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Contextual and individual factors associated with the non-use of Insecticide Treated Nets to prevent malaria among children under five years in Rwanda: Secondary analysis using Rwanda Demographic Health Survey 2010

A dissertation submitted in partial fulfillment of the requirements of the University of Rwanda-College of Medicine and Health Sciences, for the degree of Masters in Field Epidemiology (FELTP)

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ABSTRACT

Background

ITNs are known to be highly effective in reducing malaria morbidity and mortality. However, usage varies among households, and such variations in actual usage may seriously limit the potential impact of nets and cause spatial heterogeneity on malaria transmission. Our study examined underlying risk factors in ITNs non- use among children under five years in Rwanda.

Methods

We conducted a secondary analysis of ITNs utilization among survey respondents using Rwanda Demographic Health Survey (DHS), a cross sectional study conducted in 2010. Data was analyzed using STATA 11 Software. The output of analysis was sleeping under an ITN the night before the survey for children under five years. Multilevel logistic regression analysis was used to examine underlying risk factors in ITN non-use.

Results:

A total of 6,173 women aged 15-49 years nested within 492 villages were considered. The ITN non-use among children under five years was 25% with 69% and 71% for boys and girls respectively. Community wealth index (OR=0.73, 95% CI:0.63-0.85), community education (OR=0.71, 95% CI:0.59-0.84), altitude (OR=1.36, 95% CI:1.14-1.61) household with >5 members (OR= 1.42,95% CI:1.23-1.63), household with >3 nets (OR= 0.39,95% CI:0.33-0.47) , mother attendance to 1 to 4 ANC (OR= 0.45,95% CI:0.29-0.69) and >4 ANC visits (OR= 0.39,95% CI:0.21-0.70), mother occupation (OR= 1.05,95% CI:0.85-1.29), mother education (OR= 0.65,95% CI:0.56-0.76), mother marital status (OR= 0.42,95% CI:0.35-0.50) were risk factors associated with non-use of ITNs.

Conclusion:

In Rwanda there is a need to maintain universal ITN coverage and ensure that all ITNs are used effectively. There is need to target household, mother and community risk factors by promoting the alleviation poverty, the mother education sessions, the education of girls, the promotion of birth spacing, the sensitization of mothers to do ANC visits to ensure that impact of ITNs on the Malaria burden in Rwanda is not diminished by lack of use.

DECLARATION

This work was the result of my field research, except for references to other people's work which have been duly acknowledged. It has not been submitted for the award of any other degree apart from this. I am responsible for the views expressed and the factual accuracy of its contents.

Signature: **Date:**

DEDICATION

I dedicate the results of this study to my late father Mr Murindahabi Rubibi Adalbert, my mother Mrs Lutundwa Marie-Gervais, my husband Mr Mudereva Jean Baptiste for their continuous support and encouragement during my postgraduate training. To my daughter Anais and my sons Lucas and Anthony, because they missed my attention during the busy time of my research work but they had been tolerant.

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ABBREVIATION / ACRONYMS

ANC	Antenatal Care
CI	Confidence Interval
HH	Household
ICC	Inter Cluster Correlation
ITNs	Insecticide Treated Nets
LLINs	Long Lasting Impregnated Nets
MDGs	Millennium Development Goals
MOH	Ministry of Health
OR	Odd Ratio
PSU	Primary Sampling Unit
RBM	Roll-Back Malaria
RDHS	Rwanda Demographic Health Survey
SES	Socio Economic Status
STATA	Statistic and Data
WHO	World Health Organization

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1. INTRODUCTION

Malaria is the leading cause of under five morbidity and mortality in sub-Saharan Africa[1]. In Rwanda, malaria is a major endemic disease, responsible for about 6.5 % of the deaths in children under five in 2011[2]. Between 2007 and 2010 there has been a drastic reduction in the prevalence of infection with malaria from 2.6% to 1.4 % in children between 6-59 months of age following a comprehensive malaria control interventions [3]. The reduction in malaria prevalence was associated with a reduction in under- five mortality, which reduced from 133 to 76 per 1,000 births during the same period[3].

Insecticide Treated Nets (ITN) have been shown to be effective in reducing childhood morbidity and mortality through reducing mosquito bites while sleeping during the night[4][5]. ITNs have been identified to be the most cost effective measure to reduce malaria transmission in developing countries[4][6][7].

As Rwanda continues to grapple with a range of program and policy challenges related to malaria control and prevention, we believe that one important element in improving the status quo is a comprehensive and relevant evidence base that would equip the country to take informed actions. Without comprehensive information about the factors associated with the non-use of LLIN among children under five years, it is hard to plan substantial public health programs that would improve childhood malaria morbidity and mortality. Numerous studies have been conducted to examine factors associated with ITN non-use among children under five years in sub-Saharan Africa [8, 9,10,11,12,13].Preponderance of these studies has concentrated on individual level factors and only few have considered community-level factors [14]. To the best of our knowledge, there has been limited multilevel study performed to date that examined the separate and independent contributions of individual, household, mother and community factors to the ITN non-use among children under five years in sub-Saharan Africa and in Rwanda. We therefore conducted this study to fill this research gap and to draw attention to the largely unexplored contextual factors that may be associated with the ITN non-use among children under five years.

In 2010, Rwanda distributed around 4,1 million ITN through a household campaign with the intention to cover all sleeping areas in all households intending the universal coverage

and this resulted in an increase of 25% of children under five years sleeping under a mosquito net from 2007-2008 to 2010 [9,3,15]. However only 70% of children under five years slept under a mosquito net which is less than the national and international target of 80% coverage of children sleeping under a net by 2010 [3].

The objective of this study is to identify individual and contextual factors associated with non-use of bed nets among children under five years in order to make a preliminary assessment of the need for community-individual interventions to establish and promote a culture of ITNs use for malaria control. Understanding why ITNs already available in the household are not used and community factors associated is essential for refining ITN distribution programs and for developing effective behavior change communication activities to maximize the impact of ITN in reducing children under five morbidity and mortality.

2. JUSTIFICATION

Universal coverage with ITN has resulted in a significant decrease in malaria burden in Rwanda, in reduction of children under five morbidity and mortality. However the country has not yet achieved the target set of 80% of use under the guidance of RBM which will contribute in the achievement of the MDG goals 4 and 5. The findings from the current assessment will contribute to the general knowledge of barriers of non use of ITN considering both individual and contextual factors.

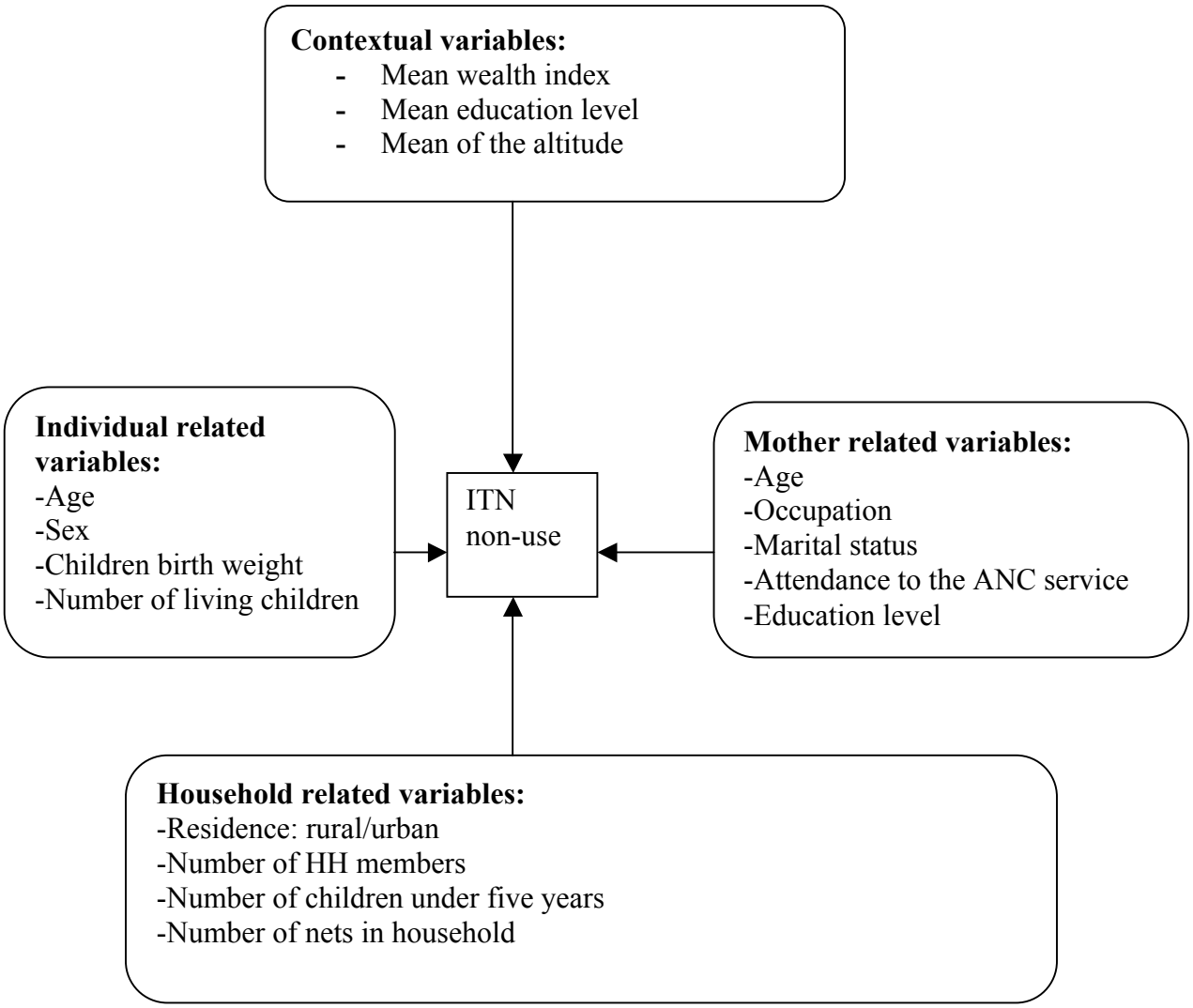
3. CONCEPTUAL FRAMEWORK

The study is conducted in analyzing factors associated with the non-use of ITN among children under five years.

3.1 ITN non-use

Previous findings have shown potential impact of universal coverage of ITN in reducing burden of disease associated with high prevalence of malaria morbidity and mortality among children under five years. The study aimed at identifying factors contributing to

the non-use of ITN among children under five years whose mothers own at least one LLIN.



4. OBJECTIVES

4.1 General objective

To assess the contribution of contextual and individual factors in the non-use of ITNs among under five children in Rwanda using DHS 2010.

4.2 Specific objectives

1. To assess the prevalence of ITN non-use among children under five years;
2. To explore key selected child, mothers, household and community factors associated with the non-use of ITN among children under five years;

5. METHODS

5.1. Study setting

Rwanda is situated in East Africa, immediately south of the equator between 1°4' and 2°51' south latitude and 28°63' and 30°54' east longitude with a total surface area of 26,338 square kilometers [3]. The country is bordered by Uganda to the north, Tanzania to the east, the Democratic Republic of the Congo to the west, and Burundi to the south.

In Rwanda's centre, mountainous terrain gives way to the rolling hills that give the country its nickname, "Land of a Thousand Hills." Here the average elevation varies between 1,500 and 2,000 meters [3] and this is one among factors which will help to understand the ITN non-use.

5.2 Study design

We used available 2010 RDHS data that applied a cross sectional study design conducted by the Rwanda National Institute of Statistics of Rwanda in collaboration with MEASURE DHS. Methods and data collection procedures have been published elsewhere [3]. DHS data are nationally representative, household survey designed to collect information on demographic, health and family planning. The 2010 survey was to obtain current information on demography, family planning, maternal mortality, infant and child mortality, and health related information such as breastfeeding, antenatal care, delivery, children's immunization, and childhood diseases. In addition, the survey was designed to evaluate information on the ownership and use of mosquito nets, and detailed treatment seeking behavior for malaria.

5.3 Sample

In total, the sample considered 492 clusters there were 13,671 women of reproductive age and 6,329 men aged 15-59 years using a multi-stage cluster sampling, design applying strata for rural and urban areas and for different regions in the country. The term community used here represents primary sampling units (PSUs). PSU are used in the dissertation to describe clustering within households belonging to similar geographical living environment. Further in the statistical analysis section, PSUs were considered as clustering variables for multilevel analysis applied.

5.4 Measures

A standardized questionnaire was administrated by interviewers to participants. The survey instruments (i.e household questionnaire and women's questionnaire) were comparable across the country, yielding inter country comparable data. We used the term community to describe clustering within the same geographical living environment. Communities were based on sharing a common primary sample unit (PSU) within the DHS data.

Individual child characteristics, those of the parents, the household and the community factors were used likely to determine the factors affecting the non- use of mosquito nets among children under-five years old. These characteristics included the age and sex of the child; those of the mother included the age, their education level, employment status, the marital status and the attendance to the ANC service. The household attributes likely to affect mosquito net use among children under-five year olds are its income or socioeconomic status, whether the household is located in a rural or urban setting, the number of children under five years of age, the number of household members, the number of nets available in the household. The community factors included were the wealth index, the education level and with regard to malaria transmission, the altitude where a household is located is also likely to be a determinant. Clusters included in the survey were categorized as < 1,600 meters, > 1,600 meters of altitude.

In this study, the education level has three categories, 1) no formal education, 2) primary, and 3) secondary and post-secondary levels. The wealth index was used as a proxy for socioeconomic status of a household and categorized in two: poorest and poor/ middle and high.

5.5 Statistical analysis

5.5.1 Descriptive Analyses

In the descriptive statistics, the distributions of respondents by the key variables were expressed as percentages. We used Pearson's chi-squared test for analyzing contingency tables. All cases in the DHS data were given weights to adjust for differences in probability of selection and to adjust for non-response. Pooled sample weights were used for descriptive statistics in this study, using STATA 11 for Windows.

5.5.2 Modelling approaches

Multilevel logistic regression models were used to examine factors associated with LLINs non-use among children under five years. Given a dichotomous dependant variable and multiple independent variables a four-level model was specified. We applied the hypothesis test to determine whether there is a significant linear relationship between the independent variable *X* and a dependent variable *Y*. The test focuses on the slope of the regression line: $Y=B_0 +B1$ where B0 is a constant, B1 is the slope (also called the regression coefficient), X is the value of the independent variable, and Y is the value of the dependent variable. Then, the relationship of each independent variable with the dependent variable is investigated. Each is tested by fitting univariate logistic regression models and estimating odds ratios (OR). Those variables having a *p-value* of less than 0.05 are retained. Afterward, we applied a backward regression method in order to have a smaller model.

We constructed 5 models, the first model was with individual-level factors. The second, third and fourth models provided additional controls for mother, household and community level factors respectively. The fifth model simultaneously controlled factors analyzed in the four previous models. The measures of association (fixed-effects) were reported as odds ratios (ORs) with their 95% confidence intervals (CIs). The measures of variation (random-effects) included variance, intra cluster correlation (ICC). The multilevel models were fitted with MLwiN 2.24. The statistical significance of covariates were calculated using the Wald test .All significance tests were two-tailed and statistical significance was defined at the 5% alpha level.

5.6 Limitation

This research has inherent limitations that should be noted when interpreting the results. As discussed in other analyses, using DHS data and considering primary sampling units (clusters) as the community level, results may be biased toward a well-functioning population. In addition, the use of cross-sectional individual-level data restricts the inferences to associations between independent and dependent individual-level variables, not causal relationships. There are also limitations associated with the community-level characteristics used in this analysis. With the exception of "urban-rural residence" all community-level variables are constructed by aggregating individual-level and household-level characteristics at the community level (the primary sampling units). That is, the community contextual variables are actually compositional variables, aggregated upwards. There are two potential problems with this approach. First, it could result in multi colinearity, since the same variables used to derive the "contextual" variables are also included as individual variables.

Second, the approach is subject the problem of making inferences at a higher level based on data collected at a lower level.

6. RESULTS

6.1 Descriptive results

Table1 presents descriptive statistics for the final pooled sample. For this analysis, information on 6,173 respondents (level 1) nested with household, mother and community levels was pooled into one data set. Most of the respondents had children aged more than 23 months (64.65%) , and most respondents lived in rural areas (85.84%). More than half of household (72.17%) owned one or two ITN and 92.55% had one or two children under five years. More than half of the respondents were married or living with a partner (84.90%), not employed or had an agricultural occupation (86.69%) and had one to four ANC visits (95.56%). At the community level, 56.07 had a middle or higher wealth index, 81% had any education and 58.76% were living the altitude more than 1,600 m.

Table 1: Description of the sample

Variables	n (%)
Level 1: INDIVIDUAL (n=6,173)	
Children age	
<= 12 M	1,110 (17.98)
13-23 M	1,072 (17.37)
> 23 M	3,991 (64.65)
Children sex	
Female	2,995 (48.52)
Male	3,178 (51.48)
Number of living children	
<= 2 children	2,726 (44.16)
> 2 children	3,447 (55.84)
Children birth weight	
>=2500g	5,926 (96)
<2500g	247 (4)
LEVEL 2: HOUSEHOLD (N=6,173)	
Residence	
Urban	874 (14.16)
Rural	5,299 (85.84)
Number of nets	
<= 2 nets	4,498 (72.87)
>= 3 nets	1,675 (27.13)
Number of household members	
<5	3,638 (58.93)
>5	2,535 (41.07)
Number of children U5	
<=2	5,713 (92.55)
>2	460 (7.45)
Number of rooms used for sleeping	
<=2	4,338 (70.62)
>=3	1,805 (29.38)
LEVEL 3: MOTHER	
Marital status	

Never in union, widowed, divorced, no longer living together	932 (15.1)
Married or living with partner	5,241 (84.9)
Occupation	
Not employed or agricultural	5,345 (86.69)
Employed	821 (13.31)
ANC visits during pregnancy	
no ANC	103 (1.73)
1 to 4 ANC visits	5,685 (95.56)
>4 ANC visits	161 (2.71)
LEVEL 4: COMMUNITY	
Community wealth index	
Poorest and poor	2,712 (43.93)
Middle and higher	3,461 (56.07)
Community education level	
No education	1,173 (19)
Any education	5,000 (81)
Altitude of Cluster in meters	
<1,600 m	2,546 (41.24)
>1,600m	3,627 (58.76)

6.2 Association between contextual and individual factors and ITN non-use among children under five years

A total of 6,173 women aged 15-59 years from 12,540 surveyed households were considered for our data analysis. General finding is that 75% of children owning at least one ITN are using it the night prior the survey. Of the 15 independent variables analyzed, nine were found to be associated with net use at $p < 0.05$ and were retained for further analysis (Table 2). At the community level those were community wealth index, community education level, altitude of cluster in meters. At household level those were the residence, the number of nets available in the household, the number of household members. At children level it was the number of living children and at the mother level the marital status, the number of ANC visits done during the pregnancy were associated with net non- use.

ITN non-use is not associated with the number of children under five years residing in the household, the number of rooms used for sleeping available in the household, the mother occupation, the children age, the children sex and the children birth weight as the $p > 0.05$.

Table 2: Association between contextual and individual factors and ITN non-use among children under five years, Rwanda DHS 2010

Variables	ITN non-used the night before the survey			
	n (%)	Unadjusted OR	95% CI	p-value
Community wealth index				
Poorest and poor	835 (30.84)	Ref		
Middle and higher	710 (20.39)	0.73	(.64 - .84)	**0.000**
Total	**1,545 (25.05)**			
Community education level				
No education	390 (32.89)	Ref		
Any education	1,155 (23.17)	0.7	(.59 - .81)	**0.000**
Total	**1,545 (25.05)**			
Altitude of Cluster in meters				
<1,600 m	523 (20.67)	Ref		
>1,600m	1,022 (28.15)	1.37	(1.19- 1.56)	**0.000**
Total	**1,545 (25.05)**			
Residence				
Urban	183 (21.43)	Ref		
Rural	1,362 (25.56)	1.06	(.86- 1.30)	**0.050**
Total	**1,545 (25.05)**			
Number of nets				
<= 2 nets	1,287 (28.61)	Ref		
>= 3 nets	258 (15.29)	0.43	(.36- .51)	**0.000**
Total	**1,545 (25.05)**			

Number of household members				
<5	861 (23.71)	Ref		
>5	684 (26.98)	1.42	(1.20-1.66)	**0.000**
Total	**1,545 (25.05)**			
Number of children U5				
<=2	1,435 (25.15)	Ref		
>2	110 (23.74)	0.96	(.74- 1.23)	0.763
Total	**1,545 (25.05)**			
Number of rooms used for sleeping				
<=2	1,106 (25.56)	Ref		
>=3	429 (23.58)	1.02	(.87- 1.19)	0.754
Total	**1, 535 (24.99)**			
Marital status				
Never in union, widowed, divorced, no longer living together	364 (39.12)	Ref		
Married or living with partner	1,181 (22.57)	0.46	(.39- .549)	**0.000**
Total	**1,545 (25.05)**			
Occupation				
Not employed or agricultural	1,332 (25)	Ref		
Employed	211 (25.33)	1.36	(1.10- 1.66)	**0.003**
Total	**1,545 (25.05)**			
ANC visits during pregnancy				
no ANC	50 (48.21)	Ref		
1 to 4 ANC visits	1,383 (24.34)	0.50	(.33- .76)	0.001
>4 ANC visits	33 (20.59)	0.46	(.26- .81)	0.008
Total	**1, 466 (24.67)**			
Children age				
<= 12 M	279 (23.98)	Ref		
13-23 M	247 (23.41)	0.93	(.75- 1.15)	0.536
> 23 M	1,019 (25.79)	1.03	(.87- 1.22)	0.725
Total	**1,545 (25.05)**			
Children sex				
Female	745 (24.81)	Ref		
Male	800 (25.27)	0.93	(.82- 1.06)	0.314
Total	**1,545 (25.05)**			

Number of living children				
<= 2 children	648 (23.71)	Ref		
> 2 children	897 (26.1)	1.12	(.94- 1.33)	0.180
Total	**1,545 (25.05)**			
Children birth weight				
>=2500g	1,482 (25.03)	Ref		
<2500g	63 (25.37)	1.27	(.93-1.73)	0.126
Total	**1,545 (25.05)**			

6.3 Determinants of bed net non-use among children under five years

The final multivariate analysis consists of nine variables (community wealth index, community education level, altitude of cluster in meters, the residence, the number of nets available in the household, the number of household members, the number of living children, the marital status, the number of ANC visits done during the pregnancy that had an association with ITN non-use the night prior the survey at a significance level of $p<0.05$ (Table 3).

The results of fitting the model including the dependent variable and individual-level factors is showed in Table 3 (Model A) and there is no statistically significant association between the ITN non-use and the age, sex, birth weight of the children. The result of fitting the model including the dependent variable and mother-level factors is showed in Table 3 (Model B). Children born to married mother or mother living with a partner were more likely to sleep under a bed net than children born to a widowed, divorced mother (OR=0.42 [95% CI:0.35-0.50]; $p<0.01$). Children born to mother having any type of education are more likely to sleep under a net (OR=0.65 [95% CI: 0.56-0.76]; $p<0.01$). Children born to employed mother are more likely to sleep under a net than those born to not employed or agricultural mother (OR=1.05 [95% CI: 0.85-1.29]; $p<0.01$). Children born to mother who had 1 to 4 or more than 4 antenatal care visits are more likely to use a net than children born to mother who did not attend any antenatal care services (OR=0.45[95% CI: 0.29-0.69]; $p<0.01$) (OR=0.39[95% CI: 0.21-0.70]; $p<0.01$) respectively.

The results of fitting the model including the dependant variable and household-level factors are showed in Table 3 (Model C). Children living in a household having 3 or more ITN are more likely to use them than children who are living in a household with 2 or less nets (OR=0.39 [95% CI: 0.33-0.47]; p<0.01). Children living in a household with 5 or more members are more likely to not sleep under an ITN than their counterparts living in household with 5 or less members (OR=1.42 [95% CI: 1.23-1.63]; p<0.01).

The results of fitting the model including the dependant variable and the community-level factors are showed in Table 3 (Model D). In this final model, a net was significantly more likely to be used if the community it belonged from a middle and higher wealth index (OR=0.73 [95% CI: 0.63-0.85]; p<0.01), of any education level (OR=0.71 [95% CI: 0.59-0.84]; p<0.01). Children living at more than 1,600 m of altitude are more likely to not use a net (OR=1.36 [95% CI: 1.14-1.61]; p<0.01) than their counterparts living at less than 1,600 m of altitude.

The result of the full model including all co-variables is shown in the Table 3 (Model E). With all factors controlled statistically, the following factors remained significantly associated with the odds of having not sleep under a net: mother - level (marital status, education level, occupation, ANC visits), household-level (number of available bed nets, number of household members) and community-level (wealth index, education level and altitude where the cluster is located).