Tropical Medicine and International Health doi:10.1111/j.1365-3156.2006.01637.x

VOLUME 11 NO 6 PP 824–833 JUNE 2006

Rolling out insecticide treated nets in Eritrea: examining the determinants of possession and use in malarious zones during the rainy season

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Summary

OBJECTIVE This paper describes determinants of insecticide treated net (ITN) ownership and use in malarious areas of Eritrea. With ITN distribution and re-treatment now free for all living in these areas, we examine barriers (other than cost) to access and use of ITNs. We explore the differences between use of an ITN as a proportion of all households in the survey (the roll back malaria indicator), and use of an ITN as a proportion of those households who already own an ITN.

METHODS A modified two-stage cluster design was used to collect data from a sample of households ($n = 2341$) in the three most malarious administrative zobas (zones or provinces). Logistic regression was used to analyse the data.

RESULTS Our findings suggest environmental heterogeneity among zobas (including program effects specific to each zoba), perception of risk, and proximity to a clinic are important predictors of ITN possession and use. Among households with at least one ITN, 17.0% reported that children under five were *not* under an ITN the night before the survey, while half of all such households did not have all occupants using them the night before the survey. The number of ITNs, as well as zoba, was also significant determinants of use in these households with at least one ITN.

CONCLUSION Current efforts to disseminate ITNs to vulnerable populations in Eritrea are working, as suggested by high ITN ownership and net-to-person ratios inside households. However, the gap between ITN ownership and use, given ownership, is large, and may represent lost opportunities to prevent infection. Closing this gap requires concerted efforts to change behaviour to ensure that all household members use ITNs as consistently and correctly as possible during and following the rains.

keywords insecticide treated net, Eritrea, effectiveness, net ownership, net use

Introduction

The use of insecticide treated bed nets (ITNs) to protect vulnerable populations from malaria parasite transmission is one of the main strategies recommended by the Roll Back Malaria (RBM) partnership (WHO 2002). While the protective efficacy, effectiveness and cost effectiveness of ITNs have been well established (Choi *et al.* 1995; Goodman *et al.* 1999; Schellenberg *et al.* 2001; ter Kuile *et al.* 2003a,b,c; Meltzer *et al.* 2003; Phillips-Howard *et al.* 2003; Wiseman *et al.* 2003; Lengeler 2004), many challenges remain as national programmes begin to scale up coverage. Such challenges include: access and availability of ITNs, cost of ITNs on the open market in resource poor settings, timely re-impregnation of bed nets and issues of proper ITN adherence, deployment and use.

Recently, a number of studies have described local perceptions of the acceptability of bed nets and insecticide, as well as the determinants of ITN possession and use (Winch *et al.* 1994, 1997; Binka & Adongo 1997; Agyepong & Manderson 1999; Schellenberg *et al.* 2001; Alaii *et al.* 2003). Socio-economic factors such as wealth, access to health care and education have been shown to be important predictors of ITN possession and use (Winch *et al.* 1997; Schellenberg *et al.* 2001; Heggenhougen *et al.* 2003). Ethnicity has also been reported as an important factor, as people with pastoralist and semi-nomadic lifestyles may be less likely to possess and use an ITN as compared to settled agricultural communities (Bradley *et al.* 1986; MacCormack & Snow 1986; Aikins *et al.* 1993; Thomson *et al.* 1996). Some research also suggests that gender may influence the use of ITNs within households, as different roles dictate different sleeping patterns for men and women (Aikins *et al.* 1993). Additionally, several investigations in urban and peri-urban Africa suggest desire for mosquito avoidance is a strong determinant of net usage (Binka & Adongo 1997; Agyepong & Manderson 1999; Macintyre *et al.* 2002). This is, of course, strongly influenced by season, but is also an effect of correct understanding of the risk of transmission.

Surprisingly, few published analyses have differentiated between possession and use, and yet this distinction is fundamental. For even though households may report they possess an ITN, if the net is not at least hung up during peak transmission seasons, its efficacy may be zero. Thus, while coverage of household ITN possession may be an important indicator for managers, it says little about the likely epidemiological impact of the programme. A recent assessment of several national surveys suggests there is considerable disparity between ITN possession and use (Korenromp *et al.* 2003). ITN possession was shown to range between 0.1% and 28.5%, while use among children less than 5 years old ranged between 0% and 16%. This disparity between household ITN possession and individual use may include such factors as: the rationing of ITNs as a result of there being fewer nets than members or beds in a household, issues related to local understanding of transmission and mosquito avoidance behaviours.

While challenges to ITN ownership may be eventually overcome as a result of the expansion of large-scale distribution efforts, and as social marketing campaigns increase the perceived benefit of ITNs and subsequently increase demand, the question of who is and who is not using ITNs once they *are* made available remains unanswered. Outstanding issues related to ITN use at the household and individual levels include determinants of proper net deployment as well as individual adherence. The issue of how adherence varies as a function of season is also extremely important as the use of ITNs only when mosquitoes are perceived as a nuisance, or only when the weather is cool (i.e. during the rains) (Alaii *et al.* 2003), may place many individuals at risk of malaria infection outside the immediate rainy season.

Answers to such questions are important and must be fed back to programme planners and policy makers to achieve the greatest impact of ITN programmes. This paper examines some of the social, economic and locational factors effecting household ITN possession and use in the context of Eritrea's National Malaria Control Programme (NMCP). We explore 'use' of an ITN in two ways: first, we define use as a proportion of all households in the survey with either all members under an ITN or all children less than 5 years old under an ITN the night before the survey. This is the definition recommended by RBM for measuring the proportion of households in a survey's universe whose members are protected by an ITN. Second, we examine the determinants of ITN use among only those households who already own at least one ITN. This second outcome variable measures more intuitively the gap between ownership and post-ownership use. The intention of this analysis is to examine the influences on both possession and use and to extract lessons applicable to the Eritrean context, or more broadly to other programmes that are using ITNs to reduce the burden of malaria.

Methods

Study area

Eritrea, with an estimated population of 3.5 million people, is divided into six administrative *zobas* (zones). Altitudes range from below sea level to 3000 m. Temperatures vary widely, although the western lowlands and coastal plains are generally associated with extremely hot and dry climatic conditions. Precipitation ranges from 200 mm/year in the lowland areas to 1000 mm/year in the highlands (Macro 2003). *Anopheles arabiensis* mosquitoes, belonging to the *A. gambiae* complex, are the main vectors in the country (Shililu *et al.* 2003a,b, 2004). *Plasmodium falciparum* is the primary species of malaria found in Eritrea, although *P. vivax* has also been reported (Shililu 2001). Malaria transmission is seasonal, with estimates of entomological inoculation rates ranging from 0 to 70.6 infective bites per person per year (Shililu *et al.* 2003b). Malaria accounts for approximately 28% of all hospital admissions and 30% of all outpatient morbidity, although malaria-free areas in the highlands do exist (Shililu 2001).

The data presented here were collected in September and October of 2003 in three zobas of Eritrea: Anseba, Gash-Barka and Debub (Figure 1). According to the NMCP, these zobas are the major malarious areas of the country, and thus also correspond to areas where intense malaria control efforts have been initiated. Since 2002, control efforts have included the distribution of free pre-treated ITNs for all households in malarious areas (a minimum of two nets per household was the goal for the programme managers in 2002–2003), improved malaria case management, indoor residual spraying (IRS) in selected villages and larval control and environmental management (again, in selected areas). The nets are distributed by ministry personnel or community malaria agents and

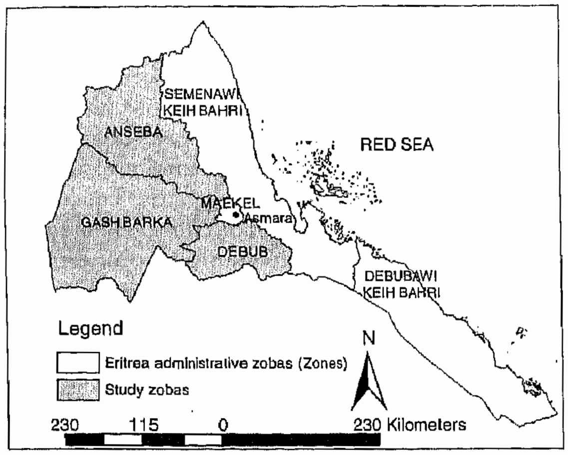

Figure 1 Map of Eritrea indicating selected study zobas. Selected zobas coincide with the most malarious regions in the country.

are either pre-treated with permethrin or permanently treated nets (Permanet). In the case of existing nets, the government offers free re-treatment at selected sites throughout these Zobas. The household survey, described below, was intentionally conducted during the rains to capture the period when members of the respective household were most likely to be *using* the nets.

Sampling strategy

A sample size of 780 households per survey domain ($n = 2340$) was used to meet survey objectives with the following parameters: probability of committing a type-1 error set at 5% (two-sided test), estimated population proportion for household bed net possession assumed to be 50%, a desire to be within 5% points from the true population parameter, and a design effect of 2.

A modified two-stage cluster design (Turner *et al.* 1996) was used to obtain a probability sample of households. The three zobas were treated as separate domains, and sampled independently using equal allocation (780 households within 30 villages per zoba and totalling 2340 households within 90 villages). After discussions with the NMCP, six sub-zobas thought to be malaria-free or too dangerous for travel were excluded from the survey universe. The survey universe thus consisted of all households within seven sub-zobas in Anseba, 13 sub-zobas in Gash-Barka and 10 sub-zobas in Debub. The total number of households within each village in each eligible sub-zoba served as the sampling frame. The number of households per village was obtained from the local government in each area. Villages, which were the primary sampling units (PSU), were systematically selected with probability-proportional-to-size (PPS).

The second stage of selection was based on a modified segmentation design (Turner *et al.* 1996). Briefly, this design involves mapping and dividing selected clusters into segments with equal numbers of houses within each, and then randomly selecting a segment and interviewing all households within that segment. Because no list of households existed at the village level, this method was the most practical to ensure that every household within selected villages (PSU) had an equal chance of being selected, and thus maximize the likelihood of a self-weighting design.

Survey instrument and data collection

A questionnaire was developed, translated into Tigrinya and pre-tested. Public health students and teachers familiar with the local languages in each zoba were recruited and trained as data collectors and supervisors. After obtaining informed consent from each selected household (one resident adult over 15 years old was the respondent), questions about mosquitoes, malaria knowledge and ITN use and re-impregnation practices were posed. Socio-economic and demographic information were also collected.

Data analysis

Data management and the respective analyses were done using STATA 7.0. Chi-square statistics and logistic regression models were used to analyse the data. Standardized strata sampling weights, based on the population size of each zoba, were applied to the data for between zoba estimates. A self-weighting design was assumed for within zoba estimates. To control for the effect of clustering at the village level, the Huber-White-Sandwich estimator of variance was used to obtain empirically estimated standard errors, with the village defined as the *cluster*.

Logistic regression was used to assess determinants of ITN use and possession at the household level with five operational outcomes: (1) proportion of households with all children <5 years old reported to have slept under an ITN the night before the survey interview; (2) proportion of households with all occupants reported to have slept under an ITN the night before the survey; (3) proportion of households with at least one ITN per two household occupants (ITN-to-occupant ratio ≥1:2); (4) proportion of households with all children <5 years old reported to have slept under an ITN the night before the survey among households reporting ownership of at least 1 ITN and (5) proportion of households with all occupants reported to have slept under an ITN the night before the survey among households reporting ownership of at least one ITN. Based on discussions with NMCP we assumed that one ITN per two people provides everyone a good chance of protection, thus we dichotomized the variable to equal 1 if the household had a ITN-to-people ratio of 1:2 (0.50) or greater, and zero if not. This is based on an assumption that on average two people share one bed. To remain consistent with RBM's definition of an ITN for measuring program coverage, an ITN is: *any new net purchased or received in the past year* (0–11 months), *or any net re-treated in last year* (0–11 months), and, in our study, was shown to the interviewer for inspection. As most ITNs obtained in the past year came from the NMCP, and as all NMCP nets were either pre-treated or permanently treated, a net procured in the past year was assumed to be an ITN.

We hypothesized that knowledge of malaria transmission, history of malaria illnesses in the household, access to a clinic and the zoba where respondents reside are important determinants of ITN possession and use. Knowledge of malaria transmission at the household level was dichotomized into correct *vs.* incorrect knowledge, with household respondents mentioning 'mosquitoes' as the primary cause being correct, and no mention of mosquitoes incorrect. A report of a history of malaria in the household was defined as any resident family member having been diagnosed at a health facility with malaria in the past 3 years. Socio-economic status of the household was not hypothesized to be a determinant of household ITN possession or use because of the extremely low variability of the indicator in this population. The presence of a health clinic in the village and zoba were the two community-level variables included in the regression models. Although household religion and ethnicity were also investigated as potential individual variables, and IRS and the presence of village health workers were explored as community variables, preliminary analyses showed that *zoba* captured much of the effect of these variables, as well as unmeasured geographic and environmental heterogeneity among the respective zobas.

Results

A total of 2341 households were visited and a questionnaire was given to a household representative (Table 1). The mean number of ITNs per household was equal to 1.35 across all zobas (1.03 in Debub, 1.50 in Gash-Barka and 1.86 in Anseba). A majority of households (66.8%) across all three zobas reported owning at least one ITN (57.1% in Debub; 70.1% in Gash-Barka and 86.5% in Anseba). The proportion of respondents who report mosquitoes as a cause of malaria transmission was also high (87.4%) across all zobas. Over half of the households said that a case of malaria had occurred (been diagnosed at a clinic) within the past 3 years in Debub (50.2%) and Gash-Barka (65.7%). Nearly a third (29.3%) of all households was within villages with a health clinic.

The proportion of households where it was reported that all children <5 years old slept under an ITN the night before the survey varied considerably by zoba (40.9% in Debub, 63.7% in Gash-Barka and 77.4% in Anseba) (Figure 2). While lower, the proportion of households where all occupants slept under an ITN the previous night followed a similar pattern to that for children (20.9% in Debub, 39.2% in Gash-Barka and 49.8% in Anseba). Overall, over half of all households reported all children <5 years under ITNs the night before the survey, while a third (32.9%) reported all household occupants under ITNs the previous night. Of those households owning at least one ITN, 49.3% reported having all members under the ITN the night before the survey; 82.7% reported having all children under five under an ITN the night before the survey. Over one-third of the households in Gash-Barka (36.8%) and Anseba (43.7%) had an ITN-to-household occupant ratio of at least 1:2, while 23.2% of households in Debub had at least this ratio (Figure 2).

Table 2 presents results of three models. Correct knowledge of malaria transmission was a significant determinant of ITN use and possession among sampled households (Table 2). After adjusting for confounders, households with correct knowledge reported by the respondent were more than twice as likely [adjusted odds ratio (OR) = 2.18, 95% confidence interval (CI) 1.34–3.54] to have all children <5 years old sleeping under ITNs the night before the survey, and over one and a half times more likely (adjusted OR = 1.84, 95% CI 1.21–2.68) to have all household occupants sleeping under ITNs the night before the survey interview, as compared to those without correct knowledge. Households having correct knowledge were also 1.5 times more likely to have an ITN-to-occupant ratio ≥1:2. Households in villages with health clinics, which also serve as ITN distribution centres, were significantly more likely to possess and use ITNs, although this affect was marginally insignificant for ITN use among all household occupants. *Zoba* was a significant determinant of ITN possession and use, with households in Debub least likely to possess or use ITNs.

Among households reporting ownership of at least 1 ITN, *zoba* continued to be a significant determinant of ITN use for children <5 and all household occupants, with Debub households least likely to have all children or all occupants under an ITN (Table 3). The total number of ITNs per household was a strong predictor of ITN use: the greater the number of ITNs owned, the more likely it was

Table 1 Characteristics of sampled households by zoba

	Debub	Gash-Barka	Anseba	All
	Zoba (SE)			
Number of households sampled (*n*)	782	779	780	2341
Mean number of occupants per household	4.78 (0.09)	4.62 (0.08)	4.95 (0.09)	4.81 (0.06)
Mean number of bed nets per household	1.63 (0.04)	2.05 (0.04)	2.05 (0.04)	1.97 (0.05)
Mean number of ITN per household	1.03 (0.04)	1.50 (0.05)	1.86 (0.04)	1.35 (0.07)
Mean bed net-to-occupant ratio	0.82:2	1:2	0.98:2	
Mean ITN-to-occupant ratio	0.51:2	0.72:2	0.89:2	
	% (SE)			
Proportion of households with at least one bed net	88.2 (0.01)	92.1 (0.01)	93.0 (0.01)	90.6 (0.02)
Proportion of households with at least one ITN	57.1 (0.02)	70.1 (0.02)	86.5 (0.01)	66.8 (0.03)
Proportion of households with all occupants under an ITN the night before the survey	20.9 (0.01)	39.2 (0.02)	49.8 (0.02)	32.9 (0.02)
Proportion of households with all children <5 years old under an ITN the night before the survey	40.9 (0.02)	63.7 (0.02)	77.4 (0.02)	56.6 (0.03)
Proportion of households with all occupants under an ITN among households with at least one ITN	36.5 (0.02)	56.0 (0.02)	57.6 (0.02)	49.3 (0.02)
Proportion of households with all children <5 years old under an ITN among households with at least one ITN	70.3 (0.03)	88.9 (0.02)	88.2 (0.02)	82.7 (0.02)
Proportion of household respondents citing mosquitoes as a means of malaria transmission	86.3 (0.01)	89.5 (0.01)	93.0 (0.01)	87.4 (0.01)
Proportion of households reporting at least one malaria case among occupants in past 3 years	50.2 (0.02)	65.7 (0.02)	27.3 (0.02)	54.5 (0.02)
Proportion of households in villages with a health clinic	20.1 (0.02)	40.2 (0.01)	20.0 (0.01)	29.3 (0.05)
Proportion of households in villages with a health attendant	100.0	66.8 (0.02)	100.0	84.7 (0.04)
Proportion of households in villages with indoor-residual spraying programs	23.4 (0.02)	40.1 (0.01)	0.0	28.2 (0.05)
Religion of household respondents				
Orthodox	88.9 (0.05)	31.6 (0.08)	13.8 (0.06)	53.2 (0.05)
Muslim	6.9 (0.04)	60.9 (0.08)	67.6 (0.08)	39.3 (0.05)
Other	4.2 (0.03)	7.6 (0.04)	18.6 (0.06)	7.5 (0.03)
Ethnicity of household respondents				
Tigrinya	95.7 (0.03)	31.6 (0.07)	15.4 (0.06)	56.2 (0.05)
Tigre	0.3 (0.01)	32.5 (0.08)	51.4 (0.08)	21.4 (0.04)
Bilen	0.1 (0.01)	1.3 (0.01)	32.3 (0.07)	4.6 (0.01)
Other	4.0 (0.03)	34.7 (0.07)	0.9 (0.01)	17.7 (0.04)

Standard Error (SE): Aggregated parameter estimates across zobas were calculated using weighted data.

that they were used by children <5 years and by all occupants. Households reporting a recent history of malaria were significantly less likely (OR = 0.74, 95% CI 0.57–0.96) to have all occupants using ITNs, although this was not a predictor for use by children <5.

Discussion

The purpose of this paper was to examine factors related to the possession and use of ITNs in Eritrea. All evidence suggests that current efforts to disseminate ITNs in Eritrea are working, with a high proportion of households reporting ITN ownership (67%), and ITN-to-occupant ratios inside households moving towards 1:2 in all zobas.

Five main findings emerge from this analysis. First, although ITN ownership is high in Eritrea, not everyone sleeps under an ITN every night. This suggests that although most people have the capacity to protect themselves, not everyone is doing so on a nightly basis, which may increase their overall risk of acquiring malaria parasites. It should be remembered that this survey was conducted just as the rains were tapering off in Eritrea, and therefore net use *should* have been at its peak. In support of this premise, our data suggests that households with all occupants sleeping under an ITN, as well as households with an ITN-to-occupant ratio of 1:2, were less likely to report a case of malaria within the household. Of course, we do recognize that there is some protective effect from

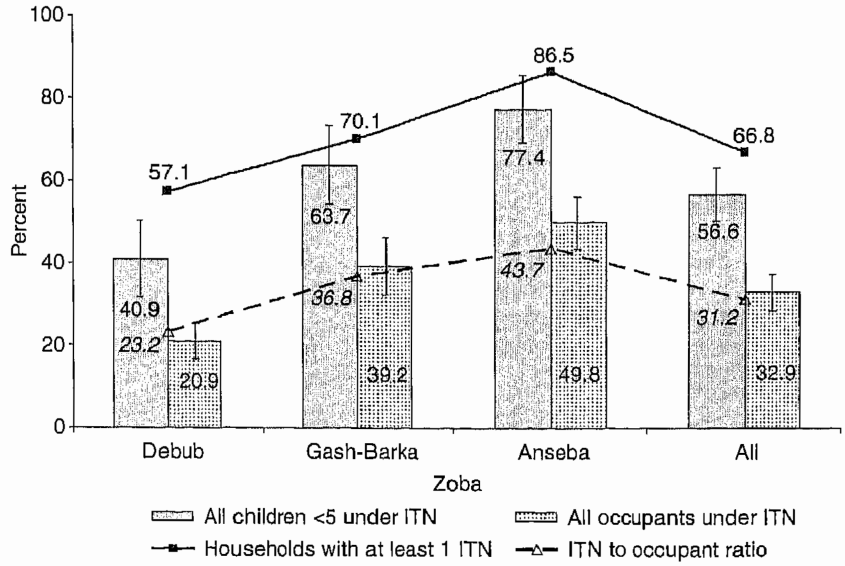

Figure 2 Proportion of sampled households by zoba with: at least one ITN, ITN to occupant ratio ≥1:2 and all children and occupants reported to have slept under an ITN the previous night (sample sizes: household with at least one ITN $n = 2341$; household ITN to occupant ratio $n = 2312$; children >5 years old $n = 1278$; all occupants $n = 2311$).

Table 2 Household and community determinants of household ITN use and possession among all households

	Outcomes†		
Determinants (PSU = 90)	All children <5 years old using ITNs ($n = 1278$) Adjusted odds ratio (95% CI)	All household occupants using ITN ($n = 2311$) Adjusted odds ratio (95% CI)	Household possession (ITN-to-occupant ratio ≥1:2) ($n = 2312$) Adjusted odds ratio (95% CI)
Correct knowledge: household respondents citing mosquitoes as a means of malaria transmission	2.18 (1.34–3.54)**	1.84 (1.21–2.68)*	1.50 (1.01–2.22)*
At least one malaria case in household in past 3 years	1.14 (0.83–1.56)	0.84 (0.68–1.04)	0.89 (0.73–1.08)
Presence of health clinic within village	1.69 (1.03–2.61)*	1.38 (0.98–1.92)	1.75 (1.26–2.44)**
Zoba			
Debub (baseline)	1.00	1.00	1.00
Gash-Barka	2.33 (1.35–4.05)*	2.38 (1.60–3.51)**	1.73 (1.17–2.56)*
Anseba	5.08 (2.84–9.10)**	3.50 (2.47–5.00)**	2.45 (1.68–3.59)**

* Significant with P-value <0.05.

** Significant with P-value <0.001.

† Weighted data were used for the logistic regression models, with dummy coding used for categorical covariates >2 levels. Standard errors were estimated using a sandwich estimator.

ITNs just through their repellent properties, i.e. their presence in the household (Alaii *et al.* 2003). Thus, we are not saying that this gap between ownership and use is expected to be entirely closed. This would probably be neither necessary nor possible. At present, our information on low prevalent areas and malaria prevention methods is still too scanty to know what the minimum proportion of the household or children should be under a net during high-risk seasons. However, if one's goal is to 'break transmission' (which Eritrea's is), then one can assume that this gap between ownership and use needs to be reasonably small. In addition, the members of some of these households where nets were owned but not used, may in fact have had some protection if the net was hanging and not stored away. Our instrument was not sensitive enough to measure the position of ITNs at night.

Table 3 Household and community determinants of household ITN use among households that own at least one ITN

Determinates (PSU = 90)	Outcomes† All children <5 years old using ITNs (n = 931) Adjusted odds ratio (95% CI)	All household occupants using ITN (n = 1650) Adjusted odds ratio (95% CI)
Correct knowledge: household respondents citing mosquitoes as a means of malaria transmission	1.79 (0.84–3.80)	1.34 (0.87–2.06)
At least one malaria case in household in past 3 years	1.27 (0.79–2.06)	0.74 (0.57–0.96)*
Presence of health clinic within village	1.03 (0.67–1.60)	1.06 (0.78–1.45)
Total number of ITN within household‡	1.47 (1.15–1.87)*	1.48 (1.30–1.69)**
Zoba		
Debub (Baseline)	1.00	1.00
Gash-Barka	3.07 (1.74–5.42)**	2.05 (1.48–2.84)**
Anseba	2.98 (1.77–5.00)**	1.94 (1.41–2.66)**

* Significant with P-value <0.05.
** Significant with P-value <0.001.
† Weighted data were used for the logistic regression models, with dummy coding used for categorical covariates >2 levels. Standard errors were estimated using a sandwich estimator.
‡ Continuous variable.

Second, correct knowledge of malaria transmission (e.g. mosquito bites are a necessary prerequisite to developing malaria) is a good predictor of ITN use within a household when one looks at all households in the survey (as the denominator). Although other studies investigating the association between bed net use and correct knowledge of malaria transmission failed to find significant associations (Aikins *et al.* 1993; Cham *et al.* 1996), and behaviour that is protective of health may occur without any insight into the nature of the relationship between disease aetiology and behaviour (Agyepong & Manderson 1999), it is clear from this study that targeted and specific education campaigns can bolster effective ITN use.

The third finding, however, contradicts the previous (i.e. second) one and begs explanation. Once the household owns a net, the variable measuring correct knowledge of transmission is no longer significant. It is possible that we are witnessing the phenomenon noted in other research related to the adoption and spread of a new technology, whereby people believe it is enough to be an 'ITN owner' and accept a free net because they are offered it, rather than because they plan to use it or think they need it. Heat, discomfort, a perception that mosquitoes are not around; all these may reduce the likelihood that a household uses the net available to them every night. A better understanding is needed as to why some people do not use nets, and what factors might improve the correct adoption of this technology once it has been distributed.

Fourth, households located in villages with clinics were more likely to possess and use ITNs, as evidenced by significant associations between proper ITN-to-occupant ratios, all children <5 years old using ITNs and the presence of clinics (Table 2). This finding is consistent with what one would expect, as clinics are used as ITN distribution centres in many areas of the country, which means households in villages with clinics are in closer proximity to free ITNs as compared to those who would have to travel to a clinic to receive a free ITN. Although the presence of a clinic is a good predictor of ITN ownership, not all occupants are using an ITN all the time. This suggests that other efforts may also be needed to disseminate malaria control information and materials to effectively protect all household members.

Fifth, the zoba in which the household was located was predictive of both ITN ownership and use in this analysis. In all three zobas, we observed high ITN ownership and use. Both Anseba and Gash Barka household were more likely to have an ITN-to-occupant ratio of 1:2 as compared to Debub, while in Table 2, where the use is measured relative to all households interviewed, Anseba households were more likely to have occupants under an ITN. However, when use is restricted to only those households that have an ITN, Gash Barka and Anseba switch, and households in the former zoba (which has had a bednet program in existence longer than Anseba) are more likely to be using it. In other words, our results suggest that households in Gash Barka have been exposed to public health messages and discussions about use of ITNs for a longer period of time than those in Anseba, and that as a result Gash Barka households appear to be more willing to use ITNs during peak transmission season.

Because the zoba is most likely measuring unobserved heterogeneity related to landscape ecology, ethnicities, religion, access to information and services and transmission patterns associated with location, it is difficult to isolate the exact reasons why these three zobas are different in terms of ITN ownership and use. However, differences in the timing of ITN distribution, as well as differences in terms of capacity of local program managers to initiate behavioural change, may provide additional explanations for these results.

Limitations

There are clearly limits to the use of cross-sectional survey designs to assess complex relationships. This is easily demonstrated with the finding that households that reported a history of malaria were found to be less likely to have all occupants using ITNs, even if an ITN was in the house. While the investigators hypothesized that this variable (a *past history* of malaria) would be more likely to dictate the *current use* of an ITN, our result may, in fact, reflect households who do not use ITNs are more likely to have put themselves at risk of malaria. There was also potential for bias in measuring the ITN treatment status due to poor recall and subsequent date heaping at '1 year'. However, there was no clear indication that this was a major problem as results did not change significantly when using the cut off of 12 months *vs.* 11 months in defining ITN re-treatment status during the analysis. While the sampling and sketch mapping strategy employed as part of this study was effective for estimating population parameters *within* the survey universe, recent security issues and a desire of the NMCP to measure their ITN distribution operations within programme areas precluded the inclusion of a few villages, which may have biased results when extrapolating beyond the survey universe.

Conclusion

In conclusion, the NMCP in Eritrea is working well to disseminate ITNs, as evidenced by high ITN ownership. At the global and national levels in Africa much attention is currently focused on increasing access to ITNs, our results suggest that additional efforts may be needed to target areas where the use of ITN is low, especially during peak transmission season. Studies may be needed to disentangle the relationship between the ITN coverage rates and factors that influence ITN use. Although evidence supports the premise that Eritrean households may now be approaching levels of adequate *access* to ITNs, there remains a significant gap between ownership and use. Reducing the size of this gap must become a focus of public health communicators, social scientists and all health programme managers in malarious areas if the ITN strategy advocated by RBM is to be truly effective. It would be tragic if this strategy were to fail in part because the scientific malaria community assumed, as the family planning community did in the 1950s and 1960s; 'build it, and they will come' – 'provide/or sell them an ITN and they shall use it.'

Acknowledgements

The work presented here was funded through two projects: (1) the American Schools of Public Health/Centers for Disease Control and Prevention cooperative agreement (S1942-21/21), Enhancing National Malaria Control in Eritrea and (2) the Environmental Health Project Contract No. HRN-1-00-99-00011-00. Support also came through the Ministry of Health, Eritrea and Tulane University. The authors also wish to thank the communities, which welcomed the interviewer teams, as well as the hard work of the public health technicians and the teachers who made up those teams.

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Implémentation des moustiquaires imprégnées d'insecticide en Erythrée: examination des déterminants de la possession et de l'usage dans les zones malariques durant la saison pluvieuse

OBJECTIFS cet article décrit les déterminants pour l'usage et la possession de moustiquaire imprégnée d'insecticide dans les zones malariques de l'Erythrée. Avec la distribution gratuite de moustiquaires imprégnées d'insecticide à tout le monde dans ces zones, nous avons analysé les barrières autres que le coût pour l'accès et l'usage de ces moustiquaires imprégnées d'insecticide. Nous avons investigué les différences entre usage d'un moustiquaire imprégnée d'insecticide comme une proportion de toutes les familles incluses dans l'étude (indicateur RBM) et l'usage d'un moustiquaire imprégnée d'insecticide en tant que proportion des familles possédant déjà un moustiquaire imprégnée d'insecticide.

MÉTHODES Une étude en grappe modifiée sur deux étapes a été utilisée pour la collecte des données dans les familles (n = 2341) dans les trois zobas (zones ou provinces) administratives les plus malariques. Une régression logistique a été utilisée pour l'analyse des données.

RÉSULTATS Nos observations suggèrent une hétérogénéité environnementale dans les zobas (incluant les effets des programmes, spécifiquement sur chaque zobas). La perception du risque et la proximité d'une clinique sont d'importants prédicteurs pour la possession et l'usage de moustiquaire imprégnée d'insecticide. Parmi les familles ayant au moins un moustiquaire imprégnée d'insecticide, 17% ont rapporté que les enfants de moins de 5 ans n'étaient pas sous moustiquaire la nuit avant l'enquête et tout le monde dans la famille n'a pas dormi sous moustiquaire la nuit précédant l'enquête dans 50% des cas. Le nombre de moustiquaires imprégnées d'insecticide ainsi que le nombre de zobas étaient aussi des déterminants significatifs de l'usage dans les familles avec au moins un moustiquaire.

CONCLUSION Les efforts actuels pour la dissémination des moustiquaires imprégnées d'insecticide aux populations vulnérables en Erythrée fonctionnent bien tel que le suggère la possession d'une moustiquaire imprégnée d'insecticide et le rapport moustiquaire par personne est élevé, ce qui peut représenter des chances de prévention contre l'infection. La complétion de cet effort requiert des efforts concertés pour changer les comportements afin de s'assurer que tous les membres de la famille utilisent autant que possible des moustiquaires imprégnées d'insecticide correctement et constamment durant et après les pluies.

mots clés moustiquaire traitée aux insecticides, Erythrée, efficacité, possession de moustiquaire, usage de moustiquaire

Despliegue de redes mosquiteras impregnadas en Eritrea: un examen de los determinantes de posesión y uso en zonas maláricas durante la época de lluvias

OBJETIVO Este artículo describe los determinantes de propiedad y uso de redes mosquiteras impregnadas (RMI) en zonas maláricas de Eritrea. Hemos examinado las barreras (diferentes al coste) existentes para el acceso y uso de las RMI ahora que la distribución y re-impregnación de las RMI es gratis para todos aquellos que viven en estas áreas. Hemos explorado las diferencias existentes entre el uso de una RMI como una proporción de todos los hogares participando en el estudio (el indicador de RBM), y el uso de las RMI como una proporción de aquellas casas en las que ya poseen un RMI.

MÉTODOS Se utilizó un diseño modificado en cluster de dos niveles para recolectar datos de una muestra de hogares (n = 2,341) en las tres *zobas* administrativas (zonas o provincias) con más malaria. Los datos se analizaron mediante regresión logística.

RESULTADOS Nuestros datos sugieren que la heterogeneidad ambiental existente entre las zobas (que incluye efectos específicos del programa implementado en cada *zoba*), la percepción de riesgo y la proximidad a una clínica, son predictores importantes para la posesión y uso de una RMI. Entre los hogares con al menos una RMI, 17% reportaron que los niños menores de 5 años *no* habían dormido bajo la RMI la noche antes de la encuesta, mientras que en la mitad de estos hogares no había habido ningún ocupante utilizándolas aquella noche previa a la encuesta. El número de RMI, al igual que la *zoba*, fueron también determinantes significativos de uso en estos hogares con al menos 1 RMI.

CONCLUSIÓN Los esfuerzos actuales para diseminar las RMI a poblaciones vulnerables de Eritrea están dando su fruto, como sugiere el alto número de hogares que poseen una RMI y la tasa mosquiteras/persona en los hogares. Sin embargo, la brecha entre el poseer una RMI y el utilizarla es aún grande, y puede representar una pérdida de oportunidades en la prevención de la infección. El cerrar esta brecha requiere de un esfuerzo conjunto que conlleve a un cambio de comportamiento, asegurándose de que todos los miembros del hogar utilizan la RMI de forma tan consistente y correcta como sea posible, durante y después de la época de lluvias.

palabras clave red mosquitera impregnada, Eritrea, efectividad, posesión de red mosquitera, uso de red mosquitera