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Background

Malaria is a leading cause of morbidity and mortality in Ethiopia, being the most frequent cause of outpatient visits and admissions in 2008[1]. Ethiopia was one of the first countries in sub-Saharan Africa to embrace the concept of scaling up for impact (SUFI) in its 2006-2010 national five-year strategic plan for malaria prevention and control, which committed to 100% coverage with, on average, two long-lasting insecticidal nets (LLIN) per household in malarious areas, and 100% access to effective and affordable malaria treatment[2]. The distribution of about 20 million nets since 2006 has meant that Ethiopia has moved from being one of the African countries with the lowest insecticide treated net (ITN) ownership to one of the highest[3].

A Demographic and Health Survey (DHS) in 2005 [4] and a national Malaria Indicator Survey (MIS) in 2007 [5] have been carried out in Ethiopia. A large representative household survey in malarious areas of the three largest regions was also done in 2006[6,7]. These surveys all assessed ITN ownership and use, with the 2006 and 2007 surveys also assessing these indicators specifically for LLIN. The results showed that the proportion of households owning at least one ITN increased from 6.5% of households in 2005[4] to 19.6% (LLIN) in 2006 [6,7] and 65.6% (LLIN) in 2007 [5]. The mean ITN per household was less than 0.1 in 2005, 0.3 (LLIN) in 2006 and 1.2 (LLIN) in 2007. In all households, the proportion of children under five using nets increased from 2% in 2005 to 31.8% in 2006 and to 42.5% in 2007, while a similar increase in the percent of pregnant women using nets was observed (1% in 2005, 35.9% in 2006 and 41.0% in 2007)[5]. However, while overall net use increased greatly to quite a high level due to increased ownership, as previously reported [8] within net owning households the proportion of participants who slept under a net decreased between 2006 and 2007: from 70.8% to 50.2% among persons of all ages; from 70.8% to 58.7% among children under five; and from 81.2% to. 66.1% among pregnant women.

Closer examination of the results obtained in the 2006 and 2007 surveys to shed further light on the patterns of net use has been reported by Shargie *et al* [8]. As expected, household net ownership and percentage of individuals using them increased dramatically between the surveys when assessed in all households. However, when the comparison was restricted to only households owning nets, there was a decline in the proportion of individuals using nets in all regions and population groups that could not be explained by climate factors between years or sampling differences between the 2006 and 2007 surveys[8]. This study aimed to investigate both household and net factors associated with the likelihood of nets being used at two time points in Ethiopia: the 2006 survey and the MIS 2007 survey subsample from Amhara, Oromia and Southern Nations, Nationalities and Peoples' (SNNP) Regions of Ethiopia.

Methods

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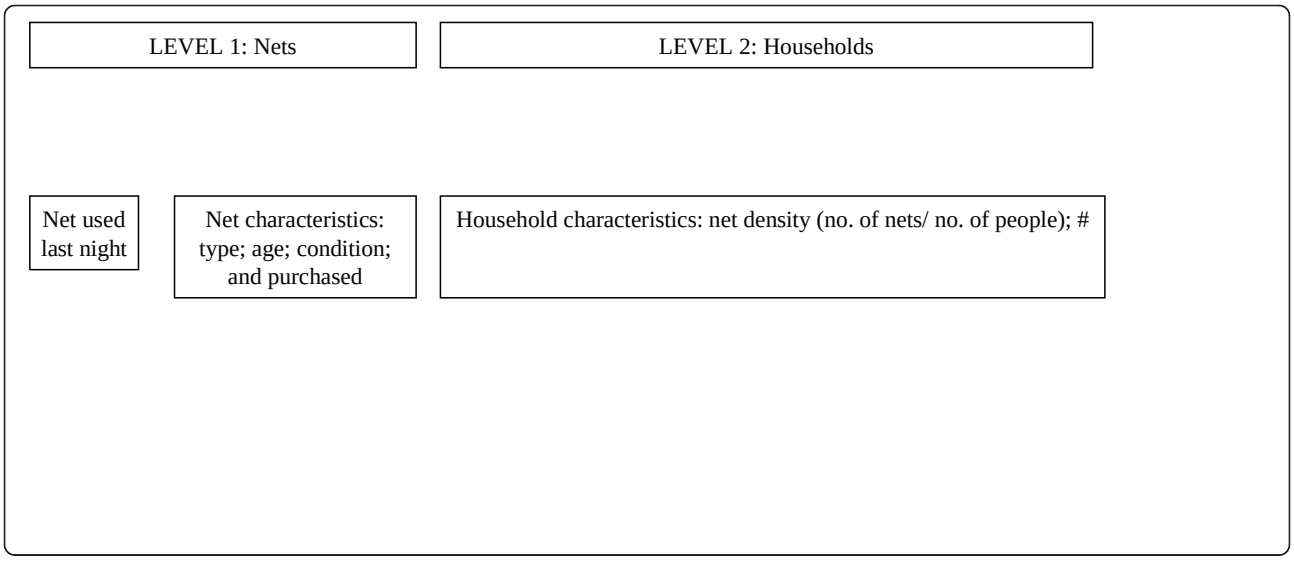
Questionnaire, modified for the local conditions to



Results

Characteristics of the sample

The characteristics of the sample are summarized in Table 2 and Figure 3. A total of 3,784 nets in 2,430 households were included in the baseline 2006 analysis while the MIS 3R 2007 analysis comprised 5,413 nets in 3,328 households. At baseline 2006 survey, 59.4% of the nets were LLIN while in MIS 3R 2007, LLIN comprised 95.1% of the nets. Despite an increase in the proportion of households owning at least one net from 37.0% at baseline 2006 to 56.7% at MIS 3R 2007 (shown visually in Figure 1 by cluster as increase in the proportion of green clusters between panels Map 1a and 2a), a lower proportion of households with nets reported using any nets the previous night during MIS 3R 2007 (shown visually in Figure 1 as a decrease in the proportion of green clusters between Map panels 1b and 2b). The proportion of households with nets in which at least one net was used the previous night was 89.3% at baseline 2006 and 68.1% at MIS 3R 2007. The proportion of all nets reported as used the previous night decreased considerably from 85.1% to 56.0% at baseline 2006 and MIS 3R 2007, respectively (Table 2 and Figure 3).

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Univariate logistic regression analysis of the associations between net use at baseline 2006 and explanatory factors is shown in Table 3. Factors associated with increased

95% CI 1.2-1.8); and increasing wealth index (lowest quintile compared to quintiles 2-5, OR = 1.2; 95% CI 1.0-1.5). Reduced proportion of nets used was independently associated with: increasing net age (Ptrend<0.001); deteriorating net condition (Ptrend<0.001); increasing household net density (Ptrend<0.009); and increasing altitude (>2000 m, OR = 0.7; 95% CI 0.04-1.0).

Discussion

This paper describes factors associated with net use based on two large cross-sectional malaria indicator sur-

the proportion of nets used between 2006 and 2007[8]. For this reason this investigation of the factors associated with net use at the two surveys using multilevel logistic regression modeling was undertaken. In 2006, LLIN were more likely to be used than non-LLIN; this association had disappeared by 2007 when the great majority of nets owned were LLIN. The association between IRS in households and increased net use at MIS 3R 2007 possibly arises from the fact that IRS is done in higher risk malarious areas, where the population perceives greater risk of malaria.

The study has a number of potential limitations. Firstly, the outcome of whether nets were used was based on self-reporting, and in cross-sectional surveys seasonality may influence reported net use behaviour depending on the perceived risk of malaria. Moreover, reported use of nets 'the previous night' only captures a cross-section of use at one-night in time and thus provides somewhat unclear indication of regular use. Secondly, while both surveys employed multistage cluster sampling, the sampling frames were slightly different. At baseline 2006, only areas defined as "malarious" (program target areas defined by expert knowledge) were included in the sampling frame. In MIS 3R 2007, the sampling frame was all areas below 2500 m, stratified to three domains: areas below 1500 m, rural areas between 1500 m and 2500 m, and urban areas between 1500 m and 2500 m. In 2006 survey, primary sampling units (PSUs) were defined as *kebeles* (the smallest administrative unit with an average of 1000 households) at baseline survey while in MIS 3R 2007, the PSUs were defined as census enumeration areas (with an average of 200 households in each). To partially account for the sampling differences between the two surveys, we used the multilevel sample weights estimated for each survey. Sensitivity analysis comparing the "malarious" (by expert knowledge definition) and non-malarious clusters from MIS 3R 2007 did not reveal any differences in household net ownership and proportion of nets used. Finally, the two surveys were conducted nearly one year apart but at slightly different times, although both followed as soon as possible after the generally accepted main rainy season of July-August, which usually precedes the peak malaria season over the next few months. If anything, the slightly earlier timing of the MIS 2007 would bias towards greater net use. Previously, evidence from climate data sources showed that neither rainfall differences between the survey years nor increase in mean temperature at the time of the surveys were likely to have biased household net use[8].

In general increased availability of nets in households, as assessed in cross sectional surveys, is associated with increased net use[12,13]. While these previous studies

Table 5 MIS 3R 2007*: univariable logistic regression analysis of association of net use and explanatory factors

Fac		T a e N = 5,413	Ne ed a = 3,031	P f e (%)	ed a	Odd Ra	95% CI	p alue
N								
Type of net	Other type	225	107	47.6		1.0		
	LLIN	5,188	2,924	56.4		1.7	1.2-2.4	0.006
Age of the net	≤6 months	1,888	1,112	58.9		1.0		<0.001
	>6 months - 1 year	2,491	1,465	58.8		1.0	0.8-1.2	
	>1 years	1034	454	43.9		0.5	0.4-0.6	
Net condition	Good**	3,890	2,245	57.7		1.0		<0.001
	Fair (no holes >33 mm)	767	475	61.9		1.3	1.1-1.6	
	Poor (1-4 holes >33 mm)	485	242	49.9				

malaria is positively associated with both their own and their children's use [25], over time the occurrence of net loss, deterioration and/or perceived lack of need or impact on disease may cause attrition in net use. This needs to be counteracted by education on net use and care, and by opportunities for net replacement.

Some of the factors associated with net use at both surveys were not surprising: for example older and more damaged nets were less likely to be used. Since we know that nets rapidly sustain physical damage (but not loss of effective insecticide levels) in Ethiopian conditions [26] this suggests that net use will be increased by

Ac ed e e

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A c b

The Ethiopia MIS Working Group undertook the MIS survey; JMN undertook data analysis; JMN & PMG drafted the manuscript which all authors edited and approved.

C e e e

The authors declare that they have no competing interests.

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Refe e ce

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