

A survey on ownership and use of long-lasting insecticidal nets in Ethiopia (2020)

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Abstract

Background: About 56.6 million people of the total Ethiopian population lives are at risk of malaria disease. The use of long-lasting insecticidal nets (LLINs) has been identified by WHO as one of the main interventions to reduce the burden of malaria. Over a decade, universal distribution of LLINs has been achieved in the country. Implementing the distribution of LLINs in the country is considered as one of the core interventions that brought the about dramatic decline of malaria persistently since 2007-2009. Though the previous national surveys claimed about two-thirds of the households owned LLINs, recent evidence is required to design new malaria elimination strategic plan for 2021-2024.

Objective: To measure key indicators on LLIN ownership and utilization across the different regions of Ethiopia.

Methods: A cross-sectional study design was conducted between February-April, 2020 and June-July, 2020. This survey implemented the quantitative data collection approaches for LLINs coverage and utilization using a standardized questionnaire. The study included malaria endemic areas across the country (Enumeration Areas (EAs) with altitude $\leq 2,000$ m above sea level) with net distribution coverage. The total sample size $n = 7650$ House Holds, and $EAs = 306$ were determined by using the appropriate formula for sample size calculation.

Result: The 2020 survey, a total of 6,773 sampled households participated with a response rate of 98.9%. The extrapolated national weighed result of this survey indicated that 66.8% of the households owned at least one long lasting insecticide treated net. This survey revealed that households in the Gambella region have the highest percentage of net ownership (85.8%) followed by Afar (82.6%) and Oromia (71.4%). The source of the nets was mainly from a government sector (>88%). Concerning sleeping under LLINs, 44.2% of the total population slept under an LLIN the previous night.

Conclusion: Regarding the proportion of households owning at least one LLIN, small progress was achieved through the years 2015-2020. Almost 33% of households still did not have LLIN in the malarious areas. The malaria program must also enhance packages and strategies that can support community awareness about proper net utilization to narrow the existing gaps.

Keywords: Malaria, Long Lasting Insecticidal-Treated Nets, Ethiopia

Introduction

In Ethiopia, malaria remains one of the endemic vector-borne diseases particularly in areas with an elevation of less than 2000m above sea level. Thus, approximately the area encompassing three-quarters of the country's landmass and above half (56.6 million) of the total Ethiopian population (~110 million) resides in this malaria risk area (Adhanom et al. 2006; Ministry of health. Ethiopia 2008). The intensity of transmission varies due to the diverse topographic features and corresponding climatic factors that determine the dynamics of malaria infection (Tulu 1993; Hiwot et al. 2018). Cognizant of the toll malaria has been causing, the government of Ethiopia has deployed key antimalarial interventions using the approach scale-up for impact (SUFII) since the mid- 2000s. Subsequently,

the Ethiopian National Malaria Control Program has registered a remarkable reduction in malaria cases and deaths as witnessed in some of the evidences (Otten 2009; Steketee and Campbell 2009; Hiwot et al. 2018). To sustain the gains that were made, the scale of interventions and endeavors to eliminate the disease from some areas of the country, the Ethiopian government in collaboration with its partners has developed a National Strategic Plan (NSP), which spans from 2017-2020 for prevention, control and elimination of the disease. The strategic plan incorporates focus areas in the fight against the disease and highlights maintenance of proven antimalarial measures. Currently, the country has developed a NSP for 2021-2025 focusing on malaria elimination. Accordingly,

vector control measures include indoor residual spraying (IRS) and long lasting insecticide- treated nets (LLINs) (FMOH 2014; EPHI 2016). IRS is mainly applied in areas of high malaria transmission and epidemic-prone areas; whereas LLINs are distributed to households residing in malaria endemic areas. The World Health Organization (WHO) has recommended nets as one of the main vector control options both for individual and community protection upon achieving a certain level of coverage (about 80%) that can impact the disease burden (WHO 2011). In the Ethiopian context, a previous national survey like Malaria Indicator Survey (MIS) 2015 showed that 64% of households owned LLINs and 45% of the children below 5 years reportedly slept under such nets (EPHI 2016). A national survey conducted in 2017 following a national net distribution campaign found that 64.8% of the households owned at least one LLIN and 51% of the children below 5 years reportedly slept under LLINs the previous night during the survey (Nigatu et al. 2019). In addition, to enhance the effective utilization of LLINs and increased malaria treatment seeking behavior there were also social and behavioral change communication (SBCC) activities that were implemented using electronic media and training of media professionals, school teachers, who are expected to play a major role in educating the public and students (WHO 2010; MOH 2010a; Nigatu et al. 2019). Over a decade, universal distribution of LLINs has been achieved in the country (WHO 2010; MOH2010b; MOH 2011; Batisso et al. 2012). This survey is, therefore, designed to investigate the status of net ownership and utilization rate of LLINs by households of malarious areas of the country. It also assessed factors that limit the use of LLINs.

Materials and Methods

Study design: This survey was conducted between February-April 2020 and June-July, 2020 in malaria endemic areas sampled from nine regional states and a city Administration. A cross-sectional survey was undertaken in systematically sampled households. The study implemented quantitative data collection approaches using a standardized questionnaire. The target population for households and individuals was limited to those at risk of malaria mainly women of reproductive age (15-49 years old) and children less than five years of age living within malaria endemic areas.

Study area: The sample was designed to provide estimates in 9 regions and one city administration for the most malaria endemic area indicators. It included malaria endemic areas (enumeration areas (EAs) with altitude $\leq 2,000$ m above sea level) with net distribution coverage. The number of household allocation in descending order was as follows in the different regions; Oromiya (13.7%), Amhara (12.7%), SNNPR (11.8%), Somali (10.7%), Tigray (10.4%), Afar (9.2%),

Benishangul-Gumuz (8.8%), Dire Dawa (7.8%), Gambela (7.5%) and Harari (7.2%).

Sampling size determination: The sample for the LLIN ownership and utilization survey was designed to provide estimates of population and malarious indicators for the country as a whole, for the urban and rural areas separately, and for each of the nine regions and a city administration in Ethiopia. The sampling frame used the 2019 population and housing census provided by the Central Statistical Agency (CSA) in constructing the sampling frame and median altitude was obtained from the CSA-GIS department to identify the altitudes of unmatched EAs. An EA is a geographic area that covers an average of 130 households. Regarding the main indicator proportion of households with at least one LLIN an expected Relative Standard Error (RSE) of 3.2% and a 95% Confidence Interval (CI) were used to represent the expected precision on the national level, regional level and also urban and rural areas level of indicators. To select a representative sample from this population, first, the initial sample size was determined by using the following scientific formula:

$$n = \text{deft}^2 \frac{(1/p - 1)}{\alpha^2}$$

Where the *deft* = design effect which is the ratio between the standard error using the given sample design and the standard error that would result if a simple random sample had been used. The total sample size was $n = 7650$, and $EAs = 306$. The sample survey was stratified and selected in two stages. In the first stage, 306 EAs were selected with probability proportional to the EA size and with independent selection in each sampling stratum. In the second stage of selection, a fixed number of 25 households per cluster were selected with an equal probability by systematic selection from the newly created household listing. Each region was stratified into urban and rural areas yielding 25 sampling strata. Sampling weight was calculated based on sampling probabilities separately for each sampling stage and for each cluster. We used the following notations:

$P1_{hi}$: first-stage sampling probability of the i^{th} cluster in stratum h

$P2_{hi}$: second-stage sampling probability within the i^{th} cluster (HH)

Let a_h be the number of EAs selected in stratum h , M_{hi} the number of households according to the sampling frame in the i^{th} EA, and $\sum M_{hi}$ the total number of households in the stratum. The probability of selecting the i^{th} EA in the 2019 LLINs ownership and utilization sample survey sample was calculated as follows:

$$\frac{a_h M_{hi}}{\sum M_{hi}}$$

Let b_{hi} be the proportion of households in the selected cluster compared to the total number of households in

EA i in stratum h if the EA is segmented, otherwise $b_{hi} = 1$. Then the probability of selecting cluster i in the sample is:

$$P_{1hi} = \frac{a_h M_{hi}}{\sum M_{hi}} \times b_{hi}$$

Let L_{hi} be the number of households listed in the household listing operation in cluster i in stratum h , let g_{hi} be the number of households selected in the cluster. The second stage's selection probability for each household in the cluster was calculated as follows:

$$P_{2hi} = \frac{g_{hi}}{L_{hi}}$$

The overall selection probability of each household in cluster i of stratum h is therefore the production of the two stages selection probabilities:

$$P_{hi} = P_{1hi} \times P_{2hi}$$

The sampling weight for each household in cluster i of stratum h is the inverse of its overall selection probability:

$$W_{hi} = 1/P_{hi}$$

The final sampling weight was normalized to give the total number of un-weighted cases equal to the total number of weighted cases at the national level, for both household weight and individual weight, respectively. The normalized weights are relative weights that are valid for estimating means, proportions and ratios, but not valid for estimating population totals and for pooled data. After determination of the EA selection process the map of each EA was obtained from CSA-GIS expert.

Data collection and analysis: The data collection tool was adapted from the PMI Monitoring LLIN Durability Study standardized questionnaire (PMI, 2015). The questionnaire collected basic demographic and socioeconomic characteristics for each person who spent the night preceding the survey in the sampled household. After getting their consent, interview questions were asked using the local language in each region. During their visit, the data collectors also observed the condition of the nets. The standardized household questionnaire was completed using touch-screen phones and the ODK electronic data collection tool. After collection, data were sent to a secure, maintained central EPHI server. Statistical analyses were then conducted using Stata and other statistical software to generate descriptive statistics of categorical and continuous variables.

Ethical clearance

This study obtained ethical approval from the Institutional Review Board (IRB) of the Ethiopian

Public Health Institute. The purpose and objectives of the study were explained to health authorities and local leaders at all levels before initiating data collection. Study participants also gave informed consent and confidentiality of data was ensured by the principal investigator. Data analysis was performed using coded data. An official letter from EPHI was written for both the health facilities and the regional health bureau.

Results

Household response rates: In this survey, a household was defined as a person or group of persons, related or not, living together in the same dwelling unit, under one household head and sharing a common cooking arrangement. A total of 7,560 households were selected for the sample, of which 6,847 were occupied. Of the occupied households, 6,773 were successfully interviewed, yielding a response rate of 98.92%. The response rate among households in rural areas (99.48%) was slightly higher than in urban areas (97.91%).

Characteristics of the respondents: More than 67% of respondents' ages were under 30 years, reflecting the young age structure of the Ethiopian population. The composition of households' gender shows 51% and 49% were male and female, respectively. Most of the respondents (78%) were living in rural areas. By region, the highest number of respondents resided in Oromiya (36%), followed by SNNPRs (23%), and Amhara (18%).

Ownership of Long Lasting Insecticide Treated Bed Nets (LLINs): Table 1 shows that 67% of households own at least one LLIN, and on average the households own 1.8 LLINs. Net ownership increased from the 2015 MIS when only 64% of households owned at least one LLIN, and the average number of nets owned was 1.3. It was found that 62% of the households received nets within the last three years. Ownership of at least one LLIN was found higher in rural areas (70.0%) than urban areas (55.4%). By region, Gambella (86%) and Afar regions (83%) had the highest number of ownership of at least one LLIN. Meanwhile, the Tigray region had the lowest number of households (58%) that received nets during the last three years. In Ethiopia, LLINs are distributed based on the average number of sleeping spaces per household. As per the 2015 National Malaria Guidelines, LLIN distribution was aimed to cover all sleeping spaces in households in malaria-endemic areas so that universal coverage- one LLIN for every two persons in a household could be ensured. During the current survey as shown in Figure 1, the proportion of households that possessed 1, 2, 3 and 4 sleeping places were 46.4%, 36%, 13.2% and 3.25% respectively.

The proportion of households that owned two and above nets (55%) could have better protection from malaria transmission than households that owned one net (45%). This may be affected by household size in which protection increases as household size decreases since

the number of persons with access to an LLIN decreases as household size increases. This is important information for the malaria program since by increasing the number of mosquito nets in the households more people can be protected from the diseases.

Concerning the sleeping space of a household, the majority of the surveyed households (43.4%) had only one sleeping space followed by the households that had two sleeping spaces (34%). In relation to the number of rooms in a household, 37.3% of households had only one room, 37% of households had two rooms and 18% households had three rooms. The majority of households (66%) had used one room for sleeping followed by the households that used two rooms (29%).

Use of mosquito nets: Table 2 shows the use of LLINs by persons in the household. Overall, 44% of the households identified persons who slept under a mosquito net the night before the survey and similarly, 48% of the households' members slept under an LLIN the night before the survey. In urban settings, 47.4% members of the households slept under a net the previous night, whereas 43.4% were in rural households. Gambella (87.9%) and Somali (83.6%) followed by Afar (75.5%) were seen to be the highest net utilizing regions during the night before the survey. Whereas, a low proportion of household net utilization (15.3%) was reported from Dire Dawa.

Table 1: Household LLINs ownership and utilization in Ethiopia, 2020

Background characteristics	Does the household own any mosquito nets for sleeping under?		Did your household receive nets during the last 3 years?		Average number of LLIN per household
	Proportion (%)	Unweighted cases	Proportion (%)	Unweighted cases	
Residence					
Urban	55.42	1,390	52.90	1,364	1.70
Rural	69.99	3,097	64.99	3,006	1.78
Region					
Tigray	62.96	477	58.04	425	1.65
Afar	82.62	562	79.46	537	1.58
Amhara	64.75	429	62.61	416	1.68
Oromiya	71.42	592	60.94	527	1.83
Somali	65.30	506	61.96	477	1.43
Beni Gumuz	67.14	426	75.01	510	1.86
SNNPR	59.85	442	61.85	454	1.87
Gambella	85.83	433	76.00	398	1.63
Hareri	60.39	302	61.82	301	1.31
Dire Dawa	63.40	318	63.27	325	1.77
Total	66.67	4,487	62.24	4,370	1.76

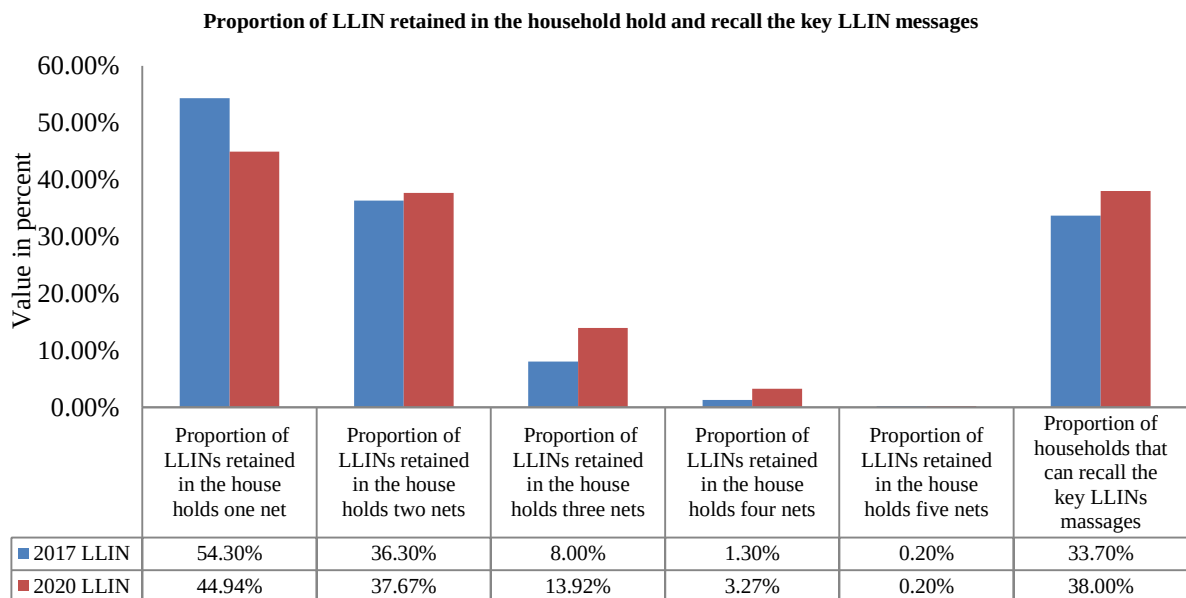


Figure 1: Summary of the comparison of net retention and recall rate over a period of time

Pregnant women and children under five years of age are considered the most vulnerable groups to severe complications of malaria infection. The percentage of the household population that slept under an LLIN varies by residence for under five years old children living in urban (61%) and rural (50%) malarious areas. On the other hand, the proportions of pregnant women

that slept under LLINs among urban (63%) and rural (62%) were slightly similar. Among children under age 5 in households with at least one LLIN, 52% of the children and 62% of pregnant women slept under a mosquito net. Comparison of net ownership and usage along with a period of time are summarized below in figure 2.

Table 2: Use of mosquito nets by persons in the household

Background characteristics	Did you sleep under a net last night?		Did anyone sleep under this mosquito net last night?	
	Weighted Proportion (%)	Unweighted Cases	Weighted Proportion (%)	Unweighted Cases
Residence				
Urban	47.38	2,360	51.51	1,296
Rural	43.40	5,371	46.94%	2,889
Region				
Tigray	35.79	691	42.52	333
Afar	75.46	651	75.76	503
Amhara	41.39	720	46.54	342
Oromiya	40.33	942	38.24	425
Somali	83.58	824	91.24	557
Beni Gumuz	68.73	1,134	78.78	573
SNNPR	45.16	973	52.26	457
Gambella	87.89	1,224	95.94	651
Hareri	50.26	382	68.68	225
Dire Dawa	15.33	190	21.64	119
Total	44.16	7,731	47.83	4,185

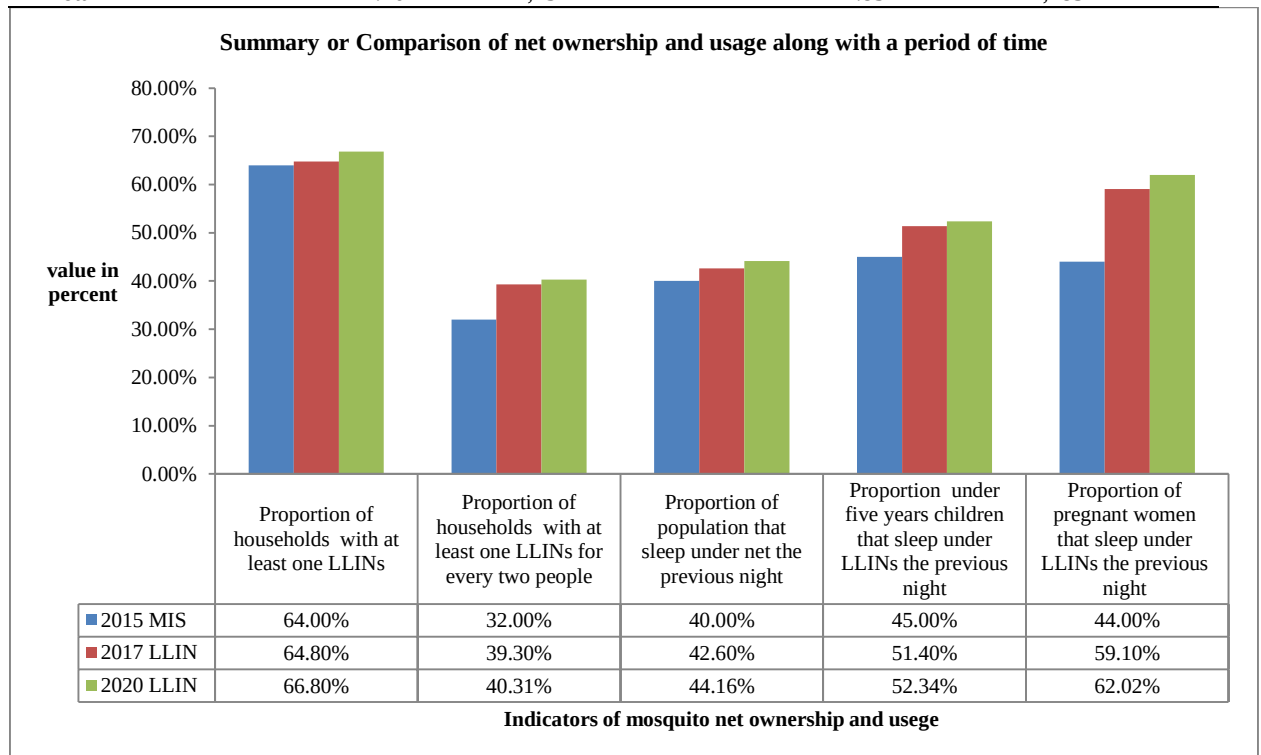


Figure 2: Summary of the comparison of net ownership and usage over a period of time

Recall status of key messages related to LLINs usage: Table 3 shows proportion of households that recall the key LLINs usage messages during the survey time. The table indicated that the percentage of the household population that recalls key LLINs

messages were similar by residence. Overall, 38% of the household heads received/heard information about the use of LLINs by using at least one of the content messages. The proportion of the population in all regions almost addressed the key message was under

50%. The recall percentages were found relatively higher in Regions of Gambella (53%), Harari (50%) and SNNPRs (45%). Contrary to this the recall

percentage, in Amhara (23%) and Somalia (28%) were relatively small.

Table 3: Proportion of households that can recall the key LLINs messages

Background characteristics	Proportion of households that can recall the key LLINs messages	
	Weighted (%)	Unweighted Cases
Residence		
Urban	38.58	2,386
Rural	37.90	5,643
Region		
Tigray	34.53	980
Afar	36.72	1,054
Amhara	22.83	239
Oromiya	40.40	1,208
Somali	27.58	487
Benish Gumuz	37.44	943
SNNPR	45.08	1,085
Gambela	53.51	747
Hareri	49.60	891
Dire Dawa	43.95	395
Nationally	38.01	8,029

Overall, 38% and 36.7% of households have received messages about mosquito nets and entailed the source of information, respectively. The most important source of information about net use entailed by the household heads was Health Extension Workers (92.28%), Health Development Army (20.55%), Health workers (15%), Community leaders (10.46%) and via radio message (7.86%). The most content of the messages received by the household respondents (83.76%) and (51.20%) was using your nets and nets care, respectively. The results for the other messages, hang up your net, sleep under your net every night, nets to prevent malaria, repair and how to wash their net were under 50%, not given to the household participants as expected to be.

From all adverse conditions listed, 65.6% of respondents perceived at least one adverse condition while using their mosquito nets. From these, 64.6% responded the LLIN caused itching and 57.6% responded that it caused facial burning. Sneezing, eye irritation and experiencing bad-smelling were also reported by few household heads. About 64% and 54.7% of net usage priority were given to young children and pregnant women respectively.

Colour, shape and source of mosquito nets:

Knowing the colour and shape preferences of nets and LLIN washing practices of the community helps the program to improve the strategies on LLIN procurement and strengthen information, education, and behavior change communication activities. During this survey, households were asked about their preference regarding the shapes and colours of LLINs.

Nearly 99% of households interviewed prefer a rectangular shape of mosquito LLINs and the colour blue (72.2%). More than 82.9% of households living in malarious areas collected mosquito nets from the health post, 5.8 % received from the health center, and 5.2% were received nets delivered to their house.

The result shows that the majority proportions of the population collected LLINs from the nearest health posts. This helps the National Malaria Elimination Program (NMEP) to determine whether they need to improve the recall rate of key messages on LLIN use through the health extension workers. Overall, 94% of mosquito nets are sourced from Government health facilities, the rest small percent came from Non-Governmental health facilities and other sources.

Net brand types and reasons for not using nets:

During this survey, a total of 5,966,432 nets were distributed. The distribution by the brand was in the following descending order, 38.6% Magnet, 32.6% Permanent, 8.5% Dawanet, 3% Olyset, 0.3% Yorkol and 0.02% Interceptor. The 2017 country distribution was 5,913,981 LLINs. According to their brands, 69% of the distributed LLINs were Permanent followed by 17.9% Magnet and 4.6% Olyset.

Households were asked why did no-one sleep under mosquito nets during the night before this survey. About 29% of the households responded no malaria, 22% replied no insects, 10% said no space for net hanging, 6% responded as inconvenient net shape for hanging, 4% suffocation or too hot, 3% absence from home and 2% infestation of bed bugs.

Other different characteristics of nets: Among households living in malarious areas, 55% received information on the use, care and repair of mosquito nets from any of the following sources. The majority (86%) received the information during the distribution time. 50.22% of the households were not given a net during the net distribution campaign. Regarding sleeping space material types with net use, 22.34%, 20.46%, 18.4% of spaces were made from bed frame (finished), bed frames (stick) and foam cushion respectively. Concerning the location of the net in the

households, 32.64% of them were observed to be hanging loose oversleeping place while 9.24% of the net distributed was still stored away in a package. Of the total household participants, 61% washed their nets. As to why their net was not washed, 31.4% answered that nets never get dirty and 21.9% of net owners believed that unwashed nets work better than washed nets. For the presence of holes on the nets, 87.95% of the respondents assured that their nets had no holes compared to that of having a hole (10.9%).

Table 4: Comparison of key indicators: the national household LLINs coverage and use surveyed at different periods

Study variables	Survey periods		
	2015 MIS (%)	2017 LLIN (%)	2020 LLIN (%)
Proportion of households with at least one LLINs	64.0	64.8	66.8
Proportion of households at least one LLINs for every two people	32.0	39.3	40.3
Proportion of population that sleep under net the previous night	40.0	42.6	44.2
Proportion under five years children that sleep under LLINs	45.0	51.4	52.3
Proportion of pregnant women that sleep under LLINs previous night	44.0	59.1	62.0
Proportion of LLINs retained in the house holds one net		54.3	44.9
Proportion of LLINs retained in the house holds two nets		36.3	37.8
Proportion of LLINs retained in the house holds three nets		8.0	13.9
Proportion of LLINs retained in the house holds four nets		1.3	3.3
Proportion of LLINs retained in the house holds five nets		0.2	0.2
Proportion of LLINs retained in the house holds Total		100.0	100.0
Proportion of households that can recall the key LLINs messages		33.7	38.0
Proportion of under five years children who sought malaria treatment at any time in the last two weeks from any source	38.0		64.2
Proportion of population /anyone sleep under this mosquito net last night			47.8

Discussion

The key findings of this survey can be best discussed by comparing them with the results of previous similar surveys. Table 4 summarizes the comparison of key indicators on LLINs coverage and use. Universal coverage of mosquito nets defined as 1 LLIN per 1.8 person is necessary to achieve significant reductions in malaria transmission. Moreover, the most vulnerable groups of the population, such as children under five years of age and pregnant women should be prioritized. LLIN ownership is a key indicator for measuring the success of the NMEP. Determining whether households had sufficient numbers of treated nets for those sleeping within the home is also an important indicator for measuring the achievement of the control malaria program.

In the 2015 MIS survey, two-thirds (64%) of households in malarious areas had at least one LLIN, and 32% of households had at least one LLIN for every two people that stayed in the house the night before the survey (EPHI 2016). Whereas, the 2017 post-net distribution survey showed 64.8% of households own at least one LLIN, and 39% of households had at least one LLIN for every two people that stayed in the house the night before the survey (Nigatu et al 2019). Though the coverage remained the same in both surveys,

improvement was observed in line with households that own at least one LLIN for every two people. The current 2020 survey showed that 67% own at least one LLIN, and 40.3% of households had at least one LLIN for every two people that stayed in the house the night before the survey. In the present survey, both indicators increased and improved.

The 2015 MIS shows 40% of the population slept under a net the previous night of the survey. The 2017 survey and the present 2020 investigation showed 42.6% and 44% slept under a net respectively. This indicator has not shown a significant increase over the years.

Concerning the number of nets owned/retained in the households, nationally in 2020, 45% of households owned one net, 38% households' two nets, 14% households three nets and 3% households four nets. During this survey time, only 38% of the households recall key information about the use of LLINs. No change was reported in this survey regarding retention of nets when compared to the 2017 survey results (Indicate relevant citation). In the 2017 survey, 33.7% of the households recalled information about net usage.

In the 2015 survey, 45% of children and 44% of pregnant women slept under an LLIN the previous night. The 2017 survey shows 51.4% of children and 59% of pregnant women slept under an LLIN the previous night.

Similarly, the 2020 survey shows 52% of children and 62% of pregnant women slept under an LLIN the previous night. These results revealed that the protection of children and pregnant women from malaria acquisition has increased overtime.

Conclusion and Recommendations

The proportion of households owning at least one LLIN showed modest progress through the years 2015-2020. Yet almost 33% of households did not have LLINs in the malarious areas. Therefore, the concerned bodies and stakeholders need to work together to achieve universal coverage in malarious areas of the country. The malaria program must enhance packages and strategies that can support community awareness about proper net utilization to narrow the existing gaps and also procure nets that have shape and color based on prevailing households' preferences. In this survey, 52% of the children under five years and 62% of the pregnant women slept under an LLIN the previous night of the survey. These figures are still small and should be improved through the Social and Behavioral Change Communication (SBCC) packages of the malaria control program.

Generally, key indicators like the proportion of households with at least one LLINs, the proportion of households with at least one LLINs for every two people, the proportion of the population that slept under a net the previous night, proportion of under five years old children that slept under LLINs the previous night did not show significant increments throughout the period 2015 to 2020. All these demand hard and meaningful work of the program in the future.

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