

Household and Community - Based Factors Associated with Universal Coverage of Insecticide - Treated Nets (ITNs). Results from a Cross - Sectional Malaria Survey in Vihiga County, Kenya

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Abstract: ***Background:** Insecticide - treated nets (ITNs) are an essential tool for preventing the spread of malaria. An adequate number of ITNs in households increases the probability of its use. Unfortunately, it's still unclear what factors prevent households from achieving universal coverage of ITNs despite the free mass net distribution every three years. This paper explored the household and community - based factors associated with universal ITN coverage in Vihiga County, Kenya. **Methods:** A cross - sectional survey was conducted among households in Vihiga County. Households were enrolled through multistage sampling and data was collected through structured questionnaire. Universal coverage was defined as the proportion of households with at least one ITN for every two people. Bivariable analysis was conducted using the chi - square test while determinants of universal coverage of ITNs and usage were assessed using multivariable logistic regression at a statistical significance of P - value < 0.05 and 95% confidence interval. **Results:** The study revealed that 262 (59.55%) had achieved universal coverage. Factors associated with universal coverage included household head marital status ($P=0.04$), ease in setting up the ITN ($P=0.011$). Household head married/ living with their partners also had a three times better likelihood of ITNs use ($OR=3.46.95\%CI= 1.47 - 8.17$). Education level was not significant in the attainment of universal net coverage. **Conclusion:** Only 59.55% of households had attained universal ITN coverage against the global target of at least 80%. Free mass net campaigns should be encouraged with more focus on single household heads or those staying alone. Additionally, a replacement framework of destroyed ITNs should be considered in order to maintain universal ITN coverage.*

Keywords: Universal ITN Coverage, Mass Net Distributions, Insecticide Treated Net, Vihiga county

1. Introduction

Malaria is a deadly disease, claiming hundreds of thousands of lives each year, and yet it remains preventable and treatable if the right interventions are in place (Hemingway et al., 2016). One of the most effective interventions to reduce malaria is the use of insecticide - treated nets, or ITNs¹. ITNs are distributed in the form of long - lasting insecticidal nets, which are designed to be hung up in a home to protect sleeping individuals from mosquito bites. However, despite the proven effectiveness of ITNs in reducing malaria, many countries, particularly those in the developing world, have struggled to achieve universal coverage of ITNs².

Malaria is a major public health problem in sub - Saharan Africa, with an estimated 270 million cases and 445, 000 deaths in 2016, accounting for 90% of the global malaria burden³. Achieving universal coverage of insecticide - treated nets (ITNs) is a key intervention in the control of malaria⁴. In addition to reducing the burden of malaria, ITNs have been associated with improved health outcomes and increased life expectancy⁵.

The 2005 World Health Assembly (WHA) set targets of $\geq 80\%$ coverage for four key interventions, including ITNs⁶. Because of the effectiveness of LLINs in malaria prevention, WHO recommended universal coverage (defined as one LLIN per two persons) of LLINs in 2007⁷. However, despite the clear benefits of ITNs, there are several challenges to

achieving universal coverage. While ITNs are available in many African countries, they are not always used by those at risk of malaria, including pregnant women and children⁸. In addition, there is a lack of awareness of the benefits of ITNs and limited resources for their distribution and use. However, despite nearly a decade of universal coverage campaigns, no country has achieved a measured level of 80% of households owning one ITN for two people in a national survey². Estimation of universal coverage uses an algorithm to calculate the number of ITNs needed for procurement based on population. Universal states that on average two people share a net, meaning that if one net is given for every two people in a household, all members have a chance to use an ITN⁹.

Given the challenge of achieving universal coverage of ITNs, it is important to understand the factors associated with their availability at the household and community level. Previous studies have examined the use of ITNs concerning socioeconomic factors, such as education and income levels¹⁰. However, there is limited evidence based on the impact of household and community - based factors such as the availability of ITNs, access to health services, and knowledge and attitudes towards ITN uses¹⁰.

In light of the existing gaps in the evidence base, this study seeks to identify the household and community - based factors associated with the universal ITN coverage in rural western Kenya. By understanding the factors associated with

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universal ITN coverage, we can inform strategies for achieving universal coverage and improving the health of populations at risk of malaria.

Universal coverage of ITNs is one of the main goals of malaria control and elimination programs worldwide, as it has been found to reduce the malaria burden by up to 50%¹⁰. However, achieving universal coverage of ITNs is not an easy task, and many factors influence the success of ITN campaigns. Universal coverage is a concept that seeks to ensure that all people have access to health services and goods, regardless of their socioeconomic status, ability to pay, or geographic location. The concept of universal coverage of insecticide - treated nets (ITNs) specifically refers to the goal of providing all people, regardless of their socio - economic status, ability to pay, or geographic location, with access to ITNs¹¹. The World Health Organization (WHO) is a key advocate of achieving universal coverage of ITNs, as it is a powerful tool for preventing malaria, a serious and potentially deadly disease. To reach this goal, countries must invest in the production, distribution and promotion of ITNs, and work to ensure that the populations most at risk of malaria are provided with access to these life - saving tools.

In this paper, we explored the potential socio - demographic factors and community - based factors associated with ITN use and achieving universal coverage of ITNs. Based on our findings, we propose recommendations for how to improve the effectiveness of ITN campaigns in achieving universal coverage. We hope that these findings and recommendations can be used by policymakers and public health practitioners to inform future ITN campaigns and help increase the coverage of ITNs in the most vulnerable populations.

2. Materials & Methods

Study design

The study was a population - based cross - sectional survey of the heads (Mother, Father or an adult household member interviewed during the survey) of the households in Vihiga county of western Kenya involving the four administrative wards; Wamuluma lugaga Central Maragoli, South Maragali, and Mungoma ward. The survey was carried out between 10th July - 30th July 2022

Sample size, sample design, and study population

A sample of 440 household heads were interviewed in Vihiga county in the sampled four wards; Wamuluma, Central Maragoli, South Maragoli, Central Maragoli and Mungoma in vihiga county. Households within the communities were enrolled through multistage sampling using a structured questionnaire. The survey targeted the head of the households (mother or father present during the house visit), hence one interview per household.

Statistical analysis

Descriptive and inferential statistics were used to analyze the data. Descriptive statistics, such as frequency counts and percentages, were used to describe the characteristics of the sample of respondents. Bivariable analysis was conducted to assess the association between the dependent variable, the universal coverage, and the independent variables using chi - square test. A multivariate logistic regression was performed

to assess the likelihood of achieving universal ITN coverage for the significant variable. The model utilized several predictor variables to predict the intended response (Harrell, 2015). All predictor variables were tested in one block to assess their predictive ability while controlling for the effects of other predictors in the model. Adjusted odds ratio (aOR) and 95% confidence interval are reported to establish determinants of universal coverage.

3. Result

Socio - demographic characteristics of the study population (table 1)

A total of 440 household heads were surveyed in the four wards in Vihiga county. 262 (59.55%) out of the total number of respondents achieved universal coverage of ITNs use. Participants ages were categorized into three groups, those in the age bracket of 31 - 60 had the highest number 269 (61.14%) as compared to other age categories, followed by >60 (94, 21.36%), and finally, ages 18 - 30 (77, 17.5%), see table 1.

Table 1: Sociodemographic characteristics of the study population

Categories	n (frequencies)	percent
Age groups		
18 - 30	77	17.5
31 - 60	269	61.14
>60	94	21.36
Marital status		
Married/ living with partners	298	67.73
Single/ never married	46	8.18
Divorced/separated	106	24.09
Religion		
Christians	419	95.23
Muslim	21	4.77
Education		
college/ university	36	8.18
Primary	262	59.55
Secondary	142	32.27
Number of household members		
mean value	5.952	
Number of ITNs in the households		
mean value	2.872	
Universal Coverage		
Yes	262	59.55
No	178	40.45

Descriptive analysis of community - based factors associated with universal ITN coverage (Table 2)

As seen in the table 2, 232 (52.73%) of the respondents agreed with the fact that there is a community initiative put in place for malaria prevention.

Family members who slept under ITNs, every time while in bed, were the highest at 45.45%, followed by every night, all season with 178 (40.45%) and finally sometimes while in bed with 60 (13.64%).

The majority of the respondents said that there are no community beliefs about ITNs use 433 (98.41%). See table 2

Table 2: Descriptive analysis of community - based factors associated with universal coverage of ITNs in Vihiga county, western Kenya (n=440)

	n	Percent
Availability of community interventions		
No	208	47.27
Yes	232	52.73
Community believes in ITN use		
No	433	98.41
Yes	7	1.59
Type of Governance		
CHV visit	307	69.77
No organized structure/effort	30	6.82
Village elders & CHC	103	23.41
A family member fell sick		
No	144	32.73
Yes	296	67.27
is there malaria prevention initiatives		
No	258	58.64
Yes	182	41.36
Any family member suffered from malaria		
No	193	43.86
Yes	247	56.14
How often family members slept under ITN		
Every night, all season	178	40.45
Every time, while in bed	202	45.91
Sometimes while in bed	60	13.64
Is it easy or difficult ITNs		
Not difficult at all	399	90.68
Very difficult	41	9.32
Distance to the nearest health facility		
4 - 7km (30 - 60 minutes walk)	135	30.68
7 - 15km (1 - 2hours walk)	28	6.36
1km (15 - minute walk)	69	15.68
3km (15 - 30 minutes walk)	208	47.27

Association between universal ITN coverage and household socio - demographic factors (Table 3)

Table 3 is a summary of the bivariable analysis of the association between sociodemographic factors and universal coverage of ITNs. Results showed that marital status was significantly associated with universal coverage of ITNs. Of those households that had attained universal coverage, 71.37% of the heads were married or living with their partners. Amongst the heads who were divorced/ separated, 60 (22.90%) of the households had attained universal coverage and finally amongst the single or who never married, 15 (5.73%) attained universal coverage

Other factors such as religion, level of education and age were found not significantly associated with the universal coverage of ITNs. The majority of the households whose heads attained primary school level achieved universal coverage 162

(61.83), compared to those with college/ university 22 (8.40) or secondary school 78 (29.77). Muslim respondents had the lowest number of those who achieved the universal coverage of ITNs at 4.96%.

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Association between universal ITN coverage and community - based factors (Table 4)

Table 4 shows the bivariable analysis of community - based factors associated with universal ITN coverage. The result shows that ease or difficulty in setting up ITNs (P value=0.011), and how often family members slept under ITNs (P value<0.001) were statistically significantly associated with universal coverage. Of those households who attained universal coverage, 230 (87.79%) had no difficulty in setting up ITNs, 129 (49.24%) had members who slept ITNs every time, (32.06%) slept under ITNs all season, 18.7% slept under net some of the times.

Table 4: Association between household and community - based factors and Universal Coverage of ITN in Vihiga county, Western Kenya

Factors	Universal coverage		Chi - square test, P - value
	Yes, n (%)	No, n (%)	
if community initiatives are in place on MP			
YES	134 (51.15)	98 (55.06)	0.420
NO	128 (48.85)	80 (44.94)	
if there are community beliefs on the use of ITN			
Yes	5 (1.91)	2 (1.12)	0.409
no	257 (98.09)	176 (98.88)	
Community health leadership and governance			

CHVs household visits	182 (69.47)	125 (70.22)	
no organized community structure/efforts through/ village leaders /CHCs	15 (5.73)	15 (8.43)	0.430
if any family member fell sick			
yes	173 (66.03)	123 (69.10)	
no	89 (32.730)	55 (30.90)	0.50
if there is a malaria prevention initiative			
no	157 (59.92)	101 (56.74)	
yes	105 (40.08)	77 (43.26)	0.506
if a family member suffered from malaria			
yes	152 (58.02)	95 (53.37)	
no	110 (41.980)	83 (46.63)	0.335
is there ease or difficulty in setting ITNs			
not difficult at all	230 (87.79)	169 (94.94)	
very difficult	32 (12.21)	9 (5.06)	0.011
Estimated distance to the nearest health facility			
4 - 7 km	87 (33.21)	48 (26.97)	
7 - 15km	19 (7.25)	9 (5.06)	
1 km	34 (12.98)	35 (19.66)	0.155
3km	122 (46.56)	86 (48.31)	
How often family members slept under itns			
Every night, all seasons	84 (32.06)	94 (52.81)	
Every time, while in bed	129 (49.24)	73 (41.01)	
Some of the time while in bed	49 (18.70)	11 (6.18)	<0.001

Multivariable regression analysis of factors associated with universal coverage of ITNs

Table 5 shows multivariable regression analysis to establish factors associated with the universal coverage of ITNs. Results showed that marital status and how often household members slept under ITNs were significantly associated with the universal coverage of ITNs.

Those who are married/ living with their partners (OR=3.46,95%CI= 1.47 - 8.17) had three times higher odds of UC coverage of ITN compared to those who are single/ never married. How often a family member slept under an ITN was associated with Universal coverage. Household family members who sleep under ITNs only some of the times had 0.25 times lower odds of UC (OR= 0.25, 95%=0.11 - 0.56) as compared to those who slept under ITNs, all the time, all the season.

Table 5: Multivariable regression analysis of determinants of universal coverage of ITNs use in Vihiga county, western Kenya

Variables	Adjusted Odds Ratio	p - value	95% CI Lower	95%CI Upper
Marital status				
divorced/ widowed	2.05	0.125	0.82	5.15
married/ living with their partners	3.46	0.004	1.47	8.17
single/ never married	REF			
Is there ease or difficulty in setting ITNs				
not difficult	0.64	0.323	0.27	1.55
difficult	REF			
If any family members fell sick				
Yes	0.84	0.458	0.53	1.34
No	REF			
How often household family slept under ITNs				
Some of the time while in bed	0.25	0.001	0.11	0.56
Every time while in bed	0.53	0.153	0.22	1.27
Every night, all seasons	REF			
Malaria prevention initiatives put in place				
Yes	0.84	0.472	0.52	1.35
No	REF			

4. Discussion

The main objective of this study was to assess household and community - based factors associated with achieving universal ITN coverage in Vihiga county, western Kenya. The study has established that about six out of 10 households have achieved universal ITN coverage where at least there is one ITN for every two persons living in the households. This level of coverage is still below the global target of at least 80%⁶. Low ITN coverage has been a challenge in sub - Saharan

African countries. A study conducted in western Kenya in 2015 has estimated that estimated effective long - lasting insecticide - treated net (LLIN) coverage was 70.5% (95 CI [58.7, 82.3]). Another study done in Nigeria established that the proportion of households with any ITN was only 42% overall while it was 75% in areas with the recent mass campaign and in these areas, only 66% of communities had coverage of 80% or even better¹². The study has confirmed that the current strategies of delivering ITN to households and in the community even though has significantly improve the

coverage, achieving and maintaining the global targets still remain a challenge, especially in rural communities.

Factors affecting universal coverage of ITN and use

The study has established that households where partners are married and living together have a significantly higher likelihood of achieving universal coverage compared to those where household heads are single, divorced, or separated. This is consistent with the findings of a study done on demographic and socio-economic factors affecting bed net ownership, usage and malaria transmission among adult patients seeking healthcare in two Ghanaian urban cities. The study showed that those married household heads were twice more likely to own and use a bed net respectively than those who never married¹³. This higher ITN coverage amongst households with married partners may be because members of large-size households are more likely to enroll or register in ITN mass campaigns and therefore receive enough ITNs to cover all household members¹⁴.

Another study conducted in Rwanda, revealed that those households headed by married or living with their partners (0.43 [0.36 - 0.52]) had 0.43 times the odds of ITNs use¹⁵. The findings of this study have shown that how often household members slept under ITNs was significantly associated with universal coverage of ITNs. Households where members slept under ITN all the time all season were more likely to have achieved ITN coverage. This could be due to more awareness and knowledge of use and nets and availability. Lower ITN coverage is associated with low use of ITNs and vice versa. According to¹⁶, only 39.8% of households owned at least one ITN per two people, and 34.7% of the general population slept under an ITN the night before the survey. This supports the findings of this study that the frequency of sleeping under bed nets facilitates the universal coverage of ITNs.

In the bivariate analysis, the ease or difficulty in setting up the ITN net was found to be significant with universal coverage of ITN use. Not having difficulty in setting up ITNs accounted for 87.79% of ITN coverage as compared to the difficulty in setting up the ITNs.

5. Conclusion and Recommendation

There was low universal ITN coverage (59.55%) among households in Vihiga county compared to the global target of at least 80%. Large families with married partners were more likely to achieve Universal coverage. Households whose members frequently use ITN were more likely to have better awareness and knowledge and are likely to have attained universal ITN coverage. Difficulty in setting up ITNs is a potential factor worth exploring as those households may be facing challenges or lack of knowledge on proper use.

Universal ITN coverage remains the goal for all people at risk of malaria. Free mass distribution of the ITN is crucial to the success of keeping the universal coverage of bed nets in the western region. To further improve coverage and to maintain universal ITN coverage, there should be deliberate efforts to explore more strategies to register all households during free mass net campaigns with special focus on single household heads or those living alone. This can significantly improve the

effectiveness of free mass ITNs distribution. Continuous distribution channels, replacement of destroyed ITNs, durability monitoring, and targeted social behavior change (SBC) on ITN use and Malaria prevention massaging especially in single or never married should be enhanced.

6. Policy Implications and Recommendation

Enhance pre- and post- mass ITN distribution education of households by Community Health Promoters (CHPs) during their routine household visits about the importance of registering for free mass ITN campaigns, ITN use, and how to properly set up and use them.

Provide targeted support to disadvantaged households, such as those with single household heads or those living alone, to ensure they have access to ITNs through flexible household registration strategies during mass ITN campaigns;

Enhance public health campaigns to raise awareness of the dangers of mosquito-borne illnesses, registration for the free mass net distribution, and the importance of ITN use.

Declaration by Authors

Ethical Approval: Approved

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