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EFFICACY, EFFICIENCY AND IMPACT OF LONG-LASTING INSECTICIDAL NETS UTILIZATION AND IN DOOR RESIDUAL SPRAYING: A SURVEY OF RURAL KAPTUMO LOCATION, NANDI COUNTY, KENYA

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Abstract

The purpose of this study was to determine the efficiency and efficacy in the long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS) utilization and their impact as malaria prevention intervention method in a bid to zero rate malaria morbidity and mortality in Kaptumo location. A quantitative, descriptive study design was employed and data from the respondents (household heads) was collected by means of self-reported questionnaires, which had closed ended questions. Using stratified random sampling, proportional stratified sampling, and convenience sampling techniques, the household heads within the location were sampled where 343 heads were then studied. Data analysis was done using SPSS version 15 and interpretation at 95% confidence. This study reports that majority of the respondents (74%) admitted that after the commencement of LLINs and IRS utilization, malaria cases reduced. However, 15% of them did not know of any changes and 8% admitting that even though there was some change, the change was still minimal. Only 3% did not have changes that they could notice even after commencing the utilization of LLINs and IRS. Major barriers to the LLINs and IRS identified included: Fear of chemicals where 58% of the respondents admitted to having the effects; and other uses other than the beds in which 44% of the respondents admitted that they could use the LLINs on the seed bed, with 34% believing that they could also be used on the chicken pens, and 22% on the walls for beauty purposes.

Keywords: Insecticidal nets, indoor residual spraying, malaria prevention, intervention method

Introduction and Literature Review

Malaria has no doubt continued to occupy the center stage of the global health community over a considerable period of time. While the disease may have been conquered principally in the western hemisphere, the same cannot be said in most parts of tropical and subtropical parts of the world. Presently the threat posed by malaria as a public health concern is increasing worldwide, causing an estimated 225 million disease cases and 781000 deaths per year (Norris & Norris, 2011).In Kenya Malaria is one of the leading causes of morbidity and mortality and it kills an estimated 34000 children under five every year. Seventy seven percent of Kenya's population lives in areas where the disease is endemic. The disease accounts for 30% of outpatient visits (requiring more than 8 million treatments at health facilities each year) and 15% of all hospital's admission. An estimated 3.5 million children are at risk of developing severe malaria (USAID, 2013). Pregnant women also face high risk and approximately 1.1 million pregnancies per year in malaria endemic zones. It is estimated that each year 6000 pregnant women suffer from malaria associated anemia and 4000 babies are born with low birth weight as a result of maternal anemia. Economically it is estimated that 170 working days are lost each year because of malaria illness (KEMRI, 2011).

LLINs are the preferred form of insecticide treated nets (ITNs) for public health distribution programs. According to Norris and Norris (2011), LLINs retain effective insecticidal doses up to 20 washes and have an expected life span of 4-5 years unlike conventional ITNs, which lose effective insecticides after one or two washes and lasts only for about 12 months. Since LLINs require no re-treatments with the insecticide, they are more convenient and preferred over ITNs. Currently there are two types of LLINs recommended by World Health

Organization: One, which is polyester netting and the insecticide, is bound to the external surface of the netting fiber using a resin and another, which incorporates the insecticide into polyethylene fiber, which is then released slowly for up to 5 years.

IRS is the application of long-lasting chemical insecticides on the walls and internal surfaces of the roofs in all houses and shelters in a given area to kill adult vector mosquitoes that land and rest on those surfaces. The primary effects of IRS towards curbing malaria transmission are to reduce the life span of vector mosquitoes so that they can no longer transmit malaria parasites from one person to another and to reduce the density of the vector. Sprayed houses are protected for about 4-10 months depending on the insecticide used and the construction materials. In some situations IRS can lead to the elimination of locally important vectors. Some insecticides can also repel mosquitoes thereby reducing the number of mosquitoes entering the sprayed room hence reducing human vector contact.

Impact of LLINs and IRS Against Malaria Vector

Vector control is one of the most important strategies in malaria control and elimination, and it must be built on a thorough understanding of vector biology, including ecology, behavior, and genetics. In Africa all significant vectors (mosquitoes) bite at night in the early hours of the morning (Norris and Norris, 2011).

Impact of Utilization of LLINs on Malaria Mortality and Morbidity

LLINs reduce human-vector contact by killing or repelling vector mosquitoes, with a documented effect in reducing malaria-related illness, death and improved pregnancy outcomes. In Asia and Latin America (areas with low malaria transmission), the use of LLINs also significantly reduced the number of clinical episodes due to both P. falciparum and P. vivax. When community coverage is high, LLINs not only protect those who sleep under them, but also protect those in the same dwelling (household effect) and the community as a whole (community effect). Protection against forest malaria has recently been demonstrated in the Amazon region and in Cambodia. This confirms that personal protection against malaria is an important aspect of the action of LLINs.

Studies in Africa have demonstrated that wide-scale use of LLINs can reduce all-cause mortality in children by about 20% and the number of clinical malaria episodes in the same age group by as much as 50%. Generally malaria illnesses and deaths are down by 50% in Kenya (Hawley et al., 2003). Studies in intense malaria transmission areas in western Kenya also demonstrate that women who were protected by LLINs gave birth to approximately 25% fewer babies who were either small for gestational age or born prematurely than those not protected by LLINs (Yartey, 2006). According to the Public Health Minister, Hon. Beth Mugo during this year's World Malaria Day celebration held on April 25, 2012 at Msambweni Coast province, Malaria morbidity and mortality in young children have dropped by between 44% and 52%, contributing to the overall reduction in child mortality and infant mortality by 36% and 31%, respectively.

It is important to note that the effectiveness of LLINs is more when provided early enough and their usage encouraged throughout all periods. LLINs can be provided either through antenatal clinics or other outlets in the public and private sectors (e.g., effective community-based mechanisms, commercial vendors). Distribution of LLINs through antenatal care or other outlets should rely on local opportunities and strategies and should seek to achieve high levels of coverage (Yartey, 2006).

Impact of Utilization of IRS on Malaria Mortality and Morbidity

IRS involves the application of a liquid insecticide, which dries up to leave a residue with long-lasting insecticidal effect on indoor resting places of the vector. Insects absorb a lethal dose when they come in contact with the surface. It also has an agitating and repellent effect on mosquitoes, with an added advantage being the reduction of the number of mosquitoes entering indoor spaces. IRS is most effective in areas of unstable transmission, areas with marked seasonal transmission peaks and disease outbreaks, and in highland areas5. If implemented just before the transmission period or seasonal peaks, it may disrupt vector population dynamics and shorten the transmission period or even suppress epidemic outbreaks entirely. It has more or less the same effects on the vector as the LLINs and its effectiveness largely depends on coverage in the community and level of acceptance (Yartey, 2006).

In a study done in Mpumalanga Province by Ngomane (2012), a notable decline in malaria case notification was observed following the increased IRS coverage from 2006/07 to 2008/09 malaria seasons. Within the eight-year period of the study, a total of 35,191 cases and 164 deaths-attributed to malaria were notified in the Province. There was a significant decrease in the incidence of malaria in Mpumalanga Province from 385 in 2001/02 to 50 cases per 100,000 population in 2008/09 ($P < 0.005$). The overall incidence and case fatality rates were 134 cases per 100,000 and 0.54%, respectively. Ngomane further asserts that decades of continuous IRS with insecticides have proved to be successful in reducing the burden of malaria morbidity and mortality in Mpumalanga Province between 2001 and 2009. A decline of above 50% in malaria morbidity and mortality was observed following expanded IRS coverage (2012). A study conducted in Uganda to assess the impact of IRS on malaria morbidity after a single round of spraying with lambda-cyhalothrin found a consistent decrease in the number of patients diagnosed with clinical malaria in the first four months after IRS (Hasifa, 2009). In South Africa, marked reductions in the number of confirmed cases and deaths in Mpumalanga and KwaZulu-Natal Provinces were observed following the introduction of IRS campaigns in Mozambique and Swaziland. In KwaZulu-Natal Province, a significant reduction in the number of cases in most endemic areas of the province was reported following the re-introduction of DDT for vector control (Ngomane & Christiaan, 2012).

Efficacy in Utilization of LLINs

In sub-Saharan Africa, considerable effort has been spent on increasing the number of households possessing LLINs. This is to say that there has been an impressive distribution effort by malaria control programs, with significant government and donor support over the past few years. Many countries have increased household coverage to a point where average household coverage with at least one LLIN has risen from 5% to 31% over the past 5 years (WHO, 2009). In 2008, 13 of the 35 highest burden countries reported at least 50% of households in malaria endemic areas owned LLINs. However, there is evidence that ownership does not translate into use at the same rate (Eisele et al., 2009)

In recent years, subjective information has suggested that some people use LLINs for purposes other than malaria protection. These reports suggest that some LLINs may be used as fishing nets. In a personal communication by J Ross, Lusaka, April 2009, they can also be used for protection of seeds and fruits against insects, as used by adults who work seasonally away from home in mosquito-ridden areas; or are being modified for personal protective gear and luxury items such as wedding veils (Zambia, 2008). A study in western Kenya found that 30% of bed net recipients did not adhere to net use. Net use tends to decrease during hot weather and it has also been observed that they are being used for drying a small zooplanktivorous fish Rastrineobola argentea, locally known as omena in fishing villages in Kenya part of Lake Victoria basin, where malaria is endemic. Traditionally, these fish have been dried on papyrus mats (Minakawa et al., 2008). It is perceived that nets have an advantage over papyrus sheets for drying this kind of fish (Minakawa et al., 2008). In that while the price of a papyrus sheet ranged between 150 and 200 Kenya shillings, a bed net could be obtained from an NGO free of charge or from local health facilities at subsidized prices (usually 50 Kenya shillings). LLINs were readily available from these organizations, but papyrus mats were only available in the weekly market in the major local town. In fact, nearly 85% of the bed nets found on the beaches were from NGOs and local health facilities. The villagers also indicated that fish dried faster on the bed nets, which provided greater aeration when laid on grass than did papyrus mats and they also noted that the fish dried straighter on bed nets, which increased the commercial value of the fish.

Factors Affecting the Efficient Utilization of LLINs and IRS Services

Apart from ownership and access to services, primary barriers to LLIN and IRS use cited include: insufficient knowledge by users of the link between mosquito bites and malaria; lack of knowledge of LLIN use as a preventive measure against malaria; and lack of knowledge as to who should be the main users of nets (Hanson et al., 2009). Poverty is also reported by some studies as a barrier to use, this is to say that poorer households have immediate needs including food, water and medical care, and therefore sell nets to meet their basic needs (Goesh et al., 2007; Githinji et al., 2008). In addition to this, the poor may store LLINs, rather than use them, for future sale or use (Hanson et al., 2009; Githinji et al.,

2008).

Other barriers are the residual effects and socio-cultural beliefs. A study done in 2010 by Sood et. al., in villages of Uttar Pradesh, India revealed that 2.8% of the respondents had reported skin irritation/ itching in LLIN villages (in Olyset net villages), only 0.16% of respondents reported eye irritation and 1.5% of respondents reported suffocation (Permanet village). According to the International POPs Elimination Project (IPEP) report, the known health effects of Indoor Residual Spraying of DDT on South Africans include: Adverse effects on male reproduction system; Increase in incidents of preterm births, underweight babies; Increase in urogenital birth defects; contaminated breast milk in lactating mothers; Potential Increases in Infant Mortality.

The community's cultural practices influence the utilization of the LLINs for example in some communities when there is a funeral family and friends stay overnights at the diseased home to comfort and show the family that they share in their sorrow. During this time no LLINs are used since sleeping arrangements are not made. Moreover, if you carry a LLIN you will create a picture that is not acceptable, that is, you want comfort where people are mourning (Goesh et al., 2007).

Kodiaga (2009) asserts that household users are mainly exposed to the residual chemicals of IRS through dermal contact with sprayed surfaces and incidental ingestion of insecticide after their houses have been sprayed, especially when food or drink are left in the house during spraying. Leaky equipment can also lead to insecticide exposure through dermal contact with the floors and incidental ingestion by children who may come in contact with the spills before they are cleaned up. These chemicals pose health risks, which some household users are not always willing to take.

Disposal is a key issue with IRS intervention that utilizes pesticides especially during the decontamination process and disposal of the liquid effluent that will arise from washing and progressive rinse. Both burying and dumping can lead to dermal exposure to residents who come in contact with the soil or water in which the pesticide was disposed. Ingestion exposure can occur from drinking contaminated surface water. Once the excess formulation gets into the soil, the pesticide can reach the groundwater, which may be used as a water supply via household wells. Residents may then be exposed to this contaminated water by ingestion or by dermal contact when it is used for cleaning or drinking purposes (USAID, 2011).

Research Methodology

This study employed a quantitative, descriptive cross-sectional study design.Collected data was changed into numbers for easy interpretation thus quantitative descriptive. In addition, the study mainly focused on the efficacy and impacts of LLINs utilization and IRS services of a representative subset (sample) in Kaptumo location, at one specific point in time without any manipulation of the variables from the investigator. A pilot study was conducted at Chemundu village where the questionnaire was pretested.

The study population consisted of 3176 households in Kaptumo location in which all family heads were required, after consenting, to answer the questionnaire that was administered.

Kaptumo is located in Kaptumo division in Nandi County situated on the western part of Rift Valley Province of Kenya. This location has a total population of 15,138, 3176 households and a population density of 283. The area is about of 638km2, approximately 65km from Eldoret town and 7km from Kapsabet town. Kaptumo enjoys cool climate for most part of the year apart from January, February and March. It receives above average rainfall annually with the temperature ranging 18º C to 25º C.

The numbers of households in Kaptumo location is 3176. Since this population was less than 10000, the sample size was calculated using the Fissures (1998) formula.

Stratified random sampling was adopted where the Location was subdivided into four existing sub-locations (strata). Using proportional stratified sampling, samples were proportionately drawn from each of the four strata having: Mugundoi = (946/3176 X 343) = 102; Chepkong'ony = (900/3176 X 343) = 97; Mosombor = (990/3176 X 343) = 107; Ibanja = (340/3176 X 343) = 37 questionnaires, respectively. Convenience sampling was then employed in the distribution of questionnaires within each of the four strata randomly by giving to the heads of families found at homes and *baraza.*

A self-reported questionnaire was administered with closed ended questions to all subjects(family heads) with the subject being al-

lowed to exercise an informed consent before responding to questions in the questionnaire. Microsoft excel and Statistical Package for Social Scientists (SPSS) Version 15.0 was used to code, manage and analyse the collected quantitative data. The data was interpreted at 95% confidence interval and P value was used to predict the enormity of associations. A paired sample t test and binomial regression were used to test the hypotheses.

Results and Discussion

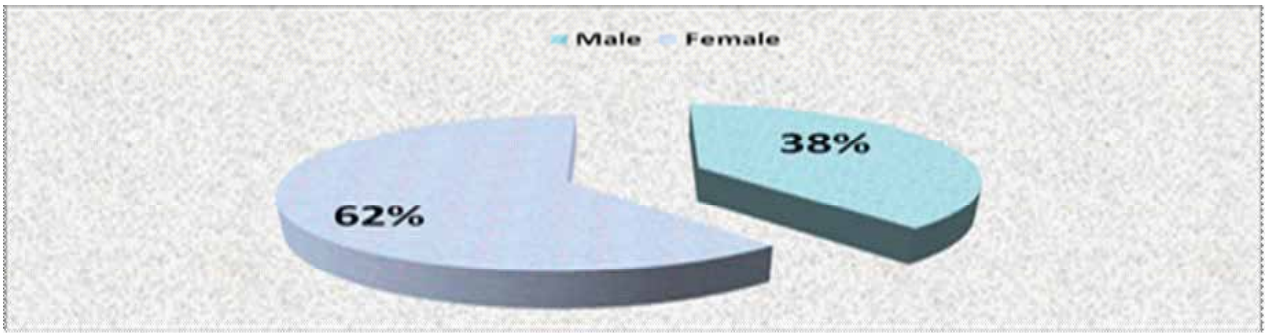

Figure 1. Gender of the respondents

As indicated, more females (62%) than males (38%) participated in the study. Having the tea factory around and most males being breadwinners, the males could not be found as the data collection time fell during their working hours.

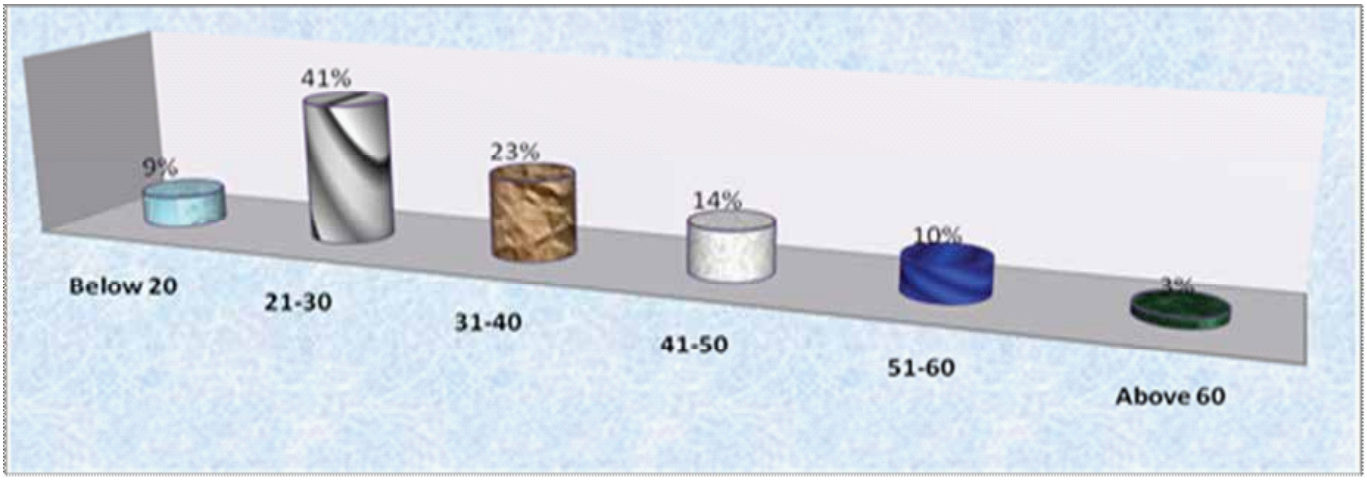

Figure 2. Age distribution of the respondents

The above figures are basically due to high population of the youths in developing countries who are in pursuit of employment and better lives. This is in line with the Kenya demographic profile, which provides the distribution of the population according to age group, and affirms that the age group of 15-64 years accounts for 54.7% of the Kenyan population (KDP, 2011).

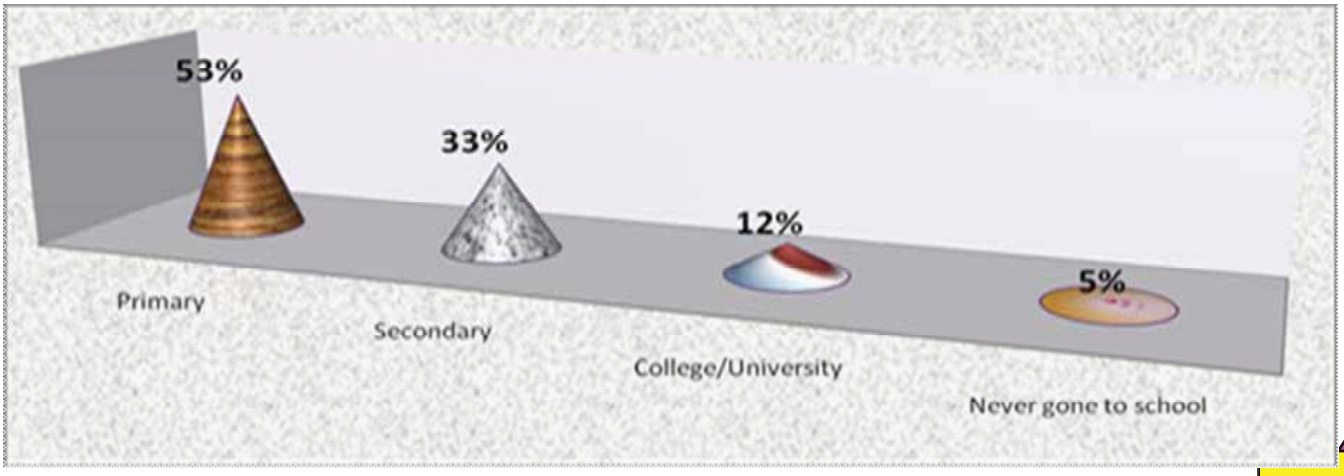

Figure 3. Educational level of the respondents

The bar graph above summarizes the educational level of the respondents most of who are primary drop outs. Being the first phase of formal education in Kenya, primary education is the more accessible form of education and this could explain why it has the majority of the respondents. In addition to this Kaptumo being a semi-urban area, cultural beliefs still have its toll and education beyond primary school is yet to be assimilated in that families are still given first priority.

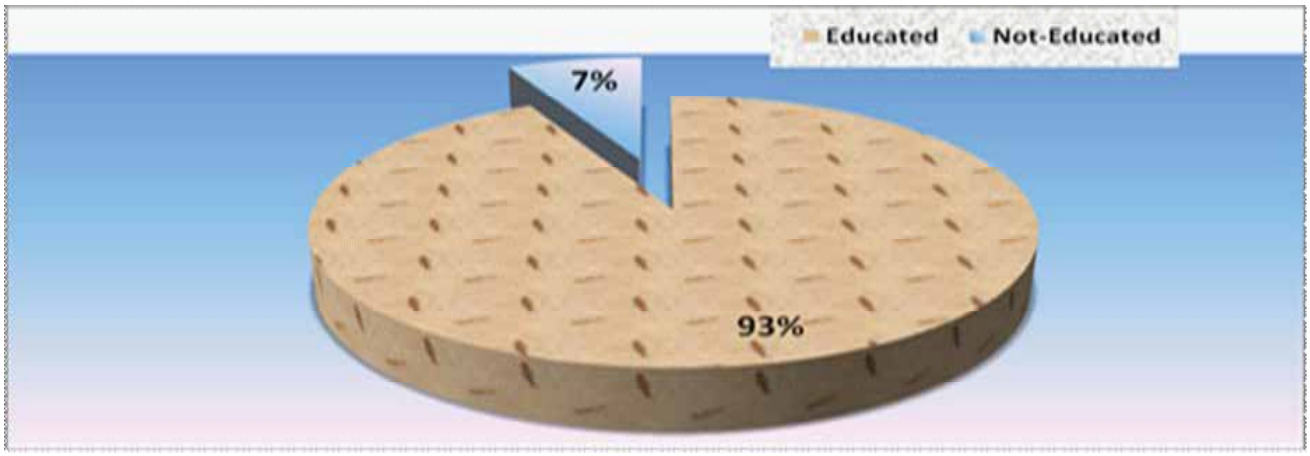

Figure 4. Understanding on malaria based on educational status

Table 1

A Chi-square Test Done in Determining Influence of Education on Understanding of Malaria

	Value	Df	Assymp sig (2 sided
Pearson Chi-Square	**11.279(a)**	**3**	

The influence of education on understanding about Malaria was determined through a chi square test. There was a relationship between understanding on Malaria and educational status with statistical significance of 0.01 (see the table above). Those respondents with some form of formal education have a clear understanding on malaria at (93%) than those who do not have any form of formal education at (7%). This is mainly because those who are educated can get more information from the health materials they come across in that they can read and understand more compared to those not educated.

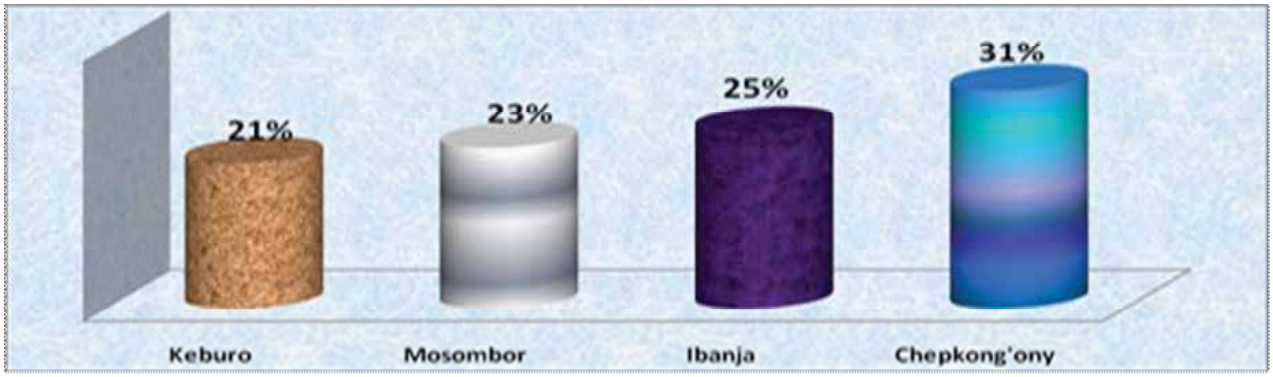

Figure 5. Understanding on malaria based on sub-location

Table 2
A Chi Square Test Done in Determining Understanding on Malaria Based on Sub-Location

Chi-Square Tests

	Value	df	Assymp sig (2 sided
Pearson Chi-Square	**9.652(a)**	**3**	

Further analysis of the data to verify whether sub location influenced understanding on Malari-awhich was determined through a chi square test and it came out clearly that there is a relationship as justified by a significance value of 0.022. As illustrated in the bar graph above, Chepkongo'ny sub-location led in understanding on malaria. This is probably due to the fact that this sub-location leads in the level of literacy and it also has dedicated CHWs who ensure that the community is well aware of the disease and the required control measure.

Impact of LLINs and IRS Against Malaria Vector

Frequency of having malaria before usage of LLINs and IRS

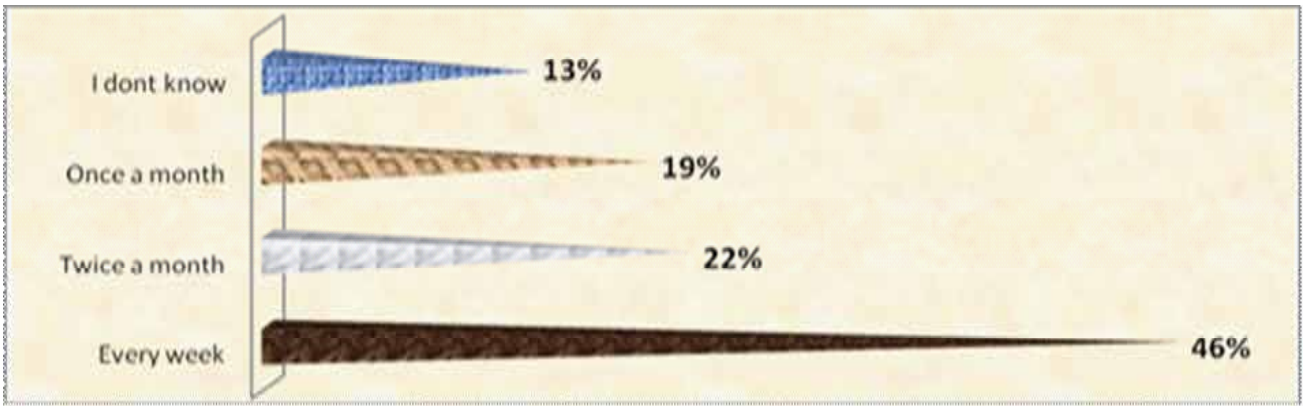

Figure 6. Frequency of Having Malaria before usage of LLINs and IRS

Figure 6 above illustrates the frequency of having malaria before usage of LLINs and IRS.As indicated in the bar graph most of the respondents at (46%) got sick weekly before the commencement on the prevention intervention methods for malaria. It was however, noted that only 13% of the respondents did not know the frequency of malaria cases before the utilization of LLINs and IRS as prevention intervention methods for malaria.

The indication in the bar graph with most of the respondents at (46%) getting sick weekly before the commencement on the prevention intervention methods for malaria, is mainly because the respondents did not have any protection on the mosquito bites and mosquito being the main vector then more cases are experienced. This is in line with the WHO facts that the transmission of the plasmodium parasite (which is the causative agent) is through the bites of infected Anopheles mosquito vectors.

Changes experienced since starting to use LLINs and IRS

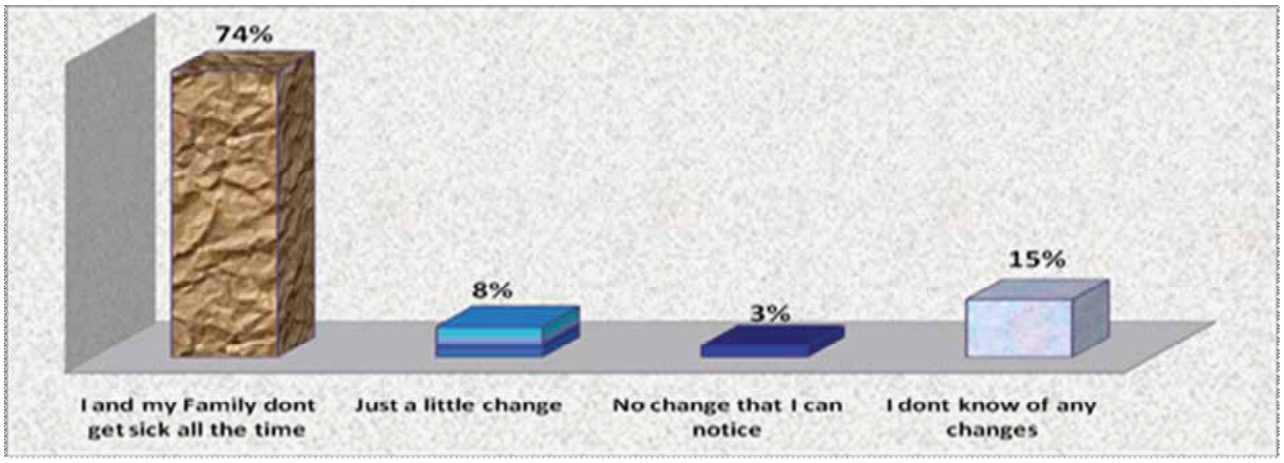

Figure 7. Changes experienced since starting to use LLINs and IRS

As illustrated, above most of the respondents at (74%) admitted that after the commencement of LLINs and IRS utilization, malarial cases reduced in that they did not get sick all the time with malaria. Only 3% of the respondent did not have changes that they could notice even after commencing the utilization of LLINs and IRS.

The illustration in the bar graph that most of the respondents (74%) admitted that after the commencement of LLINs and IRS utilization malarial cases reduced, concurs with studies that have been done in Africa which have demonstrated that wide-scale use of LLINs can reduce all-cause mortality in children by about 20% and the number of clinical malaria episodes in the same age group by as much as 50%. Generally malaria illnesses and deaths are down by 50% in Kenya. Studies in intense malaria transmission areas in western Kenya also demonstrate that women who were protected by LLINs gave birth to approximately 25% fewer babies who were either small for gestational age or born prematurely than those not protected by LLINs (Yartey, 2006; Hawley, 2003).

Okumu and Moore (2011), confirm that other than intermittent preventive treatment (IPT), artemisinin-based combination therapy (ACT) and improved case detection by rapid malaria diagnostic tests (RDTs), recent declines of malaria are mostly attributable to expanded use of LLINs and IRS.

The WHO also affirms that increased malaria prevention and control measures are dramatically reducing the malaria burden in many places. Malaria mortality rates have fallen by more than 25% globally since 2000 and by 33% in the WHO African Region (WHO, 2010).

Table 3

A Chi Square Test Done in Determining whether There Was A Reduced Frequency on Having Malaria Cases After the Commencement of the Prevention Intervention Methods

	Value	**df**	**Assymp sig (2 sided**
Pearson Chi-Square	**22.694(a)**	**12**	

To further understand the impacts of LLINs and IRS, this study went further to verify whether there was a reduced frequency on having malaria cases after the commencement of the prevention intervention methods. This was determined through a chi square test and it came out clearly as the table above outlines that indeedthere was a relationship between frequencies of having malaria before the com-

mencement of the prevention intervention methods and changes experienced after the commencement of the prevention intervention methods. This is justified by the statistical significance of 0.03 as indicated by the chi-square test table above.

Efficacy in utilization of LLINs

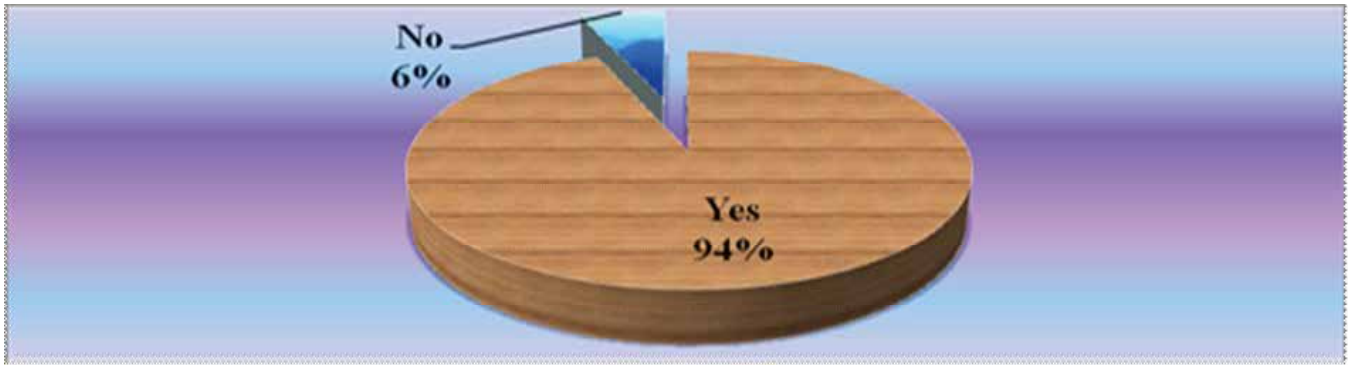

Figure 8. Understanding on Malaria

With regards to the determination of whether the population was efficaciously utilizing the LLINs, the respondents were asked whether they understood what malaria was and as indicated by the pie chart an overwhelming 94% of the respondents agreed that they indeed understood the disease. Only 6% of the respondents did not understand what malaria was.

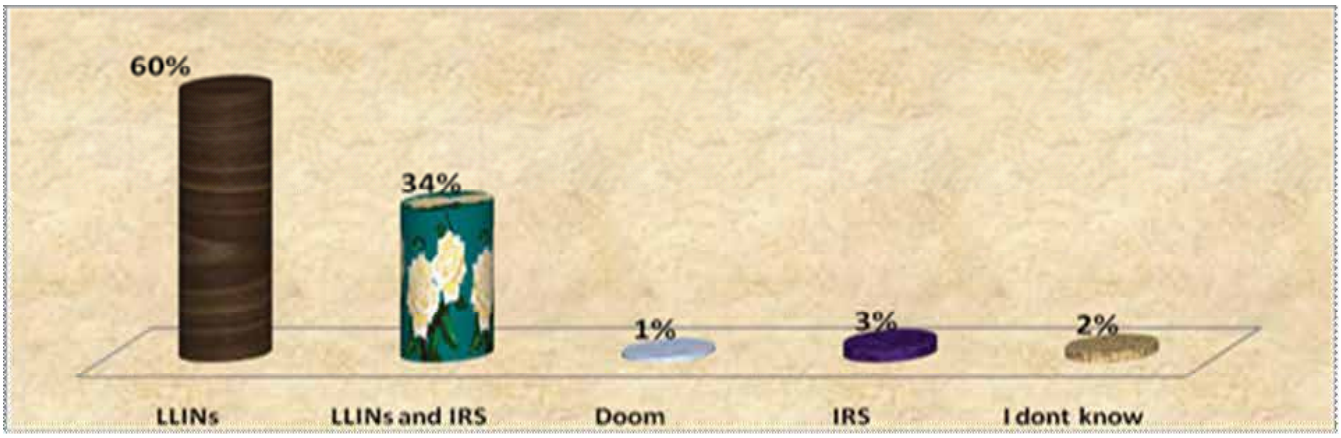

Figure 9. Prevention methods of Malaria

Having understood what malaria was the study went further to know whether the population knew of any prevention measures that can be taken. The bar graph above gives the respondents knowledge on the prevention methods of malaria. 60% of the respondents believed that LLINs could be used in preventing the disease and only 1% of the respondents believed that doom could still be used in the prevention of malaria. However 2% of the respondents did not know on the preventive intervention methods of malaria.

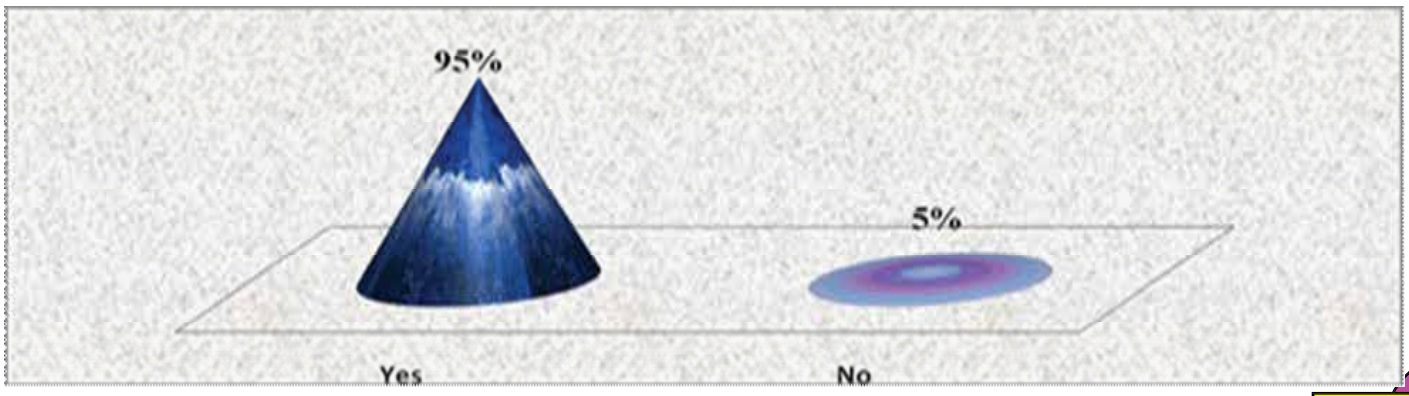

Figure 10. Utilization knowledge on Prevention methods of Malaria

The study went further to determine the utilization knowledge on prevention methods of malaria among the respondents who knew the prevention intervention methods used in malaria control. 95% of the respondents admitted that they knew how to use the prevention intervention methods and only 5% of the respondents did not have any knowledge on the prevention intervention methods.

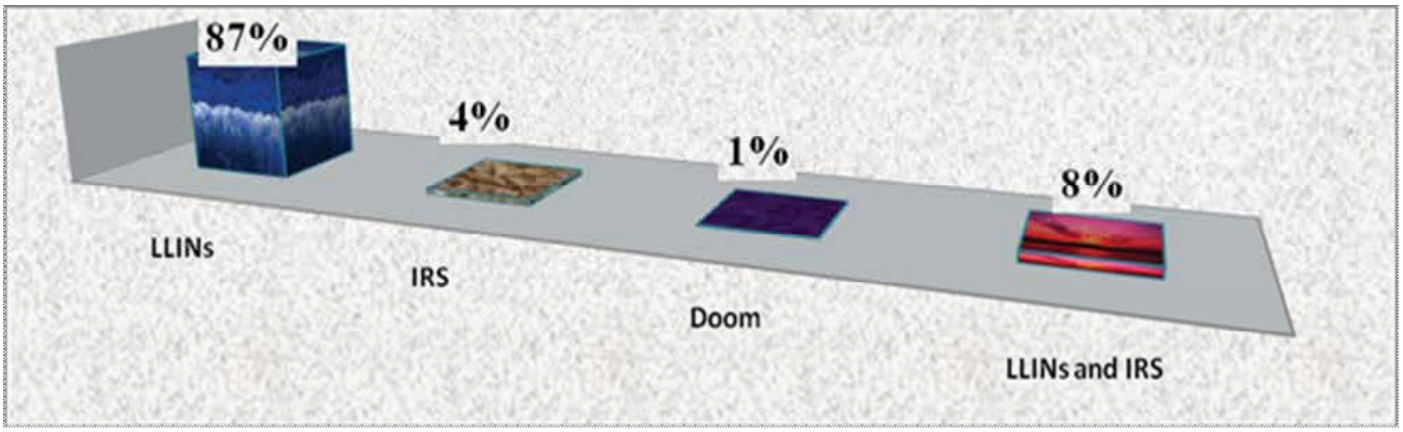

Figure 11. Preferred Prevention Methods by the household users

Figure 11 above illustrates the prevention intervention method preferred by the household users. As shown, majority of the respondents (87%) preferred LLINs compared to other prevention intervention methods.

Figure 12. Time of utilization of the LLINs

When asked on utilization time of the LLINs, 35% of the respondents confirmed that they used the LLINs every time they slept. 56% only used the LLINs at night only, 4% during the day only (mainly to keep of flies) and 3% whenever they felt like using the LLINs. It is however saddening that with the knowledge they had still 2% of the respondents did not use the LLINs even though they had them.

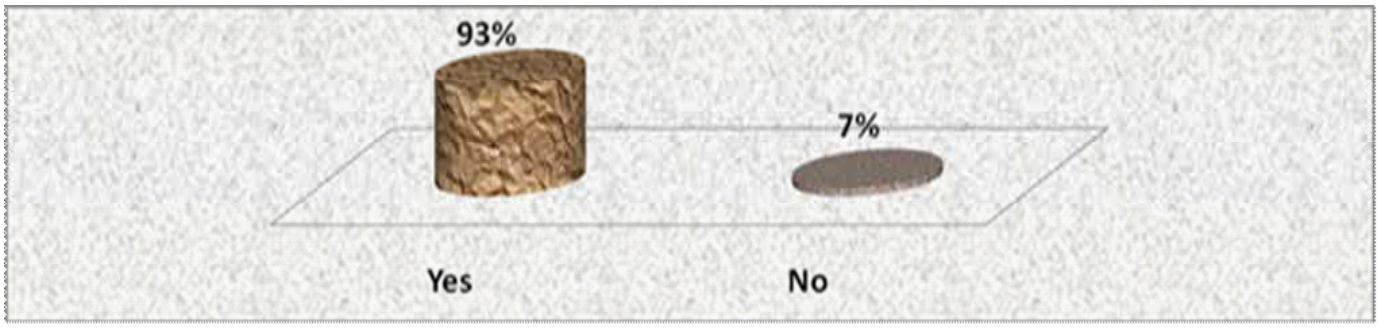

Figure 13. Knowledge on higher risk population

Majority of the respondents (93%) were well aware of those who are at higher risk of having malaria unlike 7% of them who did not know as indicated in the bar graph above.

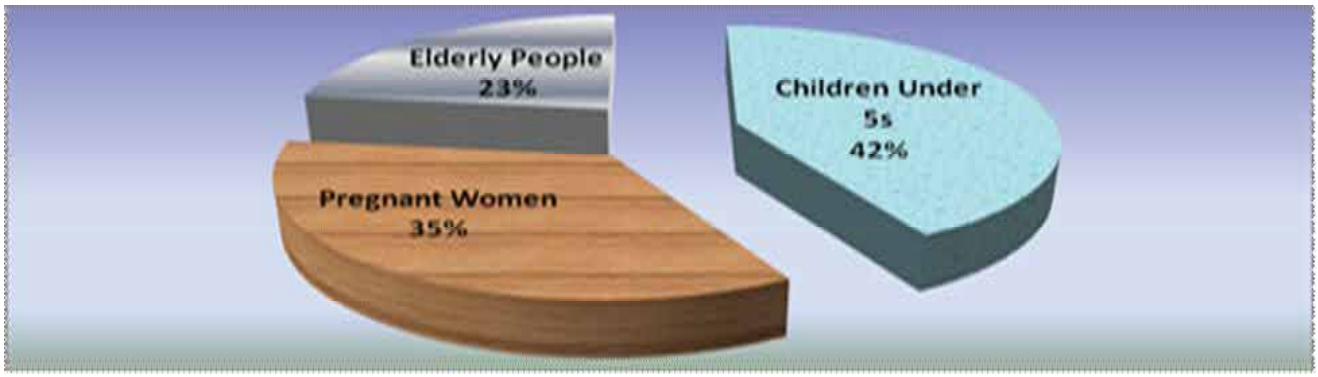

Figure 14. Higher risk population of having malaria

As indicated in the pie chart above among the respondents who knew those in higher risk of having malaria, majority 42% believed that the children under 5 years of age had higher chances of having malaria while only 23% believed the elderly were at a higher risk.

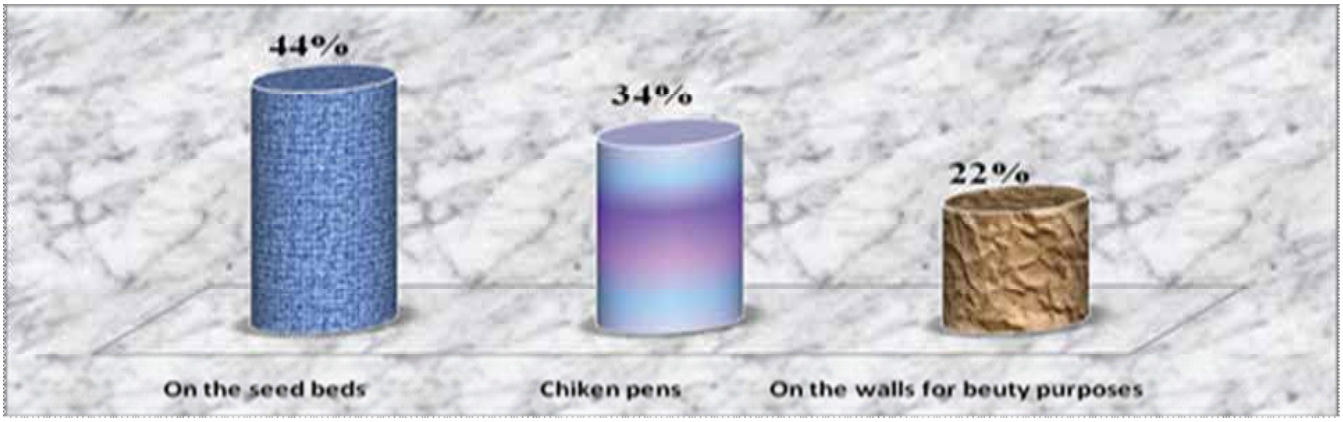

Figure 15. Other places where LLINs have been used

The bar graph in figure15 shows other places that the LLINs could be used apart from the bed, 44% of the respondents admitted that they could use the LLINs on the seed bed, 34% of them believed that they could also be used on the chicken pens, and 22% on the walls for beauty purposes.

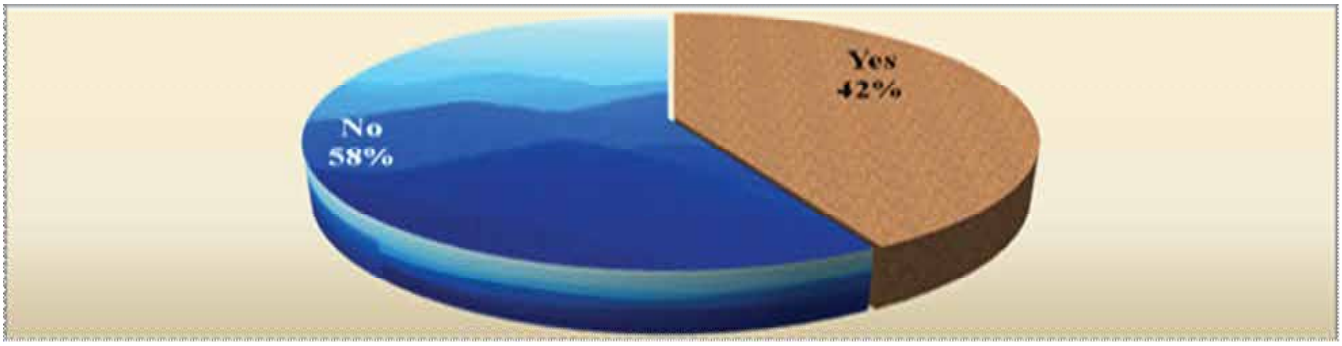

Figure 16. Those using the nets in the households

From the above bar graph, majority (68%) of the respondents agreed that all members of the family used the LLINs and only 4% did not use the LLINs at all.

By having the knowledge on malaria, risk populations, that malaria is a preventable disease and how to use its prevention intervention methods, one can efficaciously apply the required prevention intervention method in an effort to prevent or reduce the ceases of the disease. Another key element on efficacy is utilization time of the LLINs. Having the knowledge that in Africa all significant vectors (in

this case mosquito) bite at night in the early hours as confirmed by (Norris & Norris, 2011), efficacious utilization of the LLINs would mean that the LLINs would be used every time one sleeps and if not every night.

Barriers such as other places where the LLINs could be used, also affect the efficacy of the LLINs utilization. The findings of this study indicated that although 50% of the respondents believed that the LLINs should only be used on the beds, the other 50% had some other tasks of LLINs. This clearly shows that efficacy in utilization is yet to reach its actualization point in that it is yet to fully impact on the malaria cases within Kaptumo location. Among those who had other tasks for LLINs, an overwhelming 44% indicated that the LLINs can be used on the seed beds.

Through the interactions with the respondents, it was confirmed that the major reasons they use the LLINs on the seed beds is to protect the seedlings from destruction by the heavy rains and insects. They also said that due to lack of proper disposal of the LLINs after the required duration (5years) is not available hence the utilization as construction materials for the chicken pens. In addition, 22% of those who had other tasks for LLINs, admitted that they used the LLINs on the walls for beauty purposes.

Factors affecting the efficient utilization LLINs and IRS services

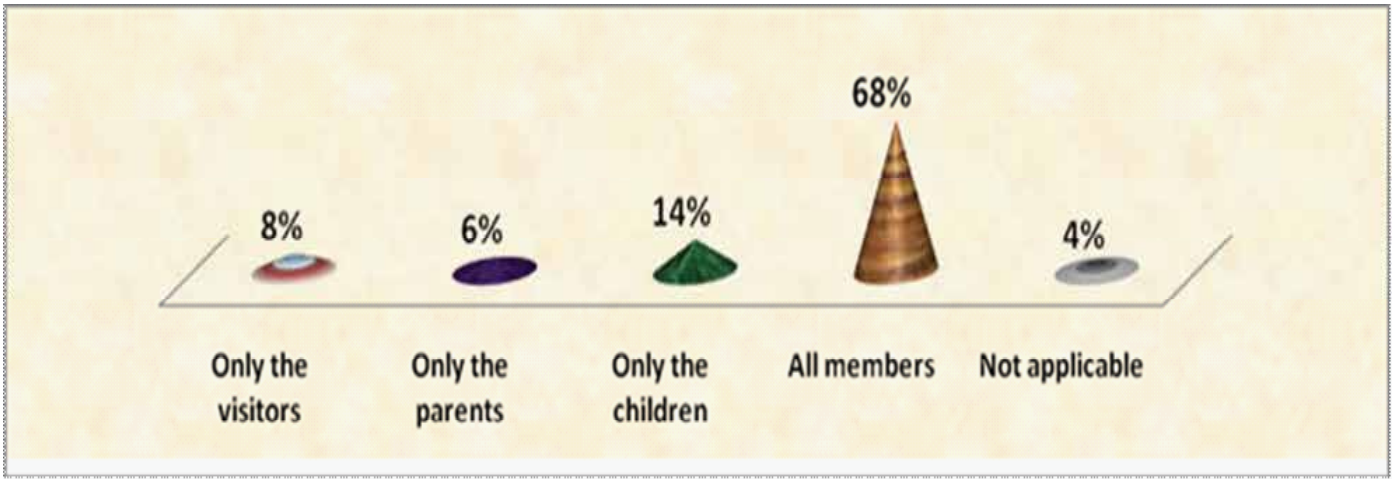

Figure 17. Not using the LLINs at times

As indicated in the pie chart above, majority of the respondents (58%) admitted they always used the LLINs while only 42% agreed that indeed there were times they did not use the LLINs.

As illustrated by the bar graph in figure 18, 50% of the respondents who believed that there were occasions where they did not use the LLINs admitted they could not use LLINs during funerals while only 9% believed they could not use them during night harambees.

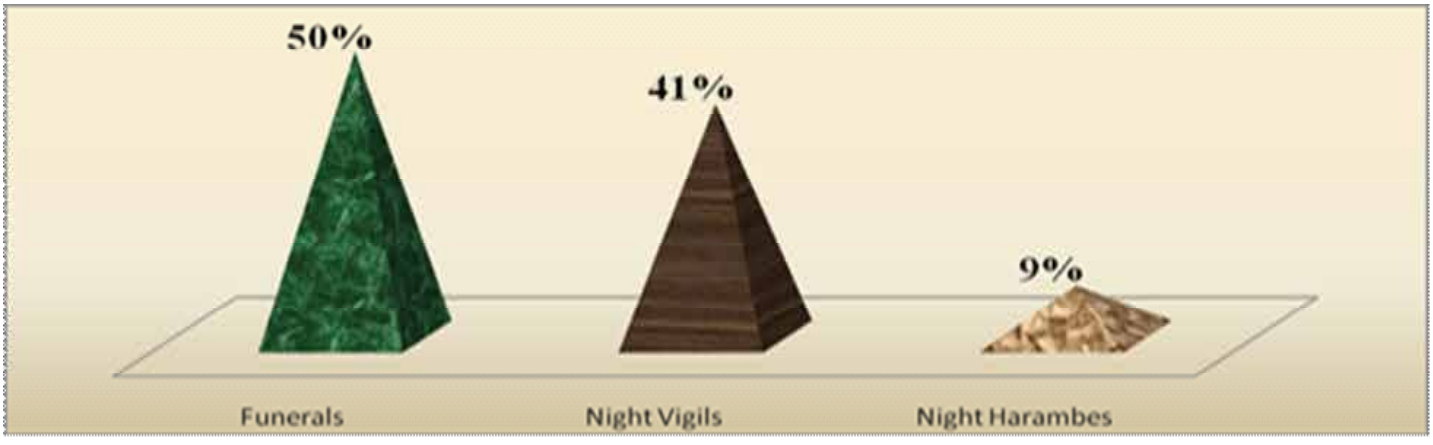

Figure 18. Occasions when LLINs are not used

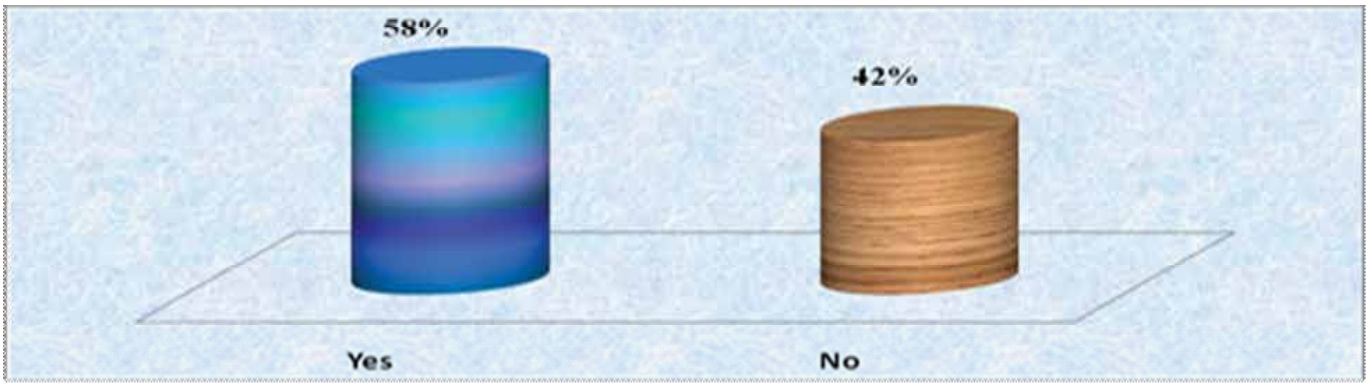

Figure 19. Experiencing any chemical effects when using LLINs and IRS

The above bar graph indicates that 58%, a substantially good number of the respondents experienced some effects of the chemical used whenever they used LLINs and IRS while 42% reported not being affected in any way.

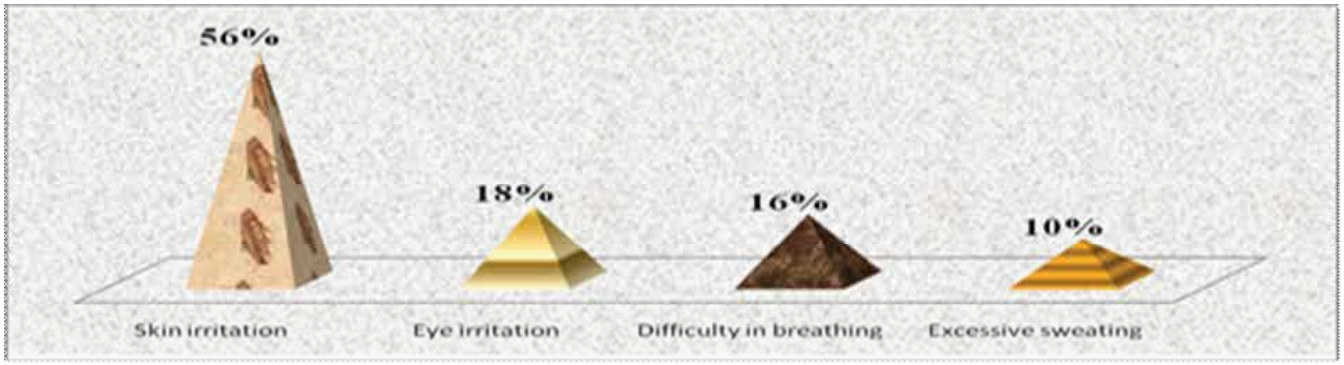

Figure 20. Chemical effects Experienced when using LLINs and IRS

As indicated in the above bar graph, a substantial majority of the respondents (56%) who had chemical effects experienced skin irritation while only10% experienced excessive sweating.

Majority of the respondents (73%) admitted they always allowed the utilization of LLINs and IRS whereas only 27% of the respondents did not. This is presented in figure 21.

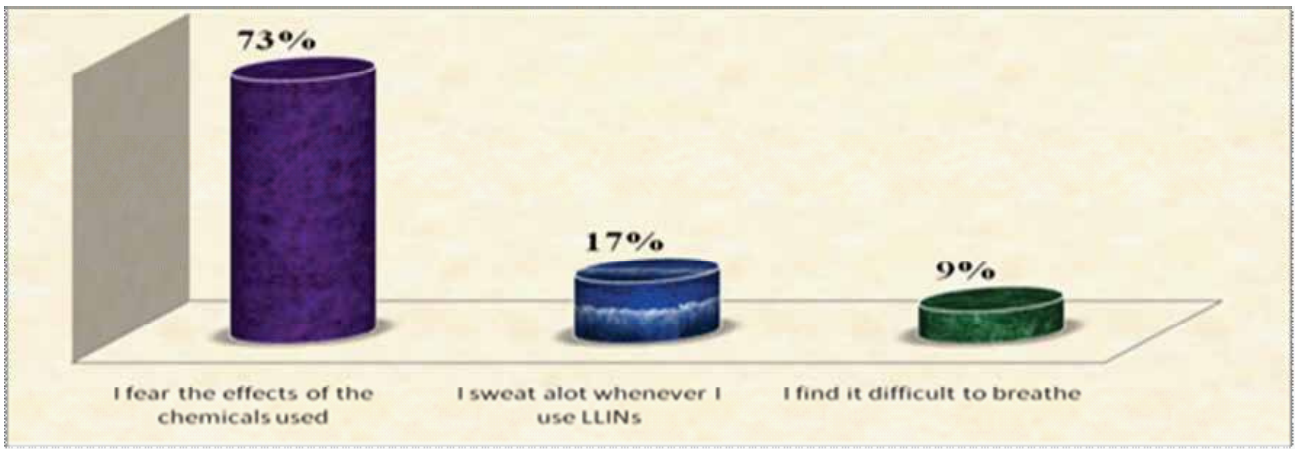

Figure 21. Always allowing usage of LLINs and IRS

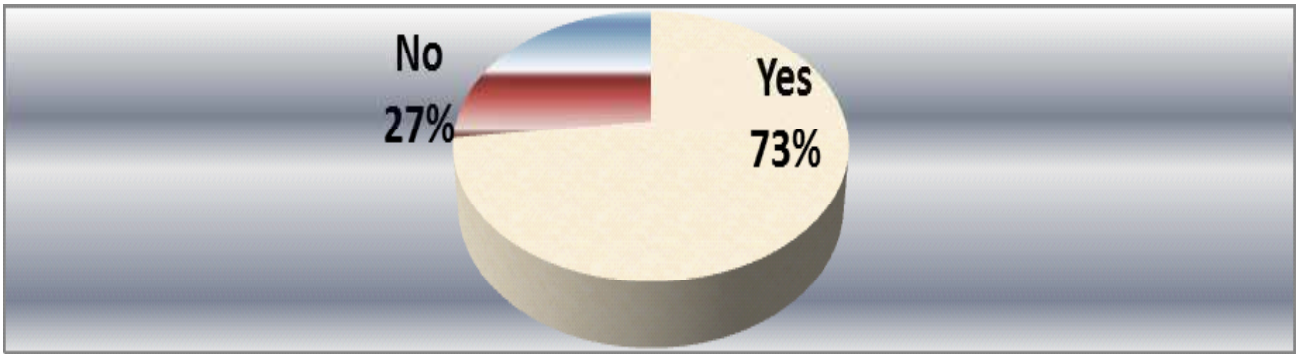

Figure 22. Why not allowing usage

Among the respondents who did not allow the utilization of LLINs and IRS, 73% of them admitted they feared the effects of the chemicals used, 17% did not like the excessive sweating they experienced and only 9% found it difficult to breathe when using the LLINs and IRS.

Generally, adherence to malaria prevention intervention practices in Kaptumo location is good. However, there are various factors that still affect efficient utilization of LLINs and IRS. This is to say that cultural and religious practices such as attending funerals, going for night vigils and harambes really affect the efficiency in LLINs and IRS utilization. For instance, in some communities when there is a funeral, family and friends stay overnights at the diseased home to comfort and show the family that they share in their sorrow. During this time, no LLINs are used since sleeping arrangements are not made, moreover if one carried a LLIN then you will create a picture that is not acceptable, that is you seeking comfort where people are mourning.

The findings of this study also indicate that chemical effects experienced also act as a barrier to the utilization of LLINs and IRS. Upon being asked whether they experienced any chemical effects as a result of their LLINs and IRS utilization, a substantial majority (58%) of the respondents accepted that indeed they had the effects. Further probing on the effects revealed that an overwhelming 56% of them admitted to having skin irritations, 18% eye irritation,16% had difficulty in breathing and 10% excessive sweating. In as much as majority (73%) of the respondents admitted to allowing usage of LLINs and IRS regardless of the effects, still 23% barred their utilization. Further questioning on reasons why they do not always allow the utilization of LLINs and IRS, 73% of them confirmed that they feared the effects of the chemicals used.

Hypotheses Testing

In the first hypothesis which was to test whether there was a significant relationship between preference on the method used and prevalence of Malaria in Kaptumo location, binomial regression analysis was employed to test the hypothesis.

Table 4

Binomial Regression Analysis on the Significant Relationship between Preference on the Method Used and Prevalence of Malaria in Kaptumo Location.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta	B	Std. Error
1 (Constant)	1.884	.132		14.238	.000
Preferred Method by the household users	.176	.086	.120	2.043	

P<0.05 or P= 0.042

Based on the readings from the above tables there is indeed a significant relationship between the preferred method of prevention intervention and prevalence of malaria in Kaptumo location. This is statistically significant at 0.042 which is below the Alpha value of 0.05. This clearly indicates that the null hypothesis is rejected and the alternative hypothesis is accepted. This shows that the method of intervention preferred i.e. (LLINS or IRS) predicts the prevalence of malaria after adoption of the intervention by Kaptumo residents. Based on the findings of this study residents of Kaptumo location prefer the LLINs more compared to the IRS. The major reason that clearly manifested was the fear of effects of the chemicals used in IRS. This significantly affected their attitude toward IRS.

For the second hypothesis which tested whether there was a significant difference in prevalence of malaria before and after the prevention interventions in Kaptumo location were adopted, paired sample t-test was employed in the testing.

Table 5

Paired Sample T-Test Analysis on Significant Difference in Prevalence of Malaria Before and After The Prevention Interventions in Kaptumo Location Were Adopted

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		Mean	Std. Deviation	Std. Error Mean
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
1 Frequency of having Malaria before usage of LLINs and IRS - Changes experienced since starting to use LLINs and IRS	.413	1.381	.082	.252	.573	5.054	285	

P<0.05 or P = 0.001

With the significance standing at 0.001, there is a clear indication that there is a very significant difference in prevalence of malaria after the prevention interventions (LLINs and IRS) than before the prevention interventions in Kaptumo location. Following the set P value of 0.05, it is very appropriate to reject the null-hypothesis accept the alternative hypothesis.

Conclusion and Recommendations

In conclusion, conformity to malaria prevention intervention practices in Kaptumo location seems to be good. However, efficacy, efficiency and full impact of LLINs utilization and IRS services is yet to be fully realized and appreciated. Barriers to the efficacy and efficiency in utilization of LLINs and IRS services are still eminent as indicated by the findings having half (50%) of the respondents believing in other tasks for the LLINs other than the beds. Moreover, in as much as majority (73%) of the respondents admitted to allowing usage of LLINs and IRS services regardless of the effects, still a sizable percentage (23%) barred their utilization in the fear of the chemical effects that come with these prevention intervention method. It is therefore important to note that work still needs to be done in order to achieve the MDGs and Kenya's vision 2030 on health and most importantly make Kaptumo a malaria free zone.

Having the findings and the supportive literature review of this study as the focus, the following recommendations are suggested: The Public Health department in Kaptumo location should intensify Health education and promotion services on malaria in order to eliminate the existing perception of using the LLINs for other tasks. The government through the ministry of Public Health and Sanitation should

come up with proper LLINs disposal mechanisms so as to eliminate excuses such as lack of disposal facilities. Other prevention intervention methods such as mosquito repellant should be encouraged for cultural and religious occasions. A further study should be conducted in order to come up with malaria vaccine so as to upgrade the prevention aspect of this disease.

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