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ABSTRACT

This paper examines household ownership and use of insecticide-treated mosquito nets (ITNs), based on data from six Demographic and Health Surveys (DHS) and one Malaria Indicator Survey (MIS) conducted in sub-Saharan Africa from 2004-06. The paper has a particular focus on children under age five and pregnant women in households that own at least one ITN. Overall, there is considerable variation in the ownership and use of ITNs among these groups, while there are several striking common findings across groups. There is no country in the study where more than half of households own an ITN, but even in households that own an ITN, members of the household do not necessarily use them. In five of the seven countries, in households that own an ITN the majority of children under age five (50-69 percent) and pregnant women (56-81 percent) use an ITN. In all countries, two variables—the number of ITNs in a household and the size of the household population—predict the use of ITNs. ITN use increases with the number of ITNs in the household, but decreases as the size of the household increases, as measured by the percentage of the household population using an ITN. The effects of several other variables are inconsistent; place of residence predicts ITN use consistently only in Tanzania and Uganda where rural residents are less likely than urban residents to use an ITN. In Senegal, household wealth is negatively associated with ITN use among the total household population and among children under age five; wealth is positively associated with use among the household population in Mali and Tanzania and among pregnant women in Mali. In Tanzania, children in the poorest households are least likely to use an ITN. Finally, children who are breastfeeding are not more likely to use an ITN than non-breastfeeding children, with the exception of Mali. Mother's level of education does not significantly predict ITN use for the child, although the mother's use of an ITN herself is highly correlated with use by the child.

Overall, the study results underscore the need for malaria control programs to take into consideration the number of members in a household when distributing nets and to pay close attention to country-specific conditions when designing and implementing ITN distribution and promotion programs.

INTRODUCTION

The global burden of malaria is immense; in the World Malaria Report 2008, the World Health Organization (WHO) estimates that in 2006 an estimated 247 million cases of malaria led to almost 881,000 deaths (WHO, 2008). A large majority of malaria deaths occur in sub-Saharan Africa. Malaria remains one of the leading causes of mortality among children under the age of five, who have not yet developed sufficient naturally acquired immunity against malarial parasites (UNICEF and RBM, 2007). Of particular concern to malaria prevention programs is the risk to pregnant women who, if infected with malaria, are at risk of death or developing malarial anemia, which can lead to low birth weight of children.

The approach of the Roll Back Malaria Partnership to malaria prevention is multi-pronged. The main recommendations are the use of Insecticide Treated Nets (ITNs) by vulnerable populations, indoor residual spraying (IRS) to kill mosquitoes, prompt and effective treatment of malaria, and use of intermittent preventive treatment during pregnancy. The use of ITNs is widely considered a highly effective intervention; various community-based trials and studies show that ITN use cuts malaria transmission and reduces malaria-related morbidity and all-cause child mortality in a variety of study settings (Gimnig, et al., 2003; Lengeler, 2004; D'Alessandro, et al., 1995; ter Kuile, et al., 2003a; Eisele, et al., 2005; Lindblade, et al., 2004). There is also substantial evidence that the use of ITNs by pregnant women is effective in averting malarial morbidity and decreasing the percentage of low birth weight children (ter Kuile, et al., 2003b). The cost effectiveness of ITN use, compared with other prevention measures, has also been widely demonstrated (Binka, et al., 1996; Picard, et al., 1993; Aikins, et al., 1998; Goodman, 2000; Goodman and Mills, 1999; Wiseman, et al., 2003). Despite evidence

on the efficacy of ITN use, most programs have not yet been able to increase ownership and use of ITNs to target levels (UNICEF and RBM, 2007).

Several studies have analyzed the socioeconomic, demographic, and cultural predictors of ITN ownership and use. Several show that access to health care, education, and wealth predicts ITN ownership and use (Winch, et al., 1997; Schellenberg, et al., 2001; Heggenhougen, et al., 2003). Some argue that ITN use is least common among children, especially those in rural areas (Aikins, et al., 1993; Makemba, et al., 1995; UNICEF and WHO, 2003), although others find no statistically significant differences by age (Rashed, et al., 1999). The number of children in a household also predicts ITN use; children of mothers who have several children are more likely to use ITNs than children whose mothers have fewer children, and older children are less likely than younger children to use ITNs (Tanner and Vlassoff, 1998; Yeneneh, et al., 1993). The influence of gender on the demand and use of ITNs has also been examined in several studies (Rashed, et al., 1999; Tanner and Vlassoff, 1998; Yeneneh, et al., 1993). However, theories to explain the mechanism of the woman's influence on possession and use range widely and remain speculative. The role of ethnicity in the uptake of ITNs has been found in several studies (Bradley, et. al., 1986; MacCormack and Snow, 1986; Thomson, et al., 1996). Some of these studies have found that semi-nomadic and pastoralist groups are less likely to own or use ITNs than more geographically settled groups. As expected, use of ITNs is strongly influenced by the season of the year, although this in turn may be modulated by a correct understanding of malaria transmission.

As malaria prevention programs scale up and continue efforts to sensitize the public toward adherence to correct and sustained ITN use, it is important to use the most recent reliable information to determine who is currently using ITNs and what factors most affect use. The

primary purpose of this analysis is to provide indicators on household ownership of ITNs and describe which persons in a household use ITNs in seven countries in sub-Saharan Africa, where the burden of malaria is the highest. There are several major strengths of this analysis. First, our study is multi-country, of which there are relatively few examples in the literature. Second, we consider use of ITNs only in households where ITNs are available, allowing examination of possible disparities between ITN ownership and use. Third, the analysis examines the use of ITNs by all household members, which is often overlooked as pregnant women and children under the age of five are the usual subjects of study (given their susceptibility to malaria and the severe adverse outcomes associated with infection in these groups). The study populations are all household members, pregnant women age 15-49, all children under the age of five, and the youngest child under the age of five who lives with his/her mother, which allows the analysis of both maternal and child characteristics (some of which are available only for the youngest child in DHS surveys). The focus on the use of ITNs by all household members is in line with the 2007 ITN position statement of WHO, which recommends *full coverage of all people at risk of malaria* with long-lasting insecticide-treated nets (LLINs) in areas targeted for malaria prevention (WHO, 2007).

DATA AND METHODS

Data

The data used come from six Demographic and Health Surveys (DHS) and one Malaria Indicator Survey (MIS) conducted from 2004-06—Benin, Ethiopia, Mali, Rwanda, Senegal, Tanzania, and Uganda. The DHS and MIS collected information from nationally representative probability samples of households and from adult women in these households. Because the sample designs of these surveys typically oversample certain categories of households or respondents, the samples are not self-weighting. To obtain nationally representative estimates, sample weights are used in tabulations. Estimates based on fewer than 25 unweighted cases are not shown in the tables in this report and estimates based on 25-49 unweighted cases are indicated in parentheses. Estimates based on small numbers of cases should be interpreted with caution.

The DHS and MIS use standard questionnaires that aid cross-country comparisons. Both types of surveys use comparable household questionnaires; one member of the household, often the head of household is asked by interviewers to show all the mosquito nets in the household. The interviewer records the number and type of mosquito nets a particular household owns and asks the respondent to identify which persons in the household slept under a particular mosquito net the night before the survey. The DHS household questionnaire also collects basic background characteristics of persons listed in the household schedule, such as age, sex, relationship to the head of household, marital status, and presence of prolonged illness in the past 12 months, as well as detailed information about household characteristics, which is necessary for calculating the household wealth index. The MIS collects similar information to the DHS in the household questionnaire.

The DHS and MIS also use an individual questionnaire to interview women age 15-49. The individual questionnaire collects more in-depth information about women and their children. This information is used in Tables 8 and 9.

Below are the definitions of key variables used in the analysis:

Insecticide-Treated Net (ITN) – A factory-treated net that does not require any further treatment, or a pretreated net obtained within the past 12 months, or a net that has been soaked with insecticide within the past 12 months.

Use of an ITN – The percentage of persons in the household who slept under an ITN the night before the survey. Analysis is restricted to households that own an ITN.

Household wealth status – A measure based on an index that divides the household population into quintiles reflecting household ownership of assets and information on such characteristics as quality of housing, source of water, and sanitation facilities (see Rutstein and Johnson, 2004).

Size of household –The number of persons who stayed in the household the night before the interview.

Chronically ill person – A person who was very sick for at least 3 months during the past 12 months and was not able to do work or normal activities. This question was asked about household members age 15-59 in Mali and household members age 18-59 in Rwanda and Uganda.

Indoor Residual Spraying (IRS) – Spraying of the interior walls of the dwelling unit with an insecticide against mosquitoes.

Methods

All analysis used information from the household questionnaires, with the exception of Tables 8 and 9, which take information from the individual DHS and MIS questionnaires. CSPro 3.3 was used to create data files for the analysis. Tabulations and estimation of logistic models were performed using STATA 9.3.

RESULTS

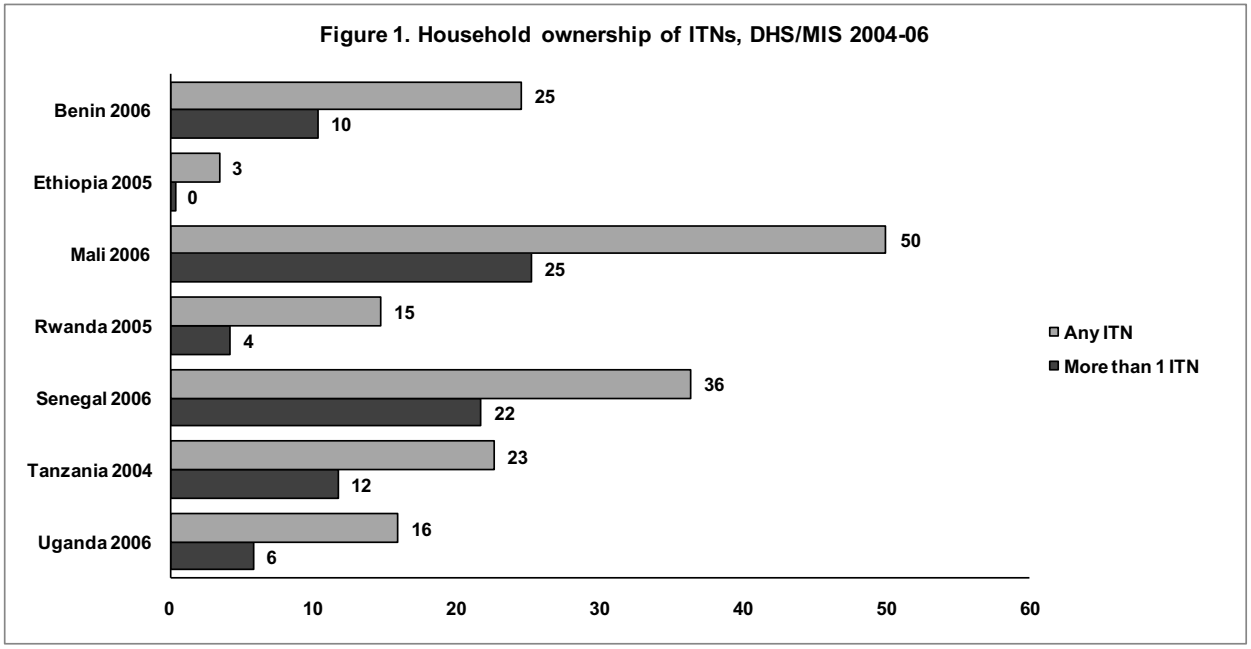
Household Ownership of Mosquito Nets and ITNs

Table 1 shows that household ownership of at least one mosquito net, regardless of type, varies widely among the seven countries studied, from only 6 percent of households in Ethiopia to 69 percent in Mali. Households in Ethiopia are also least likely to own multiple nets, at only about 1 percent, while households in Mali and Senegal are most likely to own more than one net, at nearly 40 percent.

Table 1. Household ownership of mosquito nets in selected countries, DHS/MIS 2004-2006

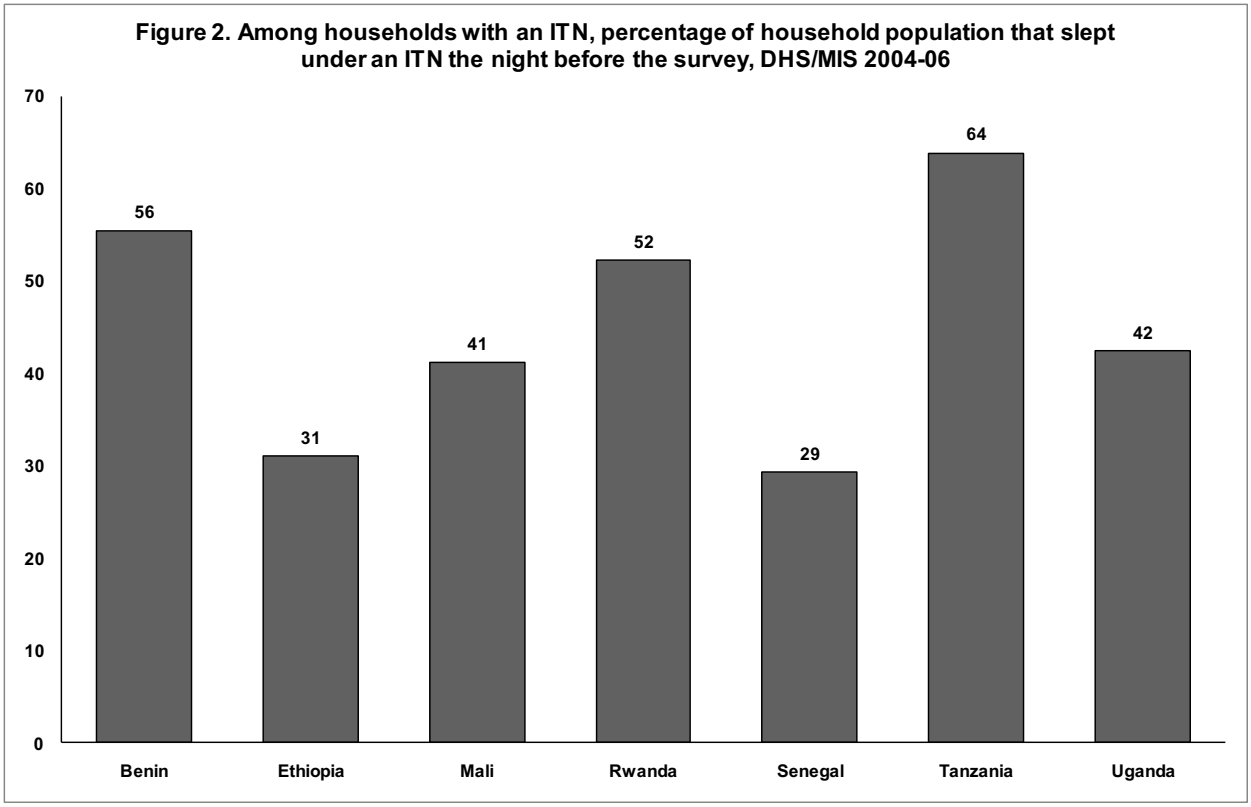
	Country						
Characteristic	**Benin 2006**	**Ethiopia 2005**	**Mali 2006**	**Rwanda 2005**	**Senegal 2006 (MIS)**	**Tanzania 2004**	**Uganda 2006**
Household ownership of:							
Any net	56.4	5.7	69.0	18.2	56.7	46.3	34.3
>1 net	28.6	0.9	39.6	5.6	39.4	26.8	14.8
Any ITN	24.5	3.4	50.0	14.7	36.3	22.6	15.9
>1 ITN	10.3	0.3	25.2	4.2	21.7	11.7	5.8
Number of households	17,511	13,721	12,998	10,272	3,063	9,735	8,870

Similarly, Table 1 and Figure 1 show that ownership of ITNs is lowest in Ethiopia (3 percent) and highest in Mali (50 percent). Ownership of multiple ITNs is lowest in Ethiopia, as well, at less than 1 percent of households. Ownership of multiple ITNs is highest in Mali (25 percent) and Senegal (22 percent).



Use of ITNs by Household Members

This section examines use of ITNs among all persons who stayed in a household the night before the survey among households that own an ITN. Figure 2 shows that the percentage of the household population that slept under an ITN the night before the survey is highest in Tanzania (64 percent), while more than 50 percent of the household population also slept under an ITN in Benin (56 percent) and Rwanda (52 percent). The percentage is lowest in Senegal (29 percent).



Differentials in Use

Among households that own an ITN, use of ITNs is somewhat higher among females than males in all countries except Ethiopia, where females and males are *about* equally likely to use an ITN (see Table 2). By age, patterns of ITN use vary widely. However, children under age 5 consistently have higher use of ITNs than persons age 5-14 or 15-19. ITN use also varies widely by urban/rural place of residence. In five of the countries (Benin, Ethiopia, Rwanda, Tanzania, and Uganda), use of ITNs is higher in urban than rural areas. In Senegal, however, use of ITNs is higher in rural areas (see Figure 3). In Mali, there is no urban/rural difference in ITN use. Patterns of ITN use by education show a U-shaped relationship; household members with no education and those with secondary or higher education have the highest levels of ITN use, while

those with primary education have the lowest levels of use. The only exception is Tanzania, where use of ITNs increases steadily with the level of education of the respondent.

Figure 3. Among households with an ITN, percentage of the household poulation that slept under an ITN the night before the survey, by residence, DHS/MIS 2004-06

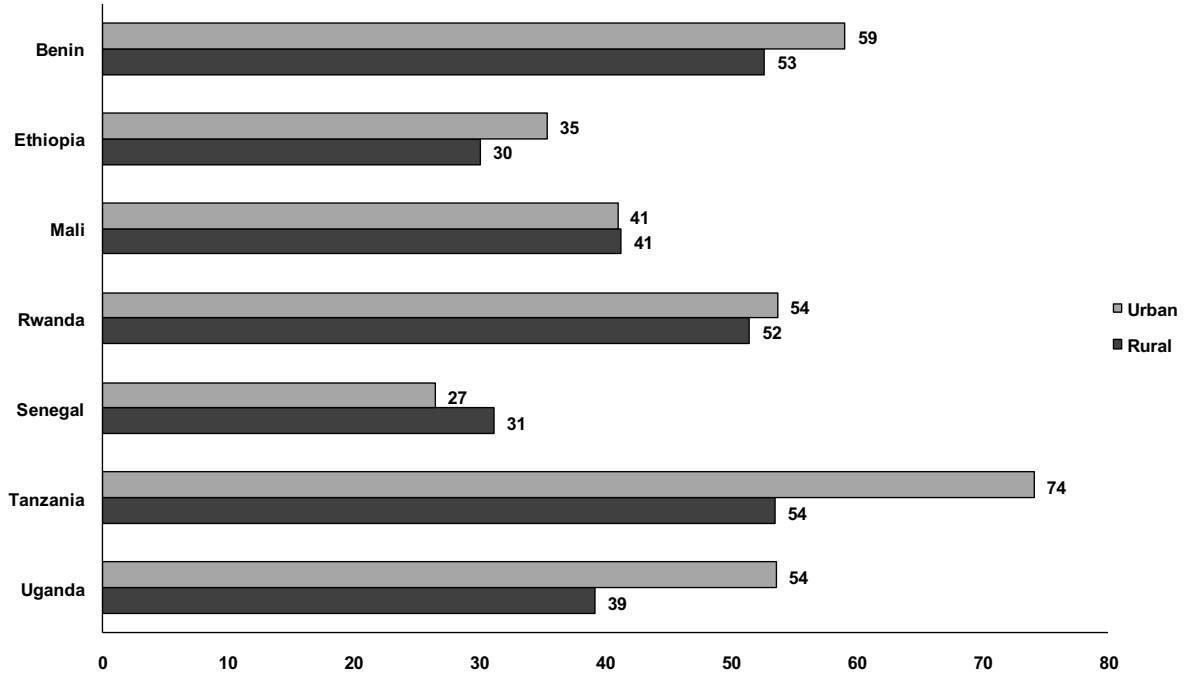


Table 2. Among households with an ITN, percentage of household population that slept under an ITN the night before the survey, by selected characteristics, DHS/MIS 2004-2006

	Country						
Characteristic	**Benin**	**Ethiopia**	**Mali**	**Rwanda**	**Senegal**	**Tanzania**	**Uganda**
Sex							
Male	51.4	31.7	36.8	50.8	27.3	61.4	40.1
Female	59.4	30.5	45.4	53.6	31.1	66.1	44.5
Age							
<5	68.8	39.3	50.1	64.2	36.2	68.8	54.5
5-14	43.3	21.7	30.1	32.0	25.4	58.7	25.9
15-19	42.0	15.3	26.9	21.5	21.0	54.8	28.6
20-24	61.0	24.9	39.9	47.8	25.2	65.3	50.2
25-29	66.9	46.3	49.6	73.6	28.6	69.0	59.9
30-34	65.1	41.4	50.9	76.8	33.5	69.6	61.7
35-39	59.8	44.9	51.5	77.4	33.8	73.7	58.6
40-44	58.2	54.7	50.4	74.4	29.6	71.6	57.0
45-49	57.9	44.2	51.0	65.5	37.7	63.1	47.6
50+	50.6	28.4	49.1	66.9	33.4	58.7	43.4

(Cont'd)

Table 2 – cont'd

Characteristic	Country						
	Benin	Ethiopia	Mali	Rwanda	Senegal	Tanzania	Uganda
Residence							
Urban	59.1	35.4	41.0	53.7	26.5	74.1	53.6
Rural	52.7	30.1	41.3	51.5	31.2	53.5	39.2
Education							
None[a]	59.0	32.9	43.1	56.2	n/a	61.0	48.1
Primary	48.9	26.0	34.1	45.8	n/a	64.1	35.9
Secondary +	58.0	35.2	39.6	66.5	n/a	73.0	50.7
Marital Status							
Never married[b]	51.5	n/a	n/a	40.8	n/a	n/a	35.3
Currently married	63.5	n/a	n/a	78.9	n/a	n/a	59.8
Formerly married	51.2	n/a	n/a	58.2	n/a	n/a	41.2
Relation to head of household							
Head	61.0	47.3	52.1	76.5	41.3	75.4	61.3
Spouse	70.5	47.6	56.9	80.5	38.6	75.4	66.4
Son/daughter/son- & daughter-in-law	54.1	25.0	36.3	44.6	28.0	63.3	38.0
Grandchild	44.3	23.6	37.3	35.6	25.5	55.7	30.0
Brother/sister	0.0	17.9	20.5	36.3	29.1	49.7	28.4
Adopted/foster child	31.8	(10.2)	24.6	22.8	27.6	54.0	26.9
Other/not related	37.7	13.0	24.8	24.9	25.9	48.1	21.4
Household wealth status							
Lowest	53.4	31.9	38.2	49.5	38.3	34.9	41.7
Second	53.0	26.5	41.6	50.3	33.5	45.2	41.1
Middle	52.9	31.5	41.7	50.6	28.2	56.1	36.3
Fourth	52.6	32.2	42.0	51.4	26.0	59.5	39.6
Highest	61.1	31.6	42.6	53.8	19.7	75.3	47.6
Size of household							
<5	73.3	38.9	55.8	69.3	49.1	77.8	63.8
5-8	58.6	30.9	42.8	47.9	35.3	63.8	41.2
9+	34.6	19.2	30.2	39.9	26.8	48.6	28.6
Chronically ill[c]							
Yes	n/a	n/a	51.0	68.9	n/a	n/a	71.6
Not asked	n/a	n/a	37.5	42.7	n/a	n/a	35.8
No	n/a	n/a	46.7	65.0	n/a	n/a	53.1
Use of IRS in the past 12 months							
Yes	n/a	35.8	n/a	n/a	26.8[d]	n/a	42.6
No	n/a	29.8	n/a	n/a	29.3	n/a	42.4
Number of ITNs in household							
1	43.0	30.1	28.4	44.2	14.2	49.0	33.1
2	65.2	34.6	44.0	63.0	18.7	66.9	54.1
3+	72.6	93.4	57.7	76.5	47.5	77.0	58.5
Total	55.5	31.1	41.2	52.2	29.3	63.9	42.4
Number	22,865	2,400	37,024	7,779	11,716	10,804	7,613

Note: Figures in parentheses are based on 25-49 unweighted cases

[a]Includes household members younger than age 5 for whom educational attainment is not ascertained

[b]Includes household respondents younger than age 15 in Rwanda and Uganda, and younger than age 10 in Benin, whose marital status is not ascertained

[c]Asked for household members age 15-59 in Mali and age 18-59 in Rwanda and Uganda

[d]Sprayed by government in past 12 months

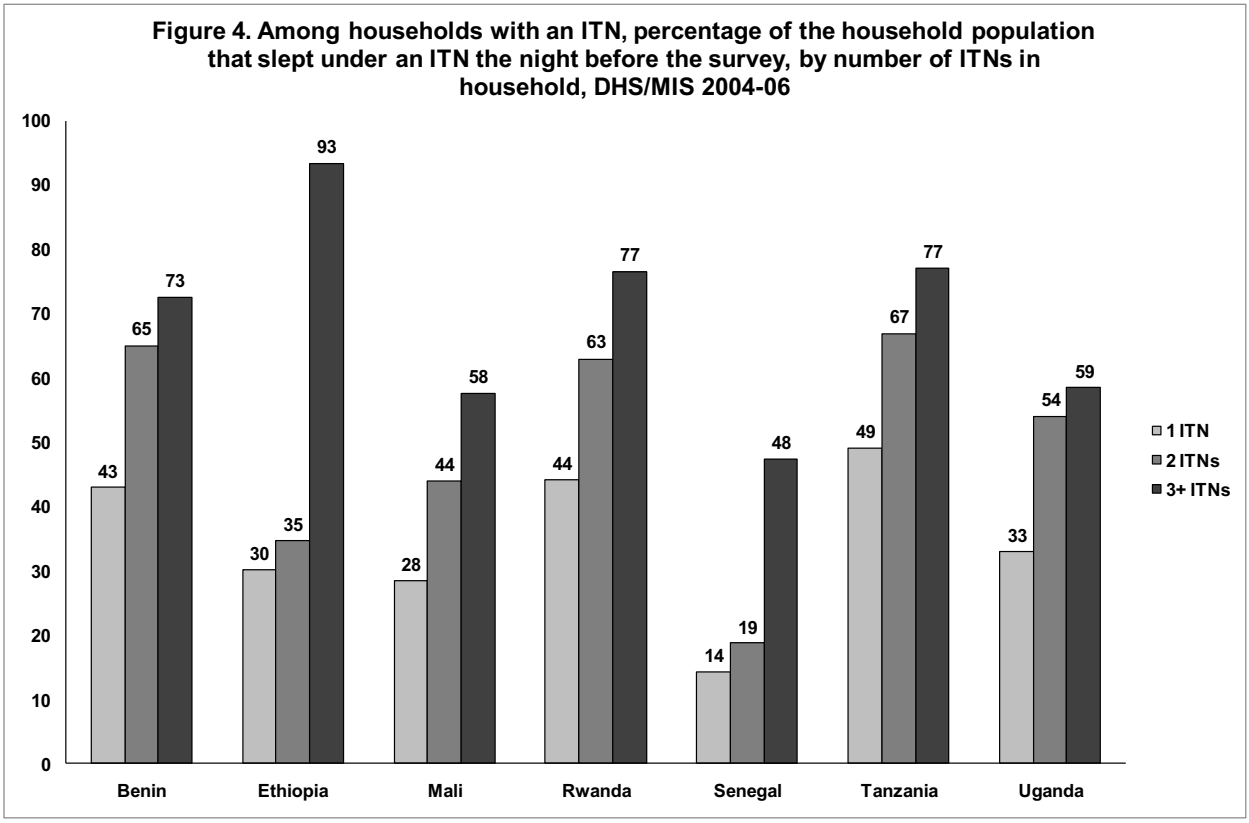
n/a= not available

Table 2 also reports the use of ITNs by the relationship of the member of household to the head of the household. In every country, the head of the household and the spouse of the head of household are most likely to use an ITN. In every country except Mali and Senegal, children of the head of household are next mostly likely to use an ITN. With the exception of Senegal, adopted and foster children are considerably less likely to use ITNs than children of the head of the household. The association between household wealth and ITN use among households that own an ITN is weak in all countries except Senegal and Tanzania. In Senegal, ITN use declines with household wealth, while in Tanzania ITN use increases with household wealth.

In every country, the percentage of household members using an ITN declines sharply as the size of household increases. In several of the countries studied, persons in households with fewer than five members are twice as likely to sleep under an ITN as those in households with nine or more members.

Of the three countries with information on chronic illnesses (Mali, Rwanda, and Uganda), household members with a chronic illness are somewhat more likely to use an ITN than others in the household, particularly in Uganda. The association between indoor residual spraying (IRS) and ITN use is weak in two of the three countries that have this information (Senegal and Uganda). However, in Ethiopia, those in a household where IRS was done in the past 12 months were more likely to sleep under an ITN.

The association between the number of ITNs the household has and the use of ITNs is strong and positive in every country studied. For example, in Senegal, people in a household with three or more ITNs are more than three times as likely to use as ITN as those in a household with one ITN (see Figure 4).



Multivariate Analysis

After controlling for the effect of several socioeconomic and demographic characteristics, gender is significant in predicting who uses an ITN in all countries except Ethiopia and Rwanda (see Table 3). Overall, women are significantly more likely to use an ITN than men. However, while the differences are significant, the effect is 41 percent or less in all countries. Older residents (in every age group in every country) are significantly less likely to sleep under ITNs than children under the age of five years. Residence is a significant predictor of ITN use in Benin, Senegal, Tanzania, and Uganda. In these countries, rural residents are significantly less likely to use an ITN than urban residents. Place of residence is not significant as a predictor of ITN use in Ethiopia, Mali, and Rwanda.

There is no relationship between educational status and ITN use, except in Rwanda, where individuals with primary education are significantly less likely to use an ITN than those with no education. The association of marital status and ITN use is variable; in Benin, household members who are currently married and those who are formerly married are significantly more likely to use an ITN than those who have never been married. In Rwanda, while the same relationship occurs for currently married members of the household, the relationship is not significant for formerly married members. In Uganda, the relationship between marital status and ITN use is not significant.

In Benin, the spouse of the head of the household is significantly more likely to use an ITN than the head of the household, but the opposite relationship is seen in Senegal and Tanzania. In addition, in every country except Senegal, adopted or foster children are less likely to use an ITN than children of the head of the household. The association between household wealth and ITN use varies from country to country. In Ethiopia and Rwanda, household wealth is not significant in predicting ITN use. In Mali and Tanzania, ITN use generally increases as household wealth increases. In Senegal, the relationship is reversed. In Uganda, members of households in the lowest wealth quintile are significantly more likely to use an ITN than those in any other wealth quintile. In all countries studied, there is a significant relationship between size of household and ITN use; as size of the household increases, the odds of using an ITN decrease. In Uganda, for example, persons in a household with nine or more members are about 80 percent less likely to use an ITN than those in a household with fewer than five members.

Chronic illness is significantly associated with ITN use only in Uganda, where household members who are chronically ill are nearly three times as likely to use an ITN as those who are not chronically ill. In Ethiopia and Senegal, the use of IRS is a significant predictor of ITN use.

In Senegal, persons in a household that used IRS are twice as likely to use an ITN as those in a household that did not use IRS.

As with findings from the bivariate analysis, multivariate analysis shows that the number of ITNs in a household is a highly significant predictor of ITN use. In all countries, as the number of ITNs increases, the odds of a household member using an ITN increase significantly. In Benin and Rwanda, for example, persons in a household with two ITNs are more than four times as likely to use an ITN as those who live in a household with only one ITN. The odds of using an ITN are even higher in households with two or more ITNs (the adjusted odds ratios range from 6.7 to 18.3).

Table 3. Among households with an ITN, adjusted odds (OR) that the household population slept under an ITN the night before the survey, DHS/MIS 2004-2006

	Country													
Characteristic	**Benin**	***p*-value**	**Ethiopia**	***p*-value**	**Mali**	***p*-value**	**Rwanda**	***p*-value**	**Senegal**	***p*-value**	**Tanzania**	***p*-value**	**Uganda**	***p*-value**
Sex														
Male[R]	-		-		-		-		-		-		-	
Female	1.32	0.000	0.88	0.322	1.41	0.000	1.12	0.071	1.37	0.000	1.35	0.000	1.17	0.015
Age														
<5[R]	-		-		-		-		-		-		-	
5-14	0.33	0.000	0.47	0.000	0.40	0.000	0.25	0.000	0.50	0.000	0.48	0.000	0.30	0.000
15-19	0.24	0.000	0.26	0.000	0.24	0.000	0.13	0.000	0.39	0.000	0.34	0.000	0.26	0.000
20-24	0.29	0.000	0.21	0.000	0.28	0.000	0.19	0.000	0.49	0.000	0.43	0.000	0.29	0.000
25-29	0.26	0.000	0.29	0.000	0.31	0.000	0.25	0.000	0.55	0.000	0.36	0.000	0.26	0.000
30-34	0.21	0.000	0.21	0.000	0.29	0.000	0.24	0.000	0.62	0.001	0.27	0.000	0.24	0.000
35-39	0.17	0.000	0.23	0.000	0.30	0.000	0.22	0.000	0.58	0.000	0.30	0.000	0.21	0.000
40-44	0.15	0.000	0.32	0.005	0.28	0.000	0.19	0.000	0.42	0.000	0.24	0.000	0.22	0.000
45-49	0.15	0.000	0.23	0.001	0.26	0.000	0.13	0.000	0.54	0.001	0.19	0.000	0.13	0.000
50+	0.12	0.000	0.12	0.000	0.27	0.000	0.15	0.000	0.48	0.000	0.17	0.000	0.12	0.000
Residence														
Urban[R]	-		-		-		-		-		-		-	
Rural	0.90	0.006	0.71	0.080	1.10	0.173	1.08	0.257	0.63	0.000	0.58	0.000	0.67	0.000
Education														
None[a,R]	-		-		-		-		n/a	n/a	-		-	
Primary	0.92	0.051	0.89	0.467	0.97	0.431	0.83	0.026	n/a	n/a	1.01	0.910	0.85	0.106
Secondary +	1.00	0.941	1.00	0.986	1.04	0.548	0.84	0.184	n/a	n/a	0.93	0.573	0.81	0.096
Marital Status														
Never married[b,R]	-		n/a	n/a	n/a	n/a	-		n/a	n/a	n/a	n/a	-	
Currently married	1.48	0.000	n/a	n/a	n/a	n/a	2.35	0.000	n/a	n/a	n/a	n/a	1.18	0.352
Formerly married	1.61	0.000	n/a	n/a	n/a	n/a	1.00	1.000	n/a	n/a	n/a	n/a	1.26	0.281
Relation to head of household														
Head[R]	-		-		-		-		-		-		-	
Spouse	1.38	0.000	1.01	0.954	0.97	0.689	0.96	0.749	0.64	0.001	0.72	0.007	1.10	0.446
Son/daughter/son- & daughter-in-law	0.50	0.000	0.16	0.000	0.28	0.000	0.24	0.000	0.42	0.000	0.26	0.000	0.22	0.000
Grandchild	0.29	0.000	0.10	0.000	0.25	0.000	0.13	0.000	0.34	0.000	0.18	0.000	0.16	0.000
Brother/sister	n/a	n/a	0.14	0.000	0.19	0.000	0.23	0.000	0.48	0.000	0.17	0.000	0.16	0.000
Adopted/foster child	0.18	0.000	0.08	0.022	0.15	0.000	0.10	0.000	0.44	0.000	0.23	0.000	0.14	0.000
Other/not related	0.28	0.000	0.12	0.000	0.18	0.000	0.09	0.000	0.32	0.000	0.14	0.000	0.10	0.000

(Cont'd)

Table 3 – cont'd

Characteristic	Country													
	Benin	*p*-value	Ethiopia	*p*-value	Mali	*p*-value	Rwanda	*p*-value	Senegal	*p*-value	Tanzania	*p*-value	Uganda	*p*-value
Household wealth status														
Lowest[R]	-		-		-		-		-		-		-	
Second	1.10	0.149	0.76	0.172	1.12	0.010	1.06	0.656	0.82	0.004	1.18	0.224	0.80	0.016
Middle	0.96	0.457	0.93	0.708	1.08	0.120	0.92	0.530	0.66	0.000	1.66	0.000	0.66	0.000
Fourth	0.88	0.033	1.17	0.408	1.13	0.017	0.86	0.220	0.49	0.000	1.57	0.000	0.82	0.033
Highest	0.95	0.409	0.78	0.223	1.40	0.000	0.97	0.828	0.28	0.000	2.06	0.000	0.74	0.003
Size of household														
<5[R]	-		-		-		-		-		-		-	
5-8	0.38	0.000	0.87	0.368	0.47	0.000	0.36	0.000	0.43	0.000	0.36	0.000	0.43	0.000
9+	0.10	0.000	0.56	0.007	0.21	0.000	0.20	0.000	0.20	0.000	0.16	0.000	0.22	0.000
Chronically ill[c]														
Yes	n/a	n/a	n/a	n/a	1.03	0.776	1.05	0.853	n/a	n/a	n/a	n/a	2.84	0.021
Not asked	n/a	n/a	n/a	n/a	0.98	0.809	0.79	0.094	n/a	n/a	n/a	n/a	0.87	0.337
No[R]	n/a	n/a	n/a	n/a	-		-		n/a	n/a	n/a	n/a	-	
Use of IRS in the past 12 months														
Yes	n/a	n/a	1.38	0.030	n/a	n/a	n/a	n/a	2.07[d]	0.000	n/a	n/a	0.88	0.186
No[R]	n/a	n/a	-		n/a	n/a	n/a	n/a	-		n/a	n/a	-	
Number of ITNs in household														
1[R]							-		-		-			
2	4.16	0.000	1.82	0.001	2.77	0.000	4.79	0.000	1.58	0.000	3.47	0.000	3.25	0.000
3+	10.69	0.000	-		7.82	0.000	18.29	0.000	7.91	0.000	9.14	0.000	6.69	0.000
Number	23,082		3,288		36,700		8,556		12,281		10,087		7,817	

[a]Includes household members younger than age 5 for whom educational attainment is not ascertained

[b]Includes household respondents younger than age 15 in Rwanda and Uganda whose marital status is not ascertained

[c]Asked for household members age 15-59 in Mali and age 18-59 in Rwanda and Uganda

[d]Sprayed by government in past 12 months

[R] = Reference category

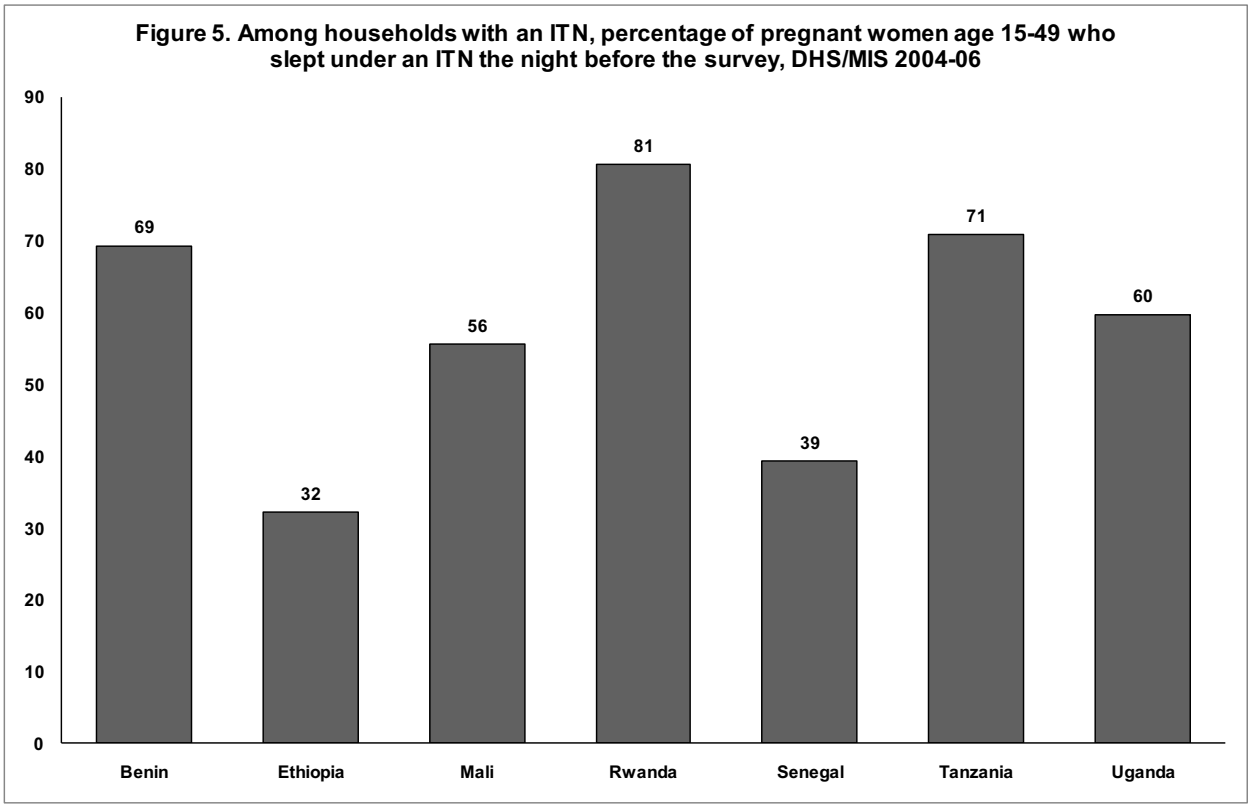
n/a= not available

Use of ITNs by Pregnant Women

Figure 5 shows that, overall, ITN use by pregnant women age 15-49 (in households with an ITN) ranges substantially, from 32 percent in Ethiopia to 81 percent in Rwanda.

Differentials in Use

In Mali, Rwanda, and Senegal, pregnant women in rural areas are more likely than pregnant women in urban areas to use an ITN. However, in Benin, Tanzania, and Uganda, the relationship is reversed (see Figure 6). The association between education and ITN use is generally weak, with the exception of Benin and Tanzania, where ITN use is positively associated with education (see Table 4). In Benin, currently married pregnant women are more likely to use an ITN than other pregnant women. In the other countries, either these data were not collected or there were too few cases to make comparisons.



ITN use differs by the relationship of the pregnant woman to the head of the household. In all countries, the pregnant wife of a head of household is more likely to use an ITN than other pregnant women in the household. In Tanzania, for example, the wife is nearly twice as likely as other women to use an ITN (80 percent compared with 47 percent).

Figure 6. Among households with an ITN, percentage of pregnant women age 15-49 who slept under an ITN the night before the survey, by residence, DHS/MIS 2004-06

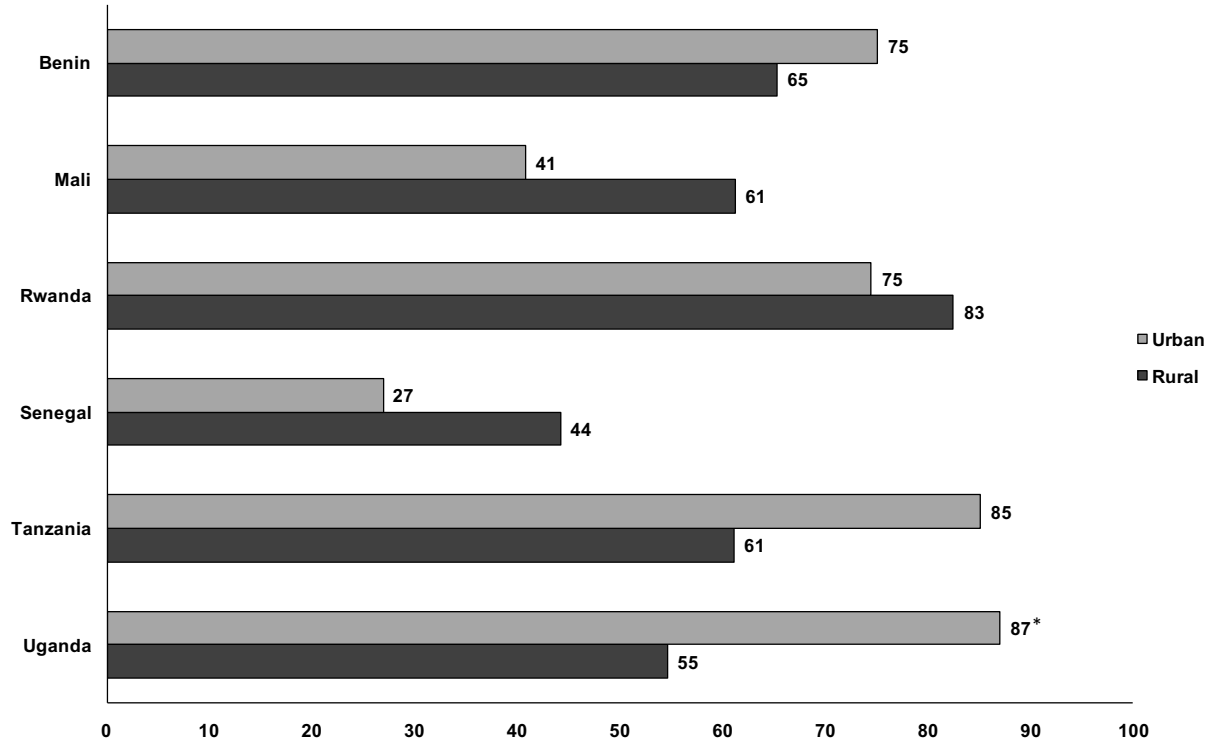


*Figure based on 25-49 unweighted cases

Table 4. Among households with an ITN, percentage of pregnant women age 15-49 who slept under an ITN the night before the survey, by selected characteristics, DHS/MIS 2004-2006

Characteristic	Country						
	Benin	Ethiopia	Mali	Rwanda	Senegal	Tanzania	Uganda
Age							
15-24	71.8	*	53.8	81.1	39.3	70.2	51.7
25-34	66.4	35.3	56.6	81.0	43.6	71.9	72.1
35-49	74.8	*	57.7	(78.9)	(40.2)	(69.3)	*
Residence							
Urban	75.1	*	40.8	74.5	26.9	85.1	(87.0)
Rural	65.3	26.1	61.2	82.5	44.2	61.1	54.6
Education							
None	66.6	31.1	56.3	(81.6)	n/a	(52.2)	(54.5)
Primary	72.8	*	49.3	82.4	n/a	72.7	60.4
Secondary +	76.1	*	57.8	74.3	n/a	(82.9)	(61.5)
Marital Status							
Currently married	70.3	n/a	n/a	81.2	n/a	n/a	63.8
Not currently married	(52.8)	n/a	n/a	*	n/a	n/a	*
Relation to head of household							
Wife	72.5	34.1	57.3	83.3	42.1	80.2	64.5
Other	56.4	*	47.2	*	37.6	46.6	50.3
Household wealth status							
Lowest	73.9	*	54.3	*	41.0	*	(47.1)
Second	63.5	*	60.7	(89.9)	48.0	*	(54.5)
Middle	73.2	*	63.7	*	40.8	(72.4)	(60.9)
Fourth	67.2	*	49.4	79.8	(33.2)	68.3	(70.4)
Highest	69.8	*	50.5	73.2	*	82.7	(65.5)
Size of household							
1-5	78.1	(37.1)	56.9	78.5	*	77.2	73.0
6+	56.3	(25.8)	54.3	85.1	38.4	59.9	49.2
Chronically ill[a]							
Yes	n/a	n/a	50.7	*	n/a	n/a	*
Not asked	n/a	n/a	40.2	*	n/a	n/a	*
No	n/a	n/a	58.8	80.3	n/a	n/a	61.2
Use of IRS in the past 12 months							
Yes	n/a	*	n/a	n/a	*[b]	n/a	*
No	n/a	37.9	n/a	n/a	39.2	n/a	60.4
Number of ITNs in household							
1	62.3	(30.6)	38.7	80.14	16.8	72.7	55.8
2	80.2	*	65.3	(79.6)	(35.3)	57.8	(67.1)
3+	81.0	*	75.0	*	58.1	(83.5)	*
Total	69.3	32.2	55.6	80.6	39.3	70.9	59.7
Number	555	39	986	191	206	242	171

Note: Figures in parentheses are based on 25-49 unweighted cases. An asterisk indicates that the percentage is based on fewer than 25 unweighted cases and has been suppressed.

[a]Asked for household members age 15-59 in Mali and age 18-59 in Rwanda and Uganda

[b]Sprayed by government in past 12 months

n/a = not available

In almost all countries, household size is negatively associated with the likelihood of use of ITNs among pregnant women. The exception is Rwanda, where pregnant women in households with six or more members are more likely to use an ITN than pregnant women in households with five or fewer members. The relationship between ITN use and number of ITNs in the household is clear; as the number of ITNs increases, the use of ITNs increases, in all countries except Rwanda and Tanzania. Patterns of ITN use by household wealth status are inconsistent. While ITN use generally increases with household wealth in Uganda, this differential is weak in other countries. In Mali, pregnant women who are chronically ill are somewhat less likely to use an ITN than pregnant women who are not chronically ill. The association between chronic illness and ITN use among pregnant women is not clear in Rwanda and Uganda (where there are too few cases for analysis).

Multivariate Analysis

After controlling for the effect of several background characteristics, the effect of age on ITN use is not significant among pregnant women in any of the countries studied, except Benin and Uganda (see Table 5). In Benin, pregnant women age 25-34 are about half as likely as pregnant women age 15-24 to use an ITN. In Uganda, pregnant women age 25-34 are more than twice as likely to use an ITN as those age 15-24. The effect of residence on ITN use is significant in four of the seven countries. In Mali, pregnant women in rural areas are significantly more likely to use an ITN than those living in urban areas (OR: 3.23, *p*-value: 0.000). In Benin, Tanzania, and Uganda, rural pregnant women are significantly less likely to use ITNs. Education and marital status of women do not significantly predict ITN use, except in Uganda where currently married pregnant women are eight times as likely to use an ITN as pregnant women not currently

married. Pregnant women married to the head of household are significantly more likely to use an ITN than other pregnant women in the household. The only exceptions are Senegal and Uganda, where the statistical relationship is not significant.

Pregnant women in the second and middle quintiles in Mali are much more likely to use an ITN than pregnant women in the lowest quintile. In Senegal, pregnant women in the highest wealth quintile are least likely to use an ITN. Household wealth is not a significant predictor of ITN use among pregnant women in Benin, Rwanda, Tanzania, and Uganda. Household size is a significant predictor of ITN use in Benin, Mali, Senegal, and Uganda. In these countries, pregnant women in households with six or more residents are significantly less likely to use an ITN than those in households with fewer members. Among pregnant women in households with an ITN, being chronically ill and the use of IRS do not significantly predict ITN use in the surveys that contain that information.

The number of ITNs in a household significantly predicts use of ITNs in Benin, Mali, and Senegal. In Benin, for example, pregnant women in households with three of more ITNs are almost six times as likely to use an ITN as pregnant women in households with just one ITN. In Rwanda, although the relationship is in the same direction as in the other countries, the number of ITNs is not a significant predictor of ITN use. Ethiopia was removed from multivariate analysis due to the small number of pregnant women.

Table 5. Among households with an ITN, adjusted odds (OR) that pregnant women age 15-49 slept under an ITN the night before the survey, DHS/MIS 2004-2006

Characteristic	Country											
	Benin	*p*-value	Mali	*p*-value	Rwanda	*p*-value	Senegal	*p*-value	Tanzania	*p*-value	Uganda	*p*-value
Age												
15-24[R]	-		-		-		-		-		-	
25-34	0.57	0.019	0.89	0.552	1.07	0.889	1.86	0.110	1.03	0.953	2.58	0.043
35-49	1.26	0.561	1.02	0.956	0.72	0.650	1.76	0.292	1.36	0.622	0.78	0.698
Residence												
Urban[R]	-		-		-		-		-		-	
Rural	0.54	0.023	3.23	0.000	1.29	0.586	1.15	0.777	0.30	0.036	0.08	0.000
Education												
None[R]	-		-		-		n/a	n/a	-		-	
Primary	1.30	0.333	1.01	0.975	1.38	0.617	n/a	n/a	1.40	0.549	1.85	0.252
Secondary +	1.69	0.183	1.39	0.400	1.06	0.933	n/a	n/a	1.19	0.824	1.32	0.695
Marital Status												
Currently married	1.79	0.172	n/a	n/a	0.46	0.383	n/a	n/a	n/a	n/a	8.35	0.013
Not currently married[R]	-		n/a	n/a	-		n/a	n/a	n/a	n/a	-	
Relation to head of household												
Wife	1.82	0.024	1.74	0.016	6.14	0.004	1.02	0.961	4.38	0.000	0.76	0.574
Other[R]	-		-		-		-		-		-	
Household wealth status												
Lowest[R]	-		-		-		-		-		-	
Second	0.75	0.522	1.64	0.044	1.39	0.700	1.39	0.456	2.60	0.175	1.45	0.576
Middle	1.12	0.786	1.86	0.023	1.35	0.747	1.47	0.454	3.45	0.077	1.76	0.346
Fourth	0.78	0.548	1.42	0.217	0.58	0.472	0.68	0.523	2.28	0.214	1.88	0.313
Highest	0.41	0.057	2.04	0.071	0.45	0.277	0.03	0.033	2.36	0.263	0.49	0.275
Size of household												
1-5[R]	-		-		-		-		-		-	
6+	0.27	0.000	0.42	0.000	1.82	0.234	0.17	0.003	0.53	0.143	0.35	0.020
Chronically ill[a]												
Yes	n/a	n/a	0.74	0.226	1.71	0.509	n/a	n/a	n/a	n/a	n/a	n/a
Not asked	n/a	n/a	0.46	0.022	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
No[R]	n/a	n/a	-		-		n/a	n/a	n/a	n/a	n/a	n/a
Use of IRS in the past 12 months												
Yes	n/a	n/a	n/a	n/a	n/a	n/a	2.76[b]	0.448	n/a	n/a	0.40	0.099
No[R]	n/a	n/a	n/a	n/a	n/a	n/a	-		n/a	n/a	-	

(Cont'd)

Table 5 – cont'd

Characteristic	Country											
	Benin	*p*-value	Mali	*p*-value	Rwanda	*p*-value	Senegal	*p*-value	Tanzania	*p*-value	Uganda	*p*-value
Number of ITNs in household												
1[R]	-		-		-		-		-		-	
2	3.24	0.000	3.75	0.000	1.15	0.810	4.25	0.008	0.62	0.241	1.23	0.689
3+	5.85	0.000	7.71	0.000	3.50	0.193	10.06	0.000	2.71	0.061	2.86	0.051
Number	555		936		209		231		236		167	

Note: The variable "chronically ill" for Uganda has been dropped from the model as it perfectly predicts use of ITNs. For Rwanda, women who were "not asked" if they were chronically ill were recoded as "no" in the model due to the small number of cases.

[a]Asked for household members age 15-59 in Mali and age 18-59 in Rwanda and Uganda

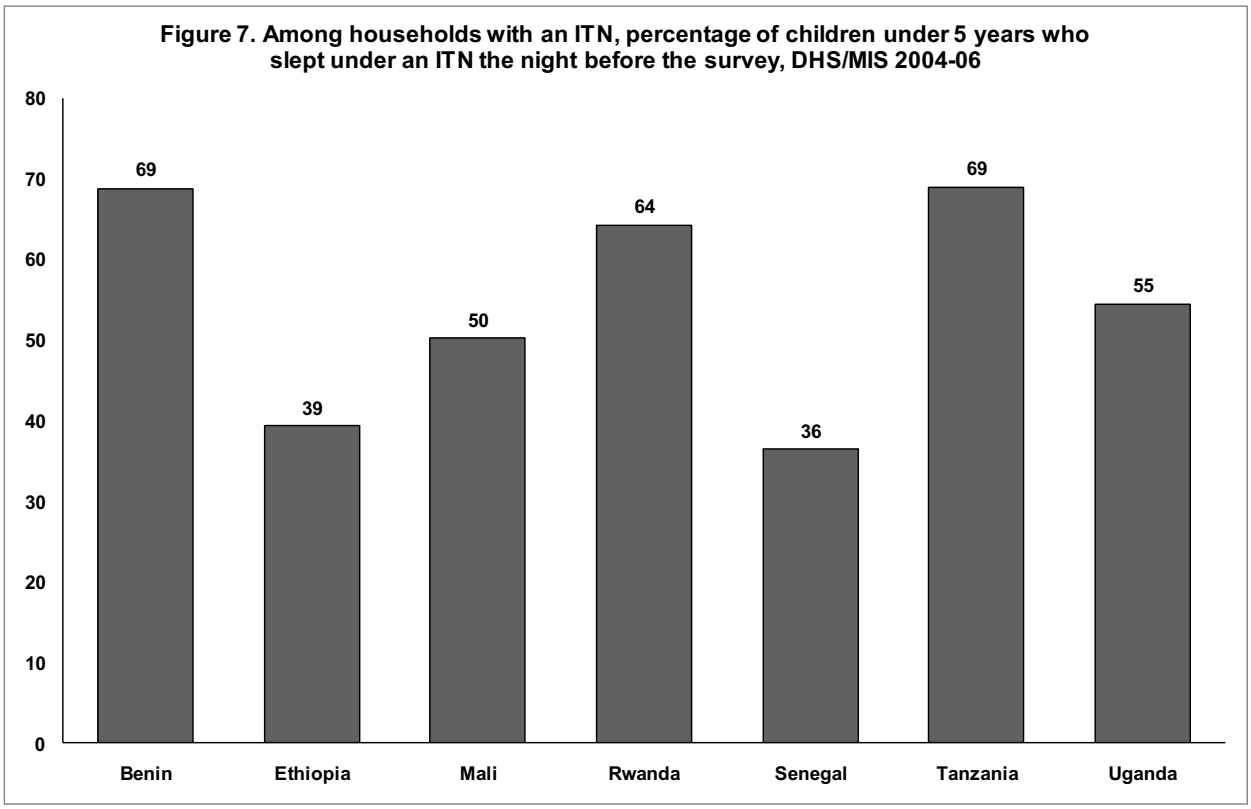
[b]Sprayed by government in past 12 months

[R] = Reference category

n/a = not available

Use of ITNs by Children under Age Five

In households with an ITN, the use of ITNs by children under age five ranges widely, from 36 percent in Senegal to 69 percent in Benin and Tanzania (see Figure 7). In all countries except Ethiopia and Senegal, 50 percent or more of children under age five used an ITN the night before the survey.



Differentials in Use

Among households with an ITN, the use of ITNs by children under age five shows little variation by sex of the child; male and female children are about equally likely to use an ITN in most countries (see Table 6). Use of ITNs is somewhat higher among male children in Ethiopia, however, and among female children in Senegal. In Benin, Mali, Rwanda, and Uganda, ITN use declines as the age of the child increases. For example, in Rwanda, 76 percent of children less

than one year old use an ITN compared with 44 percent of children age four. Age patterns of ITN use among young children are less clear in Ethiopia, Senegal, and Tanzania. By place of residence, urban children are more likely to use an ITN than rural children in Benin, Ethiopia, Tanzania, and Uganda, but there is little difference in Mali and Rwanda. In Senegal, rural children are slightly more likely than urban children to use an ITN. There is no consistent pattern in the use of ITNs by household wealth status except in Senegal, where ITN use declines steadily with household wealth, and Tanzania, where ITN use increases steadily with household wealth.

Table 6. Among households with an ITN, percentage of children under five years who slept under an ITN the night before the survey, by selected characteristics, DHS/MIS 2004-2006

	Country						
Characteristic	**Benin**	**Ethiopia**	**Mali**	**Rwanda**	**Senegal**	**Tanzania**	**Uganda**
Sex							
Male	68.9	41.3	49.9	64.1	34.4	67.6	53.7
Female	68.8	37.1	50.4	64.2	38.7	70.2	55.2
Age (years)							
0	76.0	38.1	56.1	76.3	39.9	70.9	64.0
1	75.9	49.2	53.8	71.6	43.5	73.7	60.0
2	66.9	25.6	49.8	67.5	32.0	64.4	55.5
3	64.9	39.7	48.0	54.3	38.0	70.5	45.1
4	57.2	42.2	41.8	43.7	27.9	63.7	47.0
Residence							
Urban	71.2	45.4	50.1	65.4	34.2	79.8	66.3
Rural	67.2	38.1	50.2	63.7	37.6	60.8	51.6
Relation to head of household							
Son/daughter	71.8	40.4	52.4	66.5	41.0	74.9	59.0
Other	49.3	27.5	36.3	41.5	33.3	54.3	37.9
Household wealth status							
Lowest	64.0	44.8	47.8	57.1	44.9	41.5	55.9
Second	70.8	32.9	51.7	68.5	40.3	53.9	53.6
Middle	67.0	34.2	48.2	63.5	34.1	64.9	44.5
Fourth	68.1	45.3	51.0	60.9	32.5	68.1	53.9
Highest	72.0	38.0	52.0	65.8	25.3	80.5	59.7
Size of household							
<5	84.1	40.3	58.5	78.8	60.3	82.5	75.9
5-8	71.1	38.2	52.0	59.4	45.0	69.8	52.2
9+	47.7	43.5	41.4	54.3	33.5	52.9	42.9
Use of IRS in the past 12 months							
Yes	n/a	43.3	n/a	n/a	*[a]	n/a	54.1
No	n/a	38.2	n/a	n/a	36.4	n/a	54.5
Mother of child slept under ITN							
Yes	89.7	74.6	82.9	77.8	n/a	91.4	79.2
No	15.7	9.8	8.1	12.3	n/a	18.6	17.1
Mother not in household	39.6	*	34.9	46.0	n/a	57.1	36.9

(Cont'd)

Table 6 – cont'd

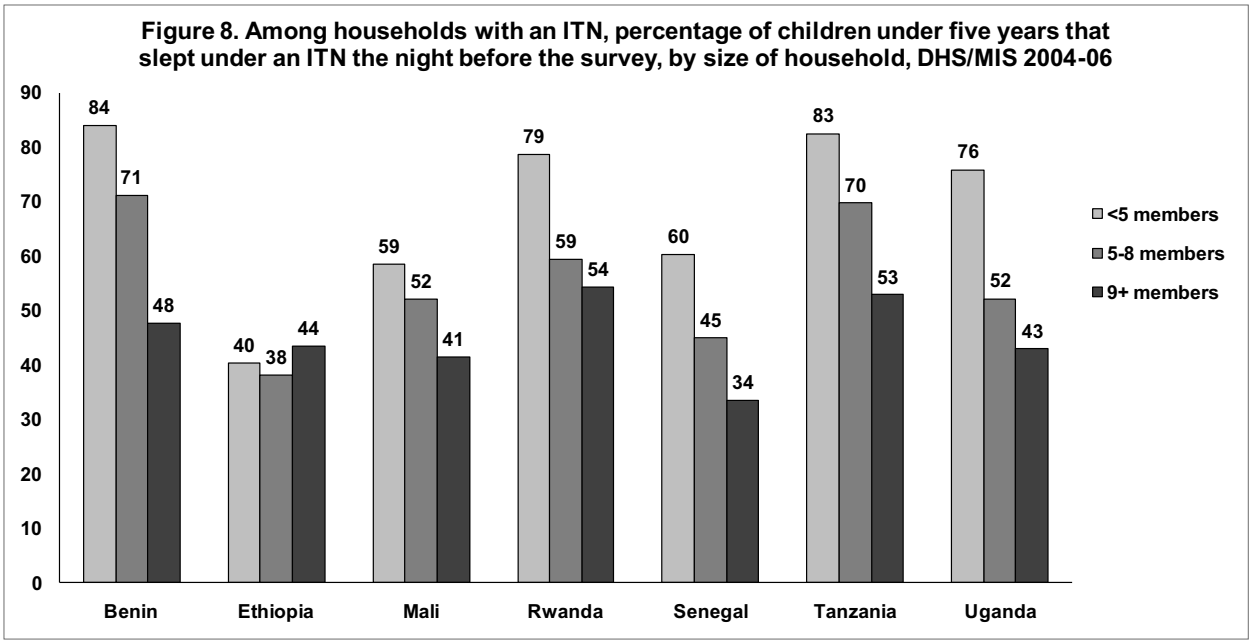
Characteristic	Country						
	Benin	Ethiopia	Mali	Rwanda	Senegal	Tanzania	Uganda
Number of ITNs in household							
1	61.5	38.3	37.9	58.5	22.6	61.7	46.6
2	77.0	40.5	55.6	74.4	23.9	24.1	66.3
3+	79.1	*	65.7	84.9	54.8	74.6	68.8
Total	68.8	39.3	50.2	64.2	36.4	68.9	54.5
Number	4,702	403	7,218	1,590	2,105	1,938	1,494

Note: An asterisk indicates that the percentage is based on fewer than 25 unweighted cases and has been suppressed.

[a]Sprayed by government in past 12 months

n/a = not available

The size of the household is negatively associated with ITN use among children under age five (see Figure 8). In Senegal, children in households with nine or more members are about half as likely to use an ITN as children in households with fewer than five members. The only exception to this pattern is Ethiopia, where the association between ITN use and household size is weak. ITN use is positively associated with IRS use in Ethiopia, but shows no relationship in Uganda. In all countries, ITN use by young children is strongly associated with whether or not the mother of the child uses an ITN. In Benin, for example, a child whose mother uses an ITN is nearly six times as likely to use an ITN as a child whose mother does not use an ITN. Given its high correlation with the outcome variable, this variable (mother's use of ITNs) is not included in the multivariate models. There is also a strong relationship between the number of ITNs in a household and use of ITNs by children under age five. As the number of ITNs increases, there is a corresponding increase in all countries except Tanzania.



Multivariate Analysis

Among children under age five in households with an ITN, the age of the child is a significant predictor of ITN use in five of the seven countries studied (see Table 7). Older children are significantly less likely to use an ITN than younger children. This pattern is clearest in Rwanda, where children age four are only one-fifth as likely to use an ITN as children less than one year old. The sex of the child is not a significant predictor of ITN use in any country. In four of the seven countries, place of residence is not a significant predictor of ITN use, In Senegal, Tanzania, and Uganda, however, rural children are significantly less likely than urban children to use an ITN.

Children of the head of the household are significantly more likely to use an ITN than other children in all countries except Ethiopia, where the direction of the relationship is the same, but the relationship is not significant. Household wealth is a significant predictor of ITN use only

in Senegal, Tanzania, and Uganda. In Senegal, higher wealth status is significantly associated with less ITN use. In Tanzania, however, higher wealth status is associated with more ITN use.

The size of the household significantly predicts the use of ITNs in all countries except Ethiopia. As the size of households increases, the odds of ITN use decrease. For example, in Mali, children in households with more than nine members are about 70 percent less likely to use ITNs than children in households with fewer than five members. For the three countries where IRS data are available, only in Senegal is IRS a significant predictor of ITN use (OR: 2.81, *p*-value: 0.026). In all countries except Ethiopia, the number of ITNs in a household significantly predicts ITN use among children under age five. In Tanzania, children in households with three or more ITNs are more than three times as likely to use an ITN as children in households with only one ITN.

Table 7. Among households with an ITN, adjusted odds (OR) that children under five years slept under an ITN the night before the survey, DHS/MIS 2004-2006

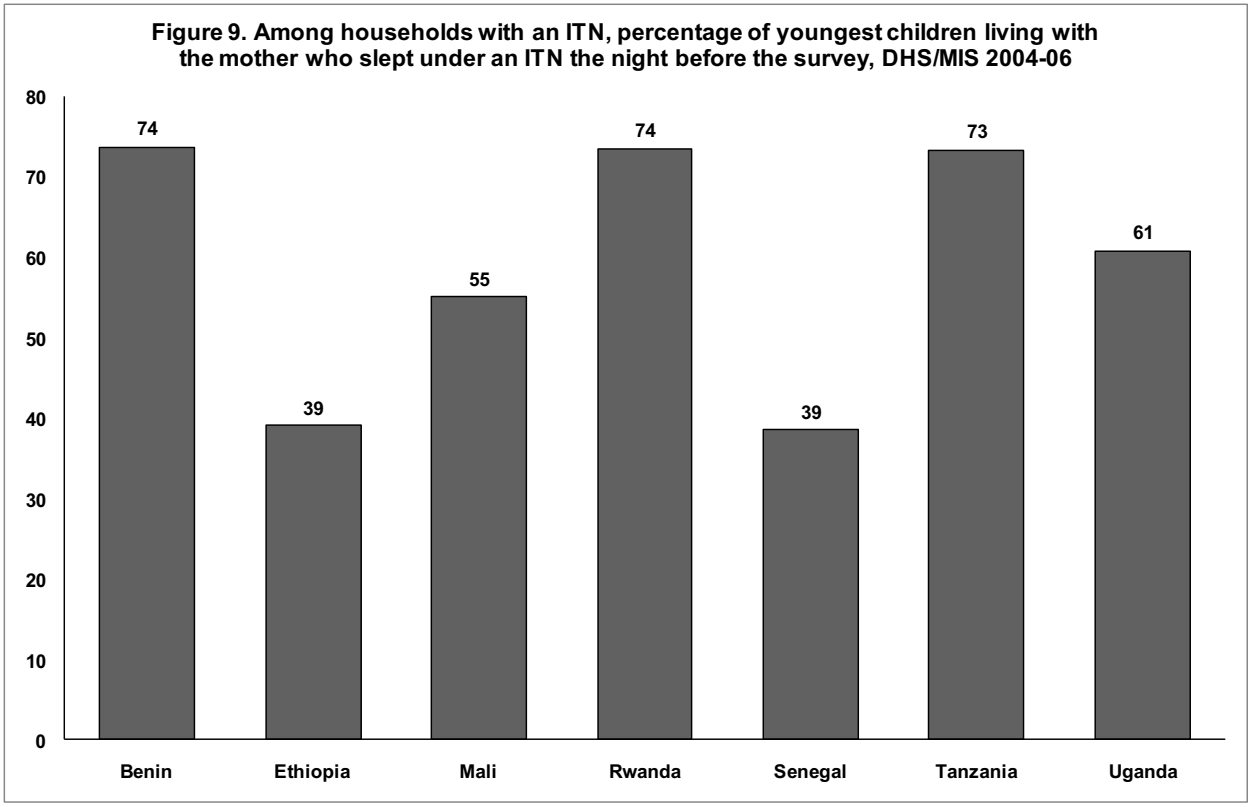
	Country													
Characteristic	**Benin**	***p*-value**	**Ethiopia**	***p*-value**	**Mali**	***p*-value**	**Rwanda**	***p*-value**	**Senegal**	***p*-value**	**Tanzania**	***p*-value**	**Uganda**	***p*-value**
Sex														
Male[R]	-		-		-		-		-		-		-	
Female	1.04	0.563	0.87	0.595	1.04	0.549	1.08	0.539	1.12	0.336	1.13	0.344	1.15	0.262
Age (years)														
0[R]	-		-		-		-		-		-		-	
1	0.97	0.772	1.43	0.346	0.88	0.244	0.74	0.101	1.14	0.454	1.27	0.253	0.84	0.358
2	0.57	0.000	0.48	0.093	0.76	0.020	0.58	0.003	0.60	0.003	0.70	0.085	0.73	0.091
3	0.59	0.000	0.96	0.919	0.73	0.004	0.34	0.000	0.77	0.135	0.92	0.669	0.49	0.000
4	0.40	0.000	1.22	0.615	0.55	0.000	0.19	0.000	0.50	0.000	0.71	0.108	0.50	0.000
Residence														
Urban[R]	-		-		-		-		-		-		-	
Rural	0.96	0.677	0.60	0.246	1.10	0.516	1.05	0.732	0.61	0.001	0.56	0.002	0.62	0.016
Relation to head of household														
Son/daughter	2.27	0.000	1.83	0.182	2.09	0.000	2.91	0.000	1.39	0.005	2.30	0.000	2.21	0.000
Other[R]	-		-		-		-		-		-		-	
Household wealth status														
Lowest[R]	-		-		-		-		-		-		-	
Second	1.43	0.008	0.62	0.277	1.20	0.046	1.53	0.106	0.80	0.133	1.35	0.269	0.73	0.075
Middle	1.06	0.619	0.68	0.352	1.00	0.962	1.13	0.645	0.68	0.016	1.92	0.009	0.47	0.000
Fourth	1.10	0.463	1.02	0.956	1.18	0.138	0.91	0.714	0.50	0.001	1.76	0.021	0.79	0.236
Highest	0.96	0.787	0.57	0.212	1.34	0.090	1.08	0.754	0.30	0.000	2.46	0.001	0.58	0.009
Size of household														
<5[R]	-		-		-		-		-		-		-	
5-8	0.36	0.000	0.89	0.726	0.60	0.000	0.36	0.000	0.40	0.015	0.44	0.000	0.31	0.000
9+	0.10	0.000	0.97	0.953	0.29	0.000	0.18	0.000	0.17	0.000	0.22	0.000	0.20	0.000
Use of IRS in the past 12 months														
Yes	n/a	n/a	1.42	0.297	n/a	n/a	n/a	n/a	2.81[a]	0.026	n/a	n/a	0.89	0.573
No[R]	n/a	n/a	-		n/a	n/a	n/a	n/a	-		n/a	n/a	-	
Number of ITNs in household														
1[R]	-		-		-		-		-		-		-	
2	3.20	0.000	1.81	0.153	2.51	0.000	3.66	0.000	1.19	0.302	2.12	0.000	2.65	0.000
3+	6.67	0.000	n/a		5.42	0.000	10.04	0.000	5.60	0.000	3.37	0.000	4.40	0.000
Number	4,732		575		7,095		1,745		2,175		1,782		1,529	

Note: The variable "mother of child slept under ITN" is highly correlated with the outcome and is not included in the models.
[a]Sprayed by government in past 12 months; [R] = Reference category; n/a = not available

Use of ITNs by the Youngest Child in the Household

This section examines the use of ITNs among the youngest child under age five who lives with the mother in the household. The major advantage of examining the youngest child is that the analysis can take into account the characteristics of the mother (for example, level of education) and the feeding behavior of the child (that is, whether the child is currently breastfeeding).

Figure 9 shows that, for this group of children, the percentage using an ITN ranges from 39 percent in Ethiopia and Senegal to 73 or 74 percent in Benin, Rwanda, and Tanzania. ITN use by the youngest child is somewhat higher than use by any child under age five years (see Figure 7 for comparison).



Differentials in Use

In Rwanda, Senegal, and Uganda, girls are slightly more likely than boys in the youngest group to use an ITN, but in other countries the differences are very small (see Table 8). In Benin, Mali, Rwanda, Senegal, and Uganda, ITN use generally declines with age of the child, while in Ethiopia and Tanzania, this relationship is less clear. ITN use also varies by urban/rural residence, but the pattern is inconsistent. In Benin, Ethiopia, Tanzania, and Uganda, ITN use among the youngest children is considerably higher in urban areas than in rural areas. In Rwanda and Senegal, however, the relationship is in the opposite direction, and in Mali there is no difference.

ITN use decreases with household wealth in Senegal but increases with household wealth in Tanzania. In Ethiopia and Uganda, ITN use shows a U-shaped relationship with household wealth, with the lowest ITN use for children in households in the middle wealth quintile. In Benin, Mali, and Rwanda, household wealth is only weakly associated with ITN use. In all countries, children of the head of the household are more likely than other children in the household to use an ITN.

Table 8. Among households with an ITN, percentage of youngest children living with the mother under five years who slept under an ITN the night before the survey, by selected characteristics, DHS/MIS 2004-2006

	Country						
Characteristic	**Benin**	**Ethiopia**	**Mali**	**Rwanda**	**Senegal**	**Tanzania**	**Uganda**
Sex							
Male	73.3	39.4	54.9	72.0	36.7	72.2	59.1
Female	74.0	38.7	55.0	74.9	40.5	74.4	62.6
Age (years)							
0	76.2	35.8	57.7	76.3	40.0	71.0	65.1
1	76.9	52.7	55.0	75.3	44.3	74.1	63.3
2	69.3	25.6	52.4	74.0	33.7	67.7	56.6
3	72.3	45.9	55.9	64.5	35.2	83.0	49.1
4	58.8	38.0	45.2	53.8	23.2	77.9	54.9
Residence							
Urban	76.3	47.8	54.6	70.8	36.2	83.2	69.9
Rural	71.8	37.1	55.1	74.5	39.8	65.1	58.3

(Cont'd)

Table 8 – cont'd

Characteristic	Country						
	Benin	Ethiopia	Mali	Rwanda	Senegal	Tanzania	Uganda
Relation to head of household							
Son/daughter	76.1	40.5	57.6	76.6	45.1	79.3	65.3
Other	55.4	14.2	35.1	40.0	34.1	55.7	40.1
Household wealth status							
Lowest	68.9	43.5	53.7	68.9	45.6	45.9	62.7
Second	74.0	35.5	55.3	79.9	42.3	58.6	61.9
Middle	72.0	25.9	53.5	73.4	38.0	69.2	51.8
Fourth	73.8	48.2	55.2	73.4	34.0	73.0	57.9
Highest	76.3	40.6	56.9	72.0	29.4	82.2	64.7
Size of household							
<5	86.7	41.0	62.7	83.8	(61.8)	83.5	80.1
5-8	75.0	38.0	58.1	70.8	47.8	73.2	58.3
9+	52.6	(38.8)	43.9	58.2	35.3	58.3	47.0
Use of IRS in the past 12 months							
Yes	n/a	42.7	n/a	n/a	*[a]	n/a	54.4
No	n/a	38.2	n/a	n/a	38.4	n/a	61.4
Mother of child slept under ITN							
Yes	94.0	81.6	89.9	91.1	92.6	95.3	88.4
No	14.3	3.9	6.1	10.9	2.8	12.5	12.3
Mother's education							
None	71.7	39.4	54.3	70.6	38.3	57.6	53.0
Primary	76.5	35.4	59.4	73.7	37.2	74.2	58.7
Secondary +	77.4	42.3	56.1	74.6	43.6	83.2	71.4
Birth order							
1	78.3	53.2	49.9	77.1	n/a	72.1	62.1
2	79.6	36.6	56.4	77.3	n/a	77.9	67.1
3	74.3	39.8	56.0	72.0	n/a	79.0	65.7
4	71.1	22.9	62.4	69.0	n/a	73.4	60.7
5+	66.7	35.5	53.7	72.0	n/a	65.8	56.6
Breastfed the night before the survey							
Yes	75.4	40.5	56.8	74.5	n/a	72.1	64.3
No	71.0	35.8	51.7	70.2	n/a	74.8	55.3
Number of ITNs in house							
1	68.3	38.6	44.4	71.2	24.8	68.3	54.2
2	79.4	(34.5)	60.5	76.4	26.4	76.2	70.2
3+	82.0	*	67.7	84.1	56.1	77.8	73.0
Total	73.7	39.0	55.0	73.5	38.5	73.3	60.8
Number	2,953	261	4,421	975	1,339	1,293	845

Note: Percentages in parentheses are based on 25-49 unweighted cases. An asterisk indicates that the percentage is based on fewer than 25 unweighted cases and has been suppressed.
[a]Sprayed by government in past 12 months
n/a = not available

Use of ITNs among the youngest children is strongly negatively associated with the size of the household in all countries except Ethiopia, where the relationship is weak. In Uganda, children in households with nine or more residents are about half as likely to use an ITN as those

in households with fewer than five residents. The association between ITN use and the mother's use of an ITN is clear and consistent across all countries; use of ITNs by the youngest children is strongly positively associated with mother's use of an ITN (see Figure 10). Among the seven countries, the percentage of youngest children using an ITN ranges from 82-95 percent if the mother uses an ITN, but from only 3-14 percent if the mother does not use an ITN.

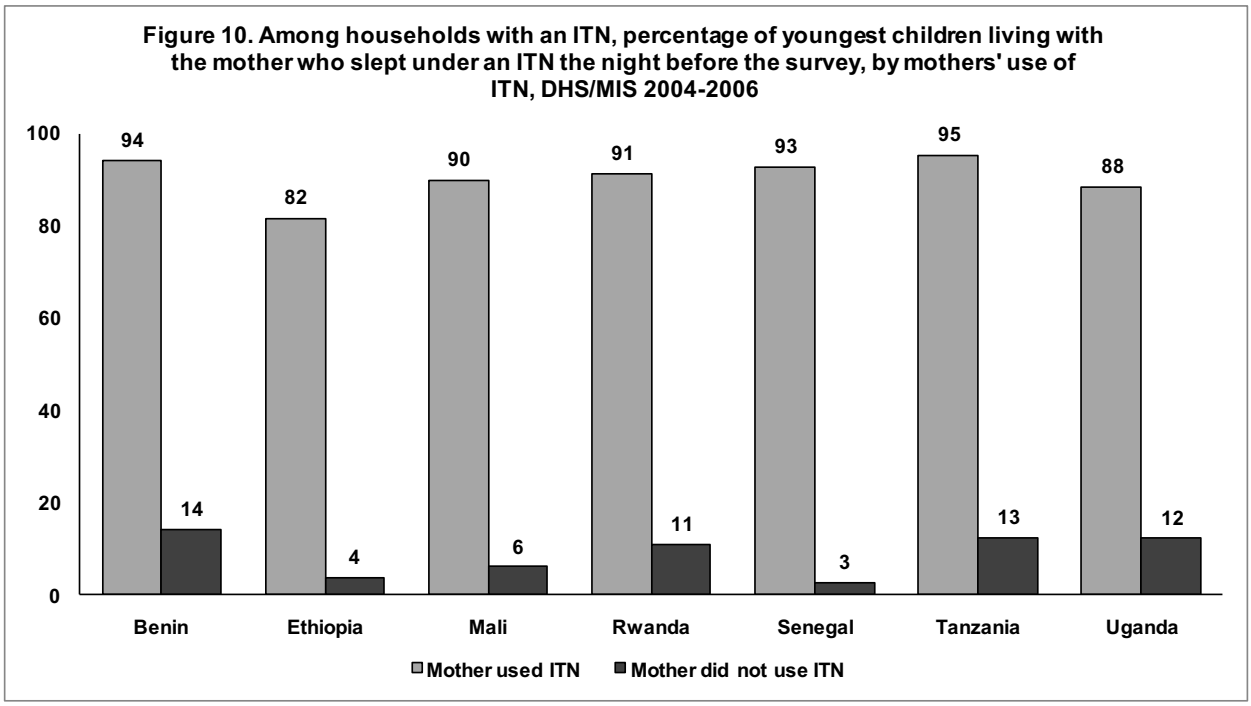


Table 8 also reports the association between ITN use among the youngest children and their mothers' level of education. In Tanzania and Uganda, ITN use increases as mothers' education increases. In Benin and Rwanda, having any education is associated with ITN use, but ITN use is similar for children whose mothers have a primary education and at least a secondary education. In Ethiopia, Mali, and Senegal, the relationship is weak and inconsistent.

Children who are breastfed (measured by breastfeeding the night before the survey) are somewhat more likely to use an ITN in all countries except in Tanzania, where the relationship is

weak. In Mali, for example, 57 percent of breastfed children use an ITN, compared with 52 percent of children who are not breastfed. There is a strong association between use of ITNs and the number of ITNs in a household. In Senegal, the youngest children in a household with three or more ITNs are more than twice as likely to use an ITN as those in a household with only one ITN.

Multivariate Analysis

Sex of the child is not a significant predictor of ITN use by the youngest child under age five in any country studied (Table 9). Age of the youngest child is significant in only three countries (Benin, Rwanda, and Senegal). In Senegal, youngest children age 2-4 are significantly less likely to use an ITN than youngest children under two years old. In Rwanda, children age four are significantly less likely to use an ITN than those less than one year old. In Benin, youngest children age 2 and age 4 are significantly less likely to use an ITN than youngest children less than one year old. Place of residence is not a significant predictor of ITN use in any country except Tanzania, where rural children are about half as likely to use an ITN as those in urban areas. Among youngest children, children of the head of the household are significantly more likely to use an ITN than others. The adjusted odds of ITN use for children of the head of the household range from 1.56 in Senegal to 8.80 in Ethiopia. Household wealth is a significant predictor of ITN use among youngest children only in Senegal, Tanzania, and Uganda. The pattern of ITN use and wealth, however, is not consistent in these three countries. In Senegal and Uganda, youngest children in households in the highest wealth quintile are least likely to use an ITN. In Tanzania, however, children in the lowest wealth quintile are least likely to use an ITN.

Table 9. Among households with an ITN, adjusted odds (OR) that the youngest child under five years living with the mother slept under an ITN the night before the survey, DHS/MIS 2004-2006

	Country													
Characteristic	**Benin**	***p*-value**	**Ethiopia**	***p*-value**	**Mali**	***p*-value**	**Rwanda**	***p*-value**	**Senegal**	***p*-value**	**Tanzania**	***p*-value**	**Uganda**	***p*-value**
Sex														
Male[R]	-		-		-		-		-		-		-	
Female	1.09	0.370	1.04	0.901	0.99	0.940	1.24	0.183	1.04	0.755	1.13	0.476	1.30	0.120
Age (years)														
0[R]	-		-		-		-		-		-		-	
1	0.98	0.851	1.68	0.226	0.90	0.361	0.85	0.423	1.14	0.471	1.30	0.238	0.94	0.789
2	0.56	0.004	0.54	0.267	0.96	0.821	0.80	0.384	0.60	0.007	0.88	0.733	0.74	0.363
3	0.68	0.122	1.53	0.562	1.14	0.547	0.51	0.053	0.60	0.032	1.77	0.172	0.56	0.178
4	0.35	0.000	1.75	0.486	0.86	0.524	0.27	0.001	0.35	0.004	1.03	0.956	0.66	0.355
Residence														
Urban[R]	-		-		-		-		-		-		-	
Rural	0.88	0.276	0.43	0.132	1.15	0.517	1.17	0.404	0.70	0.059	0.51	0.005	0.71	0.182
Relation to head of household														
Son/daughter	2.29	0.000	8.80	0.002	2.54	0.000	5.36	0.000	1.56	0.003	3.29	0.000	2.67	0.000
Other[R]	-		-		-		-		-		-		-	
Household wealth status														
Lowest[R]	-		-		-		-		-		-		-	
Second	1.39	0.061	0.55	0.283	1.10	0.447	1.64	0.184	0.95	0.778	1.60	0.159	0.81	0.408
Middle	1.12	0.491	0.37	0.086	0.96	0.747	1.13	0.737	0.88	0.537	2.14	0.019	0.46	0.007
Fourth	1.20	0.273	0.86	0.810	1.11	0.472	1.10	0.781	0.50	0.012	2.01	0.028	0.69	0.183
Highest	0.99	0.937	0.45	0.233	1.39	0.140	1.10	0.784	0.36	0.000	2.11	0.041	0.45	0.011
Size of household														
<5[R]	-		-		-		-		-		-		-	
5-8	0.39	0.000	2.32	0.069	0.62	0.002	0.56	0.011	0.42	0.057	0.63	0.073	0.37	0.000
9+	0.11	0.000	2.99	0.172	0.27	0.000	0.25	0.000	0.19	0.000	0.44	0.014	0.24	0.000
Use of IRS in the past 12 months														
Yes	n/a	n/a	1.95	0.134	n/a	n/a	n/a	n/a	3.07[a]	0.092	n/a	n/a	0.62	0.061
No[R]	n/a	n/a	-		n/a	n/a	n/a	n/a	-		n/a	n/a	-	
Mother's education														
None[R]	-		-		-		-		-		-		-	
Primary	0.98	0.890	0.90	0.840	1.15	0.290	1.15	0.548	1.14	0.495	1.36	0.229	1.30	0.252
Secondary +	0.91	0.596	0.67	0.563	1.09	0.615	1.20	0.529	1.85	0.051	1.45	0.310	2.19	0.016

(Cont'd)

Table 9 – cont'd

Characteristic	Country													
	Benin	*p*-value	Ethiopia	*p*-value	Mali	*p*-value	Rwanda	*p*-value	Senegal	*p*-value	Tanzania	*p*-value	Uganda	*p*-value
Birth order														
1[R]	-		-		-		-		n/a	n/a	-		-	
2	0.93	0.670	0.34	0.041	1.08	0.616	0.68	0.195	n/a	n/a	1.14	0.602	1.31	0.381
3	0.85	0.363	0.32	0.091	1.05	0.719	0.48	0.021	n/a	n/a	1.12	0.697	1.14	0.706
4	0.81	0.264	0.10	0.001	1.44	0.035	0.55	0.074	n/a	n/a	0.82	0.549	1.24	0.549
5+	0.80	0.199	0.14	0.001	1.11	0.544	0.62	0.146	n/a	n/a	0.75	0.317	1.07	0.843
Breastfed the night before the survey														
Yes	0.90	0.563	1.35	0.581	1.35	0.046	0.96	0.876	n/a	n/a	1.17	0.619	1.10	0.740
No[R]	-		-		-		-		n/a	n/a	-		-	
Number of ITNs in house														
1[R]	-		-		-		-		-		-		-	
2	2.71	0.000	1.19	0.746	2.27	0.000	2.08	0.001	1.22	0.340	1.75	0.009	2.21	0.000
3+	6.14	0.000	n/c	n/c	4.75	0.000	5.32	0.000	5.40	0.000	2.65	0.000	3.94	0.000
Number	2,988		378		4,404		1,056		1,375		1,184		861	

[a]Sprayed by government in past 12 months
[R] = Reference category
n/a = not available
n/c = As there are too few cases of 3 or more ITNs for the model, these were coded as "2 ITNs"

ITN use among the youngest children decreases significantly as the size of the household increases, in every country except Ethiopia. The level of mother's education and the use of IRS, however, are not significant predictors of ITN use in any country. A child's breastfeeding status is not a significant predictor of ITN use, except in Mali, where children who were breastfed the night before the survey were more likely to use an ITN (OR: 1.35, *p*-value: 0.046). The number of ITNs in a household significantly predicts ITN use in all countries except Ethiopia (where the direction of the relationship is the same but the relationship is not significant). In the other countries, the odds of ITN use increase substantially as the number of ITNs in the household increases. In Benin, children in households with three or more ITNs are six times as likely to use an ITN as those in households with only one ITN.

CONCLUSIONS

The primary objective of this paper is to examine household ownership and use of ITNs, with particular attention to children under age five and pregnant women. Overall, there is considerable variation in the ownership and use of ITNs among these groups, while there are several striking common patterns across groups.

The first key finding is that, while there is no country in the study where more than half of households own an ITN, household ownership of ITNs varies considerably from country to country. The seven countries in this study are in various stages of adopting and implementing malaria control strategies, including the mass distribution of ITNs. Hence, it is not surprising to find substantial differences in the level of household ownership of ITNs and inequities in the distribution of ITNs to various population subgroups. In Ethiopia, Rwanda, and Uganda, less than one household in five owns an ITN. Over time, with increased attention to malaria prevention measures and more funding of ITN distribution, household ownership of ITNs is expected to rise. However, considerably more marketing and mass distribution of ITNs will be necessary if these countries are to reach ITN coverage targets.

Second, this study finds that, like other studies before it (e.g., Binka and Adongo, 1997; Imoukhuede, 2003), household ownership of an ITN does not mean that members of the household necessarily use an ITN. For example, in Senegal, even among households that own at least one ITN, only 29 percent of the household population used an ITN the night before the survey. Among households that own an ITN, in five of the seven countries the majority of pregnant women use an ITN, but in Ethiopia and Senegal use is less than 40 percent.

Among children under age five, who are most vulnerable to malarial disease and who thus would reap the most benefit from ITN use, ITN use is also far from universal even in

households with at least one ITN. When the household owns an ITN, more than 50 percent of children under age five use an ITN in all countries except in Ethiopia and Senegal, where less than 40 percent use an ITN. The surveys found that the youngest children are the most likely to use ITNs among all children under age five. However, use by the youngest children is far from universal, ranging from 39 percent to 74 percent among the countries studied.

Third, two variables predict use of ITNs in all countries—the number of ITNs in a household and the size of the household. The likelihood of ITN use increases sharply with the number of ITNs in a household and decreases as the size of the household increases—a clear indication that household ITN ownership is often insufficient to meet the needs of the household. An important implication of these findings is that malaria control programs need to take into consideration the number of members in a household when distributing ITNs.

Fourth, the association between ITN use and several household characteristics varies substantially. For example, residence is consistently significant as a predictor of ITN use only in Tanzania and Uganda, where rural residents are less likely than urban residents to use an ITN. The effect of household wealth is even less consistent. In Senegal, wealth is negatively associated with ITN use among the overall household population and among children under age five, but wealth is positively associated with ITN use among the household population as a whole in Mali and Tanzania and among pregnant women in Mali. In Tanzania, household wealth predicts ITN use among children but in other countries studied there is no relationship, or an inconsistent relationship.

Finally, bivariate analysis shows that the youngest child of a woman living in the household is somewhat more likely to use an ITN if the child is being breastfed, but multivariate analysis indicates that children who are breastfeeding are not more likely to use an ITN than non-

breastfeeding children, except in Mali. We also found that the mother's education does not significantly predict ITN use for the child.

There are several caveats that must be kept in mind when interpreting the study results. This analysis measures ITN use the night before the survey. There is no information on frequency or correctness of ITN use. Questionnaires used in the DHS and MIS surveys do not collect information on how ITNs are deployed or the physical condition of ITNs, both of which can impact the effectiveness of the ITN. ITN use is strongly associated with seasonality, which our models do not take into account. A comparison of survey fieldwork dates and secondary sources of timing of the high transmission season (data not presented) shows that about half of the surveys overlapped with some part of the high transmission season. However, even if there is some overlap, the fieldwork for a typical DHS survey spans a period of about three months, so that at least some of the fieldwork is not likely to be during the high-transmission season. Despite the limitations of the study, the analysis clearly shows that ITN distribution and communication programs need to be carefully tailored to meet the needs of each country and population subgroups within each country, and that special emphasis needs to be placed on providing multiple ITNs to households to increase overall ITN use.

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