Original Research Article

SOCIO- DEMOGRAPHIC FACTORS INFLUENCING THE OWNERSHIP AND UTILIZATION OF LONG LASTING INSECTICIDE NETS AMONG ENDEMIC SUB-COUNTIES IN KISII COUNTY

ABSTRACT

Aim: To access the socio-demographic factors influencing the effectiveness of LLINs among endemic Sub-Counties in Kisii County.

Study design: A cross-sectional study which involved observational and experimental methods.

Place and Duration of Study: The study was carried out in Kisii County where study subjects were drawn from Bonchari, Kitutu Chache North and South Mugirango between March to May 2021.

Methodology: A total of 422 study participants of both sex and all age groups who attended Kiaruta and Nyamagiri dispensaries, Eramba, Sieka, Moticho and Suguta health centerswith signs of malaria were the targeted population. Structured and open ended questionnaires were used to collect data. Associations between variables were tested using Pearson's chi-square test through the Statistical Package for Social Sciences (SPSS) version 21.

Results: From the total study participants, 68.69% were having LLINs while 31.04% had no LLINs. From the total number with LLINs, 33.18% had torn LLINs while 35.78% had no torn LLINs. 61.61% study participants were sleeping under the LLINs while 38.39% were not. Of the participants who were sleeping under LLINs, 46.92% had torn LLINs while 53.08% had nets which were not torn. Positive association was seen between ownership of LLINs per household and age (P = 0.008), level of education (P = 0.011), number of children (P = 0.006), household membership (P < 0.001) and location (P < 0.001), also there was a statistical significance between use of LLINs and age (*P* < .001), level of education (*P* < .001), gender (*P* = .024), location (*P* = .002), number of children (*P* < .001) and the last year when each participant received LLINs (*P* < .001),

Conclusion: Despite coverage of LLINs being high its usage was low and this means that socio-demographic factor has shown to be having a great influence on the ownership and utilization of LLINs. Therefore regular training must be done on LLINs and malaria transmissions with the urge to reduce its' incidences.

Key words: *Plasmodium falciparum, LLINs, parasitemia, socio-demographic*

1. INTRODUCTION

Globally, 229 million cases of malaria were estimated in 2019 [1] with 94% malaria cases, whereby 215 million cases being recorded in African region [2]. In 2019 still, 87 countries were marked as malaria endemic countries whereby 29 countries accounted for ninety five percent global malaria cases [1].

The most affected region in Africa by malaria in 2019 was Sub-Saharan Africa, having 19 countries accounting for 85% worldwide malaria burden [3] where Kenya is among the Sub-Saharan countries with high cases of malaria prevalence accounting for 30% of all hospital attendance [4]. Countries surrounding coastal and Lake Victoria regions specifically the Western part of Kenya records the highest cases of malaria transmissions countrywide [1]. The level of transmissions in these parts is enormous with yearly entomological inoculation rates (EIR) of 30 to a 100 infectious bites per person [5].

Worldwide reduction of malaria cases from 2000 has been related to management of malaria cases which are improved and the use of Long Lasting Insecticides Nets (LLINs) [6]. LLINs is a bed net treated with insecticides which are safe with the aim of repelling and killing mosquitoes which carry malaria parasite or physically blocking them from transmitting malaria for a maximum of five years without retreatment. [7] reported that treated bed nets when used consistently and properly are effective in lowering malaria morbidity and mortality hence recommending free delivery of LLINs to endemic countries. [8] reported that in Kenyan Highlands sleeping under a treated bed net lowers malaria infection risks by 63%.

In the year 2004 to 2015, 49 million LLINs were distributed in Kenya whereby it followed routine system which started in 2004 October where 23.3 million bed nets were distributed [1]. The policy of distribution changed in 2011 with the aim of covering the whole population who are at risk of the disease despite the gender and age. However, in 2014 another LLINs mass distribution was effected with the aim of replacing the old ones and boosting coverage [9]. Targeted areas for LLINs universal coverage were the endemic areas which are the Lake basin and coastal regions, also the highland epidemic areas. The free of charge bed nets distribution improved equality in coverage and decreases disparities in ownership when compared to clinical based distribution [10].

A great challenge has been observed in Sub-Saharan Africa in the maintenance, use and coverage of the LLINs. Despite that LLINs are effective in preventing malaria, there are set of factors which are dependent [11]. Education, vector density and seasonal patterns of precipitation in Highlands of Western Kenya were associated with the use of [12]. Gender, occupation of the head of the household, ownership of the net, age of the net, discomfort of heat inside the net, size of the household, transport accessibility, types of the houses and shapes of the nets are some of the other factors [13]; [14]. 4 indictors to measure LLINs use and availability were recommended by World Health Organization Roll Back Malaria Monitoring and Evaluation Reference Group in 2013 [15], 2 being calculated at the population (individual) level (population proportion that used an LLIN the previous night and population proportion with an access to an LLIN within the household) while 2 others in the household level (household proportion owning at least one LLIN for two individuals and household proportion owning at least one LLIN) [16].

Being that the main aim of LLINs is to provide individual protection against mosquitoes bites, there is a need to understand the use in the context of access indicators, ownership, availability and coverage. Therefore this study aimed at assessing the socio-demographic factors influencing the effectiveness of LLINs among endemic Sub-Counties in Kisii County.

2. METHODOLOGY

2.1 Study Site

The study was carried out in Kisii County where study subjects were drawn from Bonchari, Kitutu Chache North and South Mugirango sub-counties of Kisii County. The study took place in rural areas because urban areas are considered to be having low Malaria risks compared to rural areas due to high socio-economic status, breeding sites which are few in number and housing which is improved [17]. During the year 2018 the County registered a population of 1, 406, 043 (males 674, 901 and females 731, 142) with a growth rate of 2.2% yearly [18]. The County population density is 766/km^2 when compared to Kenya average growth rate of 37 people/km^2, hence this overcrowding becomes an ideal environment for malaria rapid transmission leading to epidemic proportions [19].

2.2 Study Design

A cross-sectional study which involved observational and experimental methods was used to assess the socio-demographic characteristics, collect and observe study participants blood samples under a light microscopy for the presence of malaria parasite.

2.3 Study Population

Patients attending the selected health centers and dispensaries with signs of malaria were the targeted population. . They included both gender and all age groups excluding malaria referral positive cases from other hospitals within and outside the sub-counties.

2.4 Sample Size Determination

Sample size was determined using the formula of [20] where the formula is:

$$n = \frac{z^2 P(I-P)}{d^2}$$

n represents desired sample size in which the population > 10,000

z represents the standard normal deviate at the required confidence level.

P represents the proportion in the target population estimated to have adequate knowledge and practices on malaria control. From the fisher recommendation 50% will be used where there is no estimates available of the proportion in the target population assume to have characteristic of interest.

q=1-p =0.5

d= the level of statistics significance =0.05

$$n = \frac{(1.96)^2 (0.50) (0.5)}{(0.05)^2} = 384$$ malaria cases + 10% attrition rate =422 participants

2.5 Sampling Technique

Exponential non-discriminative snowball sampling technique was employed whereby the study started from Kisii County Teaching and Referral Hospital. Using the Kenya Health Information System (KHIS) report, the researcher was referred to malaria endemic Sub-County hospitals. From Sub-County hospitals, District Health Information System (DHIS) report was use to obtain the specific hospitals recording high cases of malaria where the researcher was referred to the specific hospitals. In the hospitals under study random sampling method was applied to collect 422 study participants.

2.6 Selection of hospitals for the study

In Bonchari Sub-County, 2019 DHIS report showed Nyamagiri, Kiaruta, Nyamagundo, Nyabioto and Oroche dispensaries leading with malaria cases. Malaria patients were recorded as 1126, 1088, 997, 813, and 224 respectively. In Kitutu Chache North Sub-County, Eramba Health Centre, Sieka Health Centre, Kitutu Chache North referral hospital, Nyagesendo Dispensary, and Nyagoto Health Centre were the leading hospitals with malaria cases. 2679, 934, 749, 677 and 576 were the malaria patients records in each hospital respectively. In South Mugirango Sub-County Moticho Health Centre, Suguta Health Centre, Etago Sub-County hospital, Nduru Sub-county referral hospital and lastly Nyatike Health Centre were recorded as the leading hospitals with malaria cases. 1747, 830, 573, 331 and lastly 168 were the malaria patients in each hospital respectively.

2.7 Questionnaires administration

Structured questionnaires (appendix i) were administered to the selected study participants to understand more on what they know and how they use vector control methods. Informed consent was obtained from the study participant before starting a face to face interview. Questionnaires in English version were translated to local language (Ekegusii) by the research assistance during interview sessions. Further, key informants made up of three public health officers from the selected sub-counties hospitals were interviewed using a semi-structured guide (appendix ii).

2.8 Data analysis

Data was entered into excel where outcome variables were categorized accordingly and summarized as mean $\pm$ standard error (SE). Association between malaria prevalence, ownership of LLINs, torn LLINs and each demographic factor with clinical characteristics was compared using chi-square (χ^2) test in Statistical Package for Social Sciences (SPSS) version 21, where P-values $\leq$ 0.05 were considered statistically significant.

3. RESULTS

3.1 Response rate

A total of 422 participants were recruited in this study. Therefore, a response rate of 100% (422 participants) was obtained.

3.2 Demographic and clinical characteristics of the respondents

3.2.1 Gender distribution of the respondents

Out of the 422 participants, 263 (62.32%) were female while 159 (37.68%) were male (Fig 1).

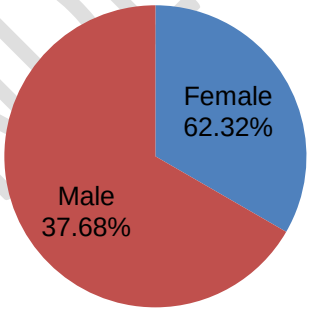

Figure 1: Gender of the participants

3.2 2 Age distribution of the participants

In this study, 23.70% (3.08 $\pm$ 0.12) participants were aged between 0-5 years, 47.16% (9.82 $\pm$ 0.19) participants were aged between 6-15 years, 19.43% (22.62 $\pm$ 0.45) participants were aged between 16 -

30 years, 7.11% (40.03 ± 0.10) were aged between 31-50 years, while 2.61% (67.36± 2.69) were aged above 51years (Fig 2).

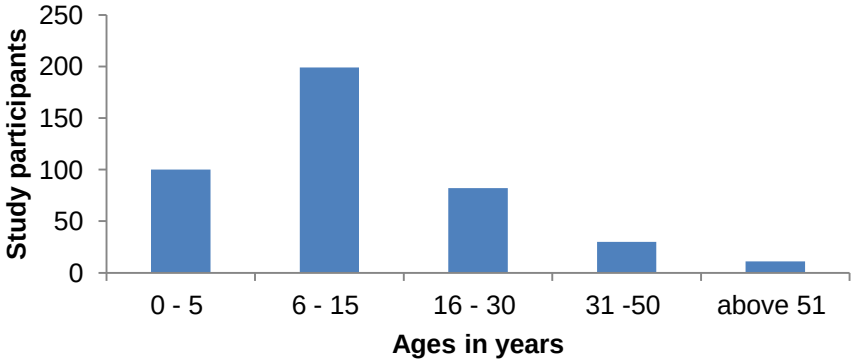

Figure 2: Categories of participants per age

3.2.3 Level of income

All of the study participants were unemployed with poor living standards majority doing brick making. 55.69% (2205.96 ± 34.53) participants had a monthly income of ksh 1000-3000, followed by 14.92% (740.48 ± 19.76) participants who had a monthly income of less than ksh 1000. Further 13.51% (4028.95 ± 71.23) had a monthly income of ksh 3000-5,000, 12.09% (7547.06 ± 266.30) had a monthly income of ksh 5000-10,000 while 3.79% (11812.50 ± 288.22) had a monthly income of more than ksh 10,000 (Fig 3).

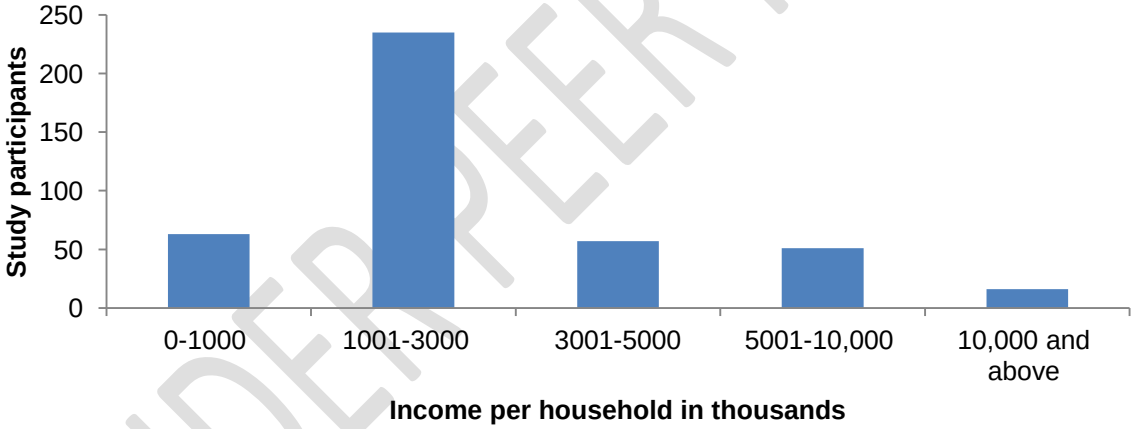

Figure 3: Participants per level of income

3.2.4 Level of Education

Regarding the level of education 72.99% (1.32 ± 0.27)) study participants had attained a primary level of education, 14.22% (1.87 ± 0.44) study participants had attained a secondary level of education 1.18% (1.60 ± 0.24) had attained a tertiary level of education while 11.61% (1.38 ± 0.70) had no formal education (Fig 4).

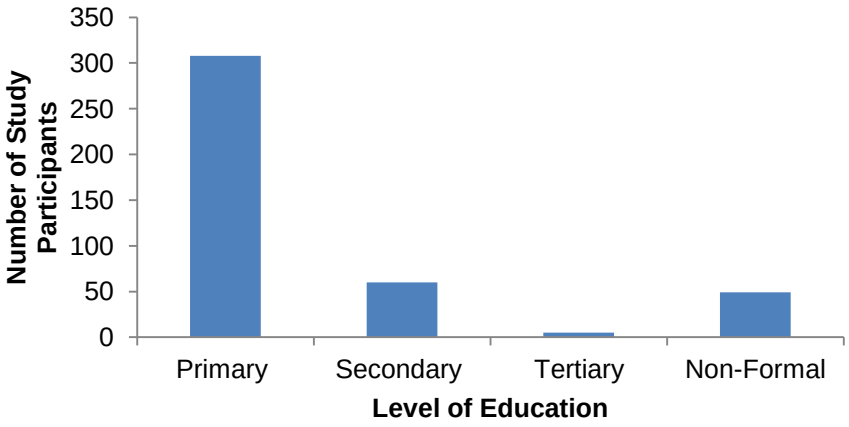

Figure 4: Study participants per level of education

3.2.5 Household membership

Household membership in the selected sample showed that 53.79% (13.89 ± 0.13) study participants had a family size of more than 11 in a household, 37.44% (7.98 ± 0.11) study participants had a family size of between 6-10 in a household, 7.58% (3.78 ± 0.18) study participants had a family size of between 1-5 in a household while 1.18% study participants were the only ones in the households (Fig 5).

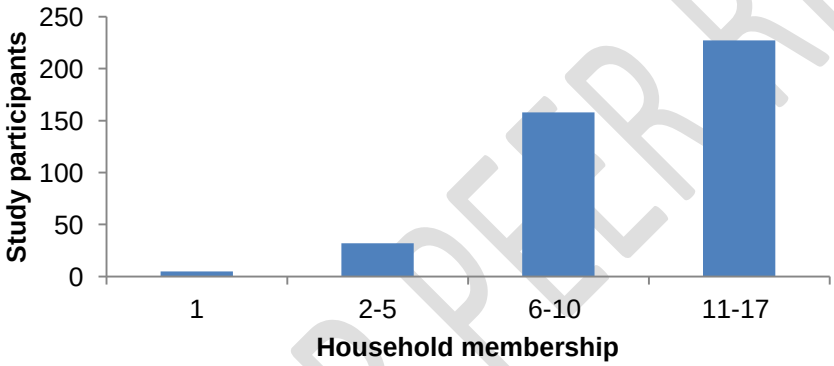

Figure 5: Study participants' household membership

3.2.6 Last year when the study participants each received LLIN

Study participants who had their LLINs issued before 2019 were 70.85% (1.23 ± 0.02), 2020 were 16.11% (1.75 ± 0.06), 2019 were 12.09% (1.93 ± 0.03) and lastly 2021 were 0.95% (2.00 ± 0.01) (Fig 6).

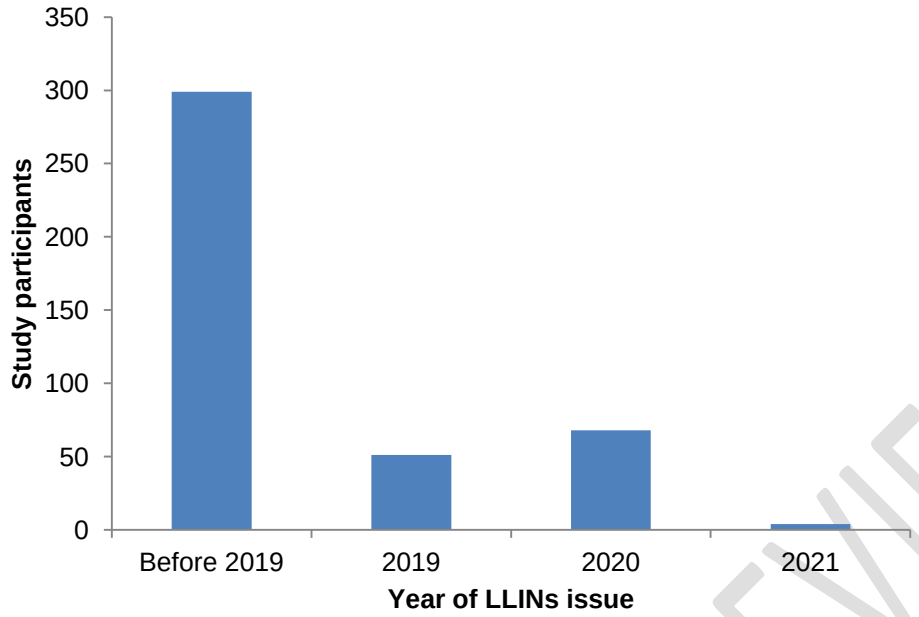

Fig 6: Study participants last year issued with LLINs

3.2.7 Study participants with torn LLINs

The study participants with torn LLINs were 33.18% (1.15 ± 0.03), without torn LLINs were 35.78% (1.95 ± 0.02) while the ones without LLINs completely were 31.04% (1.06 ± 0.02) (Fig 7).

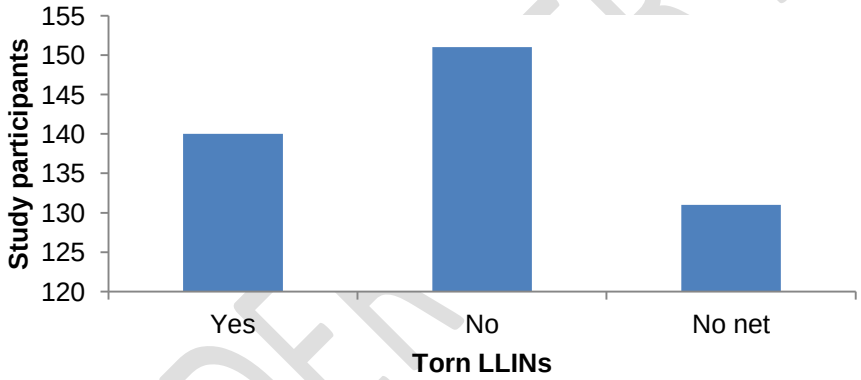

Fig 7: Study participants with torn LLINs

Out of 61.61% (1.57 ± 0.03) study participants sleeping under the LLINs nets 87.14% (122) study participants were having torn LLINs while 53.08% (138) also were not having torn LLINs. From 38.39% (1.15 ± 0.03) which were not sleeping under the LLINs, 12.86% (18) were having torn LLINs while 9.29% (13) were not having torn LLINs (Table 1)

Table 1: Study participants sleeping under torn LLINs

		Torn LLINs			Total ± SE	X^2	P-value (95%)
		yes	no	no net			
Sleep under LLINs	Yes	122	138	0	260 ± 0.03	305.45	<.001
	No	18	13	131	162 ± 0.03		

3.2.8 Total number of nets available in the study participants' households

38.15% (1.43 ± 0.04) study participants had only one net per household, 48.58% (1.39 ± 0.03) study participants had 2 nets per household, 10.66% (1.47 ± 0.08) study participants had 3 nets per household while 2.61% (1.28 ± 0.14) study participants had 4 nets per household (Fig 8).

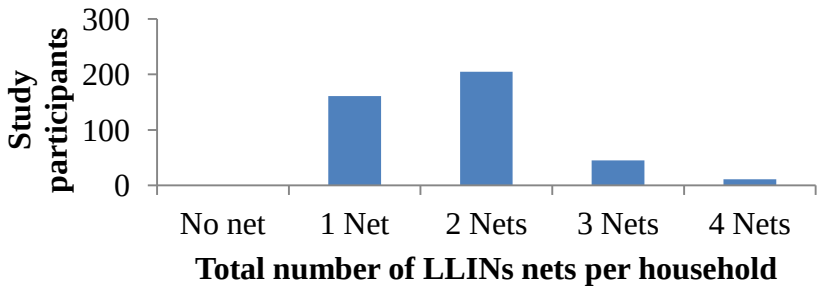

Figure 8: Total number of nets available per household

3.2.9 Thatched houses

Study participants with thatched roof houses were 83.65% (1.30 ± 0.02) while the ones with concrete roof houses were 16.35% (1.99 ± 0.01) (Fig 9).

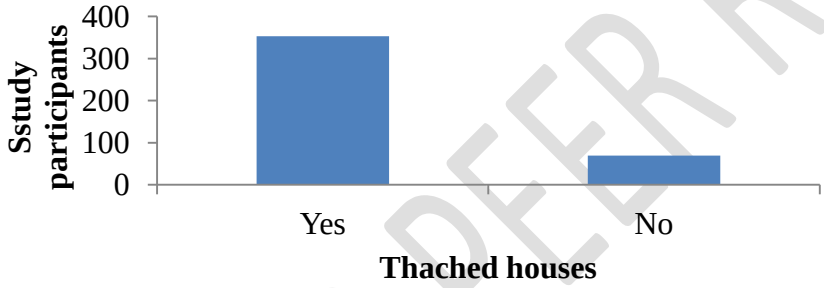

Figure 9: Study participants with thatched houses

3.3 Association between ownership of LLINs per household and socio-demographic characteristics

There was an association between ownership of LLINs per household with household membership (X^2 = 90.423; d.f = 9, *P* < .001), age (X^2 = 26.777; d.f = 12, *P* = .008), level of education (X^2 = 21.430; d.f = 9, *P* = .011), number of children (X^2 = 23.123; d.f = 9, *P* = .006) and location (X^2 = 43.717; d.f = 15, *P* < .001) while monthly income (X^2 = 9.295; d.f = 12, *P* = .678) and gender (X^2 = 5.585; d.f = 3, *P* = .134) were not statistically significant to the ownership of LLINs per household (Table 2).

Table 2: Association between ownership of LLINs per household and socio-demographic characteristics

Variable	Ownership of LLINs per household				Total	X^2 (d.f.*)	*P*- value (95% CI **)
Age (Years)	1 net	2 nets	3 nets	4 nets			
0-5	45	44	9	2	100	26.777(12)	*P* = .008
6-15	73	103	17	6	199		
16-30	30	40	10	2	82		
31-50	10	16	3	1	30		
51 above	3	2	6	0	11		

Education status							
Primary	118	156	25	9	308	21.430 (9)	*P* = .011
Secondary	22	29	0	20	60		
Tertiary	2	0	2	1	5		
Non-formal	19	20	10	0	49		
Monthly income							
<1000	30	27	5	1	63	9.295 (12)	*P* = .678
1001 -3000	88	117	22	8	235		
3001-5000	20	30	7	0	57		
5001-10,000	17	24	9	1	51		
>10,000	6	7	2	1	16		
Household membership							
0	5	0	0	0	5	90.423(9)	*P* =.001
1-5	23	7	2	0	32		
6-10	91	59	6	2	158		
7-11	42	139	37	9	227		
Number of children							
0	78	101	12	2	193	23.123(9)	*P* = .006
1-3	42	42	15	5	104		
4-6	27	45	7	3	82		
Above 7	14	17	11	1	43		
Gender							
Male	55	88	12	2	193	5.585 (3)	*P* = .134
Female	106	117	33	7	263		
Location							
Eramba Health Centre	30	46	1	1	78	43.717 (15)	*P* = .001
Sieka Health Centre	17	44	9	0	70		
Kiaruta Dispensary	37	31	6	4	78		
Nyamagiri Dispensary	45	29	15	2	91		
Moticho Health Centre	16	24	2	2	44		
Suguta Health Centre	16	31	12	2	61		

3.4 Association between torn LLINs and socio-demographic Characteristics

There was an association between study participants having torn LLINs and age (X^2 = 67.954; d.f = 8, *P* < .001), level of education (X^2 = 101.729; d.f = 6, *P* < .001), number of children (X^2 = 170.046; d.f = 6, *P* < .001), household income (X^2 = 88.826; d.f = 8, *P* < .001), year of LLINs issued (X^2 = 235.558; d.f = 6, *P* < .001), gender (X^2 = 7.166; d.f = 2, *P* = .028) and study participants sleeping under LLINs (X^2 = 305.448; d.f = 2, *P* < .001). Conversely, location (X^2 = 16.551; d.f = 10, *P* = .085) were not statistically significant (Table 3).

Table 3: Association between torn LLINs and socio-demographic Characteristics

Variable	**Torn LLINs**			**Total**	**X^2 (d.f.*)**	**P- value (95% CI **)**
Age (Years)	**Yes**	**No**	**No net**			

0 – 5	48	43	9	100	67.954 (8)	*P* = .001
6 – 15	50	61	8	199		
16 – 30	16	34	32	82		
31 – 50	19	10	1	30		
51 above	7	3	1	11		
Gender						
Male	55	45	59	159	7.166 (2)	*P* = .028
Female	85	106	72	263		
Location						
Eramba Health Centre	27	27	24	78	16.551(10)	*P* = .085
Sieka Health Centre	21	24	25	70		
Kiaruta Dispensary	24	36	18	78		
Nyamagiri Dispensary	39	32	20	91		
Moticho Health Centre	10	15	19	44		
Suguta Health Centre	19	17	25	61		
Level of education						
Primary	105	79	124	308	101.729 (6)	*P* = .001
Secondary	6	52	2	60		
Tertiary	2	3	0	5		
Non- formal	27	17	5	49		
Number of children						
0	43	31	119	193	170.046 (6)	*P* = .001
1-5	40	58	6	104		
6-10	31	48	3	82		
7-11	26	14	3	43		
Monthly income						
<1000	30	13	20	63	88.826 (8)	*P* = .001
1001 -3000	83	67	85	235		
3001-5000	21	14	22	57		
5001-10,000	6	43	2	51		
>10,000	0	14	2	16		
Sleep under LLINs						
Yes	122	138	0	260	305.448 (2)	*P* = .001
No	18	13	131	162		
Year of LLINs issued						
Before 2019	130	39	130	299	235.558 (6)	*P* = .001
2019	8	42	1	51		
2020	2	66	0	68		
2021	0	4	0	4		
Variable	**Torn LLINs**			**Total**	**X^2 (d.f.*)**	**P- value (95% CI **)**
Age (Years)	**Yes**	**No**	**No net**			
0 – 5	48	43	9	100	67.954 (8)	*P* < .001
6 – 15	50	61	8	199		
16 – 30	16	34	32	82		
31 – 50	19	10	1	30		
51 above	7	3	1	11		
Gender						
Male	55	45	59	159	7.166 (2)	*P* = .028
Female	85	106	72	263		
Location						
Eramba Health Centre	27	27	24	78	16.551(10)	*P* = .085
Sieka Health Centre	21	24	25	70		
Kiaruta Dispensary	24	36	18	78		
Nyamagiri Dispensary	39	32	20	91		
Moticho Health Centre	10	15	19	44		

Suguta Health Centre	19	17	25	61		
Level of education						
Primary	105	79	124	308	101.729 (6)	*P* < .001
Secondary	6	52	2	60		
Tertiary	2	3	0	5		
Non- formal	27	17	5	49		
Number of children						
0	43	31	119	193	170.046 (6)	*P* < .001
1-5	40	58	6	104		
6-10	31	48	3	82		
7-11	26	14	3	43		
Monthly income						
<1000	30	13	20	63	88.826 (8)	*P* < .001
1001 -3000	83	67	85	235		
3001-5000	21	14	22	57		
5001-10,000	6	43	2	51		
>10,000	0	14	2	16		
Sleep under LLINs						
Yes	122	138	0	260	305.448 (2)	*P* < .001
No	18	13	131	162		
Year of LLINs issued						
Before 2019	130	39	130	299	235.558 (6)	*P* < .001
2019	8	42	1	51		
2020	2	66	0	68		
2021	0	4	0	4		

3.5 Association between use of LLINs and socio-demographic Characteristics

There was an association between use of LLINs and age (X^2 = 43.679; d.f = 4, *P* < .001), level of education (X^2 = 22.825; d.f = 3, *P* < .001), gender (X^2 = 5.127; d.f = 1, *P* = .024), location (X^2 = 18.732; d.f = 5, *P* = .002), number of children (X^2 = 121.799; d.f = 3, *P* < .001) and the last year when the study participants received LLINs (X^2 = 90.646; d.f = 3, *P* < .001), while household income (X^2 = 7.400; d.f = 4, *P* = .116) and household membership (X^2 = 2.296; d.f = 3, *P* = .513) were not statistically significant.

Table 4: Association between use of LLINs and socio-demographic Characteristics

Variable	**Use of LLINs**		**Total**	**X^2 (d.f.*)**	**P- value (95% CI **)**
Age (Years)	**Yes**	**No**			
0 - 5	84	16	100	43.68 (4)	*P* < .001
6-15	100	99	199		
16-30	42	40	82		
31-50	25	5	30		
51 above	9	2	11		
Gender					
Male	87	72	159	5.127 (1)	*P* = .024
Female	173	90	263		
Level of Education					

Primary	169	139	308	22.825 (3)	*P* < .001
Secondary	47	13	60		
Tertiary	5	0	5		
Non-formal	39	10	49		
Location					
Eramba Health Centre	52	26	78	18.732 (5)	*P* = .002
Sieka Health Centre	38	32	70		
Kiaruta Dispensary	52	26	78		
Nyamagiri Dispensary	68	23	91		
Moticho Health Centre	20	24	44		
Suguta Health Centre	30	31	61		
Household income					
<1000	39	24	63	7.400 (4)	*P* = .116
1001 -3000	137	98	235		
3001-5000	33	24	57		
5001-10,000	39	12	51		
>10,000	12	4	16		
Number of children					
0	64	129	193	121.799 (3)	*P* = .001
1 – 3	88	16	104		
4 – 6	71	11	82		
Above 7	37	6	43		
Year of net issued					
Before 2019	141	158	299	90.646 (3)	*P* = .001
2019	49	2	51		
2020	66	2	68		
2021	4	0	4		
Household membership					
0	4	1	5	2.296 (3)	*P* = .513
1-5	20	12	32		
6-10	91	67	158		
7-11	145	82	227		

4. Discussion

All the study participants had good knowledge on the signs and symptoms of malaria whereby this study was in agreement with the study of [21] and contrary with [1]. Good community knowledge about source of malaria transmission with signs and symptoms promotes personal protective practices hygiene amongst communities which are affected. It also improves on prompt treatment and early diagnosis whereby it is the major component in malaria elimination and control. Malaria transmission in this study has been linked to human behaviors and vector, compromising the contact between the protective measures and the vector.

In this study 68.96% of the study participants had LLINs and 61.61% of these study participants were sleeping under it. This means that LLINs usage was high and this support the assumption of outdoor biting by female *Anopheles* mosquito, this is because they are moving and working people hence the likelihood of leaving home early with their young ones if their and returning home during late hours, thus becoming more prone to outdoor mosquito bites [22]. It was believed also that tired working people unknowingly after returning home from a tiresome day, may take a deep sleep without sleeping under the treated bed nets, ignoring the mosquito bites [23]. Regular human who travels either for education and occupation purposes becomes the major role in the maintenance and establishment of malaria transmission [24]. In central Tanzania it was reported that livelihood practices were among the major

social practices that determine malaria acquisition [25]. This study was in concordance with the study of [26] and contrary with the study of [22].

In addition to that, house structures with different roof materials in this study were statistically found to be influencing the presence of malaria. Statistically houses with thatched roof were providing less protection to malaria due to open eaves providing a lot of entry points of mosquitoes compared to roofed houses with concrete. This study was similar to the study of [22] and [26] which reported that houses with poor quality are the major determinant of the deadly disease malaria. Houses with good quality have less numbers of mosquitoes indoors [27]. [28] reported that open eaves and earthen roofs have been associated with high cases of malaria risks. However, the study of [29] at the highlands of Western Kenya was not in concordance with all these studies since uncovered windows and open eaves did not show any effect on the prevalence of malaria. Study participants from this study had separate main house with kitchen and the study of [29] reported that separate kitchen has high relationship with malaria incidences.

All study participants households had at least one net whereby, this study showed high rates of ownership (100%) and moderate proportion of usage (61.61%). This study was consistent with the study of [30] at Western Kenya which reported that 95% ownership and 59% usage, while the study of [12] at highlands also of Western Kenya reported a little lower ownership of LLINs of 71% and almost similar percentage of usage of 56.3%. Again similar study of [1] reported high rates of ownership of 96.9% almost like this study but a little higher percentage of usage of 98.1% just like the study of [31] which reported 99.7% ownership and 97.3% usage.

Kenya Ministry of Health has reported at least 60% roll back malaria partnership household LLINs coverage and from the above studies Kenya have met the target [32]. The major method used in Kenya to increase ownership is through free mass campaigns, free distribution of LLINs to parents with children less than five years of age during post-natal and ante-natal clinics and free distribution to mothers who are expectant [32]. The 100 % ownership of nets in this study could be due to free mass campaign distribution which happened in 2017 just like the study of [1] which reported that the three quarter of the LLINs acquisition was from a mass distribution which was free from the Ministry of Health, Kenyan government. These programs for LLINs distribution rapidly increases ownership and strengthens its usage within households [1] just like Sierra Leone where mass distribution campaigns bolster usage within households within a period of six months by 137% [33]. LLINs coverage for every two household members in the areas under this study was too low (38.15%) compared to WHO recommended level (80%) which is accepted for protection [34]. This study showed a statistical significant association between LLINs ownership, household membership, age, level of education and location. This means that ownership of LLINs in this study was very high compared to household proportion with at least one LLIN for two people; hence there was unequal distribution of nets among households in the different study areas. The main determinants of the household ownership of nets were number of children, household membership, number of rooms for sleeping, education, age and the gender of the household head. This study was in conformity with the study of [35]. The average number of nets per household is 1.8 with minimum of one household owning one net and a maximum of one household owning four nets (Fig 8). The average size of a family per household was 7 with a minimum of one member per family and a maximum of 17 members per household (Fig 5).

The usage of LLINs per household in this study significantly varied depending on age, level of education, number of children and location of the study participant. Positive association was seen in age, gender, location, number of children and level of education just like the study of [1], [36], and [37]. [38] reported that parents who were educated appreciated the treated LLINs for protection against the bite of mosquitoes and that one increased the influence of the usage of LLINs.

On the conditions of the LLINs in this study 33.18% of the study participants were having nets with holes and 31.04% did not have nets completely while 35.78% were having nets in good conditions. Majority of the study participants were not having nets or were not in good conditions this was because the study was done four years later after the last free mass distribution of the nets whereby 70.85% received their nets before 2019 (Fig 6) and also the major cause of these holes in those nets was the study participants using poorly made wooden beds and the use of sticks to support the nets within the sleeping areas [1]. For those who were having bed nets with good conditions majority of them had given birth to their young ones a maximum of one year before the study was conducted. Positive association was seen between the torn LLINs, age, gender, level of education, number of children per study participant, household

income per study participant and year when the LLINs was last issued to each study participant. This study was in agreement with the study of [30] and [39] who reported 40% and 44.9%of the nets with poor physical conditions respectively. However, our study was not in concordance with the study of [1] who reported 74.9% of nets with good conditions and 7.8% with holes. For a community to sustain the use of nets it is good to identify the motivator behind the use of nets and what discourages them from using it. The best motivator of using bed nets is to avoid nuisance biting mosquitoes than to prevent malaria as it has been reported in [40]. The disadvantage part of this motivation is that family members might end up using the nets when there is high density of mosquitoes. Also it can be taken as a luxury and not to control malaria like the study done in Ghana [41]. Nevertheless, another study in the highlands of western Kenya showed that education with seasonal patterns of vector density was linked with the use of ITNs [12]. Other factors associated with not sleeping under the treated bed nets are household characteristics [42], gender, age, access, education, demographic characteristics [43] social status [11], conditions of the nets [13] and others.

Conclusion

Communities are supposed to be educated about risks associated with exposure while outdoors and the urge to reduce incidences of malaria transmissions which are persistent. Also they need to be taught on the importance of prompt and effective treatment with proper drugs which are expected to clear the asexual cycle and destroy the developing gametocytes and reduce individual's net infectiousness as it reduces the progression of severe disease and reduces the large number of individuals in the community with malaria transmission. Lastly free of charge mass distribution of LLINs bed nets should be an adopted method for equitable ownership of nets in the households.

CONSENT

All authors declared that written informed consent was obtained from each study participant. Consent was obtained during questionnaire interviews in the specific hospitals under study and they all declared the report of the study to be published. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

Ethical approval

Ethical approval was sought from the University of Eastern Africa, Baraton, while research permit was obtained from National Commission for Science, Technology and Innovation (NACOSTI). Kisii County Government County Health Services department of training and research, County Director of Education Kisii County, County Commissioner Kisii County, Medical Officers for malaria endemic Sub-Counties hospitals and head of the selected hospitals under study were informed and also sought for approval. Voluntary informed consent was sought from the respondents before participation to the study where memorandum of understanding between the selected participants and the researcher was established hence revealing the study aim.

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APPENDIX I: QUESTIONNAIRE

Questionnaire used in the study to assess socio- demographic factors influencing the effectiveness of LLINs among endemic Sub-Counties in Kisii County

PART 1: RESPONDENTS APPROVAL COVENANT

I (number……) hereby agree to be part of this study by giving the right and comprehensive information for the benefit of all residents of Kisii County, and generally Kenyan hospitals at large.

Signature …… Date ……. /……./2021

PART 2: RESPONDENTS DETAILS

Age…….in Years

Level of education

Primary ……. [Yes/No]

Secondary……. [Yes/No]

Tertiary/college…… [Yes/No]

Non-formal…… [Yes/No]

Approximate income per month

<Ksh. 10,000……. [Yes/No]

>Ksh. 10,000…….. [Yes/No]

Ksh.10.000 – 20,000……. [Yes/No]

Location/Residence

Own home…….. (urban/regional)

Rentals …… (urban/regional)

Camp…… (urban/regional)

Status

Married …….. [Yes/No]

Single ……. [Yes/No]

Size of the family

Small (between 0-2)…… [Yes/No]

Medium (between 3-5) …… [Yes/No]

Large (<5) ……..….. [Yes/No]

Pregnancy information for the pregnant mothers

How many months pregnant are you……if more than 3months

a. When did you start antenatal care …….
b. How often do you visit antenatal care……
c. On your visitation are you given nets for mosquito protection.……....
d. Are you educated on how to use ……..
e. What do you do with it ……

PART 3: INTERVENTION PRACTICES

Have you ever used intervention practices before…….[Yes/No] if yes answer the following;

Use of insecticides treated nets (LLINs)……..[Yes/No]

Use of intermittent preventive treatment in pregnancy (IPTP) with Sulfadoxine-pyrimetamine [Yes/No] If Yes what are the;

i. Response after three days: Good…….Fair..…..…….. Poor …..…….
ii. Response after completion of the drug: Good……Fair..…… Poor …..……..
iii. Complications accompanied by the drug…….……..……

Use of Insecticides (coils or sprays) …… [Yes/No]

Use of insects repellant…… [Yes/No]

Domestic hygiene practice (cutting the grass [Yes/No], sweeping the backyard [Yes/No], pruning the trees [Yes/No])

Use of indoor residual spraying (IRS) [Yes/No] if Yes

i. When did you start to use ……..…
……..……...
ii. How often do you spray ……...
……
iii. What was the effect
    a. Immediately……
    b. After three days……..
    c. After one week……..
    d. After a month……..

What else do you do to prevent malaria in your area

……..……

PART 4:

DECLARATION FROM THE RESEARCHER

1. Malpractices or intimidation from the respondents with an aim of getting information will not be there

2. Informed consent of the study will be signed for confidence and further elaboration will be done where not understood by the respondents before the study
3. Provided information by the respondents will not be tampered or edited and will be kept private and confidential
4. Translation will be done in case language barrier arise
5. Collected data from pregnant women under the study will be used for the described purpose of the study but not to disclose information.

Researcher's name: Pacifica C. Bwogo
Signature.....
Date……

APPENDIX II: SEMI-STRUCTURED GUIDE USE TO INTERVIEW KEY INFORMANTS

PART 1: Consent form

I (number……) hereby agree to be part of this study by giving the right and comprehensive information for the benefit of all individuals residing in Kisii County, and generally Kenyan hospitals at large.
Signature …… Date …..... /…….. /2021

PART 2: RESPONDENTS DETAILS

What percentage of patient is usually referred due to malaria from health centers or dispensaries weekly……

a. How many are female……above 5……..below 5……
b. How many are male……above 5…….below 5……

What are the protective measures of malaria used in South mugirango/Kitutu chache north/Bonchari……..
When was mass spraying of insecticides house to house done in South mugirango/Kitutu chache north/Bonchari…….
When was the LLINs free mass distribution done in South mugirango/Kitutu chache north/Bonchari……..
After how long is the free mass distribution done in South mugirango/Kitutu chache north/Bonchari……..
Which criteria is usually used in South mugirango/Kitutu chache north/Bonchari to distribute LLINs since last free mass distribution……
When were the last month specific hospitals in South mugirango/Kitutu chache north/Bonchari received the LLINs for distribution to parents having children under 5……
What of a parent with more than two children under 5, how many nets are given to that patient……and which procedure is being followed……..
When was the last mass education done in South mugirango/Kitutu chache north/Bonchari about malaria……

APPENDIX III: INFORMED CONSENT

TITLE OF STUDY

Socio- demographic factors influencing the ownership and utilization of long lasting insecticide nets among endemic sub-counties in Kisii County

PRINCIPAL INVESTIGATOR

Name: Pacifica C. Bwogo
University: Kisii University
School: Pure and Applied Sciences
Department: Biological
Address: P.O Box 408-40200, Kisii

PURPOSE OF THE STUDY

(You are being asked to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. Please read the following information carefully. If there is anything that is not clear kindly feels free to ask for clarification.)

The purpose of this study is to understand the socio- demographic factors influencing the effectiveness of LLINs as malaria transmission reduction interventions among endemic sub-counties in Kisii County.

Malaria continues to strike hardest among pregnant women and children especially in Africa. Malaria compromises the health of children and pregnant mothers and puts them at a higher risk of death. It leads to low birth weight, anemia in the mother, neonatal and infant mortality. LLINs are the key malaria vector control measure, but socio- demographic factors has been seen to be influencing its effectiveness to control malaria.

STUDY PROCEDURES

The study procedures include: blood samples collection, questionnaires interview for soci-demographic data collection and malaria parasite light microscopy testing. After that association between socio-demographic factors and the effectiveness of LLINs will be analyzed.

RISKS

Pain while collecting blood samples might be observed but with the presence of hospital health workers it will be controlled.

BENEFITS

This study will benefit everybody residing in Kisii County and Kenya at large since the socio- demographic factors influencing the effectiveness of LLINs as malaria transmission reduction interventions among endemic sub-counties in Kisii County will be evaluated and published online for every individual within Kenya and outside for future referrals.

CONFIDENTIALITY

Your participation to this study will be anonymous. Please any identifying information will not be indicated on your samples. Every effort will be made by the researcher to preserve your confidentiality. Participant data will be kept confidential except in cases where the researcher is legally obligated to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk.

CONTACT INFORMATION

If you have questions at any time about this study, or you experience adverse effects as the result of participating in this study, you may contact the researcher whose contact information is provided on the first page. If you have questions regarding your rights as a research participant, or if problems arise which you do not feel you can discuss with the Primary Investigator, please contact the Institution of study of the researcher as provided on the first page again.

VOLUNTARY PARTICIPATION

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you decide to take part in this study, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

CONSENT

I have read and I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature _____ Date _____

Investigator's signature _____ Date _____