections with Plasmodium falciparum in asymptomatic malaria parasite carriers in southwestern Nigeria. *Int J Parasitol*. 2022;52(1):23-33. doi:10.1016/j.ijpara.2021.06.003

2. World Health Organization. *World Malaria Report 2023.*; 2023. Accessed August 20, 2025. https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2024

3. Lindblade KA, Steinhardt L, Samuels A, Kachur SP, Slutsker L. The silent threat: asymptomatic parasitemia and malaria transmission. *Expert Rev Anti Infect Ther*. 2013;11(6):623-639. doi:10.1586/eri.13.45

4. Bertozzi-Villa A, Bever CA, Koenker H, et al. Maps and metrics of insecticide-treated net access, use, and nets-per-capita in Africa from 2000-2020. *Nat Commun*. 2021;12(1):3589. doi:10.1038/s41467-021-23707-7

5. Kamau A, Musau M, Mtanje G, Mataza C, Bejon P, Snow RW. Long-lasting insecticide-treated net use and malaria infections on the Kenyan coast. *Trans R Soc Trop Med Hyg*. 2022;116(10):966-970. doi:10.1093/trstmh/trac029

6. Olapeju B, Choiriyyah I, Lynch M, et al. Age and gender trends in insecticide-treated net use in sub-Saharan Africa: a multi-country analysis. *Malar J*. 2018;17(1):423. doi:10.1186/s12936-018-2575-z

7. Roberts SA, Brabin L, Tinto H, Gies S, Diallo S, Brabin B. Seasonal patterns of malaria, genital infection, nutritional and iron status in non-pregnant and pregnant adolescents in Burkina Faso: a secondary analysis of trial data. *BMC Public Health*. 2021;21(1):1764. doi:10.1186/s12889-021-11819-0

8. Tairou F, Diallo A, Sy O, et al. Malaria-associated risk factors among adolescents living in areas with persistent transmission in Senegal: a case–control study. *Malar J*. 2022;21(1):193. doi:10.1186/s12936-022-04212-8

9. Topazian HM, Gumbo A, Puerto-Meredith S, et al. Asymptomatic Plasmodium falciparum malaria prevalence among adolescents and adults in Malawi, 2015–2016. *Sci Rep*. 2020;10(1):18740. doi:10.1038/s41598-020-75261-9

10. Deutsch-Feldman M, Parr JB, Keeler C, et al. The Burden of Malaria in the Democratic Republic of the Congo. *J Infect Dis*. 2021;223(11):1948-1952. doi:10.1093/infdis/jiaa650

11. Bashir IM, Nyakoe N, Van Der Sande M. Targeting remaining pockets of malaria transmission in Kenya to hasten progress towards national elimination goals: an assessment of prevalence and risk factors in children from the Lake endemic region. *Malar J*. 2019;18(1):233. doi:10.1186/s12936-019-2876-x

12. Nguyen TT, Nguyen XX, Wilson-Barthes M, et al. Why using bed nets is a challenge among minority populations in Central Vietnam. *Malar J*. 2022;21(1):87. doi:10.1186/s12936-022-04114-9

13. Njatosoa AF, Mattern C, Pourette D, et al. Family, social and cultural determinants of long-lasting insecticidal net (LLIN) use in Madagascar: secondary analysis of

three qualitative studies focused on children aged 5–15 years. *Malar J*. 2021;20(1):168. doi:10.1186/s12936-021-03705-2

14. Hiruy HN, Zewde A, Irish SR, et al. The effect of long-lasting insecticidal nets (LLINs) physical integrity on utilization. *Malar J*. 2021;20(1):468. doi:10.1186/s12936-021-03976-9

15. Larson PS, Minakawa N, Dida GO, Njenga SM, Ionides EL, Wilson ML. Insecticide-treated net use before and after mass distribution in a fishing community along Lake Victoria, Kenya: successes and unavoidable pitfalls. *Malar J*. 2014;13(1):466. doi:10.1186/1475-2875-13-466

16. Malede A, Aemero M, Gari SR, Kloos H, Alemu K. Barriers of persistent long-lasting insecticidal nets utilization in villages around Lake Tana, Northwest Ethiopia: a qualitative study. *BMC Public Health*. 2019;19(1):1303. doi:10.1186/s12889-019-7692-2

17. Tusting LS, Bottomley C, Gibson H, et al. Housing Improvements and Malaria Risk in Sub-Saharan Africa: A Multi-Country Analysis of Survey Data. Von Seidlein L, ed. *PLOS Med*. 2017;14(2):e1002234. doi:10.1371/journal.pmed.1002234

18. Tesfay K, Yohannes M, Mardu F, Berhe B, Negash H. Assessment of community knowledge, practice, and determinants of malaria case households in the rural area of Raya Azebo district, Northern Ethiopia, 2017. Carvalho LH, ed. *PLOS ONE*. 2019;14(10):e0222427. doi:10.1371/journal.pone.0222427

19. KNBS I. Kenya Demographic Health Survey 2022. Published online March 11, 2023. Accessed October 9, 2024. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.knbs.or.ke/wp-content/uploads/2023/08/Kenya-Demographic-and-Health-Survey-KDHS-2022-Summary-Report.pdf

20. Mensah BA, Myers-Hansen JL, Obeng Amoako E, Opoku M, Abuaku BK, Ghansah A. Prevalence and risk factors associated with asymptomatic malaria among school children: repeated cross-sectional surveys of school children in two ecological zones in Ghana. *BMC Public Health*. 2021;21(1):1697. doi:10.1186/s12889-021-11714-8

21. Schmidt NA, Brown JM, eds. *Evidence-Based Practice for Nurses: Appraisal and Application of Research*. Sixth edition. Jones & Bartlett Learning; 2025.

22. Jung S. Stratified Fisher's exact test and its sample size calculation. *Biom J*. 2014;56(1):129-140. doi:10.1002/bimj.201300048

23. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. *JAMA*. 2013;310(20):2191. doi:10.1001/jama.2013.281053

24. Zerdo Z, Bastiaens H, Anthierens S, et al. Prevalence and associated risk factors of asymptomatic malaria and anaemia among school-aged children in Dara Mallo and Uba Debretsehay districts: results from baseline cluster randomized trial. *Malar J*. 2021;20(1):400. doi:10.1186/s12936-021-03937-2

25. Ng'ang'a PN, Aduogo P, Mutero CM. Long lasting insecticidal mosquito nets (LLINs) ownership, use and coverage following mass distribution campaign in Lake Victoria basin, Western Kenya. *BMC Public Health*. 2021;21(1):1046. doi:10.1186/s12889-021-11062-7

26. Babalola AS, Idowu OA, Omilabu OG. Varying levels of protection against Plasmodium falciparium infection were conferred on non-users of long lasting insecticidal nets (LLINS) sleeping in rooms where different number of LLINS were hung in hyper endemic state of West Africa. *J Parasit Dis*. 2021;45(1):137-145. doi:10.1007/s12639-020-01286-6

27. Wanzira H, Yeka A, Kigozi R, et al. Long-lasting insecticide-treated bed net ownership and use among children under five years of age following a targeted distribution in central Uganda. *Malar J*. 2014;13(1):185. doi:10.1186/1475-2875-13-185

28. Scott J, Kanyangarara M, Nhama A, Macete E, Moss WJ, Saute F. Factors associated with use of insecticide-treated net for malaria prevention in Manica District, Mozambique: a community-based cross-sectional survey. *Malar J*. 2021;20(1):200. doi:10.1186/s12936-021-03738-7