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Long-lasting insecticide–treated net usage in eastern Sierra Leone – the success of free distribution

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Summary

OBJECTIVE Médecins Sans Frontières (MSF) runs a malaria control project in Bo and Pujehun districts (population 158 000) that includes the mass distribution, routine delivery and demonstration of correct use of free, long-lasting insecticide–treated nets (LLINs). In 2006/2007, around 65 000 LLINs were distributed. The aim of this follow-up study was to measure LLIN usage and ownership in the project area.

METHODS Heads of 900 randomly selected households in 30 clusters were interviewed, using a standardized questionnaire, about household use of LLINs. The condition of any LLIN was physically assessed.

RESULTS Of the 900 households reported, 83.4% owning at least one LLIN. Of the 16.6% without an LLIN, 91.9% had not participated in the MSF mass distribution. In 94.1% of the households reporting LLINs, the nets were observed hanging correctly over the beds. Of the 1135 hanging LLINs, 75.2% had no holes or 10 or fewer finger-size holes. The most common source of LLINs was MSF (75.2%). Of the 4997 household members, 67.2% reported sleeping under an LLIN the night before the study, including 76.8% of children under 5 years and 73.0% of pregnant women.

CONCLUSION Our results show that MSF achieved good usage with freely distributed LLINs. It is one of the few areas where results almost achieve the new targets set in 2005 by Roll Back Malaria to have at least 80% of pregnant women and children under 5 years using LLINs by 2010.

keywords malaria, Sierra Leone, prevention, bed nets, long-lasting insecticide–treated net, mass distribution, antenatal care, Abuja target, Roll Back Malaria

Introduction

Malaria still threatens the lives of millions, particularly in lower-income countries where it is endemic. Approximately half the world's population is at risk from this preventable, treatable and curable disease. In 2006, 247 million malaria cases caused nearly 1 million deaths, mostly in children under 5 years (WHO 2008). A major interdisciplinary strategy to control malaria is underway, based on prevention and prompt and effective treatment (Anonymous 2008; WHO 2008). Long-lasting insecticide–treated nets (LLINs) are part of the prevention strategy.

Across a range of transmission settings in Africa, high levels of LLIN use have been shown to reduce malaria-related mortality, especially in children under 5 years (Lengeler 2004). Achieving such levels is a goal in the malaria control efforts of the Roll Back Malaria (RBM) Partnership (WHO 2008). The 2000 RBM Summit in Abuja, Nigeria, set a target for 2005: 60% of those most vulnerable to malaria (children under 5 years and pregnant women) should have access to and sleep under LLINs (WHO 2000; Rowe *et al.* 2006). In 2005, RBM raised this target to 80% to be reached by 2010 (RBM 2005). There is no clear consensus on the most suitable and effective way of achieving socio-economic equity in distribution and full population ownership (possession of an LLIN) and usage (sleeping under an LLIN). Opinions differ on the benefits of mass distribution versus routine delivery and free distribution versus cost-sharing (Curtis *et al.* 2003; Cohen & Dupas 2008; Khatib *et al.* 2008). To determine the effectiveness of distribution channels, assessments of LLIN ownership are important. However, usage rather than ownership is the crucial indicator for whether distribution will lower the burden of malaria (Baume & Marin 2007).

In southeast Sierra Leone, malaria is hyper-endemic with perennial transmission. It is the main cause of morbidity and mortality especially for children under 5 years (Ministry of Health and Sanitation 2007). Médecins Sans Frontières (MSF) has run a health project in this area since 1995. Since 2006, a major focus of the project has been malaria control, with free rapid diagnostic tests, treatment and prevention activities. Severe malaria was the principal cause of morbidity in the area, accounting for 54.3% (3733/6875) of all admissions in the paediatric department of the MSF referral hospital in 2008 (A. Mukhtar & S. Dunkley, personal communications).

In 2006 and 2007, MSF organized a mass distribution of LLINs using deltamethrin-impregnated PermaNet® 2.0 (Vestergaard Frandsen, Switzerland) which has a WHO Pesticide Evaluation Scheme (WHOPES) recommendation, declaring it safe and effective for the prevention and control of malaria (WHO 2007). Around 65 000 LLINs were distributed using two strategies: free mass distribution and routine delivery of free LLINs for patients discharged from the referral hospital and for women attending antenatal care in the primary health structures. In the mass distribution, LLINs were distributed to households with pregnant women (one per woman) and children under 5 years. Households with 1–2 children under 5 years received one LLIN; a maximum of two LLINs was given to households with three or more children under 5 years. In each village, a reference person was chosen from the community and trained by the distribution team to work as a volunteer to help calculate the number of LLINs needed for the village, facilitate the distribution process and support villagers in correctly hanging and using LLINs.

Before the mass distribution, at least two education and awareness meetings were held with the head of the village and village opinion leaders with the help of a health educator. A theatre performance took place in each village demonstrating how to hang and use LLINs. Malaria education sessions were held at least weekly in the primary and secondary health structures to coincide with antenatal clinics.

The aims of this follow-up study were to measure the usage and ownership of LLINs and to see whether these results met the RBM Abuja targets.

Methods

Study design

We used a three-stage cluster sampling method with a probability proportional to the estimated population adapted from the method recommended by WHO (Henderson & Sundaresan 1982). Randomly selected households were interviewed on usage and ownership of LLINs.

Study area and population

The study area was the catchment area of the MSF project; approximately 357 villages with a total population of 158 000 in a radius of around 10 km around five community health centres. The study population included everyone living in the catchment area. The basis for the population and village estimation was a 2007 MSF mapping (MSF in-house mapping 2007). Each of the five community health centre catchment areas contained between 22 580 and 39 208 people living in 43–93 villages. Most houses were widely scattered around the village centre, usually the market place, and accessible only by footpath. The population size per village averaged 440 (minimum 16, maximum 3431 persons). Half the population are subsistence farmers and a quarter are diamond diggers (Gerstl 2009). Fewer than 20% of adults are able to read and write (Gerstl 2008).

Sample size

The average household size was between six and seven household members (MSF in-house mapping 2007, unpublished; MSF internal report 2008, unpublished; Gerstl 2008). We took six household members as the conservative average, so with an estimated population size of 158 000, there were about 26 300 households in the catchment area. From previous studies (Gerstl 2008), we also estimated that at least 50% of households would own at least one LLIN. With a precision of 10%, α-error of 5% and design effect of 2, 758 households were required. A sample size of 760 children under 5 years, an at-risk group for malaria, was estimated as necessary for an expected use of LLINs of 50%, precision of 10%, α-error of 5% and design effect of 2. As this study was part of a mortality and nutritional study in which 900 households and 900 children under 5 years were required, the minimum sample size was exceeded.

Sampling procedure

A three-stage cluster sampling methodology was used. In the first stage, 30 clusters were selected from a list of all five community health centre catchment areas using a probability of allocation proportional to the respective population size of each area. In the second stage, the selected number of clusters per catchment area (between 4 and 7) was allocated to villages within this area by systematic sampling. The probability of allocation was proportional to the respective population size of each village.

In the third stage, 30 households were randomly selected within a village (=cluster). A pen was thrown on the ground in the centre of the village, and a line drawn in the direction it pointed, towards the edge of the village. Households were counted along this line by walking to the edge of the village. With the use of a random number chosen from a random number table, one of these households was selected as the first to be interviewed. The next closest household was then interviewed until 30 had been included. If the village had fewer than 30 households, the cluster was continued by selecting the (geographically) closest village where the same methodology was used to select the first household.

Data collection

Heads of households were interviewed at their homes in one of the local languages (Mende or Creole) or English using a standardized, pre-piloted questionnaire. The study was anonymous. Five teams of three interviewers completed one cluster in 1 day. Household members were asked about the presence and quantity of LLINs in the household, details and quality of existing LLINs and usage of LLINs. If there were no nets in the household, household members were asked the reason why. In net-owning households, interviewers asked permission to enter and count LLINs and establish whether they were hanging correctly over sleeping places. If LLINs were tied up over the sleeping place, household members were asked to demonstrate correct usage. Interviewers noted the brand and assessed the condition of LLINs by counting holes graded in three sizes: finger (no finger-size holes, 1–10 finger-size holes, >10 finger-size holes), fist (likewise) and head (likewise). The head of each household was asked why LLINs were not hanging correctly over sleeping places (if applicable), the source of each LLIN, the year of acquisition and the frequency with which it was washed.

Data management and analysis

Data were entered into EpiData 3.0 software (The EpiData Association, Odense, Denmark). Data cleaning checked for inconsistencies in data entry and responses. Data analysis used STATA 8.1 (StataCorp, College Station, TX, USA) and SPSS 11.0 (SPSS, Chicago, IL, USA).

All indicators (e.g. sex and age of the study population, LLIN usage and ownership) were calculated as proportions and when appropriate with 95% confidence intervals (95%CI). Estimates of actual design (cluster) effect were also calculated. For all variables, the design effect was close to 1, therefore we did not report the estimates.

Ethical issues

Ethics approval was received from the Ethics Review Board of MSF and the Research and Ethics Committee of the Ministry of Health and Sanitation of Sierra Leone. Informed, written consent was obtained from the heads of households before the interviews, and care was taken to ensure that all household members understood that household participation was entirely voluntary.

Results

Demographics

Between the 22nd and 30th October 2008, 900 households with a total of 4997 people were visited and interviewed. No one refused to participate. Table 1 shows general characteristics of the study population.

LLIN ownership in households

Of the 900 households interviewed, 83.4% (751/900, 95%CI 78.5–88.4) reported owning at least one LLIN; 16.6% did not own an LLIN (149/900, 95%CI

Table 1 General characteristics of the study population

	n	%
*Study population (*N = *4997)*		
Age (years)		
<5	1206	
≥5	3791	
Mean, median (minimum–maximum)	22.4, 18 (0–99)	
Gender		
Male	2315	46.3
Female	2682	53.7
Illiteracy (aged ≥15)		
Study population	2192	80.6
Male (*n* = 2315)	830	70.3
Female (*n* = 2682)	1362	88.5
*Households (*N = *900)*		
Household size (total)		
1–4 members	328	36.5
5–10 members	551	61.2
>10 members	21	2.3
Mean household size (members)	5.6	
Household size (children <5 years)		
0 children	247	27.4
1–2 children	527	58.6
3–5 children	120	13.3
6–8 children	6	0.7
Mean household size (children <5 years)	1.5	

11.6–21.5); 91.9% (136/148, one missing datum) of these households said they had not participated in any MSF LLIN distribution. See Table 2 for all reasons given for not owning an LLIN.

Of the 149 households with no LLIN: 44.3% (66/149) were not eligible for the mass distribution (did not include a child under 5 years or a pregnant woman); 38.9% (58/149) included at least one child under 5 years, 10.1% (15/149) included at least one child under 5 years and at least one pregnant woman and 6.7% (10/149) included at least one pregnant woman.

Table 2 Main reason given for not owning LLINs

	Households without LLINs (n = 148*)	
	n	%
Household did not participate in any MSF distribution	136	91.9
LLINs are too expensive to buy	9	6.1
Household had LLIN which went missing	2	1.4
LLIN was damaged and thrown away	1	0.6

LLINs, long-lasting insecticide–treated nets; MSF, Médecins Sans Frontières.
*One missing datum.

Sixty hundred and eighty households were eligible for the mass distribution: 12.2% (n = 83) of these did not own an LLIN. 30.0% (66/220) of houses not eligible for the mass distribution did not own an LLIN.

LLIN usage in households

Of the 751 households that reported owning at least one LLIN, 94.1% (707/751) had the LLIN(s) correctly hanging over the bed(s); 5.1% (38/751) had at least one LLIN, but not hanging over the bed(s); and in 0.8% (6/751), the room(s) with the LLIN(s) were locked and could not be checked.

The main reasons given by the 38 households for incorrectly hanging LLIN(s) were: LLIN(s) currently not used and still in original packaging (34.2%, 13/38), LLIN(s) used to wrap mattress(es) as protection against bedbugs (28.9%, 11/38) and LLIN(s) being washed at time of interview (28.9%, 11/38) (Table 3). Of these 38 households: 29 (76.3%) included at least one child under 5 years; nine (23.7%) did not include a child under 5 years or a pregnant woman.

LLIN frequency in households

The 751 households that owned LLINs included 3356 household members. In these households, interviewers counted 1421 LLINs: 1135 were correctly hanging over the beds, 286 were not. Therefore, one LLIN (hanging

Table 3 Main reason given and observations made regarding LLINs not correctly hanging over the bed

	Households owning LLIN(s) but observed not hanging them (n = 38*)		LLINs observed not correctly hanging over bed (n = 286)	
	n	%	n	%
Currently not used (still in original packaging)	13	34.2	109	38.2
Used to wrap mattress as protection against bedbugs	11	29.8	99	34.6
Washed at the time of interview†	11	29.8	27	9.4
Spare LLIN	1	2.6	25	8.7
Not enough beds to hang all LLINs			6	2.1
Removed from bed as roof leaked			4	1.4
No reason given	1	2.6	4	1.4
Other reasons	1‡	2.6	12§	4.2

LLINs, long-lasting insecticide–treated nets.
*Of the 38 households, 25 owned one not-hanging LLIN, 10 owned two not-hanging LLINs, two owned three and one owned four not-hanging LLINs, respectively. The reasons for not-hanging LLINs were the same for all LLINs in those households with more than one LLIN.
†Many LLINs observed to be drying correctly in the shade.
‡LLIN old and used as clothing.
§Used as blanket, alternate use with correctly hanging LLIN, LLIN not usable anymore (each n = 2), LLIN old and used as clothing, too small for bed, impossible to hang LLIN, belief of dying when using LLIN, used as pillow, used for guests (each n = 1).

correctly or incorrectly) was shared between 2.4 household members (3356/1142), and one correctly hanging LLIN was shared between three household members (3356/1135). The main reasons given for the 286 incorrectly hanging LLINs were LLIN(s) currently not used and observed to be in original packaging (38.2%, 109/286), and LLIN(s) used to wrap mattress(es) as protection against bedbugs (34.6%, 99/286). See Table 3 for all reasons given.

LLINs correctly hanging over a bed

Table 4 sets out the conditions, brand, source, year of distribution and washing frequency of correctly hanging LLINs. Of the 1135 correctly hanging LLINs, 598 (52.7%) did not have any holes, and a further 256 (22.6%) had at most 10 finger-sized holes. Stratified by year of acquisition, the number of LLINs without holes was 111 (70.7%) of the 157 LLINs received during 2008, 374 (55.1%) of the 679 LLINs received during 2007 and 109 (39.1%) of the 279 LLINs received before 2007 (Table 5). PermaNet® was the most common brand in 81.6% (926/1135). The most common source of LLINs was MSF: 595 (52.4%) were handed out during MSF mass distributions and 259 (22.8%) in the antenatal programme or upon discharge from the referral hospital. In 2007 (59.8%, $n = 679$) or before 2007 (24.6%, $n = 279$), 84.4% (958/1135) of LLINs were received, and 73.8% (838/1135) of LLINs had been washed up to 4 times. Stratified by year of acquisition, the number of LLINs that had not been washed was 50 (31.8%) of those acquired in 2008, 38 (5.6%) of those acquired in 2007 and 11 (3.9%) of those acquired before 2007 (Table 5).

Usage of LLINs the night before the study

Of the 4997 people in the study, 3356 (67.2%, 95%CI 59.1–74.3) had slept under an LLIN the night before the study, as reported by the head of the household. Sex and educational status were not correlated with usage. Of children under 5 years, 76.8% (926/1206, 95% CI 69.8–82.6) were reported as sleeping under an LLIN. Of the 137 women aged 15–49 , who were more than 3 months pregnant, 73% (100/137, 95%CI 59.8–83.1) had slept under an LLIN.

Of those aged 5–14 , 54.6% (585/1071, 95% CI 51.6–57.6) were reported as sleeping under an LLIN as were 61.6% (659/1069, 95%CI 58.7–64.5) of 15–29 year olds, 73.0% (931/1275, 95%CI 70.5–75.4) of 30–59 year olds and 69.9% (258/369, 95%CI 65.0–74.4) of those aged 60 and older.

Table 4 Conditions, brand, source and age of correctly hanging LLINs

	LLINs observed correctly hanging over bed ($n = 1135$)	
	n	%
Conditions		
No holes	598	52.7
1–10 finger-size holes	256	22.6
1–10 fist-size holes	197	17.4
>10 fist-size holes	1	0.1
1–10 head-size holes	79	6.9
>10 head-size holes	4	0.3
Brand		
PermaNet® 2.0 (Vestergaard Frandsen)	926	81.6
Brand unreadable	98	8.6
Olyset® (Sumitomo, Japan)	88	7.8
Brand unknown (cotton structure)	23	2.0
Source		
MSF mass distribution	595	52.4
MSF antenatal care*	212	18.7
Market	172	15.2
MSF referral hospital	47	4.1
Gift within family†	44	3.9
UNICEF	26	2.3
MoHS/National Red Cross	16	1.4
Non-governmental organization (World Vision, Merlin)	14	1.2
Unknown source	6	0.5
Other sources‡	3	0.3
Year of acquisition		
During 2008	157	13.8
During 2007	679	59.8
Before 2007	279	24.6
Unknown date	20	1.8
Frequency of washing§		
Never	99	8.7
1–4 times	739	65.1
5–20 times	245	21.6
>20 times	14	1.2
Missing data	38	3.3

LLINs, long-lasting insecticide–treated nets; MSF, Médecins Sans Frontières; MoHS, Ministry of Health and Sanitation.
*Since April 2008, the MSF antenatal care programme has been distributing LLINs after delivery in a community health centre.
†LLINs mainly given by children (who were part of the LLIN mass distribution target group) to their parents (who were not in the target group).
‡LLIN bought at a second-hand shop, barter, gift for assisting the traditional birth attendant (each $n = 1$).
§Thirty-eight missing data for washing information.

Table 5 Conditions and frequency of washing stratified by year of acquisition of correctly hanging long-lasting insecticide–treated nets (LLINs)

Year of LLIN acquisition	*N*	*n/N*	%
During 2008	157		
	Frequency of washing		
	Never	50	31.8
	1–4 times	99	63.1
	5–20 times	6	3.8
	>20 times	1	0.6
	Missing data	1	0.6
	Conditions		
	No holes	111	70.7
	1–10 finger-size holes	30	19.1
	1–10 fist-size holes	13	8.3
	>10 fist-size holes	0	0.0
	1–10 head-size holes	2	1.3
	>10 head-size holes	1	0.6
During 2007	679		
	Frequency of washing		
	Never	38	5.6
	1–4 times	528	77.8
	5–20 times	98	14.4
	>20 times	4	0.6
	Missing data	11	1.6
	Conditions		
	No holes	374	55.1
	1–10 finger-size holes	162	23.9
	1–10 fist-size holes	114	16.8
	>10 fist-size holes	0	0.0
	1–10 head-size holes	26	3.8
	>10 head-size holes	3	0.4
Before 2007	279		
	Frequency of washing		
	Never	11	3.9
	1–4 times	110	39.4
	5–20 times	136	48.7
	>20 times	9	3.2
	Missing data	13	4.7
	Conditions		
	No holes	109	39.1
	1–10 finger-size holes	58	20.8
	1–10 fist-size holes	67	24.0
	>10 fist-size holes	1	0.4
	1–10 head-size holes	44	15.8
	>10 head-size holes	0	0.0

Discussion

In a resource-limited and difficult setting, our distribution strategy resulted in high ownership and usage of LLINs: 84% of households owned at least one LLIN, almost all these households (94%) had hung their LLINs correctly and almost two-thirds (67%) had slept under an LLIN the night before the study. Usage was even higher for the most malaria-vulnerable groups – children under 5 years (77%) and pregnant women (73%). Only 12% of households eligible for mass distribution did not own an LLIN. According to the WHOPES Working Group, an LLIN should retain biological activity for at least 20 washes and 3 years of use (WHO 2007). Most LLINs were assumed to be still biologically active; households had received them between 2006 and 2008 and only around 1% had been washed more than 20 times. Many were in good condition – two-thirds had no holes or fewer than 10 finger-sized holes.

Our results surpassed the 2005 RBM target of at least 60% of pregnant women and children under 5 years using LLINs (WHO 2000) and were close to the 2010 target of 80% (RBM 2005). The impact on malaria prevention is limited if LLIN usage does not match LLIN ownership. In contrast to our findings, a discrepancy of 20–55% between ownership (usually relatively high) and usage of LLINs (usually low) has been seen in Ethiopia (Fettene *et al.* 2009), Ghana (Grabowsky *et al.* 2007), Sudan (Hassan *et al.* 2008) and Niger during the dry season (Thwing *et al.* 2008). One reason for this discrepancy could be the lack of educational campaigns accompanying LLIN distributions (Gikandi *et al.* 2008; Hassan *et al.* 2008; Pare Toe *et al.* 2009). The strong educational component of the MSF distribution campaign might have increased usage of LLINs in our study. Another reason for high usage could be seasonality since people tend to use LLINs more during the rainy season. However, as Sierra Leone has a perennial humid climate with continuous rainfall, this factor would not affect our results.

Discrepancies between LLIN usage and ownership will persist even if ownership of at least one LLIN per household is attained (Eisele *et al.* 2009). Only when distribution programmes achieve a greater net-to-person ratio inside households can adequate intra-household access be guaranteed. In our study, on average, three household members theoretically shared one correctly hanging LLIN. Although other studies suggest a maximum of two people per LLIN per household as close to ideal, our reported usage rates were very good (Korenromp *et al.* 2003; Macintyre *et al.* 2006; Baume & Marin 2007; Killeen *et al.* 2007; Eisele *et al.* 2009).

The MSF distribution strategy of handing out free-of-charge LLINs during mass distribution in the villages and routine free delivery at health facilities achieved high ownership: 75% of LLINs had been received via these channels. Recent studies have supported our assumptions that distributing free LLINs results in greater ownership, equal or even better usage and increased socio-economic equity in distribution than that achieved by selling LLINs. In Kenya, a comparison of three strategies showed that free

mass distribution resulted in a dramatic increase of LLIN ownership and near equality between all socio-economic classes (Noor *et al.* 2007). In Kinshasa, an increase of 54% in LLIN use was seen in women after distribution of free LLINs at the time of delivery (Pettifor *et al.* 2009). In Tanzania, the largest increases in ownership of LLINs occurred in districts that received free nets during a vaccination campaign (Hanson *et al.* 2009). Again in Tanzania, all delivery methods underserved the poorest, especially the sale of nets at full market price; there was a 20% increase of LLIN use for each higher socio-economic class (Khatib *et al.* 2008; Bernard *et al.* 2009; Matovu *et al.* 2009). In Nigeria, the wealth index predicted LLIN ownership (Oresanya *et al.* 2008). In Zanzibar, free LLIN distribution was related to higher child survival rates (Bhattarai *et al.* 2007), and in rural Kenya, free LLIN distribution was related to lower child mortality and morbidity (Fegan *et al.* 2007; Noor *et al.* 2007). In Kenya, people who received free LLINs were no less likely to use them than those who had paid for them (Cohen & Dupas 2008). A positive correlation between LLIN ownership and free distribution was seen in a comparison of survey data from 40 malaria-endemic countries in Africa (Noor *et al.* 2009a).

Finally, free distribution seems the only way to abolish inequalities in ownership and to achieve high LLIN usage. Some countries such as Senegal, Zambia and Uganda have achieved substantial increases in LLIN usage (Baume & Marin 2008). Nevertheless, there remain many areas where usage is low. In 2007, only 18.5% (20.3 million) of African children living in areas of stable malaria transmission were protected by an LLIN (Noor *et al.* 2009a). By 2007, 130–264 million LLINs would have been required to reach 80% coverage in malaria-vulnerable population groups (Miller *et al.* 2007). However, at the end of 2006, only 72 million effective LLINs were in circulation in Africa (WHO 2008).

Long-lasting insecticide–treated nets at high ownership and usage levels affect vector population survival, and even those not sleeping under a net will benefit, thus achieving mass protection (Noor *et al.* 2009b). A relatively low usage of 35–65% gives community-wide benefits (Killeen *et al.* 2007). Our LLIN usage and ownership rates therefore should give protection to the whole community.

There are some limitations in generalizing our usage and ownership results. We did not include a control area. Therefore, it is difficult to extrapolate our results to other areas and other malaria settings, and we cannot conclusively link our results with our intervention. However, a multi-cluster indicator survey by UNICEF in Sierra Leone in 2005 showed that only 5% of children under 5 years had slept under an LLIN (UNICEF 2007), a much lower rate than we observed.

The study was conducted in an area where for some years MSF has offered free malaria prevention, diagnosis and treatment embedded in a system of free primary heath care, and the population is therefore used to high quality free service. The costs for the mass distribution were around US$10 per LLIN. We are aware that in resource-limited settings and for other regional, national and international organizations, these costs might be difficult. However, LLIN distribution is cost-effective. In Togo, distribution of LLINs within the Togo Integrated Child Health Campaign resulted in costs in terms of cases, deaths and disability-adjusted life years (DALY) averted being well within commonly agreed benchmarks set by other malaria prevention studies (Mueller *et al.* 2008). It has been estimated that universal coverage with LLINs in Africa is achievable by 2010, at the minimal cost of $3 billion per year (Sachs 2005; Teklehaimanot *et al.* 2007).

In conclusion, ownership and usage of LLINs in our study population almost achieved the 2010 RBM target of 80% LLIN usage in vulnerable population groups. To reach the 2010 RBM targets, we recommend the use of mass distribution and routine delivery of LLINs with an entirely free-of-cost approach.

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