Long Lasting Insecticide-treated Bed Net Ownership, Utilization and Associated Factors Among School-age Children in Dara Mallo and Uba Debretsehay Districts, Southern Ethiopia

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Abstract

Background

Malaria is one of the major causes of morbidity and mortality among school-aged children (SAC) in Sub-Saharan Africa. SAC account for more than 60% of the reservoir of malaria transmission, but they were given less emphasis on prioritizing malaria prevention interventions. This study was aimed at assessing the ownership of bed nets, its utilization and factors associated with ownership of bed nets by households and bed net utilization among SAC in malaria prone areas of Dara Mallo and Uba Debretsehay districts in Southern Ethiopia, October to December 2019.

Methods

This study is part of baseline assessment in a cluster randomized controlled trial. The data were collected through interview and observation following structured questionnaire from 2261 SAC households. Univariable and multivariable logistic regressions were used to assess the association between bed net ownership or utilization and potential predictor variables. Odds Ratio (OR) and corresponding 95% Confidence Interval (CI) were used to determine the strength and statistical significance of association.

Results

The ownership of at least one bed net by households of SAC was about 19.3% (95% CI: 17.7%-21.0%). It was affected by living in altitude ranged from 1100 to 1250 meters above sea level with Adjusted OR (AOR) of 0.5 (95%CI: 0.3–0.9) and presence of child age less than 5 years (AOR = 2.1; 95%CI: 1.2–3.7). About 7.8% (95% CI: 6.7%-10.0%) of all SAC participated in the study and 40.4% (95% CI: 57.4% − 66.7%) of children in households owning at bed net passed the previous night under bed net. Bed net utilization by SAC conditional to its presence was lower among children age > 9 years (AOR = 0.2; 95%CI: 0.03–0.8); higher in children with mothers who had an education level above grade six (AOR = 5.2; 95%CI: 1.8–17.0); and when the household size to bed net ratio was ≤ 2 (AOR = 37.8; 95%CI: 4.1–1106).

Conclusion

Ownership of bed net was lower than universal coverage of at least one bed net for two individuals. It is important to monitor replacement needs and educate mothers with low education level and their SAC on the benefit of consistent utilization of bed nets.

Background

Malaria is one of the leading causes of morbidity and mortality among infectious diseases in the world (1). It is caused by a protozoan parasite of the genus Plasmodium and transmitted through the bite of the
female Anopheles mosquito. There are five known species of Plasmodium that cause malaria in humans: Plasmodium (P). falciparum, P. vivax, P. ovale, P. malariae and P. knowlesi. P. knowlesi is a zoonotic parasite and predominantly found in the Asian countries, while the rest were human parasites (2). An estimated 228 million malaria cases and 405,000 malaria deaths occurred in the world in 2018. Of these, 93% of the cases and 94% of deaths due to malaria occurred in the African region (3).

There was substantial decrease in the prevalence of malaria globally and also in the African region in the last two decades. Between 2010 and 2015, malaria incidence rates (new malaria cases) fell by 21% and the malaria mortality rate by 31% in the African region (4). However, the rate of change in decline of malaria incidence remained 57 per 1000 at risk population per year from 2014 through to 2018 (3). Malaria is seasonal in most parts of Ethiopia with the peak malaria transmission season between September and October following the main rainy season from June to August (4, 5). A study carried out in North Gonder zone revealed that the highest incidence of malaria was observed between June and November while the lowest transmission period was from December to early April (6). The number of malaria cases in September, October, November, May, June, and July were above the average malaria cases in Boricha district in Southern Ethiopia, whereas those of March, January, February, December, August and April were months when malaria cases were below average (7).

The national malaria control program deployed by the Ethiopian government and partners has led to a promising decrease in the burden of malaria. As indicated by data collected from 41 hospitals in Ethiopia, the overall malaria inpatient case was 54% lower and malaria death was 68% lower than that predicted by the trends during 2001–2005 in 2011 (8). Moreover, in 2015 death due to malaria was decreased by 40% as compared to the number of deaths due to malaria in 2005 (9). Decreased exposure of children under the age of five years resulted in delayed development of immunity in their growth and now a day’s school-aged children (SAC) became the other highly susceptible group of people (10–12). In stratified analysis of studies targeting the general population as well as studies focused on SAC reveal that the burden of malaria was higher among this group of the population in Ethiopia (13–15). The consequence of malaria infection on children suffering affects their physical growth, mental development and overall economic development of the country (16, 17). Above all, they were responsible for about 60% of infection to mosquito vector for the transmission of the disease in all seasons (18).

Long lasting Insecticide-treated nets (LLINs) is the cornerstone of malaria prevention in Sub-Saharan Africa (SSA). Its effectiveness was dependent on universal coverage as well as consistent utilization of the nets (4). Utilization of LLINs reduces the clinical attack of malaria, Plasmodium infection and death due to malaria. It reduced child mortality of all causes by 17% which corresponds to 5.6 lives each year for every 1000 children protected with LLINs as compared to those did not use bed nets. In addition, it reduced incidence of uncomplicated episodes of Plasmodium falciparum malaria by almost half (19).

The national coverage of bed net ownership and its utilization conditional to ownership in Ethiopia were 40% and 61% respectively (13). However, cross-sectional survey conducted in different parts of the country targeting on different population segments indicated that the coverage and utilization differ
widely. In Jima, for example, the overall ownership and utilization were 70.9% and 38.4% respectively in the community (20). Near to Gilgel Gibe hydroelectric power project, 56.6% of the households owned at least one bed net and of those households owned bed nets, 60% slept under bed net the previous night preceding the survey (21). In Shashogo district in southern Ethiopia, the ownership and utilization of bed net were very low. Only 15.8% of pregnant mothers’ household own bed net and half of those owning bed nets utilized it (22). Unlike this, the coverage and utilization were good in Mirab Abay district in Gamo Gofa zone with the respective numbers being 89.9% and 85.5% (23). There were few studies that assessed the utilization of bed nets by SAC. In studies comparing bed net utilization between SAC and other population segments, SAC less likely used bed nets (16, 17). Despite SAC become at high risk of malaria and malaria associated morbidities, their access to and benefit from existing malaria prevention interventions were not well addressed. Previous studies mainly focused on assessing access to and intervention of malaria prevention interventions among pregnant mothers and children age less than five years. As mentioned elsewhere in this document, long lasting insecticide treated bed nets is one of the major malaria prevention interventions in use in SSA. Assessing the coverage of bed net ownership of households of SAC and utilization of bed nets, and their associated risk factors among SAC are important for optimizing malaria responses in Ethiopia and other similar settings in SSA in light of targets set in global technical strategy of malaria 2016–2030.

Methods

Study setting

The study was conducted in Dara Mallo and Uba Debretsehay districts in Gamo and Gofa Zones respectively. Both zones are found in South Nation’s Nationalities and People’s Regional state which is the 3rd populous region in Ethiopia. These districts are found in the western part of Arba Minch town which is the capital of the former Gamo Goffa zone as indicated in the Fig. 1 bellow. These districts were selected based on the burden of malaria contribution to the total malaria cases in the Zones. Based on the 2007 national census, a total of 150, 145 people were living in the two districts, and of whom 76550 (51%) were male (24).

Study Design

This was part of a baseline assessment in cluster randomized controlled trial with nested process evaluation that is going to evaluate the effect of malaria prevention education on malaria, anemia and cognitive development among SAC in two malarious districts in Southern Ethiopia. The trail is registered in Pan African Clinical Trails Registry with trial ID of PACTR202001837195738.

Sampling Techniques And Method Of Data Collection
A total of 3204 children attending their primary education were approached from 32 primary schools in Dara Mallo and Uba Debretsehay districts. Seventy two children from grade one to three were selected by using systematic random sampling technique from the domain by using a class roster as sampling frame. All participants involved in the trial were included to address the research objective in this study. The number of students to participate in the trial from each grade level (grade 1 to 3), was determined by the relative contribution of each grade level to the total enrolment of students in that school. The included households were approached by trained data collectors for interview. A pretested structured questionnaire was used to collect data on the demographic, water source, toilet structure, household assets and bed net related questions. These questions were adapted to local context from the Demographic and Health Surveys (DHS) malaria indicator survey household questionnaire (25). The questionnaire was uploaded to tablets in Open Data Kit (ODK) data collection tool. The data collectors were trained on how to use the data collection tool and ethical procedures to be followed. They interviewed mothers or caregivers of the selected children, observed the toilet structure and the number of bed nets in the household as well as placement of the existing bed nets in the households (hanged over sleeping place or not).

**Data analysis**

The data collected by using ODK data collection tool with tablet apparatus was converted to Microsoft excel speared sheet by using ODK briefcase. This data is imported to RStudio version 4.0.0 statistical software for data analysis and STATA version 14 is used to predict the principal components from household assets, housing condition, farm animals and drinking water sources at household level. The predicted index from principal component analysis is categorized into for quartiles to determine the wealth index of the households. The cleaned data were subjected to descriptive statistical analysis like the proportion for categorical variables and plots and descriptive measures for continuous data. Logistic regression was used for both univariable and multivariable logistic regression. Odds ratio and corresponding 95% level of confidence were used to assess the strength of association between bed net ownership or bed net utilization and potential predictor variables. Both forward and backward elimination methods were used to select fitness of the model. The fitness of the model is checked by using Akaike Information Criterion (AIC). The variables considered to check the fitness of the model were based on available literature and the level of association in univariable logistic regression. The averages of the household coordinates taken by Global positioning system (GPS) data were used to represent the coordinates of each school. The geospatial data is added to QGIS to present the ownership and utilization percentages at school level.

**Ethical consideration**

The trial mentioned above was approved with written consent procedure to be followed by the Institutional Research Ethics review Board (IRB) in College of Medicine and Health Sciences, Arba Minch University with the reference number of IRB/154/12. Official permission letter to conduct the research is submitted to district health offices and education offices in Dara Mallo and Uba Debretsehay districts. Support letter written by the respective education offices was given to each participating school to
support and participate in the study and written consent was obtained from the school headmasters. Parents of the selected SAC were invited to come to the schools and written consent was obtained before data collection at school and household levels. Written informed consent was obtained from each of the selected students’ parent at school and documented in college of medicine and Health Sciences in Arba Minch University.

**Results**

A total of 2261 SAC and their households participated in this study: 1419 and 842 from Uba Debretsehay and Dara Mallo districts respectively. Of the total children participated in the study, 50.3% were female and 85.5% were from rural area. The mean age of children was 8.7 years with standard deviation (SD) of 1.6 years. About 39.1%, 28.1% and 32.8% of the children were attending their education in grade one, two and three respectively. The detail socio-demographic characteristics of the households participated in this study was presented in Table 1.
Table 1
Socio-demographic characteristics of participants involved in Dara Mallo and Uba Debretsehay districts, Southern Ethiopia, 2019

| Factor                        | Value categories | Frequency (%) |
|-------------------------------|------------------|---------------|
| Place of residence           | Rural            | 1928(85.3)    |
|                               | Semi-urban       | 185(8.2)      |
|                               | Urban            | 148(6.5)      |
| Sex of household head        | Male             | 2103(93.0)    |
|                               | Female           | 158(7.0)      |
| Age of household head        | <=30             | 358(18.3)     |
|                               | 31–35            | 544(20.1)     |
|                               | 36–40            | 805(35.6)     |
|                               | > 40             | 554(24.5)     |
| Occupation of the household head | Farmer        | 1852(81.9)    |
|                               | Civil servant    | 158(7.0)      |
|                               | Merchant         | 115(5.1)      |
|                               | Housewife        | 72(3.2)       |
|                               | Daily laborer    | 31(1.4)       |
|                               | Others           | 33(1.5)       |
| Educational status of household head | Illiterate | 1311(58.0)    |
|                               | Literate         | 949(42.0)     |
| Ethnicity                     | Goffa            | 1156(51.1)    |
|                               | Gamo             | 928(41.0)     |
|                               | Amhara           | 31(1.4)       |
|                               | Others           | 146(6.5)      |
| Age of child mother*          | <=25             | 241(10.7)     |
|                               | 26–30            | 907(40.1)     |
|                               | 31–35            | 621(27.5)     |
|                               | > =36            | 492(21.8)     |
| Occupation of the child mother | Housewife     | 1867(82.6)    |
### Ownership Of Bed Net

The ownership of at least one bed net at household level was 19.3% with 95% confidence interval (CI) of 17.7–21.0%. The mean number of bed nets in the household owning bed nets was 1.8 (SD = 0.9) while only 45 of the participated households had adequate numbers of bed nets (at least one bed net for 2 individuals). The ownership of at least one bed net, any person or participating SAC passed the previous night under a bed net conditional to the presence of bed net or irrespective of its presence were indicated in detail in Fig. 2.

There was wide difference in the ownership of bed nets in the households per schools where children attend their education as depicted in Fig. 3 bellow.

In univariable analysis, the ownership of bed net was affected by characteristics related to place of residence, household head occupation status, maternal occupation status and socioeconomic status. The residence place related factors affecting ownership of the bed nets were living in urban and semi-urban area as compared to rural area, living in area below 1100 meters above sea level as compared to those living above and those living in rented or governmental house as compared to those living in their own house. From the household head perspective, ownership of bed net was higher among those who had formal education and being a civil servant. Maternal factors associated with ownership of bed net were age bellow 25 years, civil servant occupation, being literate and education level above grade seven.

| Factor                        | Value categories | Frequency (%) |
|-------------------------------|------------------|---------------|
| Farmer                        |                  | 189(8.4)      |
| Merchant                      |                  | 89(3.9)       |
| Employee                      |                  | 82(3.6)       |
| Others                        |                  | 34(1.5)       |
| Educational status of mother  | Illiterate       | 1682(74.4)    |
|                               | Literate         | 579(25.6)     |
| Sex of the SAC                | Female           | 1137(50.3)    |
|                               | Male             | 1123(49.7)    |
| Grade of SAC                  | Grade 1          | 884(39.1)     |
|                               | Grade 2          | 635(28.1)     |
|                               | Grade 3          | 740(32.8)     |
| Household size                | Less than or equal to 5 | 457(20.2) |
|                               | Greater than 5   | 1804(79.8)    |
Households in the middle two quartiles of socioeconomic status were more likely to own bed nets as compared to the poorest and the richest categories. The crude odds ratio and the corresponding 95% confidence interval for each of variables were presented in Table 2.
| Factor                      | Value categories | Bed net owned | COR(95% CI) | AOR(95% CI) |
|-----------------------------|------------------|---------------|-------------|-------------|
|                             |                  | No (%)        | Yes (%)     |             |
| **District***               |                  |               |             |             |
| Uba                         | 1102(77.6)       | 318(22.4)     | 1.8(1.4–2.2)|             |
| Debretsehay                 | 724(86.0)        | 118(14.0)     | 1           |             |
| Dara Mallo                  |                  |               |             |             |
| **Place of residence***     |                  |               |             |             |
| Rural                       | 1620(84.0)       | 309(16.0)     | 1           | 1           |
| Semi-urban                  | 121(65.4)        | 64(34.6)      | 2.8(2.0–3.8)| 0.6(0.3–1.1)|
| Urban                       | 85(57.4)         | 63(42.6)      | 3.9(2.8–5.8)| 1.6(0.8–3.0)|
| **Residence house is***     |                  |               |             |             |
| Private                     | 1763(81.3)       | 405(18.7)     | 1           |             |
| Not private                 | 62(66.7)         | 31(33.3)      | 2.2(1.4–3.4)|             |
| **Sex of household head**   |                  |               |             |             |
| Male                        | 1701(80.8)       | 403(19.2)     | 0.9(0.6–1.3)|             |
| Female                      | 125(79.1)        | 33(20.9)      | 1           |             |
| **Age of household head**   |                  |               |             |             |
| <=30                        | 283(79.1)        | 75(20.9)      | 1           |             |
| 31–35                       | 443(81.4)        | 101(18.6)     | 0.9(0.6–1.2)|             |
| 36–40                       | 671(83.4)        | 134(16.6)     | 0.8(0.6–1.0)|             |
| >40                         | 428(77.3)        | 126(22.7)     | 1.1(0.8–1.5)|             |
| **Occupation of the household head*** |      |               |             |             |
| Farmer                      | 1563(84.4)       | 289(15.6)     | 0.2(0.1–0.3)| 0.3(0.1–0.6)|
| Civil servant               | 52(51.9)         | 76(48.1)      | 1           | 1           |
| Merchant                    | 81(70.4)         | 34(29.6)      | 0.5(0.3–0.7)| 0.6(0.2–1.8)|
| Housewife                   | 5677.8)          | 16(22.2)      | 0.3(0.2–0.6)| 0.4(0.1–1.2)|
| Daily laborer               | 25(80.6)         | 6(19.4)       | 0.3(0.1–0.6)| 0.5(0.1–2.6)|

*Statistically significant at univariable analysis* and multivariable analysis**
| Educational status of household head* | Others | Illiterate | Literate | Other | Rate (95% CI) |
|--------------------------------------|--------|-----------|----------|-------|--------------|
| **Educational status of household head*** |        |           |          |       |              |
| Illiterate                           | 1075(84.9) | 188(15.1) | 1        | 0.9(0.4–1.9) | 1.5(0.3–8.8) |
| Literate                             | 768(75.6) | 248(24.4) | 1.8(1.5–2.2) |          |              |

| Age of child mother* | Others | <=25 | 26–30 | 31–35 | >=36 | Other | Rate (95% CI) |
|----------------------|--------|------|-------|-------|------|-------|--------------|
| <=25                 | 182(75.5) | 59(24.5) | 1      | 1      |      |       |              |
| 26–30                | 748(82.4) | 160(17.6) | 0.7(0.4–0.9) | 1.1(0.6–2.0) |       |      |              |
| 31–35                | 507(81.8) | 113(18.2) | 0.7(0.5–0.99) | 1.4(0.7–2.8) |       |      |              |
| >=36                 | 388(78.9) | 104(21.1) | 0.8(0.6–1.2) | 1.4(0.6–3.2) |       |      |              |

| Educational status of mother* | Others | Illiterate | Literate | Rate (95% CI) |
|-------------------------------|--------|-----------|----------|--------------|
| **Educational status of mother*** |        |           |          |              |
| Illiterate                    | 1379(84.1) | 260(15.9) | 1        |              |
| Literate                      | 446(71.7) | 176(28.3) | 2.1(1.7–2.6) |          |              |

| Education level of mother* | Others | <=grade 7 | >=grade7 | Rate (95% CI) |
|---------------------------|--------|-----------|---------|--------------|
| <=grade 7                 | 268(78.0) | 76(22.1)  | 1       |              |
| >=grade7                  | 138(58.7) | 97(41.3)  | 2.5(1.7–3.6) | 1.4(0.9–2.4) |              |

| Occupation of mother* | Others | Housewife | Farmer | Merchant | Employee | Others | Rate (95% CI) |
|-----------------------|--------|-----------|--------|----------|----------|--------|--------------|
| Housewife             | 1526(81.7) | 341(18.3) | 0.3(0.2–0.5) | 1.8(0.8–4.5) |          |       |              |
| Farmer                | 163(86.2) | 26(13.8)  | 0.2(0.1–0.4) | 4.9(1.3–18.6) |          |       |              |
| Merchant              | 68(76.4) | 21(23.6)  | 0.4(0.2–0.8) | 2.7(0.97–7.6) |          |       |              |
| Employee              | 47(56.6) | 36(43.4)  | 1       | 1        |          |       |              |
| Others                | 21(63.6) | 12(36.6)  | 0.8(0.3–1.7) |          |          |       |              |

| Presence of pregnant mother | Others | No | Yes | Other | Rate (95% CI) |
|-----------------------------|--------|----|-----|-------|--------------|
| No                          | 1608(81.0) | 377(19.0) | 1      |              |
| Yes                         | 217(78.6) | 59(21.4)  | 1.2(0.8–1.6) |          |              |

| under 5 children in the household** | Others | Not present | Present | Other | Rate (95% CI) |
|-------------------------------------|--------|-------------|---------|-------|--------------|
| Not present                         | 622(81.4) | 142(18.6)  | 1       | 1     |              |
| Present                             | 1203(80.4) | 294(19.6)  | 1.1(0.9–1.3) | 2.1(1.2–3.7) |          |      |              |

| Stagnant water around home | Others | Not present | Present | Other | Rate (95% CI) |
|---------------------------|--------|-------------|---------|-------|--------------|
| Not present              | 1685(81.0) | 394(19.0)  | 1       |       |              |

*Statistically significant at univariable analysis* and multivariable analysis**
| Wealth index in quartile* | Present | | | |
|--------------------------|---------|---------|-------|
| First                    | 731(85.7) | 122(14.3) | 1     |
| Second                   | 203(71.2) | 81(28.5)  | 2.4(1.7–3.3) | 1.9(0.9–4.1) |
| Third                    | 407(72.7) | 153(27.3) | 2.3(1.7–2.9) | 1.4(0.7–2.6) |
| Fourth                   | 484(85.8) | 80(14.2)  | 1(0.7–1.3)   | 0.7(0.4–1.5) |

| Altitude of residence masl** | Present | | | |
|------------------------------|---------|---------|-------|
| <=1100                       | 623(73.8) | 221(26.2) | 1     |
| (1100–1250]                  | 626(83.2) | 126(16.8) | 0.6(0.4–0.7) | 0.5(0.3–0.9) |
| >1250                        | 575(86.6) | 89(13.4)  | 0.4(0.3–0.6) | 0.7(0.3–1.4) |

*Statistically significant at univariable analysis* and multivariable analysis**

After fitting the model to multivariable logistic regression, households living in area of altitude between 1100 to 1250 mSL (AOR = 0.5; 95% CI: 0.3–0.9) as compared to those living below 1100 meters above sea level were less likely to own bed nets. The presence of children aged less than five years become the independent factor affecting ownership of bed net by the households (AOR = 2.1; 95% CI: 1.2–3.7).

**Bed Net Utilization**

The percentage of any person passed the previous night under bed net from the total participating households and households conditional to bed net ownership was 12.0% (95%CI; 10.6% -13.4%) and 62.2% (95%CI; 57.4%-66.7%) respectively. About 40.3% (95% CI: 35.8–45.1%) of participated SAC in the households owning bed net and 7.8% (6.7%-10.0%) of all participating SAC passed the previous night under bed net irrespective of a bed net ownership.

Passing the previous night under a bed net by SAC in univariable analysis was affected by place of residence of the children, maternal level of education, maternal occupation, child age and the knowledge of mothers on the transmission of malaria. Children living in semi-urban area were 2.6 (95% CI: 1.5–4.5) times more likely to use bed net while those living in urban area were 0.4 (95% CI: 0.2–0.8) times less likely to use a bed net as compared to those living in rural area in univariable analysis. Children age more than 9 years were about 0.6 (95% CI: 0.3–0.99) times less likely to use a bed net than children age less than 10 years. Children from mothers who had formal education above grade 6 (COR = 2.7 ; 95% CI: 1.4-5.0); those who were housewife (COR = 0.4 ; 95% CI: 0.2–0.9); and others (COR = 0.2; 95% CI: 0.1–0.6) occupation compared to civil servant mothers; mothers who know that malaria is transmitted only through the bite of mosquito (COR = 2.4 ; 95% CI: 1.5–4.3) and presence of adequate (at least one for 2
individuals) number of bed net in the house (COR = 3.4 ; 95% CI: 1.8–6.6) were associated with bed net utilization by SAC. However, after fitting the model in multivariable logistic regression, those living in urban area (AOR = 0.04; 95% CI: 0.01–0.2); children age above 9 years (AOR = 0.2; 95% CI: 0.03–0.8), education level of mother above grade 6 (AOR = 5.2; 95% CI: 1.8–17.0) and presence of adequate bed net (AOR = 37.8 ; 95% CI: 4.1–1106) in the household were the independent predictors of bed net utilization by the SAC conditional to ownership of bed nets by the households as indicated in the Table 3.
Table 3
Univariable and multivariable logistic regression analysis LLINs utilization by SAC conditional to its ownership, 2019

| Factor                        | Value categories | Bed net owned | COR(95% CI) | AOR(95% CI) |
|-------------------------------|------------------|---------------|-------------|-------------|
| District                      |                  |               |             |             |
| Uba                           | 185(58.2)        | 133(41.8)     | 1.3(0.9-2.0) |             |
| Debretsehay                   |                  |               |             |             |
| Dara Mallo                    | 75(63.6)         | 43(36.4)      | 1           |             |
| Place of residence**          |                  |               |             |             |
| Rural                         | 18(60.5)         | 122(39.5)     | 1           | 1           |
| Semi-urban                    | 24(37.5)         | 40(62.5)      | 2.6(1.5–4.5) | 1.3(0.3-3.0) |
| Urban                         | 49(77.8)         | 14(22.2)      | 0.4(0.2–0.8) | 0.04(<0.01–0.2) |
| Residence house is            |                  |               |             |             |
| Private                       | 242(59.8)        | 163(40.2)     | 1           |             |
| Not private                   | 18(58.1)         | 13(41.9)      | 1.1(0.5–2.2) |             |
| Gender of SAC                 |                  |               |             |             |
| Female                        | 133(58.1)        | 96(41.9)      | 1           |             |
| male                          | 127(61.4)        | 80(38.6)      | 0.9(0.6–1.3) |             |
| Age of the SAC**              |                  |               |             |             |
| < 10                          | 200(57.3)        | 149(42.6)     | 1           | 1           |
| >=10                          | 60(69.0)         | 27(31.0)      | 0.6(0.3–0.99) | 0.2(0.03–0.8) |
| Grade of the child            |                  |               |             |             |
| One                           | 107(60.4)        | 70(39.5)      | 1           |             |
| Two                           | 67(56.8)         | 51(43.2)      | 1.2(0.7–1.9) |             |
| Three                         | 86(61.0)         | 55(39.0)      | 1.0(0.6–1.5) |             |
| Sex of household head         |                  |               |             |             |
| Male                          | 238(59.1)        | 165(40.9)     | 1.4(0.7-3.0) |             |
| Female                        | 22(66.7)         | 11(33.3)      | 1           |             |
| Age of household head         |                  |               |             |             |
| <=30                          | 45(60.0)         | 30(40.0)      | 1           |             |
| 31–35                         | 66(65.3)         | 35(34.7)      | 0.8(0.4–1.5) |             |

Statistically significant at univariable analysis* and multivariable variable analysis**
| Factor                                | Value categories | Bed net owned | COR (95% CI) | AOR (95% CI) |
|---------------------------------------|------------------|--------------|--------------|--------------|
|                                       |                  | No (%)       | Yes (%)      |              |
| Bed net owned                         |                  |              |              |              |
| 36–40                                 |                  | 84 (62.7)    | 50 (37.3)    | 0.9 (0.5–1.6) |
| > 40                                  |                  | 65 (51.6)    | 61 (48.4)    | 1.4 (0.7–2.5) |
| Occupation of the household head      | Farmer           | 174 (60.2)   | 115 (39.8)   | 0.7 (0.4–1.2) |
|                                       | Civil servant    | 40 (52.6)    | 36 (47.4)    | 1            |
|                                       | Merchant         | 23 (67.6)    | 11 (32.3)    | 0.5 (0.2–1.2) |
|                                       | Others           | 23 (62.2)    | 14 (37.8)    | 0.7 (0.3–1.5) |
| Educational status of household head  | Illiterate       | 112 (59.6)   | 76 (40.4)    | 1            |
|                                       | Literate         | 148 (59.7)   | 100 (40.3)   | 1 (0.7–1.5)  |
| Age of child mother                   | <=35             | 206 (62.0)   | 126 (38.0)   | 1            |
|                                       | > 35             | 54 (52.0)    | 50 (48.0)    | 1.5 (1.0–2.4) |
| Educational status of mother          | Illiterate       | 157 (60.4)   | 103 (39.6)   | 1            |
|                                       | Literate         | 103 (58.5)   | 73 (41.5)    | 1.1 (0.7–1.6) |
| Education level of mother**           | < grade 7        | 54 (71.1)    | 22 (28.9)    | 1            |
|                                       | >= grade 7       | 47 (48.1)    | 50 (51.1)    | 2.7 (1.4–5.0) |
|                                       |                  | 2.7 (1.4–5.0) | 5.2 (1.8–17.0) |
| Occupation of mother*                 | Housewife        | 203 (59.5)   | 138 (40.5)   | 0.4 (0.2–0.9) |
|                                       | Employee         | 14 (38.9)    | 22 (61.1)    | 1            |
|                                       | Others           | 43 (72.9)    | 16 (27.1)    | 0.2 (0.1–0.6) |
| Presence of pregnant mother           | No               | 229 (60.7)   | 148 (39.3)   | 1            |
|                                       | Yes              | 31 (52.5)    | 28 (47.5)    | 1.4 (0.8–2.4) |

Statistically significant at univariable analysis* and multivariable variable analysis**
| Factor                                    | Value categories | Bed net owned | COR (95% CI) | AOR (95% CI) |
|------------------------------------------|------------------|---------------|--------------|--------------|
|                                          |                  | No (%)        | Yes (%)      |              |
| under 5 children in the household       | Not present      | 83 (58.5)     | 59 (41.5)    | 1            |
|                                          | Present          | 177 (60.2)    | 117 (39.8)   | 0.9 (0.6–1.4)|
| Stagnant water around home              | Not present      | 234 (59.4)    | 160 (36.6)   | 1            |
|                                          | Present          | 26 (61.9)     | 16 (38.1)    | 0.9 (0.5–1.7)|
| Mosquito only transmits malaria*        | No               | 238 (62.3)    | 144 (37.7)   | 1            |
|                                          | Yes              | 22 (40.7)     | 32 (59.3)    | 2.4 (1.5–4.3)|
| IRS last 12 months                      | No               | 107 (55.7)    | 85 (44.3)    | 1            |
|                                          | Yes              | 153 (62.7)    | 91 (37.3)    | 0.7 (0.5–1.1)|
| IRS < 4 months                          | yes              | 85 (67.5)     | 41 (32.5)    | 1            |
|                                          | No               | 68 (57.6)     | 50 (42.4)    | 1.5 (0.9–2.6)| 2.3 (0.7–8.1)|
| Altitude of residence masl              | <=1100           | 139 (62.9)    | 82 (37.1)    | 1            |
|                                          | >1100            | 121 (56.3)    | 94 (43.7)    | 1.3 (0.9–1.9)| 0.3 (0.1–1.1)|
| Wealth index in quartile                | First            | 96 (60.8)     | 62 (39.2)    | 1            |
|                                          | Second           | 40 (61.5)     | 25 (38.5)    | 1 (0.5–1.7)  |
|                                          | Third            | 59 (61.5)     | 37 (38.5)    | 1 (0.6–1.6)  |
|                                          | Fourth           | 65 (55.6)     | 52 (44.4)    | 1.2 (0.8–2.0)|
| Household size to bed net ratio**       | >2               | 245 (62.7)    | 146 (37.3)   | 1            |
|                                          | <=2              | 15 (33.3)     | 30 (66.7)    | 3.4 (1.8–6.6)| 37.8 (4.1–1106)|

Statistically significant at univariable analysis* and multivariable variable analysis**

Discussion
The ownership of bed nets and sleeping under a bed net the night preceding the survey by SAC was assessed in this survey. The ownership of bed net by the households where SAC were living in the study area was 19.3%. Owning bed net was negatively affected in altitude ranging from 1100 to 1250 meters above sea level and positively influenced by the presence of children aged under-five years in the household. The percentage of children that slept the previous night under a bed net was 7.8% among the total studied and 40.3% in conditional to the presence of a bed net in the household. Bed net utilization by the SAC was positively affected by being a resident in rural areas, age of children below 10 years, mothers with educational status of above grade six and the presence of adequate numbers of bed nets in the households.

The household bed net ownership in the present study was much lower than the universal coverage target of the national malaria control program (26). Not only the ownership but also the adequacy of access to households owning bed net which should be taken as the major indicator of effectiveness of bed nets than ownership alone (27) was also poor. The ownership of bed net was lower than the coverage estimated in the most recent malaria indicator survey in Ethiopia (13) and most other studies conducted in Ethiopia (21, 24, 28, 29) except a study conducted among households of pregnant mothers in Shashogo district in Southern Ethiopia (22). The finding from the present study was also lower as compared to similar studies conducted outside Ethiopia such as national and district level studies in Uganda (30–32), Madagascar (33), Ghana (34, 35), Zimbabwe (36), Equatoria Guinea (37), Yemen (38), among migrant population in Myanmar (39) and in Kenya (40). The higher ownership of bed nets in these countries and specific study localities might be occurred due to difference in the study population since pregnant mothers and children age less than fivers were known to be at higher risk of malaria or timing of data collection relative to the time when the distribution has occurred since some bed nets get lost because of different reasons as time goes on. It might also be related to the level of drug resistant strains circulating in the community as resistant strains had a higher potential to lead to death that in turn might be enabling factor to own bed nets. The difference in finding from Shashogo district in Southern Ethiopia might be difference in the level of endemicity of malaria transmission.

The bed net utilization by SAC in the study area was lower than its utilization by people living in malaria endemic areas in Africa (1). The bed net utilization was lower among this study population (20, 21, 24, 28, 29) as compared to pregnant mothers, children age less than five years in Ethiopia as well as other countries outside Ethiopia like the general population and under five children in Zimbabwe (36), SAC in Uganda, Tanzania and Yemen (31, 38, 40–42), care givers of under five children in Ghana (35), SAC and the general population in Kenya (40) and Nigeria (43). These differences could be due to differences on the level of awareness of the targeted population as pregnant women and children age less than five years were well known high risk population groups than the SAC. The other possible explanations for such differences might be the difference in the level of awareness on the susceptibility of SAC for malaria and its consequences.

There were different factors influencing the bed net utilization among the different target population. From the socio demographic factors, being female and living in urban areas (36, 37, 44) were positively
influencing the utilization of bed net by the study population though this was not shown in the present study with respect to residence area. According to this study, the bed net utilization was higher among children in rural area as compared to those in urban area. In Malawi, the bed net utilization was positively associated with being resident in urban areas but not with female gender (45) which was also similar with respect to gender in Yemen (38). In similar to our finding, gender related difference in the utilization of bed net was not seen in a community based cross-sectional study in Katakwi district in Uganda (32). These differences might be related to cultural differences in giving priority to the different population segments in different contexts or ignorance to children mainly aged above nine years.

In most of studies those assessed the influence of presence of pregnant mother or children aged < 5 years, the presence of pregnant mother or children aged less than five years in the household were positively associated with bed net utilization. However, in this study both had positive relation but not significant enough which might be related to low number of bed net owned by the households.

Bed net utilization was significantly associated with the presence of either a pregnant mother or under five years aged children in the household among internally displaced households in the Democratic Republic of Congo (16), household members in the Budondo sub-country in Uganda (28), a national community based survey in Madagascar (30). In agreement with our finding, bed net utilization by SAC was not affected by the presence of pregnant mother or children aged less than five years in the household in Malawi (45) and general population in Yemen (38). In addition to the above explanation, these disparities between studies could be due to differences in the culture as pregnant women or young children might share the same sleeping place with the SAC.

The other factors affecting utilization of the bed net by the SAC in the present study area were maternal level of education and the ratio of bed nets to the household size. In Uganda and Zimbabwe, bed net utilization was significantly influenced by the density of bed nets in the households (14, 36). This was also corroborated by the 2007 national malaria indicator survey in Ethiopia (44), 2009 community based Survey in Madagascar (33). However, the proportion of bed nets in Adami Tulu did not influenced utilization of bed nets by children aged less than 5 years (29) and this difference might be related to difference in the attitude towards the bed net utilization on the prevention of malaria.

The bed net utilization was also influenced by the economic status of the population as it could give an opportunity to buy in areas where there was access. The review of the national malaria indicator survey revealed this in Countries of SSA (46). The finding of the present study was in contrast to this where socioeconomic status of the household had no significant impact on the utilization of bed net. In similar with studies conducted in Adami Tulu, utilization of bed net among the study population was higher when the mother of children had higher level of education [36]. The same thing was true for study population in Equatorial Guinea (37). However, the educational status of caregiver of children aged bellow five years was not influenced by their educational status in Ghana (35) which could be related to differences in decision making capacity by the caregivers where non parental care givers might had low
influence in ordering the children to sleep under the bed net or low decision making power in the household.

Finally, the readers of this manuscript shall interpret the finding of this research by taking the following limitations and strengths of the study. The 1st limitation was due to involving only school enrolled children as the situation could be different for those non-enrolled to the school. The 2nd limitation was due to study design used since cross-sectional studies are not strong in generating evidence for cause and effect relationship. The strengths of this study is that we were able to do research in a hard to reach study setting and underexplored area, the sample size was large enough, making the power of the study high.

**Conclusions**

Ownership of the bed nets, access to adequate numbers of bed nets in the households of SAC and their bed net utilization was lower than the target set to achieve universal coverage of the bed nets to control malaria. It is important to monitor replacement needs of households with the main emphasis given to households where there were no children age less than five years and those living in altitude range between 1100 and 1250 meters above sea level. Utilization of bed net conditional to the presence of at least one bed net in the household was affected by maternal education level, age of the child and living in urban areas. Barriers to utilization of bed net among children aged above 9 years should be explored in urban residents. Then, malaria prevention education to correct these barriers and increasing awareness about the benefit of effective and consistent utilization of insecticide treated bed nets should be given to children and mothers with low educational level to realize the elimination of malaria and the broad vision to see the world free of malaria.

**Abbreviations**

AIC
Akaike Information Criterion
AOR
Adjusted Odds Ratio
CI
Confidence Interval
COR
Crude Odds Ratio
DHS
Demographic and Health Surveys
GPS
Global positioning system
IRB
Institutional Research Ethics review Board
Declarations

Ethical Approval and consent to participate

The trial mentioned above was approved with written consent procedure to be followed by the Institutional Research Ethics review Board (IRB) in College of Medicine and Health Sciences, Arba Minch University with the reference number of IRB/154/12. Official permission letter to conduct the research is submitted to district health offices and education offices in Dara Mallo and Uba Debretehay districts. Support letter written by the respective education offices was given to each participating school to support and participate in the study and written consent was obtained from the school headmasters. Parents of the selected SAC were invited to come to the schools and written consent was obtained before data collection at school and household levels. Written informed consent was obtained from each of the selected students’ parent at school and documented in college of medicine and Health Sciences in Arba Minch University

Consent for publication:

Not applicable

Availability of data and materials
The datasets used and/or analyzed during the current study will be available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that we have no competing interests.

**Funding**

Arba Minch University financed the data collection process.

**Authors' contributions**

ZZ, JP, HD, SA and FM conceived the idea, designed the study, analyzed, interpreted and drafted the manuscript; MM, MS and YC conceived and involved in acquisition of the data; GB, AT& TY conceived the idea

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Figures

Figure 1

Location map of two districts selected from former Gamo Gofa zone, in Southern Ethiopia.
Figure 2

LLINs ownership, any person or SAC passed the previous night under LLINs, 2019 Own = ownership of LLINs by the participating households ANU_n = any person passed the previous night under LLINs conditional to presence in the household SAC_n = participating SAC passed the previous night under LLINs conditional to its ownership by the household ANU = any person passed the previous night under LLINs from total participated households SAC = participating SAC passed the previous night under LLINs from total participated SAC

Figure 3

Percentage of bed net ownership among households per schools where participated children attend their education