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Impact of long lasting insecticidal nets on asymptomatic malaria during pregnancy, in a rural and urban setting in Cameroon

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ABSTRACT

According to the world malaria report more malaria cases were reported in 2020 than in 2019, due to disruptions in the distribution of insecticide treated nets, caused by the COVID-19 pandemic. Consequently a projected 34.32% (11.6 million out of 33.8 million) pregnancies were exposed to malaria in the WHO African Region in 2020. This study was therefore designed to assess the impact of long lasting insecticidal nets (LLINs) on asymptomatic malaria in the pregnant women attending the Foubot District Hospital (rural setting) and the Bamenda Regional Hospital (urban setting). This was a hospital based cross-sectional study done within three months from February to April 2021. A structured questionnaire and the CareStart™ Pf Malaria HRP2 qualitative rapid diagnostic test were used for data collection. Data were analysed using descriptive statistics, and Chi-square test. The relative risk, attributable risk, odds ratio, and likelihood ratio of malaria occurrence in exposed patients were determined by Chi-square (and Fisher's exact) test. The prevalence of asymptomatic malaria was 10.14% (63/621), with a higher prevalence among the pregnant women in the rural setting (12.21%; 37/303), than the urban setting (8.18%; 26/318). As indicated by the attributable risk, 21% of malaria incidence was attributed to absence of LLINs distribution in neighborhoods of the rural setting meanwhile 10% of malaria incidence is attributed to absence of LLINs distribution in neighborhoods of the urban setting. Regular screening for asymptomatic malaria in pregnancy and consistent free distribution of LLINs are recommended in endemic areas, especially in the rural settings.

1. Introduction

According to the world malaria report in 2021 an estimated 241 million malaria cases were registered in 2020, indicating an approximate increase of 6.17% from the 227 million cases reported in 2019, mostly from the WHO African Region (WHO, 2021). In fact, a projected 11.6 million pregnancies out of 33.8 million were exposed to malaria in the WHO African Region in 2020 and malaria infections in these pregnancies resulted to an estimated 819,000 babies with low birth weights (WHO, 2021). In the West and Central Africa where Cameroon is geographically located, malaria prevalence among pregnant women was 39.8% and 39.4% respectively, in 2020 (WHO, 2021). Moreover there is higher prevalence of anemia among pregnant women with asymptomatic malaria, compared to the non-infected women (Yimam et al., 2021; Rouamba et al., 2021). In Sub Saharan Africa the general prevalence of asymptomatic malaria among pregnant women is estimated to be 26.1%, with *Plasmodium falciparum* being the most dominant species (WHO, 2016). While many studies have reported high prevalence of asymptomatic malaria among pregnant women (Rouamba et al., 2021; Mlugu et al., 2020; Kitojo et al., 2020; Feleke et al., 2020; Nega et al., 2015; Onyenekwe et al., 2002; Agan et al., 2010), others have shown that asymptomatic malaria parasitaemia was significantly higher among primigravidae than the multigravidae (Yimam et al., 2021; Anorlu et al., 2001).

According to the Global technical strategy for malaria 2016–2030 (GTS), reduction in malaria transmission could be achieved by

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optimizing the use of vector control to levels above 80% coverage of at risk population (WHO, 2015). In 2020 about 229 million ITNs were distributed to malaria endemic countries (mostly Sub-Saharan Africa) as opposed to about 253 million ITNs distributed in 2019, indicating more nets delivery in 2019 due to disruptions caused by the COVID-19 pandemic (WHO, 2021). In 2020 and 2019, the percentages of pyrethroid–piperonyl butoxide (PBO) nets distributed were 7% and 19.4% respectively (WHO, 2021). Meanwhile, out of the global distribution of 2.3 billion ITNs within 2004 and 2020, 2 billion (86%) were delivered to sub-Saharan Africa. The use of LLINs has experienced marked increase, from <2% in 2000 to approximately 46% and 55% in 2014 and 2015 respectively (WHO, 2016). Even with substantial increase, the median percentage of ITN usage was estimated to be 74% and 20% amidst the five countries with the highest and lowest usage estimates respectively (WHO, 2016). This is far from 100% coverage however, a study which assessed household usage of ITN in sub-Saharan Africa reported that increase number of ITNs ownership corresponded to increase level of use among household members (Olapeju et al., 2018).

In Madagascar out of 2211 households surveyed there was 93.5% coverage with up to 74.8% of the households owning at least two LLINs and 77.2% having access to the nets (Finlay et al., 2017). A similar survey was conducted in Uganda among 5196 households, in 2017 after a national LLIN distribution campaign. The LLIN coverage was 16% while children with insufficient LLIN coverage, were most at risk of parasitaemia (Rugnao et al., 2019). In a study to assess the success of a second mass LLIN distribution campaign in Katakwi district, Uganda, there was an average of 10% and 7% increase in at least one net for every two persons and increase in household population with access to LLIN respectively (Wanzira et al., 2018). There was also a 24.87% increase in household population that slept under the nets after the second mass LLIN distribution campaign (Wanzira et al., 2018). In 2014, a cross sectional survey of 504 households in the Mount Cameroon area revealed that the general LLINs coverage was 77.6%, with rural communities having lower coverage. Malaria prevalence was significantly reduced by increase in LLINs coverage (Njumkeng et al., 2019). Meanwhile in 2017, ITN ownership, usage and effective usage was 78.8%, 50.9% and 29.9% respectively, in the Mount Cameroon area (Teh et al., 2021). A study in the south west region of Cameroon also reported 68.1% and 58.3% ownership and utilization of ITNs, after the second phase of nationwide free distribution of ITNs (Apinjoh et al., 2015). In this study net ownership was lower in rural settings where malaria prevalence was significantly higher (Apinjoh et al., 2015). Also in a survey involving 1251 households in Tiko, Santa and Bamenda health districts in 2017 and 2018 there was low ownership of LLINs, compared to the goal of one LLIN for every two household members (Nchang et al., 2018). After the third mass distribution campaign of free LLINs in the Tiko Health district, ownership, coverage and accessibility of LLINs were reported to be 72%, 24.9%, and 14.1% respectively (Fru et al., 2021). But ownership was no surety for utilization as up to 24.9% did not sleep under the LLINs the previous night (Fru et al., 2021).

In a recent study to assess the effectiveness of impregnated mosquito nets, 36 months after their distribution in the South of Cameroon, household LLIN coverage rates was 55.5% and 66.94% in an urban and rural areas, meanwhile the rates of use were 78.01% and 75.22% respectively (Nopowo et al., 2020). These rates are all lower than the estimated WHO use and possession rates (Nopowo et al., 2020). Moreover since 2015, progress in exceptional decreases in malaria has stalled due to pyrethroid-resistant *Anopheles* vectors (Protopopoff et al., 2018; Churcher et al., 2016). Notwithstanding insecticide treated nets (ITNs) remain the chief techniques of vector control, even with the WHO's recommendation of RTS-S malaria vaccine against *P. falciparum*, in children living in areas with moderate to high malaria transmission (WHO, 2021). The percentages of net ownership and usage among the pregnant women was 81% and 42.7% respectively, with a higher malaria prevalence (63.8%) among those who failed to use the nets (Sidiki et al., 2020). Although LLINs have been shown to reduce morbidity and mortality, malaria remains a problem due to inadequate utilization and coverage in both rural and urban areas of malaria endemicity like Foubot and Bamenda respectively, especially during the COVID-19 pandemic. This study was therefore designed to assess the impact of LLINs on asymptomatic malaria in pregnant women attending the Foubot District Hospital and the Bamenda regional hospital.

2. Methods

2.1. Study area

This study was carried out in a rural setting of Foubot and in an urban setting of Bamenda, located in the West and North-West regions of Cameroon. These two regions are located in the highland areas, >1000 m above the sea level. These regions are most grasslands, with a temperate climate and an average annual rainfall is 8 months estimated at 1800 mm/year. The estimated population in these two regions is 1.9 million. The estimated population of Foubot and Bamenda are 77,130 337,036 inhabitants, respectively (Nlinwe et al., 2021; Nlinwe and Nange, 2020). The entomological inoculation rate varies from 4.9 to 11 infective bites/person/year in the North-West region and 2.24 infective bites/person/month was reported in the West region (Tchuinkam et al., 2010; Tabue et al., 2014; Amvongo-Adjia et al., 2018). *Anopheles gambiae*, *Anopheles coluzzii* and *Anopheles funestus* are the most frequent mosquito species in the study area (Etang et al., 2016). Malaria prevalence among pregnant women in Cameroon has been generally high with the current study areas of no exception. In 2019 the prevalence of malaria among pregnant women in Mamfe Health District, located in the South West region, was reported to be 39.6% (Elime et al., 2019). Meanwhile in 2020 the prevalence of malaria parasitaemia among pregnant women consulting at the Bamenda Regional Hospital and in Foubot were 18% and 33.16% respectively (Ebai et al., 2020; Mounvera et al., 2020). A recent study in 2022 indicates that symptomatic malaria among pregnant women in Yaounde, located in the central region, was 69.2% (Ebong et al., 2022). In Foubot, malaria infections are mostly asymptomatic with a stable transmission and a prevalence of 47.06% reported among adult patients in March 2020 (Sidiki et al., 2020; Nlinwe et al., 2021). In a neighboring town of Fouban, malaria prevalence among pregnant women was 53.4% within April to July 2018 (Sidiki et al., 2020).

2.2. Study design/participants

This was a hospital based cross-sectional study done within three months from February to April 2021. The inclusion criteria for this study was all pregnant women attending the antenatal care unit of the Foubot district hospital and the Bamenda Regional hospital. All afebrile pregnant women who gave their consent by signing the informed consent form were consecutively enrolled into the study within the study period, using the convenient sampling method. The minimum sample size (N) for the study was calculated as follows:

$$N = z^2pq/d^2 \text{ (Charan and Biswas, 2013)}$$

Where $z^2 = (1.96)^2$, $p =$ previous malaria prevalence and $q = 1-p$.

For Foubot, $p = 0.198$ (Nlinwe et al., 2021) and for Bamenda $p = 0.2133$ (Mahamat et al., 2020), $d^2 = (0.05)^2$.

Estimated minimum sample size = 244 (Foubot) and = 258 (Bamenda).

Therefore $N = 244 + 258 = 502$ pregnant women in both study areas.

2.3. Ethical considerations

The Ethical Review Committee of the University of Bamenda gave the ethical clearance for this study, with ethical clearance number 2021/189H/UBa/IRB; 2021/083H/UBa/IRB. Signed informed consents were gotten from the pregnant women who accepted to be enrolled in the study.

2.4. Data collection

The inclusion criteria for this study were all afebrile pregnant women who came for their first visit at the maternity unit of the Bamenda regional and the Foubot district hospitals, within the study period. The health facility-based study settings were chosen because of the required study population of pregnant women who register for regular antenatal care visits. A structured questionnaire and laboratory investigation were used to obtain data. Since the study was designed to assess the impact of LLINs on asymptomatic malaria among pregnant women, the questionnaire was designed to collect information on respondent's socio-demographic characteristics and LLINs distribution, ownership, utilization and net care among the pregnant women. About 5 μ L of capillary blood was collected by a finger prick and the CareStart™ Pf Malaria HRP2 qualitative rapid diagnostic test was used for malaria diagnosis (WHO, 2009). Data on participant's socio-demographic characteristics, the acquisition and utilization of LLINs, in addition to information on net care and sleeping habits under LLINs were gotten. The socio-demographic characteristics were marital status, age, duration in Foubot, educational level, religion, and gravidity.

Table 1
Participant characteristics (socio-demographical, pregnancy and LLIN utilization).

| | | Foubot 303 | Bamenda 318 |
|-----------------------------|------------------------------|---------------|----------------|
| Marital Status | Single (%) | 61(20.13) | 50(15.72) |
| | Married (%) | 242(79.87) | 268(84.28) |
| Age/years | 15–24 (%) | 157(51.82) | 132(41.51) |
| | 25–34 (%) | 129(42.57) | 130(40.88) |
| | 35–44 (%) | 16(5.28) | 52(16.35) |
| | ≥ 45 (%) | 1(0.33) | 4(1.26) |
| Duration at study area | < 1 yr (%) | 72(23.76) | 270(84.91) |
| | >1 year (%) | 231(76.24) | 48(15.09) |
| Religion | Christian (%) | 78(25.74) | 294(92.45) |
| | Moslem (%) | 221(72.94) | 20(6.29) |
| | Others (%) | 4(1.32) | 4(1.26) |
| Educational Level | \leq Primary Education (%) | 74(24.42) | 30(9.43) |
| | Secondary Education (%) | 219(72.28) | 186(58.49) |
| | Higher Education (%) | 10(3.3) | 102(32.08) |
| Monthly income (FCFA) | 50,000–250,000 (%) | 293(96.7) | 312(98.11) |
| | >250000 (%) | 10(3.3) | 6(1.89) |
| Age of Pregnancy | 0-3 months (%) | 29(9.57) | 56(17.61) |
| | 4-6 months (%) | 108(35.64) | 132(41.51) |
| | 7-9 months (%) | 166(54.79) | 130(40.88) |
| Gravidity | Primigravidae (%) | 151(49.83) | 74(23.27) |
| | Multigravidae (%) | 152(50.17) | 244(76.73) |
| Slept under LLIN last night | Yes (%) | 175 (57.76) | 218 (68.55) |
| | No (%) | 128 (42.24) | 100 (31.44) |
| Stay outdoor after 7 pm | Yes (%) | 155 (51.16) | 188 (59.12) |
| | No (%) | 148 (48.84) | 130 (40.88) |

2.5. Data analysis

Baseline features for the acquisition, use of LLINs and, socio-demographic factors of women with or without malaria were determined using excel. The characteristics include sums and mean percentages. The frequency distribution for the acquisition and, use of LLINs was displayed in a fourfold (2×2) contingency table was entered into Graph Pad Prism version 8.2.1. In each of the four cells, the contingency table had frequencies for acquisition or deprivation; use or nonuse; and the care or neglect of LLINs by both the negative and positive malaria cases. The relative risk, attributable risk, odds ratio, and likelihood ratio of malaria occurrence in malaria exposed patients was determined by Chi-square (and Fisher's exact) test. Graph Pad Prism version 8.2.1 was used for all statistical analyses and results were determined at a 95% confidence level.

As computed by the risk calculator in the statistical package, using the *P*-value of 0.05: The formula for relative risk is the likelihood of malaria occurring when not exposed to LLINs divided by the likelihood of malaria occurring when exposed to LLINs. Attributable risk was gotten by subtracting the risk of malaria occurring in the group exposed to LLINs from the risk of malaria occurring in the group not exposed to LLINs. While the likelihood ratios were used to show how likely it is that a participant not exposed to LLINs has malaria, the odds ratio represents the odds that those not exposed to LLINs will test malaria positive, compared to the odds of malaria occurring with the presence of LLINs exposure. The odds ratio was calculated as the odds of malaria occurrence in those not exposed to LLINs divided by the odds of malaria occurrence in those exposed to LLINs.

3. Results

A total of 621 pregnant women were enrolled into this study, 303 in Foubot and 318 in Bamenda. In both study settings, most of the women were married, within the 15–24 years age group, had secondary level of education and, with income of 50,000–250,000 FCFA. Generally most of the women slept under LLINs the previous night, and also stayed outdoor after 7 pm. Nonetheless most (76.24%) of the women in Foubot had lived there for more than a year, while most (84.91%) of the women in Bamenda had lived there for less than a year (see Table 1).

The general prevalence of asymptomatic malaria was 10.14% (63/621) with a higher prevalence registered among the women in the rural setting, Foubot (12.21%: 37/303) than those in Bamenda, the urban setting (8.18%: 26/318). In Foubot malaria prevalence was higher among the younger age group, meanwhile in Bamenda there was a higher prevalence among the older age group, with a generally higher prevalence among the multigravidae. In both study areas although most of the women owned LLINs before 2019 (57.43% in Foubot and 74.21% in Bamenda), up to 42.24% (128/303) of the women in Foubot and 31.44% (100/318) of the women in Bamenda did not sleep under the nets the previous night (see Table 2).

Owning LLINs before the year 2019 was significantly associated to reduce risk of malaria among the pregnant women. The women who owned nets before 2019 had 0.66 times the risk of malaria among those without LLINs before 2019. The attributable risk also

Table 2
Overall Pf RDT positivity rates in study locations.

| | | RDT Pos Foubot | Total Foubot (%) | RDT Pos Bamenda | Total Bamenda (%) |
|-------------------------------|-------------------|----------------|------------------|-----------------|-------------------|
| | Total (%) | 37(12.21) | 303 | 26(8.18) | 318 |
| Marital Status | Single (%) | 13(21.31) | 61(20.13) | 8 (16) | 50(15.72) |
| | Married (%) | 24(9.92) | 242(79.87) | 18(6.72) | 268(84.28) |
| Age/years | 15–24 (%) | 26(16.56) | 157(51.82) | 6(4.55) | 132(41.51) |
| | 25–34 (%) | 10(7.75) | 129(42.57) | 10(7.69) | 130(40.88) |
| | 35–44 (%) | 1(6.25) | 16(5.28) | 8(15.38) | 52(16.35) |
| | ≥45 (%) | 0(0) | 1(0.33) | 2(50) | 4(1.26) |
| Duration at study area | < 1 yr (%) | 7(9.72) | 72(23.76) | 22(8.15) | 270(84.91) |
| Age of Pregnancy | 0-3 months (%) | 4(13.79) | 29(9.57) | 4(7.14) | 56(17.61) |
| | 4-6 months (%) | 19(17.59) | 108(35.64) | 12(9.09) | 132(41.51) |
| | 7-9 months (%) | 14(8.43) | 166(54.79) | 10(7.69) | 130(40.88) |
| Gravidity | Primigravidae (%) | 20(13.25) | 151(49.83) | 2(2.7) | 74(23.27) |
| | Multigravidae (%) | 17(11.18) | 152(50.17) | 24(9.84) | 244(76.73) |
| Used LLIN the previous night | Yes (%) | 19 (10.86) | 175 (57.76) | 14(6.42) | 218(68.55) |
| | No (%) | 18 (14.06) | 128 (42.24) | 12(12) | 100 (31.44) |
| Stayed outdoor after 7 pm | Yes (%) | 18 (11.61) | 155 (51.16) | 6(3.19) | 188 (59.12) |
| | No (%) | 19 (12.84) | 148 (48.84) | 20 (15.38) | 130 (40.88) |
| LLINs with holes | Yes (%) | 13 (10.57) | 123 (40.59) | 8 (4.12) | 194 (61) |
| | No (%) | 17 (13.18) | 180 (59.41) | 18 (14.52) | 124 (38.99) |
| Own LLIN before the year 2019 | Yes (%) | 20(11.49) | 174(57.43) | 22(9.32) | 236(74.21) |
| | No (%) | 17 (13.18) | 129 (42.57) | 4 (4.89) | 82 (25.78) |

indicate that 20% of malaria incidence is attributed to not owning nets before 2019 while the odds ratio show that those who owned nets before 2019 had 45% of the odds of testing malaria positive as those without nets before 2019. Sleeping under the LLINs the previous night was also significantly associated to reduce risk of malaria among the pregnant women. The women who slept under the nets had 0.31 times the risk of those who did not sleep under the nets. The attributable risk also show that 41% of malaria incidence is attributed to not sleeping under the nets the previous night while the odds ratio show that those who slept under the nets the previous night had 15% of the odds of testing malaria positive as those who did not. The 0.48 and 0.18 likelihood ratios for owning of LLINs before 2019 and sleeping under nets the previous night respectively, all indicate a significantly decreased probability of testing malaria positive (see Table 3).

Noticing holes in the nets was significantly associated with a reduced risk of malaria. According to the relative risk those with holes in their LLINs had 0.28 times the risk of malaria among those who did not notice holes in their nets. Consequently 10% of malaria could be attributed to presence of holes in the LLINs. Likewise those who stayed out door after 7 pm had 0.2 times the risk of malaria among those who did not and 12% of malaria could be attributed to staying out door after 7 pm (see Table 4).

4. Discussion

The overall prevalence of asymptomatic malaria among pregnant women in this study was 10.14% (63/621). In a recent systematic review and meta-analysis of asymptomatic malaria infection in pregnant women in SSA, the overall asymptomatic malaria was estimated at 26.1%, with *P. falciparum* being the dominant species (Yimam et al., 2021). Although the overall prevalence in this current study is less than the estimated overall prevalence, asymptomatic malaria in pregnancy remains a public health threat with increase chances of anemia in infected cases (Yimam et al., 2021; Rouamba et al., 2021). The net coverage was 79.54% in the rural setting (Foumbot) but only 60.73% of the women owned LLINs. However, net coverage was 67.3% in the urban setting but with a higher percentage (81.13%) of net ownership. In the rural setting some households were probably left out during the distribution campaign. In the urban setting while there was 67.3% LLINs coverage, net ownership was higher (81.13%) indicating that other distribution centers like the health facilities were perhaps engaged. Consequently the risk of malaria was significantly lower in the urban setting. Although sleeping under LLINs the previous night was not significantly associated with decrease risk of malaria in the urban setting, having holes was. The use of perforated nets still provided reduce malaria risk compared to the complete lack of LLINs usage. This can possibly explain why having discomfort under LLINs was associated with increased risk of malaria. Those feeling discomfort under the nets will surely not use the nets at all. But in the rural setting the distribution of LLINs in neighborhoods, ownership of LLINs before 2019 and sleeping under nets the previous night were all significantly associated with a reduced risk of malaria. The likelihood ratio of 0.18 for sleeping under nets the previous night indicates a decrease risk of malaria occurrence among women in this group. Notwithstanding most of the women in the rural setting failed to sleep under LLINs the previous night, probably because of the lower percentage of net ownership.

In the urban setting staying outdoor was rather significantly associated with reduced risk of malaria, suggesting a possible change in vector biting activity with the vector being more prone to bite indoors than outdoors (Githeko et al., 1996; Carnevale and Manguin, 2021). The LLINs intervention coverage levels may have provided some community wide reductions in malaria transmission (Everett, 2013; Klinkenberg et al., 2010) in the urban setting which had a higher percentage of LLINs ownership. As earlier indicated accurate identification of asymptomatic malaria gives a clue on the burden of malaria transmission (Feleke et al., 2020). Generally the accessibility to LLINs in both study areas outstrips the 14.1% accessibility reported in Tiko after the third mass distribution of LLINs campaign (Fru et al., 2021). In the current study 71.18% (442/621) of the women had access to LLINs. This difference may be due to differences in the time setting of data collection and the peculiarity of the study population. Data for the current study was collected about two years after the date of launching, giving more time for increase coverage of the nets. Unlike the study in Tiko health district which was conducted among the general population, the current study focused on pregnant women who are always given priority during LLINs distribution.

The percentage of LLINs ownership was 57.43% and 74.21% before the year 2019 in Foumbot and Bamenda respectively and 60.73% (Foumbot) and 81.13% (Bamenda) currently. This means there was a 3.3% and 6.92% increase in net ownership among the

Table 3

Measurement of infection risk associated with LLINs effective use and handling during pregnancy, in Foumbot.

| Variable | Relative risk (95% CI) | Attributable risk (95% CI) | Odds ratio (95% CI) | LR | P-value |
|--|------------------------|----------------------------|------------------------|------|-----------------|
| Owning LLINs before the year 2019 | 0.66 (0.39 to 0.99) | 0.2 (0.02 to 0.41) | 0.45 (0.2 to 0.99) | 0.48 | 0.0466* |
| Recent distribution of LLINs in neighborhood | 0.75 (0.52 to 0.95) | 0.21 (0 to 0.39) | 0.35 (0.15 to 0.77) | 0.4 | 0.0143* |
| Slept under LLIN the previous night | 0.31 (0.13 to 0.61) | 0.41 (0.28 to 0.61) | 0.15 (0.06 to 0.42) | 0.18 | <0.0001 **** |
| Holes in the net | 0.75 (0.43 to 1.2) | 0.1 (−0.05 to 0.28) | 0.65 (0.3 to 1.34) | 0.68 | 0.2833 |
| Stay outdoor after 7 pm | 0.87 (0.58 to 1.2) | 0.7 (−0.1 to 0.25) | 0.77 (0.39 to 1.52) | 0.79 | 0.4856 |

*Significant P values; ^CConfidence Interval.

Table 4

Measurement of infection risk associated with LLINs effective use and handling during pregnancy, in Bamenda.

| Variable | Relative Risk (95% CI) | Attributable Risk (95% CI) | Odds Ratio (95% CI) | LR | P-value |
|--|---------------------------|-------------------------------|------------------------|------|---------|
| Owned LLINs before the year 2019 | 1.91 (0.72 to 5.22) | 0.04 (−0.04 to 0.10) | 2 (0.69 to 5.52) | 1.16 | 0.2487 |
| Recent distribution of LLINs in neighborhood | 0.3 (0.14 to 0.63) | 0.10 (0.017 to 0.17) | 0.27 (0.12 to 0.6) | 0.55 | 0.0019* |
| Slept under LLINs last night | 0.53 (0.90 to 3.81) | 0.05 (−0.03 to 0.12) | 0.50 (0.23 to 1.15) | 0.77 | 0.1213 |
| Holes in LLINs | 0.28 (0.12 to 0.61) | 0.10 (0.02 to 0.17) | 0.25 (0.11 to 0.61) | 0.48 | 0.0014* |
| Stayed out door after 7 pm | 0.20 (0.08 to 0.48) | 0.12 (0.04 to 0.18) | 0.18 (0.07 to 0.43) | 0.37 | 0.0001* |

*Significant P values; ^{CI}Confidence Interval.

women in Foubot and Bamenda respectively. In line with expectation asymptomatic malaria prevalence was lower in the urban setting with a higher percentage of net ownership. However 6.92% increase in net ownership in Bamenda is relatively low compared to the 10% increase in net ownership in Katakwi district, Uganda, after the second phase of net distribution. 60.73% of LLINs ownership in Foubot is lower than the 81%, 68.1% and 93.3% ownership recorded in Fouban, Tiko and Bamenda health districts respectively (Apinjoh et al., 2015; Fru et al., 2021; Sidiki et al., 2020; Nlinwe et al., 2021). Moreover net utilization was 57.76% in Foubot and 68.55% in Bamenda, relatively lower than the estimated median percentage usage of 74% and higher than the 20% lowest usage estimate in the SSA (WHO, 2016). These percentages are however higher than the 24.9% and 38.3% reported in Tiko and Fouban health districts respectively (Fru et al., 2021). In line with findings from other studies LLINs ownership and utilization was lower in rural settings with higher risk of malaria (Njumkeng et al., 2019; Teh et al., 2021; Apinjoh et al., 2015), suggesting the need for regular free distribution of LLINs (Sidiki et al., 2020; Zhou et al., 2014; Ntonifor and Veyufambom, 2016; Wogu et al., 2013; Fokam et al., 2016).

5. Conclusion

The prevalence of asymptomatic malaria was higher among the pregnant women in the rural setting than those in the urban setting. Mass distribution of LLINs is a profitable way to achieve widespread coverage despite the challenge of maintaining high LLINs coverage and utilization especially in the rural locations. A single mass campaign every five years in addition to intermittent distribution of LLINs from health facilities may scarcely sustain effective malaria control. Therefore regular screening for asymptomatic malaria in pregnancy, continuous free distribution of LLINs and integrated vector management are recommended in endemic areas especially in the rural settings.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper entitled “Impact of LLINs on asymptomatic malaria during pregnancy, in a rural and urban setting in Cameroon”.

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