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2024 No. 206

DEMOGRAPHIC AND HEALTH SURVEYS

September 2024

DHS Working Papers No. 206

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September 2024

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Acknowledgments: We are very grateful to the United States Agency for International Development (USAID) for funding our research project. We acknowledge and thank the high-quality team of the ICF and the DHS Fellows Program. Particular thanks to Drs. Sara Riese, Elma Laguna, and Azaz Bin Sharif for their time in guiding us during the workshops and in preparing this paper. Their commitment and valuable contributions helped to shape and uplift the quality of this paper. We are also grateful for the extensive review by Taylor Cameron and appreciate all the hard work and time devoted to this publication. We are grateful to our institution, the Department of Geography, Geo-informatics and Climatic Sciences, Makerere University, which granted us permission to participate in the Fellowship, despite other competing local demands.

This study was conducted with support from USAID through The DHS Program (#720-OAA-18C-00083). The views expressed are those of the authors and do not necessarily reflect the views of USAID or the United States Government.

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Editors: Diane Stoy and Greg Edmondson
Document Production: Natalie Shattuck, Joan Wardell, and Chris Gramer

Recommended citation:

Semakula, Henry Musoke, and Frank Mugagga. 2024. *Predictors of Insecticide-treated Net Utilization among Children under Age 5 in Refugee Settlements in Uganda: Analysis of the 2018–19 Uganda Malaria Indicator Survey.* DHS Working Papers No. 206. Rockville, Maryland, USA: ICF.

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ABSTRACT

Background: The World Health Organization has identified the use of insecticide-treated nets (ITNs) as an effective approach for malaria prevention. Despite the distribution of ITNs by the Government of Uganda to refugees, malaria is among the key causes of mortality and morbidity among children under age 5 in refugee settlements. There are persistent challenges and complexities in malaria control and prevention efforts in these settings. By addressing the unique challenges faced by refugees in using ITNs for their children under age 5, we can make significant strides toward achieving malaria control and improving the health and well-being of children in refugee settlements.

Methods: We utilized data from the 2018–19 Uganda Malaria Indicator Survey, the first nationally representative survey that focused on malaria indicators in refugee settlements, to identify individual and household factors associated with ITN usage among children under age 5 in refugee settlements. Our analytic sample included 589 children under age 5 who live in refugee settlements. We used descriptive analysis to generate summary statistics, chi-square tests to assess the bivariate association between ITN use and the independent variables, and multivariable logistic regression modeling to assess the magnitude of the associations after controlling for other covariates. All analyses considered the survey sampling design and sampling weights and were conducted with Stata version 18.

Results: The logistic regression analysis revealed several significant associations among factors that influence ITN usage. The odds of children sleeping under an ITN were higher if their mothers had secondary and higher education (8.1 times) as well as primary education (1.5 times) compared to children whose mothers had no education. The odds of children sleeping under an ITN were reduced by 50% if their mothers were pregnant, as compared to children whose mothers were not pregnant. The odds of children sleeping under an ITN were 70% lower if their mothers knew that "not sleeping in nets" caused malaria compared to those who didn't know. Mothers who were exposed to anti-malaria messages had lower odds of their children sleeping under ITNs. Greater odds of children sleeping under ITNs were observed if their mothers were able to hang the ITNs with ease (3.7 times). Households with televisions had lower odds of their children sleeping under ITNs. In addition, the odds of children sleeping under an ITN were reduced by 40% in female headed households compared to male headed households. Further, children in households in the northern refugee settlements had 2.4 times greater odds of sleeping under ITNs compared to those in the southern refugee settlements.

Conclusion: When correctly and consistently used, ITNs can provide significant benefits for malaria prevention. The results highlight areas of intervention that can increase ITN use among children under age 5 in refugee settlements in Uganda. Improving access to education for mothers, providing targeted health education on the importance of ITN usage during pregnancy, dispelling misconceptions about malaria transmission, facilitating the proper installation of ITNs, addressing gender disparities in household decision-making, and ensuring equitable distribution of ITNs across refugee settlements can contribute to increased ITN utilization among children under age 5. Further exploration is needed to understand why television ownership and exposure to anti-malaria messages did not translate into increased ITN usage and to identify potential barriers or factors that influence this relationship.

KEY WORDS: children under age 5, insecticide-treated nets, malaria, Malaria Indicator Survey, refugees, settlements, Uganda

1 INTRODUCTION

Malaria, a vector-borne and a climate-sensitive disease, remains a major cause of mortality and morbidity worldwide. By 2022, an estimated 249 million malaria cases in 85 malaria endemic countries were recorded globally, with over 233 million cases (94%) documented in the World Health Organization (WHO) African Region.[1] In 2022, the WHO African Region accounted for 95.4% of deaths globally. Approximately 78.1% of all deaths in this region were children under age 5. The African countries that accounted for almost half of all malaria cases globally included Nigeria (27%), the Democratic Republic of the Congo (12%), Uganda (5%), and Mozambique (4%). Uganda, which accounts for 5% of the 249 million global malaria cases,[1] is also a leading host country for refugees in sub-Saharan Africa (SSA) that accommodates over 1.7 million refugees, of which 57% are children.[2] The refugees in Uganda come from neighboring countries in East Africa and the Great Lakes Region, where there is political instability, persecution, ethnic tensions, human rights abuses, and other calamities.

By 2023, South Sudan had the largest refugee population in Uganda (57%), followed by the Democratic Republic of the Congo (31%), and other refugees (12%) that came from Somalia, Rwanda, Burundi, and Sudan.[2] Most of the refugees (92%) live in settlement camps, while 8% live in Kampala, the capital city of Uganda. The refugee settlements in Uganda suffer from overcrowding, inadequate and temporary shelters, limited vector control efforts, and poor access to water and sanitation, all of which enable the rapid spread of malaria.[3] These conditions make children in refugee settlements vulnerable to malaria infections. A recent study conducted across nine refugee settlements in Uganda that utilized the 2018–19 Malaria Indicator Survey (MIS) dataset indicated that malaria prevalence among children under age 5 was 32.8%.[3] This is an emerging challenge that requires urgent attention.

The malaria burden in endemic countries is further amplified by climate change. The individual and complex interacting effects of temperature, rainfall, and humidity have been shown to expand the geographical scope of malaria, increase transmission intensity, reintroduce malaria in areas where malaria was recently eliminated, and enhance larval development, mosquito survival, the human biting rate, and the parasite development rate.[1,4,5] There is increasing evidence that refugee settlements in Uganda are exposed to extreme weather conditions and particularly high temperatures, as well as extreme and erratic precipitation.[6] This high level of exposure, in combination with the population's limited abilities to cope and adapt to climate change, has heightened malaria risks in already marginalized populations. Children in refugee settlements experience multiple life-threatening risks that include high rates of malnutrition and a variety of public health emergencies such as measles, cholera, typhoid fever, and hepatitis. Since the refugee population is steadily increasing in Uganda, malaria prevention among children must be given urgent attention to reduce the potential humanitarian crisis of malaria.

The use of insecticide-treated nets (ITNs) is one of the most effective ways to prevent malaria transmission and has proven to significantly reduce malaria morbidity and mortality across a range of transmission settings in Africa.[8–10] By 2022, a total of 254 million ITNs were distributed in all malaria endemic countries with an estimated 235 million (93%) distributed in sub-Saharan Africa (SSA).[1] Half of the ITNs distributed in SSA were received by six countries that include the D.R. Congo (33.6 million), Nigeria (28.4 million), Ethiopia (21.4 million), Sudan (18.9 million), Uganda (13.8 million), and Mali (12.5 million).[1] The Government of Uganda adopted the policy of mass distribution of ITNs as one of the significant

interventions for malaria prevention. Three mass campaigns across Uganda that included refugee settlements were implemented in 2013–14, 2017–18, and 2020–21.[11] Upon arrival, the refugees are given free ITNs by the United Nations High Commissioner for Refugees (UNHCR) in collaboration with Uganda's Malaria Control Division of the Ministry of Health. Since 2023, over 1.1 million ITNs have been distributed to refugees in Uganda.[12] This effort has led to additional free distribution of ITNs in homes, health centers, antenatal clinics, and children's clinics to promote access and increase utilization of ITNs among refugees and the general population. The ITNs kill or repel mosquitoes, which feed and rest indoors, as well as preventing mosquito bites at night.

Despite this high level of investment in ITN distribution in SSA, the incidence of malaria infections and associated deaths has continued to be a significant development challenge among the vulnerable populations in SSA.[13] Two recent studies, conducted in refugee settlements of Uganda and based on the 2018–19 MIS data,[3,14] identified malaria risk factors that include (1) age of child, (2) roof materials (thatch roofs), (3) wall materials (poles with mud and thatch walls), (4) lack of ITNs, (5) type of toilet facility (no toilet facility), (6) distance to water sources, (7) limited knowledge of the causes and prevention of malaria, and (8) mother's level of education. However, the utilization of ITNs in any community is influenced by varied individual, household, and community level factors that may not have been adequately considered during the distribution of ITNs. For example, studies have shown that the key determinants of ITN utilization in SSA also include hot weather, absence of visible mosquitoes, poor attitude about using ITNs, lack of ownership of ITNs, negligence among households, suffocation caused by ITNs, and unpleasant odor associated with ITNs.[13] In Uganda, the factors that influence the use of ITNs include access to ITNs, age of household head, sex of household head, number of sleeping rooms, wealth, malaria prevalence, mother's level of education, mother's knowledge of malaria transmission, residence, and region.[15–17]

Although these and other studies provide valuable insights about the factors that influence the general utilization of ITN, they provide no specific evidence about the determinants of ITN usage in refugee settlements of Uganda. This is important because context-specific behavioral and sociocultural information is key to understanding the interactions that encourage the utilization of ITNs within these unique local dynamic settings. Given the fact that malaria remains a significant health threat in refugee settlements, where resources are often limited and vulnerable populations face heightened risks, exploring ITN utilization among children under age 5 is essential. In refugee settings, where access to healthcare services may be constrained and living conditions exacerbate the risk of malaria transmission, the effective use of ITNs can be a life-saving intervention. Refugee populations in Uganda are structurally disadvantaged, which could potentially influence their access to ITNs and their utilization. In addition, the diverse social, cultural, and economic backgrounds of refugee populations can influence perceptions, beliefs, and practices related to malaria prevention and ITN usage. Research on ITN utilization among children under age 5 in refugee settlements can provide valuable insights into the effectiveness of interventions and the identification of barriers to ITN utilization that are specific to this vulnerable group. By understanding these barriers and tailoring interventions to address them, we can improve ITN coverage and compliance among children in refugee settings, which ultimately can reduce the burden of malaria and improve health outcomes in these refugee populations in Uganda.

1.1 Research Questions

This study addresses the following research questions:

1. What is the level of utilization of ITNs among children in refugee settlements of Uganda?

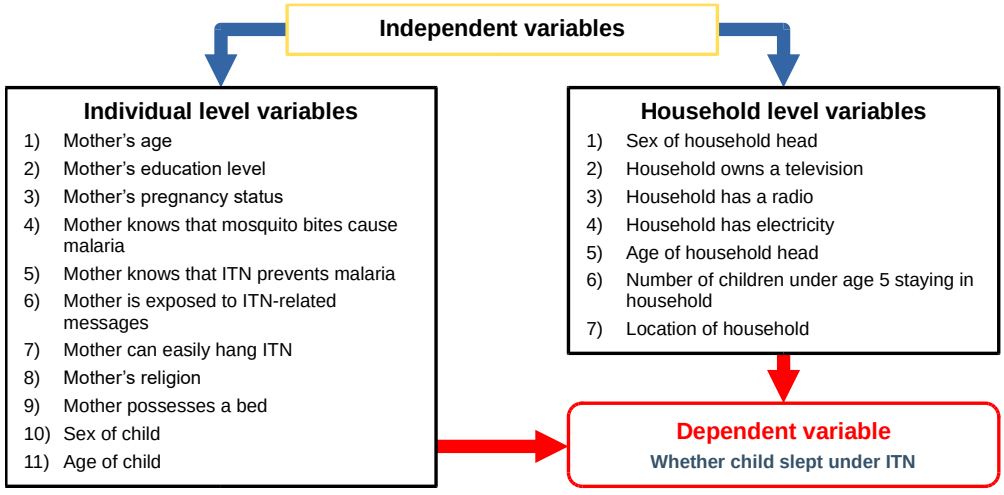
2. What individual and household level factors are associated with ITN utilization among children under age 5 in refugee settlements of Uganda?

This is the first study of the utilization of ITNs in refugee settlements of Uganda based on nationally representative datasets. Studying the factors that determine ITN utilization in these unique communities, which are characterized by overcrowding, inadequate and temporary shelters, limited vector control efforts, and occupation by people from diverse socioeconomic and cultural backgrounds, can lead to a better understanding of the actions that can increase ITN use in these settings. Well-informed targeted actions will improve the fight against malaria, which is the leading cause of mortality and morbidity in refugee settlements. The results of this study will provide important answers on ITN usage and will inform decisions on ITN distribution, access and utilization campaigns, the development of ITN replacement strategies, and the development and deployment of tools that include behavioral change communication activities. The results of this study will also inform the kinds of behavioral change strategies that will support greater ITN utilization in refugee settlements.

1.2 Conceptual framework

The variables used to construct the conceptual framework for this study were chosen from a review paper that focused on identifying factors associated with ownership and utilization of ITNs among children under age 5 in SSA.[13] The identified variables were categorized into two levels, individual and household, as shown in Figure 1 below.

Figure 1 Conceptual framework

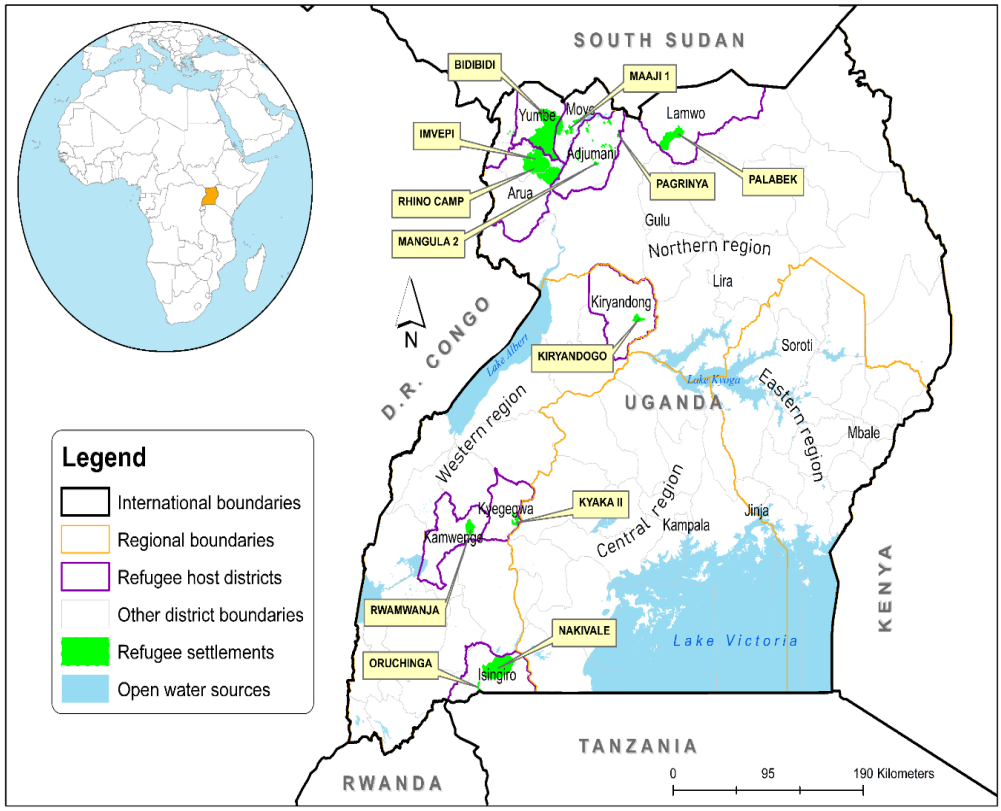


2 DATA AND METHODS

2.1 Data

The study is a secondary analysis of the 2018–19 Malaria Indicator Survey (MIS) of Uganda and 12 refugee settlements (Figure 2).

Figure 2 Location of refugee settlements in Uganda



The 2018–19 MIS is the third malaria survey conducted in Uganda. The MIS is a DHS Program survey and is a household-based survey designed to collect data focused on internationally accepted malaria indicators. This survey has specific questions about malaria and the testing of malaria parasitemia. The survey was conducted during the high malaria transmission period shortly after the rainy season. The MIS collected data on the availability and use of ITNs in households and several other malaria indicators in refugee settlements of Uganda. The sampling frame was based on Uganda's Population and Housing Census frame of 2014. This survey employed a two-stage stratified sampling procedure. In the first stage, we conducted stratification of the sampling frame by geographic area (urban, rural, and refugee). The stratification was based on the enumeration areas of Uganda's population census of 2014. Within the first stage, two activities were completed: selection of clusters from each stratum and the listing of households in the selected clusters. The second stage involved selection of the households to be interviewed. In this study, the unit of analysis was children. The Kids Recode (KR file) was downloaded from The DHS Program website (https://dhsprogram.com/). A total of 7,124 children were included in this survey. Since our focus was

children in refugee settlements, we excluded other children from non-refugee camps. After weighting and excluding children with missing responses (67), the sample size was 589 children.

2.2 Variables

2.2.1 Dependent variable

Our outcome variable was if a child slept under an ITN last night. In the KR file, this variable was coded with three categories: no net, only treated nets, and only untreated nets. This outcome variable was binary by showing if a child slept under a bed net the night before the survey (no = 0, yes = 1).

2.2.2 Independent variables

With our conceptual framework, two level variables (individual and household) that are associated with utilization of ITNs were identified from empirical evidence.[13] Both the individual and household level factors are shown in Table 1.

Table 1 Categorization of the independent variables

Independent variables	Categories
Individual level factors	
Child's age in months	0–11 months, 12–24 months, 25–59 months
Sex of child	Male or female
Age of mother (years)	<24 years, 25–34 years, 35–49 years
Mother's educational level	No education, primary level, secondary and above
Mother's pregnancy status	Pregnant or not pregnant
Mother's religion	Christian (Catholic, Anglican, Orthodox, Pentecostal, Jewish, Baptist) or Muslim
It's easy for mother to hang a bed net	Yes or no
Has a bed to sleep on	Yes or no
Mother's knowledge—not sleeping in net causes malaria	Yes or no (Does mother know that not sleeping under net causes malaria?)
Mother's knowledge—mosquito bites cause malaria	Yes or no (Does mother know that mosquito bites cause malaria?)
Mother's exposure to malaria messages	Yes or no
Household characteristics	
Sex of household head	Male or female
Age of household head (years)	<30 years, 31–39 years, 40 years or more
Household has television	Yes or no
Household has radio	Yes or no
Household has electricity	Yes or no
Region of residence	Northern Region (households in Adjumani, Arua, Moyo, Yumbe, and Lamwo districts) or Southern Region (households in Kamwenge, Isingiro, Kiryandongo, and Kyegegwa districts)
Number of children in household	1 child, 2–3 children, 3 or more children

2.3 Statistical Analysis

Three types of analyses were performed. These included descriptive analysis of the data resulting in summarized statistics; bivariate analysis to assess the association between the outcome and the independent variables using the chi-square test; and multivariable logistic regression modeling to assess the magnitude of the associations after including controls. Three multivariable logistic regression models were performed for (1) individual level factors, (2) household level factors, and (3) a combination of both the individual and household level factors. The multivariable logistic results are presented with adjusted odds ratios (AORs) with 95% confidence intervals (CIs). The p values of <.001, <.01, and <.05 were set for statistical significance. The data were weighted to account for disproportionate sampling and nonresponse. The analysis also adjusted for the effect of the complex survey design. All statistical analyses were conducted with Stata version 18.

3 RESULTS

3.1 Descriptive Statistics of the Respondents

A total of 589 children living in refugee settlements were included in the study. Table 2 presents the basic characteristics of the study population. For the outcome variable, 68.8% of the children in the refugee settlements slept under an ITN on the night before the survey. Children younger than age 11 months were 24.3%, those age 12–24 months were 37.2%, and those above age 25 months were 38.5%. In this study, 52.6% of the children were females, while 52.6% of the mothers of the children were age 25–34. In addition, 47.2% of the mothers had no formal education. Mothers who did not know that "not sleeping in nets" caused malaria were 93.9%, while 75.7% of the mothers were exposed to malaria messages. Although the majority of the mothers were exposed to malaria messages, 78.9% did not know that mosquito bites cause malaria infection. Six in 10 of the households were headed by women. Most of the households had two children (70.1%), and 45.2% of the household heads were younger than age 30, 33.1% were age 31–39, and 21.7% were above age 40. The majority of the households (94.4%) were categorized as poor. Most of the households (68.6%) were in refugee settlements found in the northern districts of the country.

Table 2 Characteristics of the study population

Variables	Number	Percent
Child's characteristics		
Age in months		
0–11	143	24.3
12–24	219	37.2
25–59	227	38.5
Sex		
Male	279	47.4
Female	310	52.6
Children slept under the net last night		
No	184	31.2
Yes	405	68.8
Mother's characteristics		
Age (years)		
Less than 24	153	26.0
25–34	310	52.6
35 and above	126	21.4
Educational level		
No education	278	47.2
Primary	263	44.7
Secondary and higher	48	8.2
Pregnancy status		
Not pregnant	544	92.4
Pregnant	45	7.6
Religion		
Muslim	56	9.5
Christian	533	90.5
It's easy for mother to hang a bed net		
No	13	2.2
Yes	576	97.8
Has a bed to sleep on		
No	265	45.0
Yes	324	55.0

Continued…

Table 2—*Continued*

Variables	Number	Percent
Knows not sleeping in net causes malaria		
No	553	93.9
Yes	36	6.1
Knows that mosquito bites cause malaria		
No	465	78.9
Yes	124	21.1
Exposed to malaria messages		
No	446	75.7
Yes	143	24.3
Household characteristics		
Sex of household head		
Male	235	39.9
Female	354	60.1
Age of household head (years)		
Less than 30	266	45.2
31–39	195	33.1
40+	128	21.7
Household has television		
No	583	99.0
Yes	6	1.0
Household has radio		
No	508	86.3
Yes	81	13.8
Household has electricity		
No	467	79.3
Yes	122	20.7
Region of residence		
Northern districts	404	68.6
Southern districts	185	31.4
Number of children staying in household		
One child	98	16.6
Two children	413	70.1
Three children and above	78	13.2
Total	**589**	**100.0**

3.2 Bivariate Analysis

The test of association between the dependent variable (ITN use) and the independent variables was performed with the chi-square test. The results are shown in Table 3. Only five independent variables (child's age, mother's education, pregnancy status, knowledge on causes of malaria, and ownership of a television) were significantly associated with the dependent variable (child slept under ITN last night). Utilization of an ITN was most common among children younger than age 11 months (76.7%) and children age 12–24 months. The use of ITNs among children younger than age 5 was higher among those whose mothers had secondary and higher levels of education compared to those whose mothers did not have any formal education (62.3%). Also, the use of ITNs among children was higher among those whose mothers were not pregnant (69.5%) compared to those whose mothers were pregnant (44.4%). In addition, the use of ITNs among children was highest among those whose mothers didn't know that "not sleeping in nets" caused malaria (68.5% compared to 45.9% among those whose mothers knew). Finally, the level of ITN utilization was higher among households that had no television (67.4%) compared to those with a television (33.1%).

Table 3 Association between dependent variable (child slept under net last night) and child's, mother's, and household's characteristics

	Percent	95% CI	*p* value
Child's characteristics			
Age in months			<.001
0–11	76.7	63.7–86.1	
12–24	69.6	60.0–77.7	
25–59	58.1	46.0–69.2	
Sex of child			.488
Male	65.1	54.3–74.4	
Female	68.1	55.9–78.2	
Mother's characteristics			
Age (years)			.737
Less than 24	65.7	45.7–81.3	
25–34	69.4	56.4–79.8	
35 and above	61.9	40.2–79.7	
Mother's educational level			.004
No education	62.3	50.9–72.5	
Primary	67.8	57.5–76.6	
Secondary and higher	90.8	67.7–97.9	
Pregnancy status			.003
Not pregnant	69.5	60.6–77.0	
Pregnant	44.4	26.4–64.0	
Religion			.623
Muslim	71.1	50.5–85.5	
Christian	66.2	55.1–75.8	
It's easy for mother to hang a bed net			.528
No	56.7	26.1–83.0	
Yes	66.8	56.3–75.9	
Has a bed to sleep on			.125
No	61.1	47.1–73.5	
Yes	72.6	62.2–81.0	
Mother knows not sleeping in net causes malaria			.003
No	68.5	58.8–76.9	
Yes	45.9	31.0–61.6	
Mother knows mosquito bites cause malaria			.427
No	65.3	54.0–75.1	
Yes	71.4	55.6–83.3	
Exposure to malaria messages			.548
No	67.2	57.6–75.6	
Yes	63.7	45.8–78.5	
Household's characteristics			
Sex of household head			.644
Male	65.6	53.9–75.6	
Female	68.1	55.8–78.4	
Age of household head (years)			.506
Less than 30	68.9	57.5–78.4	
31–39	68.0	54.8–78.8	
40+	60.2	41.6–76.4	
Household has television			.024
No	67.4	57.3–76.2	
Yes	33.1	11.6–65.2	
Household has radio			.512
No	66.2	55.7–75.3	
Yes	69.6	55.6–80.7	

Continued…

Table 3—*Continued*

	Percent	95% CI	*p* value
Household has electricity			.876
No	66.3	57.6–74.0	
Yes	67.6	45.0–84.2	
Region of residence			.126
Northern	73.1	61.7–82.0	
Southern	59.4	44.1–73.1	
Number of children staying in household			.837
One child	67.0	48.4–81.5	
Two children	67.4	57.4–76.1	
Three children and above	61.1	32.2–83.9	

3.3 Determinants of ITN Utilization among Children Younger than Age 5

A multivariable logistic regression analysis was performed to determine the magnitude of the associations between the independent variables and the outcome variable (see Table 4). Children age 25–59 months had 60% lower odds of sleeping under an ITN compared to the reference category (younger than age 11 months). The odds of children sleeping under an ITN were higher if their mothers had secondary and higher education (8.5 times) as well as primary education (1.5 times) compared to children whose mothers had no education. The odds of children sleeping under an ITN were reduced by 50% if their mothers were pregnant, compared to children whose mothers were not pregnant. The odds of children sleeping under an ITN were 70% lower if their mothers knew that "not sleeping in nets" caused malaria compared to those who didn't know. Greater odds of children sleeping under an ITN were observed if their mothers were able to hang the net with ease (5.9 times). The odds of children sleeping under an ITN were reduced by 40% among female headed households compared to male headed households. The odds of children sleeping under an ITN were 2.4 times higher in households located in refugee settlements of the northern districts compared to households located in the refugee settlements in the southern districts.

Table 4 Adjusted logistic regression for the predictor of ITN utilization among children in refugee settlements

	Child slept under net last night					
	Individual characteristics		Household characteristics		Combined individual and household characteristics	
Variables	**AOR**	**95% CI**	**AOR**	**95% CI**	**AOR**	**95% CI**
Age in months (ref: less than 11)						
12–24	0.7	0.5–1.2	-	-	0.6	0.4–1.0
25–59	0.4***	0.3–0.6	-	-	0.4***	0.3–0.5
Sex of child (ref: male)						
Female	1.3	0.9–2.0	-	-	1.5	1.0–2.2
Age of mother (years) (ref: less than 24)						
25–34	1.4	0.5–4.3	-	-	1.5	0.5–4.3
35–49	1.2	0.4–3.6	-	-	1.9	0.5–7.1
Mother's educational level (ref: none)						
Primary	1.5*	1.0–2.1	-	-	1.5*	1.0–2.3
Secondary and higher	8.1***	2.9–22.8	-	-	8.5***	2.7–26.8
Pregnancy status (ref: not pregnant)						
Pregnant	0.5*	0.2–1.0	-	-	0.5	0.2–1.2
Mother's religion (ref: Muslim)						
Christian	0.9	0.3–2.6	-	-	0.7	0.2–3.1
It's easy for mother to hang a bed net (ref: no)						
Yes	3.7*	1.2–11.3	-	-	5.9**	1.6–21.5
Has a bed to sleep on (ref: no)						
Yes	1.4	0.7–2.7	-	-	1.2	0.6–2.5
Mother knows not sleeping in net causes malaria (ref: no)						
Yes	0.3*	0.1–0.9	-	-	0.3*	0.1–0.8
Mosquito bites cause malaria (ref: no)						
Yes	1.1	0.5–2.5	-	-	1.1	0.5–2.6
Exposure to malaria messages (ref: no)						
Yes	0.7	0.5–1.1	-	-	0.5*	0.3–1.0
Sex of household head (ref: male)						
Female	-	-	0.6*	0.3–1.0	0.5	0.3–1.0
Age of household head (years) (ref: <30)						
31–39	-	-	1.0	0.5–2.1	0.9	0.5–1.7
40+	-	-	0.6	0.3–1.1	0.5*	0.2–1.0
Household has television (ref: no)						
Yes	-	-	0.0*	0.0–0.5	0.1*	0.0–0.8
Household has radio (ref: no)						
Yes	-	-	0.9	0.6–1.5	1.3	0.6–2.6
Household has electricity (ref: no)						
Yes	-	-	1.5	0.8–2.7	1.8	1.0–3.4
Region (ref: Southern)						
Northern	-	-	2.4*	1.2–4.7	2.4*	1.2–4.7
Number of children (ref: one child)						
Two children	-	-	0.9	0.4–1.7	0.9	0.4–1.6
Three or more children	-	-	0.6	0.2–1.9	0.4	0.1–1.6

AOR = adjusted odds ratio
***p < .001; **p < .01; *p < .05.

4 DISCUSSION

This study provided an overview of the determinants of ITN utilization among children under age 5 in refugee settlements of Uganda by using the 2018–19 MIS datasets, which are nationally representative. Overall, 68.8% of children under age 5 slept under an ITN in households on the night before the survey. This percentage is moderate given the high levels of ITN distribution in Uganda via the various universal coverage campaigns in 2013–14, 2017–18, and 2020–21.18 This finding is lower than that of a study conducted in the Soroti District, North Eastern Uganda where it was observed that 89.4% of children slept under the bed net the night before the survey, a figure that is much higher than the national estimates.17 The absence of 100% ITN utilization among refugee children under age 5 explains the observed 32.8% malaria prevalence among the children.[3]

The study established significant factors associated with the use of ITNs for malaria control among children under age 5 in refugee settlements in Uganda. The age of the child was critical in influencing ITN utilization. The results show that older children (age 25–59 months) had 60% lower odds of utilizing ITNs. This agreed with findings by another study conducted to evaluate bed net use in Soroti District, North Eastern Uganda.17 Possible explanations could be that older children in refugee settlements might be viewed as being immune to malaria infections and do not require an ITN for sleeping at night. In cases with fewer ITNs, young children could be given priority compared to the older children. This finding is also consistent with other studies conducted in sub-Saharan Africa on the factors that influence the use of bed nets by children under age 5.[13]

Our results further indicate that children whose mothers had some formal education had greater odds of sleeping under ITNs compared to children whose mothers had no education. There was also a significant association between formal education and ITN utilization in children under age 5 observed in other studies.[13,16,20] This result is not surprising since educated mothers can make better decisions about health outcomes of children compared to uneducated mothers. Investing in education initiatives for mothers in these populations can potentially improve ITN coverage and contribute to the prevention of malaria and other vector-borne diseases.

Our results further indicated that children whose mothers were pregnant had lower odds of sleeping in an ITN compared to children whose mothers were not pregnant. This finding highlights a potential gap in ITN utilization among children under age 5 in refugee settings and underscores the importance of targeted interventions to promote ITN use among this vulnerable group. This result could be attributed to the fact that pregnant women who seek antenatal care (ANC) receive education focused on both maternal and fetal health rather than their children under age 5. Thus, health workers in ANC health facilities could also emphasize the importance of ITNs for children of pregnant mothers.

The odds of children sleeping under ITNs were 70% lower when their mothers were aware that “not sleeping in nets” could cause malaria, compared to mothers who were unaware of this fact. This finding underscores the importance of understanding the complex factors that influence ITN usage among children in refugee settings. This also suggests that maternal knowledge and beliefs about malaria transmission and prevention play a significant role in shaping mothers’ behaviors related to ITN use among their children. Addressing misconceptions and promoting accurate knowledge about malaria transmission and the

effectiveness of ITNs are crucial strategies for improving ITN utilization and reducing the burden of malaria among children under age 5 in refugee settlements of Uganda.

Our findings suggest that the ease with which mothers were able to hang ITNs contributed to increased usage of these nets with their children. This highlights the importance of practical factors such as accessibility and convenience in malaria prevention interventions, particularly in refugee settings. Providing support and resources that facilitate the proper installation and maintenance of ITNs can enhance their effectiveness as a tool for preventing malaria transmission among children under age 5.

Our findings suggest that mothers who were exposed to malaria messages had lower odds of their children sleeping under ITNs. This unexpected result may indicate a potential discrepancy between the messaging content or delivery and its effectiveness in promoting ITN use among mothers in refugee settings. Further exploration is needed to understand why exposure to malaria messages did not translate into increased ITN usage and to identify potential barriers or factors that influence this relationship. Adjustments to messaging strategies or targeted interventions may be necessary to improve the uptake of ITNs among children in these populations.

Our findings suggest that households with televisions had lower odds of their children sleeping under ITNs. This unexpected result raises questions about the potential influence of television ownership on household priorities or behaviors related to malaria prevention. Further investigation is warranted to understand the underlying factors that contributed to this association and to explore potential avenues for promoting ITN usage among households with televisions. Adjusting communication strategies or integrating malaria prevention messages into television programming may be necessary to address this discrepancy and improve ITN coverage among children in these households.

In addition, the odds of children sleeping under ITNs were 2.4 times higher in households located in refugee settlements of the northern districts compared to households located in refugee settlements in the southern districts. This significant difference underscores the importance of considering regional factors and geographical location when implementing malaria prevention interventions within refugee populations. Understanding the specific challenges and barriers to ITN utilization in different areas can inform targeted strategies that improve coverage and promote consistent use of ITNs among children living in refugee settings across Uganda.

Our study has some strengths and limitations. This is the first study to provide an overview of ITN utilization among children in the refugee settlements of Uganda using the MIS data, which are nationally representative. The study had an adequate sample size, which made the findings generalizable to the refugee children in Uganda. Despite these strengths, our study had limitations.

The cross-sectional nature of the study design did not allow for a cause-effect relationship to be established with certainty among the identified predictors. Moreover, malaria incidence follows a seasonal pattern which was not considered in the MIS. Despite these limitations, the study was adequately powered to detect several important determinants of ITN utilization among children under age 5.

5 CONCLUSION

Despite the increased distribution of ITNs in refugee settlements in Uganda, malaria infections among children under age 5 have persisted. Although ITNs are effective in preventing malaria when used correctly and consistently, there is the challenge with their consistent use in refugee settlements. This study has identified several factors associated with ITN utilization, including age, maternal education, pregnancy status, knowledge of malaria causes and prevention, household head gender, and refugee household location. These findings underscore the importance of considering these factors in the distribution and promotion of ITNs within refugee settlements. Tailored interventions that address specific barriers to ITN use, such as providing targeted health education, ensuring equitable access to education, addressing gender dynamics within households, and adapting distribution strategies to local contexts, are essential for improving ITN utilization and ultimately reducing the malaria burden among children in refugee settings. Future studies should explore additional factors such as seasonality and other socioenvironmental determinants that may influence ITN utilization in refugee settlements. By gaining a deeper understanding of the complex interplay of factors that affect ITN use, stakeholders can develop more effective strategies for combating malaria and improving health outcomes in refugee populations.

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