Effectiveness of the school-based social and behavior change communication (SBCC) interventions on insecticide-treated nets utilization among primary school children in rural Ethiopia: A quasi-experimental design

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Abstract

Background: Evidence regarding the impacts of school-engaged social and behavior change communication (SBCC) interventions on malaria preventive behaviors in rural primary schools is limited. This study examined the effect of the school-based SBCC approach on the utilization of the insecticide-treated nets among primary school students in malaria-endemic settings of Ethiopia.

Methods: Engaging primary schools and community; various participatory, educational, and communication interventions were implemented from 2017 to 2019 in 75 rural primary schools in Jimma to promote malaria preventive practices in target the villages. A post-intervention quasi-experimental design was conducted with randomly selected 798 students (i.e. 399 intervention and 399 control groups). Data were collected by trained interviewers using structured questionnaires. The SPSS version 26 software was used to analyze the data. Propensity score matching analysis was performed to control for possible confounding biases. The average effects of the intervention were estimated using multivariate general linear modeling and chi-square tests based on the nature of the outcome data. P-value < 5% was considered for statistical significance.

Results: The result showed a significant difference of 39% in the proportion of ITN utilization between the intervention and control groups; (95% CI: 38.23% to 39.77%). The intervention also led to a significant mean differences (MD) of self-efficacy (MD=15.34; 95% CI: 13.73 to 16.95), knowledge (MD=5.83; 95% CI: 5.12 to 6.55), attitude (MD=6.01; 95% CI: 5.26 to 6.77), perceived malaria risk (MD=2.14; 95% CI: 1.53 to 2.76), and perceived family supports (MD=6.39; 95% CI: 5.57 to 7.22). Multiple logistic regression modeling results showed that knowledge ($\beta=0.194$, 95% CI: 1.09 to 1.35) and perceived family supports ($\beta=0.165$, 95% CI: 1.11 to 1.25) and self-efficacy ($\beta=0.10$, 95% CI: 1.22 to 2.32) significantly predicted the ITN utilization among the school children.

Conclusion: The finding of this study suggested that the school-based SBCC approach combined with peer education activities advanced the malaria-related knowledge, attitude, self-efficacy, risk perceptions, and family supports and ultimately improved the sustained use of ITNs among school-going children. Further research should be conducted to understand the mechanism of these effects given the influences of social, health services, and school systems are considered.

Keywords: “Malaria”, “SBCC”, “Insecticide-treated nets”, “ITNs”, “student”, “Ethiopia”
**Background**

Malaria is one of the oldest vector-borne diseases transmitted by the bite of an infected mosquito from Anopheles species (1). Malaria has an important global public health concern. Recent pieces of evidence showed that an estimated 219 million malaria cases were reported globally in 2017; with Africa accounts 92%. There was no significant global reduction in malaria cases between the periods 2015 and 2017. The top 10 highest-burden countries affected by an increase in malaria cases between 2016 and 2017 were all in Africa (2,3).

In Ethiopia; it is estimated that three-fourths of the land is below 2000 meters and is malarious with two-thirds (60%) of the country’s population being at risk (4). Peak malaria transmission occurs between September and December in most parts of Ethiopia, after the main rainy season (5). Consequently; malaria is one of the leading causes of morbidity and mortality in the country (6). The health management information systems (HMIS) report showed that there were about 1,530,739 confirmed malaria cases; with 356 reported deaths due to malaria in 2017 (5). There was significant regional variation with malaria distribution in Ethiopia (7).

Malaria affects the lives of almost all people living in malaria-prone areas. Young children and pregnant women are the most vulnerable group of population to malaria (4). Malaria remains a major health problem among school-aged children, affecting the critical period of learning and development (8) (9). Although the prevalence of *Plasmodium* infection in this age group often exceeds that seen in younger children; less emphasis was given to school-aged children for malaria control so far (10–12). Malaria is one of the causes of school absenteeism and a reduction in the learning capacity of students in Africa (13).

In recent years, malaria elimination has received outmost global attention (14–17) where appropriate use of ITNs (14), prompt care-seeking, and access to effective antimalarial drugs is one of the key strategies to move towards the elimination target (14). Ethiopia has achieved 100% IRS coverage in areas where the malaria burden is high (5). The utilization of ITNs is one of the key national malaria control strategies (18,19) and the national target sets a 100% coverage in households in malarious areas with at least two ITNs per person in the household and reaches 86% ITNs use among vulnerable groups by 2020 (19).
However; evidence showed access to, and utilization of ITN is affected by many underlying behavioral, environmental, and vector related factors (14). The first set of factors; the human behavioral driven-failure accounts for significant gaps followed by the access-driven failure (14). Specific to students; the use of ITNs was considerably low compared to that of the general population (20). For instance, one earlier school-wide survey of malaria in Ethiopia showed that; the overall ITNs use among school children was 46% (21). In some African countries; only 32.4% in Malawi and 67.9% in Kenyan school children undertook some sort of malaria preventive practices (22). The low access to ITNs, cognitive and behavioral-driven factors are responsible for the failure in malaria preventive actions among school children in Africa (22).

Schools' participation in malaria actions has got attention to support the disease surveillance, track the coverage of malaria preventive efforts such as ITNs use, adoption of IRS, and access to effective malaria services at community-level (23). For instance; school-based studies in Uganda show that schoolchildren reliably reported net ownership and use in their households (24,25). In addition to achieving behavioral changes among students, it was indicated that the school-based health promotion practices were aimed to enhance students’ and teachers’ enrollment as health messengers which in-turn influence family and local communities towards health actions (26).

One of the potential and effective strategies to engage community and schools in malaria preventive programs is the use of the SBCC approach (5). Although a wealth of evidence is available on the impacts of the SBCC on malaria prevention in the general population (27) (28) (29); there was no documented evidence on how schools and community-engaged malaria prevention and control efforts influence behaviors among students as far as the SBCC is concerned. This is partly due to the recent emergence of the practice of SBCC (30,31).

This study examined the effectiveness of the school-based peer education combined with the SBCC intervention on malaria preventive knowledge, attitude, risk perceptions, self-efficacy, and utilization of ITNs among primary school students in malaria-endemic settings of Ethiopia.
Methods and materials

Study setting

A project entitled “advancing community practices on malaria prevention and control (ACP-malaria) through schools communities” was implemented from 2017 to 2017 in 75 selected rural schools of Jimma zone; the State of Oromia. Jimma zone is located 352 km away from Addis Ababa; the capital city of Ethiopia. Based on the projected 2007 Census conducted by the CSA, the total population of Jimma zone was 2,486,155 (50.3% male and 49.7% female) and the rural population accounts for more than 89%. The zone lies within an altitude ranging between 900 and 3500 meters above sea level.

The current intervention was conducted in five selected districts of Jimma Zone for intensive engagement on malaria communication. These districts were Limmu Kossa (population=209261), Shebe Sombo (population=146805), Nono Benja (population=77452), Chora Botor (population=74756), and Gera (population=147120). According to the Zonal health department report of 2016; an annual parasite incidence (API) rate in these districts was 16% in Chora Botor, 14.1% in Shebe Sombo, 10% in Nono Benja, 5.5% in Limmu Kossa, and 3.1% in Gera. The project was dedicated to benefiting schools and various community groups including vulnerable groups such as children less than five years, pregnant women, and school students.

Theoretical bases to inform the school-based SBCC interventions

To guide the SBCC content and interventions process, concepts, and principles drawn from some behavioral change theories or models were combined and applied. Accordingly; the Motivation Protection Theory (MPT) and the health belief model (HBM) were used to design the proposed SBCC elements (32). These theories explain the cognitive mediation process of behavioral change in terms of threat and coping appraisal. According to the theories, the appraisal of the health threat (i.e. health risk due to malaria in this case) and the appraisal of the coping responses result in the intention to perform adaptive responses which are called protection motivation (i.e. using malaria preventive measures such as ITNs, IRS, prompt care-seeking, and proper use of medications).

Thus, the theories propose that the intention to protect oneself or families from certain conditions (i.e. malaria) depends upon four factors: 1) the perceived severity of a threatening event (e.g., a
malaria attack), 2) the perceived probability of the occurrence, or vulnerability (e.g. perceived vulnerability of the individual to a malaria attack), 3) the efficacy of the recommended preventive behavior (e.g. perceived effectiveness of recommended actions to prevent or remove the health risk, malaria in this case) and 4) the perceived self-efficacy (i.e., the level of confidence in one’s ability to undertake the recommended preventive behavior, such as regularly sleeping under ITNs, prompt care-seeking behavior and properly using medications) (32). To this end, formative assessment was undertaken in the target districts based on the assumption and framework of the MPT and HBM. The results obtained from this formative assessment were used to guide the malaria communication activities and to monitor behavioral change progress indicators in schools and target villages.

The second theory; the theory of diffusion of innovation (DOI) was applied to complement the individual based theories. DOI is one of the most widely used communication theories. According to the DOI, the population can be broken down into five different segments, based on their propensity and time it takes them to adopt a specific behavior (e.g. adoption of recommended malaria prevention measures in this case). These are innovators, early adopters, early majorities, late majorities, and laggards and people in each category have different needs, perceptions and require tailored interventions (33). In this intervention, early adaptors were considered a role model for other group members after receiving basic malaria training.

Success stories and experiences of these role models were captured and used for educational purposes to motivate other students and family remembers. People in each category of adoption need different interventions ranging from sharing simple facts to implementing groups’ norms (33). Thus, the due emphasis was given on promoting social and groups’ norms rather than just the health benefits of interventions and emphasize the risks of being left behind for those who are late and laggards to adopt the behaviors. Thus, the group members reinforce each other; and households who do not practice the recommended behavior begin to model a new behavior and change themselves as a result of pressure from the group members and social networks. Household status and student behaviors were monitored and evaluated, and tailored education was provided accordingly.
**Intervention descriptions**

The current school engaged peer education combined with SBCC intervention was designed to facilitate behavior changes on malaria prevention and control targeting various levels of personal, organizational, and community factors. Ultimately; it was intended to promote the five key malaria prevention and control practices both at schools and community levels. These were the use of insecticide nets (ITNs), appropriate & timely seeking care for malaria, appropriate use of quality anti-malaria drugs, acceptance of insecticide residual spray (IRS), and draining of potential breeding sources in the villages.

The interventions encompassed various capacity building and educational sessions that were implemented from 2017 to 2019 engaging 75 schools and respective villages. The program was first initiated through participatory consultations of stakeholders or representatives of the community including key peoples from health offices, education offices, health extension workers (HEWs), and village leaders and schools. The formal supervisory committee was organized before the actual joint situation analysis that identified malaria situations, the interventions' needs, and strategies. Based on the need assessment results; joint planning (i.e. identifications of roles, developing goals/objectives, devising monitoring, and evaluation mechanisms). Finally; the plan was implemented over two and a half years through active engagement of the community, health institutions, and primary schools. Summary of intervention process was presented in figure 1. Furthermore, details about the intervention were presented elsewhere in the previously published study as part of the project evaluation (29).

**Study design**

The study employed a quasi-experimental evaluation design to collect post-intervention data from selected primary school students (i.e. grade 6th through grade 8th). A post-intervention quasi-experimental design was most widely and effectively used in impact evaluation of large scale interventions (34). Students in intervention schools were considered exposed (intervention group) and those selected from non-intervention schools are comparison/control group. Controls were selected from adjacent schools to the project area of the same cluster.
Study populations and sample size

All grades 6th through 8th students in randomly selected schools from both the intervention and controls were considered to study population and included in the study. The sample size was calculated using two population proportion given by; $n = \frac{(P)(1-P)(Z\alpha + Z\beta)^2}{E^2} \left[ \frac{r+1}{r} \right]$ where; $P = \frac{P_1 + P_2}{2}$, $E = P_1 - P_2$ and $r$= the ratio of the two proportions. It was assumed to detect the effect or odds ratio two (OR=2 or greater) for 90% power; $(Z_\beta =0.96)$ and 5% level of significance; $(Z_{\alpha/2}=1.96)$ with an equal number of intervention and comparison groups. The $P_2$=population prevalence of ITNs use among school children was 46% which was taken from the previous study (21). This yields a sample size of 380 (190 each intervention and control groups) was calculated. Considering a factor of 2 for sampling variation or design effect and 5% for non-response rate, the final sample of 798 (399 each intervention and control groups) was drawn.

Sampling techniques

Seventy-five; (75) schools in five districts were addressed by the intervention. A total of 4 schools per each district (i.e 4*5=20 schools) were randomly selected from the intervention village. And; two corresponding schools from non-intervention village (i.e 2*5=10 schools), but in the same district were randomly selected. Stratification was further done to distribute a 399 sample to each school and grade levels through grades 6th to 8th assuming an equal number of students in all schools. This was done by dividing 399/20 for intervention and 399/10 for control; which gives 20 and 39 students per school respectively. Down stratifying to grades level; 6th through 8th=3, (i.e 20/3=7 and 39/3=13) for intervention and non-intervention schools respectively. Finally; 399 students each from 20 intervention and 10 non-intervention schools were interviewed. (Figure 2)

Data collection tools and methods

Malaria related data were collected using a questionnaire adapted from relevant literature such as malaria indicator survey and health, and demographic survey (35,36). The questionnaire form covered socio-demographic factors, peer education experiences, behavioral outcomes such as ITN use, and psychographic outcomes such as knowledge, risk perceptions, self-efficacy, and attitude related to malaria and its preventive measures. The questionnaires were then translated into the local language; Afan Oromo before data collection. Data was collected on an
interviewer-administered basis. Qualified data collectors recruited ad three days of training were
given to data collectors and supervisors about the purpose of the study, instruments, and data
collection procedures. The data collection process was closely supervised by the research teams.
Eligible students were called on by schools’ administrators to appropriate places for the
interview which was conducted face-to-face.

Variables and measurements
The current study measured two outcomes of interest in the effects of the interventions. The first
or primary outcome of interest was the ITNs utilization. The second or secondary outcomes of
interest were the psychographic outcomes that include multidimensional knowledge, attitude,
group, family supports, self-efficacy, and perceived malaria risk and severity. The psychographic
outcomes or variables are conceptualized in this study as mental processes such as attitude,
perceptual process, and beliefs about an individual’s behaviors or practices in the context of
malaria preventive behaviors.

Knowledge: Multidimensional knowledge (MDK) questionnaire was used to measure
comprehensive malaria knowledge related to the cause of malaria, signs/symptoms, vulnerable
groups, preventive measures, and mosquito vectors biting behaviors. Questions encompassing 31
items were used (37). For each item, the correct answer was assigned (1=Yes) and an incorrect
answer as (0=No). Scores of correct responses were computed for subsequent analysis.

Attitude: This is evaluative beliefs or acceptance and benefits towards the ITN, indoor residual
spray, vulnerable groups, and malaria situation in the study area. The items were scored on a
five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The reliability
statistics or internal consistency of the items were equals; α=0.72. The overall attitude score was
computed by summing up the items after performing the reverse scoring for negatively worded
sentences. A higher composite score indicated a more favorable attitude.

Perceived malaria risk: This was defined as individuals’ perception of vulnerability to malaria
in the context of their daily experiences about the presence or absence of malaria, individuals
who suffered from malaria in the villages. It was measured using seven items on a five-point
Likert scale; (α=0.76). A higher composite score was interpreted as a higher perception of risk.
**Perceived severity of malaria:** This represented the perceptions of bad consequences of the malaria infection in causing pain, death, interruption with daily activities such as schooling, and its impact on their academic performances. Four items were used to tap this construct by using a five-point Likert scale, ($\alpha=0.84$). Reverse scoring was done for both perceived risk and severity before conducting further analysis.

**Self-efficacy:** Self-efficacy is defined as an individual’s confidence or beliefs about the ability to prevent themselves from malaria infections under given circumstances by using ITNs or any other preventive measures. It addresses aspects of malaria prevention such as using ITN, application of IRS despite its perceived discomforts, ITN handling, early care for fevers and drug adherence, etc. Four items were used to measure it. Scoring and computing were all were done the same way. The items showed an acceptable level of internal consistency with $\alpha=0.89$.

**Perceived family support:** This was conceptualized as perceptions about how much their family (parents and siblings) are motivated to use ITNs or IRS as preventive measures, advice and encourage the individuals on ITN access and use, and help them handle the ITNs for effective and sustained use. Ten items were used to measure this dimension using five-point Likert scales. The measure of internal consistency or reliability statistics was acceptable level; $\alpha=0.84$. A higher score was interpreted as strong perceived family supports.

**Utilization of ITNs:** The access to and use of ITNs was assessed by three items that include the presence of ITNs in the home, number of ITNs, and ITN utilization every night. It was coded as Yes=1 if the student used the net and otherwise No=0. Access to ITNs (ratio of ITNs) was defined as the presence of at least one ITN per two individuals in the household (14).

**Social desirability bias (SDB):** is defined as a tendency to portray oneself in a socially desirable manner (38). In this study; it’s believed that the SDB might exist especially among respondents in intervention schools as they were aware of the aim of the intervention. They could respond to the interview in a socially desirable manner; thus hiding reality. Consequently; we were intended to measure the SDB to analytically adjust for its confounding effects on the outcomes. This was measured using the SDB for children scale that consists of 20 items constructed such that; Yes=1 if the condition exists and No=0, otherwise (38). The continuous score was computed from all
1’s (correct) responses. A high score was interpreted as the presence of a high SDB. This score was adjusted in every subsequent analysis and considered during the interpretation of the result.

**Statistical data analysis**

Data were analyzed using statistical package for social sciences (SPSS) version 26 Amoss software for analysis. Means, standard deviations, frequencies, and proportions were calculated as descriptive analysis. The propensity score matching (PSM) technique was performed as a matching analysis to reduce the selection bias due to a lack of randomization in this study. This study analyzed post-intervention data which was collected from the intervention and control groups (i.e. data that comes from an un-matched population). The PSM was recommended in evaluation studies to adjust for the possible differences at baseline (39). The method was found effective in reducing biases of unmatched or quasi-experimental study in a study conducted to evaluate the effectiveness of community-based SBCC interventions on the use of ITNs (40).

Accordingly; propensity scores were predicted or computed based on the selected covariates that may lead to the possible differences at baseline. Ten covariates that include age, gender, cumulative grade point average (GPA), grade level, ethnicity, religion, schools, altitude in meters at village levels, roles of the student in the class, and participation in school wide-clubs were selected to compute propensity scores. Participants were matched using the one-to-one nearest neighbor algorithm by imposing tolerance level or calipers of width equal to 0.20 of the standard deviation of the estimated propensity scores (41). Individuals not falling within this specified distance were excluded (39). The test of normality of the predicted scores was done to evaluate the balance of the matching result. The matched sample was used in the subsequent analysis.

The average effect of the intervention on psychographic outcomes (e.g Knowledge, attitude, etc.) was estimated using multivariate general linear modeling. The adjusted mean differences and effect size was calculated to examine the effects of the interventions on these psychographic outcomes. A Chi-square test was used to estimate the average effect of the intervention on ITN utilization. The analysis was controlled for the effects of the SDB (to adjust for potential bias) and predicted propensity score. The predicted propensity score was included in the model to adjust for covariates it has been represented in matching analysis. Covariates that were included in the estimation of propensity score were excluded from this analysis.
Furthermore, the receiver operating curve (ROC) curve analysis was conducted using predicted probability scores of logistic regression modeling to evaluate the efficacy of the intervention in discriminating the outcome of interest (i.e utilization ITN) between the intervention and control groups. The predicted probability score used for ROC analysis was generated by regressing the dependent variable on the psychographic outcomes, SDB, and predicted propensity scores. A P-value of less than 5% was considered for statistical significance.

Results

Socio-demographic characteristics

A total of 709 individuals participated; with a response rate of 89% (50.2% versus 49.8% for control and intervention groups respectively). However, the analysis was done with 631 matched samples resulting from PSM analysis (figure 1). The majority of the participants were the age fewer than 14 years and grade seven accounts large proportion for both intervention and control groups (34.3% vs 34.5%). A large number of participants from control and intervention groups have a GPA of less than 73 and greater than 89 respectively. The favorite subject for the majority of control was Afan Oromo (the local language) as math was for the intervention group. The minority of the participants; 48 (15.2%) and 64 (20.3%) from control and intervention have leadership roles respectively. (Table 1)

Table 1: Sociodemographic characteristics of primary school students in Jimma (N=631)

| Characteristics         | Control, n (%) | Intervention, n (%) | p-value |
|-------------------------|----------------|---------------------|---------|
| Age                     |                |                     |         |
| <14 years               | 179 (56.6)     | 161 (51.1)          | 0.094   |
| >15 years               | 137 (43.4)     | 154 (48.9)          |         |
| Gender                  |                |                     |         |
| Male                    | 161 (50.9)     | 165 (52.4)          | 0.390   |
| Female                  | 155 (49.1)     | 150 (47.6)          |         |
| Religion                |                |                     |         |
| Muslim                  | 231 (73.1)     | 203 (64.4)          |         |
| Orthodox                | 60 (19)        | 63 (20)             | 0.008   |
| Protestant              | 25 (7.9)       | 49 (15.6)           |         |
| Ethnicity               |                |                     |         |
| Oromo                   | 251 (79.4)     | 283 (89.8)          |         |
| Amhara                  | 47 (14.9)      | 19 (6)              | 0.001   |
| Others (Kefa, Guraghe)  | 18 (5.7)       | 13 (4.1)            |         |
| Grade level             |                |                     |         |
| Grade 6th  | 106 (33.5) | 95 (30.2) |
| Grade 7th  | 109 (34.5) | 108 (34.3) | 0.556 |
| Grade 8th  | 101 (32)   | 112 (35.5) |

| cGPA per quartile | <73  | 73 - 81 | 81 - 89 | >89 |
|-------------------|------|---------|---------|-----|
|                   | 104 (32.9) | 84 (26.6) | 75 (23.7) | 53 (16.8) |
|                   | 64 (20.3)  | 70 (22.2) | 83 (26.3) | 98 (31.1) |

| Favorite subject | Biology | 38 (12) | 34 (10.8) |
|                 | Chemistry | 36 (11.4) | 40 (12.7) |
|                 | Mathematics | 53 (16.8) | 78 (24.8) |
|                 | Geography | 42 (13.3) | 39 (12.4) | 0.0001 |
|                 | English language | 25 (7.9) | 33 (10.5) |
| Afan Oromo (local language) | 92 (29.1) | 53 (16.8) |
| Civic and ethical education | 30 (9.5) | 38 (12.1) |

| Roles in the class | Class leader | 48 (15.2) | 64 (20.3) | 0.175 |
| Class vice leader | 43 (13.6) | 34 (10.8) |
| Class members | 225 (71.2) | 217 (68.9) |

**Peer learning and education activities in schools**

The majority; 65 (87.8%) of students in the intervention schools have a membership to health-related or malaria clubs. The highest number of participants from intervention schools had leadership roles; 133 (66.5%). Peer education activities on malaria issues were one of the activities components of school clubs. A considerably large number of students from intervention; 282 (54.4%) and control; 236 (45.6%) have reported they conducted peer education schedule every week. The majority; 108 (55.7%) and 86 (44.3%) for intervention and control schools; respectively reported the peer education activities were self-initiated (by students). In the same way; the majority; (238 (61.7%) of participants from the intervention group reported a high degree of participation among members during the peer education sessions. A low level of participation was reported by the majority of control participants; 143 (23%).

Regarding exposure to malaria information; a large number of participants from both intervention; 306 (52.8%) and control; 274 (47.2%) were exposed to malaria-related information from different sources. Specific to sources of information, the highest; 161 (93.6%) and lowest;
11 (6.4%) exposures rate to information from peer educators' were reported among intervention and control groups respectively. The same thing is true for teachers, community, and mass media with 135 (91.8%) and 80 (22.3%), 31 (68.9%) and 14 (31.1%), and 68 (87.8%) and 21 (23.6%) in control and intervention groups respectively. Table 2

Table 2: Main sources of malaria information and peer learning and education activities among primary school students in Jimma, Ethiopia, 2019 (N=631)

| Engagement in PE activities | Control, n (%) | Intervention, n (%) | p-value |
|-----------------------------|----------------|---------------------|---------|
| **Membership to malaria/health club** | | | |
| Yes                         | 9 (12.2)       | 65 (87.8)           | 0.001   |
| No                          | 166 (42.8)     | 222 (57.2)          |         |
| **Roles in any clubs in the schools** | | | |
| Leader                      | 57 (33.5)      | 133 (66.5)          |         |
| Secretary                   | 56 (51.4)      | 53 (42.3)           | 0.001   |
| Member                      | 203 (57.7)     | 149 (42.3)          |         |
| **Frequency of peer education sessions** | | | |
| Within week                 | 236 (45.6)     | 282 (54.4)          | 0.001   |
| >2 weeks                    | 80 (700)       | 33 (29.2)           |         |
| **Initiation of peer discussion** | | | |
| Student self-initiated      | 86 (44.3)      | 108 (55.7)          | 0.039   |
| Teachers initiated          | 19 (49.7)      | 193 (50.3)          | 0.509   |
| School principal initiated  | 34 (54.6)      | 28 (46.4)           | 0.293   |
| **Participation in peer discussion** | | | |
| Low                         | 168 (27)       | 73 (11.3)           |         |
| Active                      | 143 (23)       | 238 (61.3)          |         |
| **Ever exposed to malaria information** | | | |
| Yes                         | 274 (47.2)     | 306 (52.8)          | 0.001   |
| No                          | 39 (95.1)      | 2 (4.9)             |         |
| **Sources of malaria information** | | | |
| Peer educators              | 11 (6.4)       | 161 (93.6)          | 0.001   |
| Team member                 | 12 (8.2)       | 135 (91.8)          | 0.001   |
| Teachers                    | 80 (22.3)      | 278 (77.7)          | 0.001   |
| Community*                  | 14 (31.1)      | 31 (68.9)           | 0.006   |
| Mass media**                | 21 (23.6)      | 68 (87.8)           | 0.001   |
| **Message contents (major)** | | | |
| About cleaning around house | 73 (38)        | 119 (62)            | 0.006   |
| About sleeping under ITN    | 77 (26.7)      | 211 (73.3)          | 0.008   |
| About care-seeking for fever| 20 (14.9)      | 114 (85.1)          | 0.001   |
| About adherence to AMD’s    | 27 (22)        | 96 (78)             | 0.006   |
Effects on malaria-related psychographic outcomes

The results showed significant mean differences (MD) regarding self-efficacy (MD=15.34; 95% CI: 13.73 to 16.95), comprehensive knowledge (MD=5.83; 95% CI: 5.12 to 6.55), attitude (MD=6.01; 95% CI: 5.26 to 6.77), perceived malaria risk (MD=2.14; 95% CI: 1.53 to 2.76), and perceived family support (MD=6.39; 95% CI: 5.57 to 7.22) between the intervention and control groups. But, the finding showed a lower mean score for the perceived severity of malaria; (MD=-3.58; 95% CI: -4.16 to -3.00) among intervention groups. Further; comparatively, the highest and lowest impact of the intervention (effect sizes) was reflected on self-efficacy, (ES=31%) and perceived malaria; (ES=7%). Table 3

| Outcomes              | Group status | Mean (SD) | MD (95% CI)                | P-value | Effect sizes |
|-----------------------|--------------|-----------|---------------------------|---------|--------------|
| MDK score             | Intervention | 15.03 (4.55) | 5.83 (5.12 to 6.55) | 0.000 | 0.30         |
|                       | Control      | 9.00 (4.03)   |                           |         |              |
| Attitude              | Intervention | 26.02 (3.92) | 6.01 (5.26 to 6.77) | 0.000 | 0.28         |
|                       | Control      | 20.93 (5.39)  |                           |         |              |
| Self-efficacy         | Intervention | 55.76 (7.71) | 15.34 (13.73 to 16.95) | 0.000 | 0.31         |
|                       | Control      | 42.26 (11.82) |                          |         |              |
| Perceived risk        | Intervention | 19.26 (3.72) | 2.14 (1.53 to 2.76) | 0.000 | 0.07         |
|                       | Control      | 17.70 (3.85)  |                           |         |              |
| Perceived severity    | Intervention | 13.48 (3.99) | -3.58 (-4.16 to -3.00) | 0.000 | 0.19         |
|                       | Control      | 16.45 (3.11)  |                           |         |              |
| Family support        | Intervention | 25.04 (4.01) | 6.39 (5.57 to 7.22) | 0.000 | 0.26         |
|                       | Control      | 14.65 (3.87)  |                           |         |              |
Figure 3 indicated a graphic representation of the comparison of the psychographic outcomes profile between the intervention and control groups. Except for perceived severity; the graph showed that the curve for the intervention group is consistently aligned above and over that of the control group indicating the intervention group has higher scores of the remaining psychographic outcomes. On the contrary; perceived severity scores were seen higher for control in this study indicating the reduction in this construct due to exposure to the intervention. Knowledge is generally found lower for both groups compared to other variables. As indicated there was no difference in SDB scores between the intervention and control groups.

**Effect of the intervention on ITN Utilizations**

The majority of both the intervention and control groups; (98.1% and 94.6%) respectively reported the presence of at least one ITN in the household. The number of respondents who reported having at least one ITN in the household is higher in the intervention group (difference; D=3.5%; 95% CI: 38.23 to 39.77). Roughly; half of the students reported having more than one ITN per two family members; 153 (50.3%) for control and 143 (46.4%) for intervention) groups. In the effects of the intervention; the proportion of ITNs utilization was significantly higher in the intervention groups compared to the control one with a difference of 39%, 95% CI: 38.23 to 39.77. This implies; the observed 39% higher use of the ITNs in the intervention group was attributed to the intervention. (Table 4)

Table 4: Comparison of access to, and utilization of ITNs between the SBCC intervention target and control groups among primary school students in Jimma, Ethiopia, 2019 (N=631)

| Behavioral outcomes                  | Intervention, n1 (%) | Control, N0 (%) | Effects or D% [95% CI] | $\chi^2$ (df) | P-value |
|--------------------------------------|----------------------|-----------------|------------------------|---------------|---------|
| Presence of at least one ITNs in the household | n1=313               | N0=316          |                        |               |         |
| Yes                                  | 307 (98.1)           | 299 (94.6)      | +3.5 [1.650, 7.201]    | 5.35 (1)      | 0.021   |
| No                                   | 6 (1.9)              | 17 (5.4)        | -                       | -             | -       |
| The ration of ITN per 2 persons      | N1=308               | N0=304          | -                       | -             | -       |
| ≤1 ITNs                              | 165 (53.6)           | 151 (49.7)      | -                       | -             | -       |
| >1 ITNs                              | 143 (46.4)           | 153 (50.3)      | -3.9 [-4.520, -3.28]   | 0.97 (1)      | 0.334   |
Independent predictors of the ITNs utilization

We conducted multivariable logistic regression modeling (adjusted for predicted propensity score and intervention status) to examine how psychographic dimensions interacted with each other to affect the primary outcome of the intervention (i.e. ITN utilization among primary school students). Accordingly; knowledge (MDK), self-efficacy, perceived family support, peer educators as main sources of information, and the ratio of ITN in the household were significantly predicted the ITN utilization.

This implies; students who reported having one ITN per two family members were nearly two times more likely to use ITNs (AOR=1.76, 95% CI: 1.01 to 3.07). Higher scores of knowledge (β=0.194, 95% CI: 1.09 to 1.35) and perceived family support (β=0.165, 95% CI: 1.11 to 1.25), and self-efficacy (β=0.10, 95% CI: 1.22 to 2.32) were associated with improved use of ITNs among students. However; important factors in the health behavior change process such as attitude (β=-0.03, 95% CI: 0.90 to 1.05), perceived disease risk (β=-0.004, 95% CI: 0.96 to 1.05), and severity (β=-0.07, 95% CI: 0.99 to 1.16) were not significantly predicted ITNs use among students. Those who had adequate access to the nets and thought they had greater family support were more likely to use it and vice versa. (Table 5)

Table 5: Multivariable logistic regression modeling of the independent predictors of ITNs use among primary school students in Jimma, 2019 (combined sample, N=631)

| Predictors                        | Beta (β) | AOR       | 95% CI         | p-value |
|-----------------------------------|----------|-----------|----------------|---------|
| Intervention status               |          |           |                |         |
| Control                           | 0.95     | 2.58      | [1.53, 4.34]   | 0.001   |
| Intervention                      | -0.001   | 1.70      | [0.29, 9.96]   | 0.304   |
| Predicted propensity score        |          |           |                |         |
| Peer educators                    | 0.96     | 2.60      | [1.30, 5.22]   | 0.002   |
| School teachers                   | -0.27    | 0.76      | [0.36, 1.61]   | 0.477   |
| Mass media*                       | -0.50    | 0.61      | [0.29, 1.26]   | 0.180   |
| Community**                       | 1.25     | 3.49      | [0.89, 13.74]  | 0.074   |
| Ratio ITNs per 2 persons in the home |         |           |                |         |
| ≤1 ITNs                           |          |           |                |         |
|                                | >1 ITNs |       |       |       |
|--------------------------------|---------|-------|-------|-------|
| Frequency of peer education sessions | 0.57    | 1.76  | [1.01, 3.07] | 0.045 |
| ≤ 2 weeks Ref. Ref. Ref. Ref. Ref. | -0.16   | 0.86  | [0.42, 1.73] | 0.665 |
| ≥2 weeks | 0.194   | 1.22  | [1.09, 1.35] | 0.000 |
| Knowledge | 1.97    | 1.22  | [0.90, 1.05] | 0.478 |
| Attitude towards preventive measures | 0.100   | 1.10  | [1.08, 2.12] | 0.003 |
| Self-efficacy preventive measures | 0.165   | 1.18  | [1.11, 1.25] | 0.000 |
| Perceived family support | 0.044   | 1.004 | [0.96, 1.05] | 0.864 |
| Perceived malaria risk | 0.071   | 1.074 | [0.99, 1.16] | 0.079 |

Key: *=mass media include (TV, radio, billboard, posters), ** = community includes (religion, community gatherings, meetings), Significance was considered at P<5%

**Efficacy of the intervention using ROC analysis**

Model quality to discriminating between the intervention and control groups concerning ITN use was examined using the Receiver operating curve (ROC). The ROC curve shown in figure 4 was constructed based on predicted probability scores of logistic regression (Table 4) to model the ITN use. The curves of both intervention and control groups lie at the left-hand corner of the reference curve with a value of 0.5 (area of a random guess) indicating successful predictions. For a given value of specificity (=0.57) and sensitivity (=0.76); the curve shows good discrimination between the two groups concerning ITN use and this yields the maximum alternative classification of 0.85.

The curve representing an intervention group extended above that of control group indicating effectiveness of the intervention. The area under the curve (AUC) was 0.81 (Std. Err=0.04, 95% CI: [0.720, 0.864]) for intervention and 0.64 (Std. Err=0.05, 95% CI: [0.543, 0.738]) for control group. The *t-test* for group area difference under the curve showed significant difference of 0.152 (Std. Err=0.062, 95% CI: [0.031, 0.272], z=-2.46). (Figure 4)

**Discussion**

This study was intended to evaluate the effectiveness of the SBCC approach to the utilization of ITNs as malaria preventive practices in primary schools in rural Ethiopia. This study was supposed to be the first of its kind in Ethiopia that had evaluated the integrated school-engaged and SBCC interventions on malaria preventive practices among rural primary school students.
The study demonstrated improved malaria-related psychographic outcomes (i.e. knowledge, attitude, risk perceptions, self-efficacy) and the utilization of ITNs among target students; indicating the effectiveness of the interventions.

Knowledge is considered a basic factor in the process of health behavior change efforts. The knowledge score which was measured as knowledge was significantly higher among the intervention groups in our study. A study conducted in India to evaluate the effects of multiple behavior change approaches (i.e. health education plus distribution of learning materials versus only learning materials) showed significant improvement in knowledge by 21% among students in the intervention schools (42). In Mali; school-based malaria education and distribution of ITNs indicated increased malaria-related knowledge and net use in intervention schools (43). Furthermore; evaluation studies of school-based participatory health education in Mali and Ghana showed significant improvement in knowledge about ITN, cause of malaria, and preventive measures among school children (20) (44). This proves that the importance of health education to reduce misconceptions about malaria thereby improving health literacy (20).

Having led to a significant improvement in perceptions of disease risks, attitudes, and self-efficacy towards malaria preventive actions; the current interventions justified the notions of cognitive-behavioral theories (32). Thus; it implicated efforts targeted at enhancing the threat perceptions and attitudes with balanced coping skills would be fruitful in such behavior change intervention efforts. However; the intervention resulted in a reduced level of perceived severity of malaria in intervention groups compared to the intervention one. This implies; the students in the SBCC target schools tend to hold lower beliefs of malaria risks compared to their counterparts. This finding contradicted the principles of many behavioral theories which claimed individuals who have a higher perception of severity or consequences of the disease are more likely to follow a certain course of preventive actions (32,45,46).

The possible reasons for this paradoxical result may be due to the improvement in self-efficacy and social supports on ITN utilization among the intervention groups. This finding is in fact; appears consistent with the result of a community-based study conducted to evaluate the same program (i.e. the school-based SBCC approach); which indicated the reduction in the community’s attitude (-3.5%) and perception of risk (-3.3%) regarding malaria (29). The
aforementioned study was conducted among parents while the participants of our current study are students. However, this interesting relationship must be further investigated.

Family participation in school health programs was considered one of the principal components of the Health Promoting Schools policy (47). The theory of communication indicated that targeting social norms and support in behavior change intervention reinforces behavior to sustain (46). Engaging parents was one of the key components of the current intervention aimed to enhance family supports for improved adoption and sustained malaria prevention in the community and schools. Consequently, the result showed higher mean scores in perceived family supports among the intervention group. The improved communication between parent and students on malaria prevention in this study might have impacted the perception of family influence in the intervention groups (42). Furthermore, this effect might also be attributed indirectly to the fact that improved parental knowledge and attitude from malaria education by HEWs at-home visits.

Further; the primary outcome of interest in the current study was changes in the utilization of the ITNs in the intervention targets. In principle, the observed changes in the levels of psychographic and social supports outcomes should be translated into actions or behaviors (32). The result demonstrated that significant differences in the percentage point of 39% in ITNs utilization between the two groups. Similar findings were reported from previous evaluation studies of school-based interventions (42,48). Different levels of impact on net use were reported from previous studies conducted in India (22.2%) and Mali (41%) (42) (43). However; the contradictory finding was reported from other studies conducted in Ghana with no changes in malaria preventive practices such as using ITN in the intervention schools (20).

The possible difference might be attributed because of integrated peer education networks and community-led SBCC approaches in the current program. Parents were actively participating in the program through what is locally called “geengoo qulqullina barnootaa” which means; the circle for quality of education. He circles for the quality of education are made of members representing the community, teachers, students, and accountable to school directors have the ultimate task of improving the quality of education. More importantly; the community-based
evaluation study conducted enrolling parents indicated improved acceptance of the intervention that employed students as messengers of malaria information (29).

The multivariable logistic regression modeling identified knowledge, self-efficacy, family supports, peer educators as sources of information, and the ratio of ITNs in the household as independent predictors of ITN utilization among school students. Access to more than one ITN per two persons in the household independently predicted the use of ITN in this study. A similar finding was reported from a previous school-based study in that ownership was found as the main predictor of ITN use (37). This is in fact; access alone can’t guarantee the ITN of use among school children. Several underlying factors such as access to resources, money, or family support could affect its use. For instance; a study indicated that the net use behaviors were significantly less among school-aged children than the rest of the population (48). These factors are mainly classified as behavior-driven and access-driven non-use (49). With behavior-driven factors; the current study identified knowledge, family supports, and self-efficacy as factors influencing the use of ITNs among school children which is consistent with that of previous studies (22). (37).

In the previous study; the total knowledge index was significantly associated with both ITN ownership and its use. However; the study reported varying levels of influence for different domains of knowledge (37). In short; the finding implies; intervention targeting comprehensive knowledge would produce effective behavior change outcomes regarding malaria prevention in schools. On the other hand, self-efficacy; the individual perception of confidence to undertake specific health behavior (ITN use in this case); was associated with ITN use in this study. Notably; self-efficacy has a strong theoretical basis in social cognitive theory (46) and has been identified as the strongest predictor of health behaviors (45).

Though evidence is scarce in this regard; the implication of the current study could be explained by the notion of cognitive-behavioral theories. Given that adequate knowledge; a higher tendency of perceived coping responses to certain health risks (i.e. malaria infection in this case) can lead to behavior change (32). However; in this study, perceived ability should be interpreted with precaution as access to enabling factors such as ITNs might hamper the translation of individuals’ confidence and readiness into action.
Perceptions about family support independently predicted the use of ITN among school children in this study. Effective behavior change interventions require enhancement of social support and this is the ultimate goal of SBCC strategy which influences community norms, social factors, and reinforcements to bring about sustained behavior change (46). Families are considered the immediate persons to influence their children and their support could reinforce behaviors. A significant family influence observed in this study might be due to the improved parent-student communication in response to malaria messages and education offered to parents by students. Further; the indirect influence might be attributed to malaria education by HEWs during home visits (29). The finding implies emphasizing knowledge, self-efficacy while addressing social support would be fruitful to improve ITN use in primary schools.

The analysis has evaluated the effects of various sources of malaria information such as peer educators, teachers, mass media, and community (interpersonal) on ITN use among students. Among these various sources reported in this study; peer educators were found positively associated with the use of ITN in this study. This might be because of greater attention and opportunity for open discussions that result from perceived age similarity among the students and the length of time they spent together (50). The school-level small social network among students could help the promotion of normative changes through behavioral modeling and facilitated sharing of success stories, experiences, and simple facts during educational sessions which were accomplished in the current intervention. Evidence suggested the importance of this approach to promoting social and groups’ norms rather than just the health benefits of interventions and emphasizes the risks of being left behind for those who are late to adopt the behaviors (33).

The relationship between ITN use and important factors such as attitude and perceptions of disease threat was not significant in this study and this contradicts the principles of many behavioral change theories (45). Specific to attitude; the possible reasons behind this fact can be explained in many ways. First; the observed effects of self-efficacy and family support on ITN use in this study might have underestimated or masked the roles of attitudes. Evidence showed that attitude-behavior consistency is influenced by a condition called situational constraints related to the presence of external factors. Situational constraints are circumstances that affect
(through moderation) the relationship between attitude and behaviors (51). Accordingly; strong associations between behaviors and external factors such as self-efficacy and social influences create strong situations and this in turn weakens the relationship between attitude and behaviors (33). In short, attitudes tend to predict behavior better in weak situations than in strong ones.

Second, students might hold a non-responsive attitude or affection that is acquired or learned from the existing values or social norms (53). For instance; ITN may be most commonly liked in the area simply for some reason other than its actual benefits. Such a situation may also happen if attitude questions in the survey were understood more as affection rather than objectively defined benefits and this was explained in observational learning theory (the modeling effects) (49). It was also indicated that attitudes predict behavior to the extent that attitude and behavior are measured at the same level of specificity (33). However; this complex relationship must be further explored.

**Limitation of the study**

For this study; we did not collect any information on a parasitological survey which might have added value to our finding. Arguably; the choice of outcome measures for health intervention is critical in that health outcomes should be considered the index of success of interventions designed to change health behaviors (52). However; it's believed that changes in behavioral measures such as sustained use of ITN are supposed to be a proxy indicator of health outcomes (i.e. reduced malaria infections). Thus; objective analysis of behavioral outcomes could be informative when evaluating behavior change interventions.

Furthermore; limitation inherently to the unmatched design employed in the current study might have introduced bias that affects the result. However; an advanced statistical technique: the PSM analysis was applied as matching analysis to remove the possible confounding bias arising from the lack of matching so that the average effects of the intervention were easily estimated (39).

On top of this; different sources of biases were also considered and dealt with in our study. For instance; the possibility of information contamination among the control groups due to human mobility and interaction is often difficult to control in communication interventions. Furthermore, performance bias and social desirability bias (SDB) due to the self-reported behaviors might have also affected the data. Presumably; the SDB may be high among the
intervention group since the population under study was already aware of the aim of the intervention and could respond to the interview in a socially desirable manner; thus hiding underlying reality. The measure of SDB score was controlled during the subsequent analysis to effectively estimate the averaged effects of the intervention. The data collectors were kept blind about the intervention and the target settings to control for possible performance bias.

**Conclusion:** This study suggested the school-based SBCC combined with peer education approaches advanced the malaria-related knowledge, attitude, self-efficacy, risk perceptions, and family supports; which have ultimately improved the sustained use of ITNs among school-going children. Schools' involvement through the integrated peer education and SBCC approaches would result in effective behavior changes in schools regarding malaria preventions and beyond; which in turn helps to accelerate malaria elimination efforts. Furthermore; research should be conducted to broadly understand the mechanism by which the SBCC approach affects students’ behaviors given the influences of social, health services, and school systems.

**Ethical approval and consent to participate**

The research was approved by the Institute of Research Board (IRB) of Jimma University before data collection. Permission was obtained from the Jimma Zone health department for permissions. Though; parents should be consented to involve children less than 18 years in the research process; consenting parents appears inconvenient as the study was conducted in schools. And, school teachers can better play a parental role in taking care of their students once they are in school. Importantly; students were familiar with the current study as they were actively engaged in the implementation process of the project in which they acted as massagers of malaria information to parents and local communities. Considering all of these challenges and inconveniences; the IRB has ethically approved the study. Therefore; written consent was taken from school principals on behalf of parents in this study. Similarly; oral assent was sought from children after explaining the purpose of the study in the language they can understand. Confidentiality and anonymity were assured for study participants during data collection.

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Author contributions
FA conceived the idea, designed the study, collected data, analyzed the data, and drafted the manuscript. MS; designed the study, supervised data collection, critically reviewed manuscript, LA designed the study, supervised data collection, YK designed the study, supervised data collection, critically reviewed manuscript, GA designed the study, supervised data collection, and critically reviewed the manuscript. All authors read and approved the final manuscript.

References
1. World Health Organization. Malaria vector control: Report of a WHO Study Group. Switzerland, Geneva; 2006. (WHO Technical Report Series, 936).
2. World Health Organization (WHO). World malaria report 2017. Switzerland, Geneva; 2017.
3. World Health Organization (WHO). World malaria report 2018. Switzerland, Geneva; 2018.
4. Autino B, Noris A, Russo R, Castelli F. Epidemiology of Malaria in Endemic Areas. Mediterr J Hematol Infect Dis. 2012;4.
5. Ethiopia; President US, Initiative M. President’s Malaria Initiative Ethiopia: Malaria operational plan FY 2019. Addis Ababa, Ethiopia; 2019.
6. Berhe B, Mardu F, Legese H, Negash H. Seasonal distribution and seven year trend of malaria in North West Tigrai: 2012 – 2018, Ethiopia; 2019. Trop Dis Travel Med Vaccines. 2019;5(15):1–7.
7. MOH E. presidents malra initiatives: Malaria operational plan FY 2008, Ethiopia.
8. Nankabirwa J, Brooker SJ, Clarke SE, Fernando D, Gitonga CW. Malaria in school-age children in Africa: an increasingly important challenge. 2014;19(11):1294–309.
9. Kuecken M. Does malaria control impact education? A study of the Global Fund in Africa. 2014;
10. Pullan RL, Bukirwa H, Staedke SG, Snow RW, Brooker S. Plasmodium infection and its risk factors in eastern Uganda. Malar J. 2010;1–11.
11. Yeka A, Nankabirwa J, Mpimbaza A, Kigozi R. Factors Associated with Malaria Parasitemia, Anemia and Serological Responses in a Spectrum of Epidemiological Settings in. 2015;1–19.
12. Walldorf JA, Cohee LM, Coalson JE, Bauleni A, Nkanaunena K, Kapito-tembo A, et al. School-Age Children Are a Reservoir of Malaria Infection in Malawi. 2015;1–13.
13. Thuilliez J. Social Science & Medicine Fever, malaria and primary repetition rates amongst school children in Mali: Combining demographic and health surveys (DHS) with spatial malarialogical measures. Soc Sci Med [Internet]. 2010;71(2):314–23. Available from: http://dx.doi.org/10.1016/j.socscimed.2010.03.034
14. World Health Organization (WHO). Guidelines for malaria vector control. Geneva Switzerland; 2019. (Licence: CC BY-NC-SA 3.0 IGO).
15. World Health Organization (WHO). Global technical strategy for malaria 2016–2030. Switzerland, Geneva; 2016.
16. RBM Partnership. RBM Partnership To end Malaria: The Strategic Framework for Malaria Social and Behaviour Change Communication 2018-2030. 2018.
17. President US, Initiative M. PRESIDENT ’ S MALARIA INITIATIVE ETHIOPIA. 2019;
18. Federal Democratic Republic of Ethiopia; Ministry of Health. Health Sector Development Program IV 2010/11 – 2014/15. 2010.
19. Ethiopia M. Federal Minstry of Health: National startegic plan for malaria prevention 2011-2015. Addis Ababa, Ethiopia; 2010.
20. Ayi I, Nonaka D, Adjoou JK, Hanafusa S, Jimba M, Bosompem KM, et al. School-based participatory health education for malaria control in Ghana : engaging children as health messengers. Malar J. 2010;9(98):1–11.
21. Ashton RA, Kefyalew T, Tesfaye G, Pullan RL, Yadeta D, Reithinger R, et al. School-based surveys of malaria in Oromia Regional State , Ethiopia : a rapid survey method for malaria in low transmission settings. Malar J [Internet]. 2011;10(1):25. Available from: http://www.malariajournal.com/content/10/1/25
22. Umwangange ML, Chironda G, Mukeshimana M. Knowledge , Attitude and Practice towards Malaria Prevention among School Children aged 5 -14 years in Sub-Saharan Africa - A review of Literature. 2018;1(1):22–30.
23. Brooker S, Kolaczinski JH, Gitonga CW, Noor AM, Snow RW. The use of schools for malaria surveillance and programme evaluation in Africa. Malar J. 2009;8(231):1–9.
24. Ndyomugyenyi R KA. Using schoolchildren’s reports of bed net use monitored by schoolteachers as a proxy of com- munity coverage in malaria endemic areas of Uganda. Trop Med Int Heal. 2007;12:230–7.
25. Kilian A BW. Surveillance of mosquito net coverage using primary school based data collection in the districts of Kaborole, Kamwenge and Kyenjojo, 2000-2004. Gesellschaft fur Technishe Zusammenarbeit (GTZ) and District Health Services report; 20. Uganda; 2005.
26. Nonaka D, Kobayashi J, Jimba M, Vilaysouk B. Malaria education from school to community in Oudomxay province , Lao PDR. 2008;57:76–82.
27. Mugisa M, Muzoora A. Behavioral change communication strategy vital in malaria prevention interventions in rural communities : Nakasongola district , Uganda. 2012;13(Supp 1):1–5.
28. Bowen HL. Impact of a mass media campaign on bed net use in Cameroon. Malar J. 2013;12(36):1–18.
29. Kebede Y, Abebe L, Alemayehu G, Sudhakar M. School-based social and behavior change communication (SBCC ) advances community exposure to malaria messages , acceptance , and preventive practices in Ethiopia : A pre- posttest study. 2020;1–21. Available from: http://dx.doi.org/10.1371/journal.pone.0235189
30. Report F. C-Change Final Report [Internet]. Washington DC; 2013. Available from: www.c-changeproject.org/sites/default/files/C-Change-Final-Report.March2013.pdf
31. C-Change U. Social and behavior change communication (SBCC). 2012.
32. Maddux, J.E., & Rogers RW. Protection motivation theory and self-efficacy: A revised theory of fear appeals and attitude change. J Exp Soc Psychol. 1983;19:469–47.
33. Rogers EM, Everett M. Diffusion of innovation; Third Edition. third. New York: The free press: A division of macmillan publishing Co. Inc.; 1962.
34. White H, Sabarwal S. Quasi-Experimental Design and Methods: Methodological Briefs. Impact Eval 8, UNICEF Off Res Florence [Internet]. 2014;(8). Available from: http://www.unicef-irc.org/KM/IE/
35. Central Statistical Agency; Ethiopia: DHS Program ICF; Rockville, Marryland U. Ethiopia Demographic and Health Survey. Addis Ababa, Ethiopia; 2016.
36. EPHI, MOH E. Ethiopia national malaria indicator survey 2015. Addis Ababa; 2016.
37. Ovadje L, Nriagu J. Multi - dimensional knowledge of malaria among Nigerian caregivers : implications for insecticide - treated net use by children. Malar J. 2016;1–11.
38. Miller PH, Baxter SD, Royer JA, Hitchcock DB, Smith AF, Collins KL, et al. Children ’ s social desirability : Effects of test assessment mode. Pers Individ Dif [Internet]. 2015;83:85–90. Available from: http://dx.doi.org/10.1016/j.paid.2015.03.039
39. Caliendo M, Caliendo M, Kopeinig S. Some Practical Guidance for the Implementation of Propensity Score Matching. 2005;(1588).
40. Boulay M, Lynch M, Koenker H. Comparing two approaches for estimating the causal effect of behaviour-change communication messages promoting insecticide-treated bed nets : an analysis of the 2010 Zambia malaria indicator survey. Malar J. 2014;13(342):1–8.
41. Cochran WG, Rubin DB, Sankhyā S, Indian T, Series A, Cochean BWG. Controlling Bias in Observational Studies : A review controlling bias in observational studies. indian J Stat Ser A. 2020;35(4):417–46.
42. Swain S, Pati S. Health Promoting School ’ Model in Prevention of Vector-Borne Diseases in Odisha : A Pilot Intervention. J Trop Pediatr. 2019;0:1–11.
43. Save the Children, National Malaria Control Program (NMCP), National Institute for Public Health Research (INRSP), London school of Hygiene & Tropical Medicine (LSHTM) NC for S (CNRS). Malaria control in schools in Mali : Results from a Cluster Randomized Control Trial in Sikasso Region, Mali. 2012;
44. Sureshbabu J, Vasudevan S, Raj P. Original Research Article A study of the effectiveness of school health education programs on selected mosquito borne diseases : school based cross-sectional study. Int J Res Med Sci. 2017;5(6):2728–33.
45. Rosenstock I. Historical origins of the Health Belief Model. Health Education Monograph, 24, 328–335. 1974.
46. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Psychol Rev. 1977;191–21(84):191–215.
47. Langford R, Bonell C, Jones H, Poulou T, Murphy S, Waters E, et al. The World Health Organization’s Health Promoting Schools framework : a Cochrane systematic review and meta-analysis. 2015;1–15.
48. Buchwald AG, Waldorf JA, Cohee LM, Coalson JE, Chimbiya N, Bauleni A, et al. Bed net use among school - aged children after a universal bed net campaign in Malawi. Malar J. 2016;1–8.
49. Birhanu Z, Abebe L, Sudhakar M, Dissanayake G, Yihdego Y. Access to and use gaps of insecticide- treated nets among communities in Jimma Zone , southwestern Ethiopia : baseline results from malaria education interventions. BMC Public Health [Internet]. 2015;1–11. Available from: http://dx.doi.org/10.1186/s12889-015-2677-2
50. Merakou K, Kourea-kremastinou J. Peer education in HIV prevention : an evaluation in schools. Eur J Public Heal Vol. 2006;16(2):128–32.
51. Wallace DS, Paulson M, Lord CG, Jr CFB. Which Behaviors Do Attitudes Predict? Meta-Analyzing the Effects of Social Pressure and Perceived Difficulty. 2005;9(3):214–27.

52. Michie S, Abraham C. Interventions to change health behaviours: evidence-based or evidence-inspired? Psychol Health [Internet]. 2004;19(1):29–49. Available from: http://dx.doi.org/10.1080/0887044031000141199