Tropical Medicine and International Health doi:10.1111/j.1365-3156.2006.01684.x

VOLUME 11 NO 9 PP 1367–1374 SEPTEMBER 2006

Socially marketed insecticide-treated nets effectively reduce *Plasmodium* infection and anaemia among children in urban Malawi

Don P. Mathanga[1,2], Carl H. Campbell[3], Terrie E. Taylor[4], Robin Barlow[1] and Mark L. Wilson[1]

1 *Department of Epidemiology, School of Public Health, The University of Michigan, Ann Arbor, MI, USA*
2 *Department of Community Health, College of Medicine, University of Malawi, Malawi*
3 *Center for Disease Control and Prevention, Atlanta, GA, USA*
4 *College of Osteopathic Medicine, Michigan State University, East Lansing, MI, USA*

Summary

BACKGROUND Use of insecticide-treated nets (ITNs) has become a central focus for the Roll Back Malaria campaign, and many countries in Africa have now embarked on large-scale public health programmes aimed at making ITNs available to those at greatest risk. However, the effectiveness of these programmes has rarely been evaluated.

METHOD We conducted a cross-sectional survey to assess the impact of an ITN social marketing programme on *Plasmodium falciparum* infection and anaemia among children in urban Malawi.

RESULTS Knowledge of ITNs was high; however, only 42% of the children surveyed reported to have used an ITN the previous night. Nevertheless, 17% (295/1721) of children had a positive *P. falciparum* smear at enrolment. Use of ITNs was associated with 52% protective efficacy against *Plasmodium* parasitemia. More than two-thirds of children were anaemic, yet the mean haemoglobin concentration was significantly higher in children using ITNs than in those not using nets. ITN use was associated with wealth, as poorer households were 60% less likely to use treated nets.

CONCLUSION Although ITN social marketing programmes have the potential of improving malaria control and prevention, additional efforts are required to reach those for whom even subsidized nets are still too expensive.

keywords insecticide-treated nets, social marketing, effectiveness, malaria infection, anaemia

Introduction

Randomized community trials in Africa demonstrated a 17% reduction in all-cause mortality and a 50% decrease in the number of clinical malaria episodes in under-five children using Insecticide-Treated Nets (ITNs) (Lengeler 2006). Depending on the extent of ITN coverage in the community, children not using ITNs also had reduced risk of malaria (Hawley *et al.* 2003). Thus, ITN use has become a central focus for the Roll Back Malaria (RBM) campaign, and many countries in Africa have now embarked on large-scale public health programmes aimed at making ITNs available to those at greatest risk (WHO 2000). However, neither the optimal method of distributing ITNs nor the effect of distribution mechanism on the magnitude and sustainability of public health benefits has been established.

Social marketing (the adaptation of commercial marketing techniques to increase the acceptability of desired health practices, services and products) is an increasingly popular method of ITN distribution in Africa, with nets and insecticides being made available for purchase at lower-than-market costs through subsidies provided either by other consumers or external donors (Mushi *et al.* 2003). However, the effectiveness of ITN social marketing programmes has rarely been carefully evaluated. In The Gambia, an ITN programme that substantially decreased child mortality rates under research conditions was deemed less effective when charges for insecticides were introduced as a cost recovery measure (Cham *et al.* 1997). However, a different ITN social marketing programme in Tanzania, where nets and insecticides were promoted and sold through both public and private outlets, considerably reduced all-cause mortality (Schellenberg *et al.* 2001). These differing results, coupled with low ITN coverage typically achieved under programme conditions (WHO 2003), as well as emerging insecticide resistance (Chandre *et al.* 1999) and concerns of rebound mortality (Snow & Marsh 1995), all suggest that the effectiveness of ITN administration programmes should be evaluated in other

epidemiological settings. For these reasons, we undertook a study designed to determine the impact of an ITN social marketing programme on malaria infection and anaemia among children younger than 5 years in urban Malawi.

Methods

Study site

This study was conducted in Ndirande, a peri-urban township of 90 000 people within the city of Blantyre, in Malawi. The area is characterized by an average annual rainfall of 1144 mm, with average temperatures ranging from 17.3 to 27.5 °C, depending on the season. Malaria transmission in the area peaks during the rainy season (November–May) and is mainly by *Anopheles gambiae* mosquitoes. Malaria is the main cause of under-five morbidity, with anaemia among the top 10 causes of illness (unpublished data). Malaria control is based on prompt diagnosis and treatment of cases, and on use of ITNs.

Insecticide-treated nets programme in Blantyre

Since 1998, ITN distribution in Blantyre mostly has been through a social marketing programme administered by an NGO, Population Services International (PSI). Prior to this, ITNs were not generally available. Two types of nets (blue and green) and net-re-treatment insecticide were distributed and few other nets, potentially from other sources, were found (data not shown). The blue conical nets are available to anyone who can buy them through the commercial sector, while the rectangular green nets are available only at health clinics for pregnant women or mothers with children less than 5 years of age. At the time of our study, the consumer prices were about US$6.00 for the blue net, US$2.00 for the green net and US$0.20 for the insecticide re-treatment kit.

Study design

A cross-sectional survey of children aged 6–59 months was carried out during January and February 2002. Fifty census tracts ('enumeration areas') were randomly selected from a total of 72 that were in the study area. A complete census was carried out in each of these 50 census tracts and every household with a child under the age of five was given an identity number. Forty households were systematically selected from each census tract by visiting every fifth household on the census list. The youngest child per household was eligible to participate and informed consent to enrol the child was sought from the parent or guardian. The study protocol was reviewed and approved by Institutional Review Boards at the University of Malawi, The University of Michigan, and the US Centers for Disease Control and Prevention.

Interview with parent/guardian

Structured interviews were conducted with one parent/guardian of each child to gather information on the socioeconomic status (SES) of the household, the parent/caregiver's knowledge of malaria, use of anti-malarial drugs, mosquito avoidance behaviour, travel history and ITN use. Information was recorded on a pre-coded standard questionnaire. When use of a net was indicated, this was verified by asking to see that it was present in the house.

Laboratory procedures

Blood samples were collected from each child for on-the-spot measurement of haemoglobin concentration (HemoCue, Angelhom, Sweden). Thick and thin blood smears were prepared for microscopic diagnosis of malaria parasites. Blood slides were stained with a 3% Giemsa solution for 45 min. The number of asexual forms of *Plasmodium* per 200 white blood cells (WBCs) was counted and parasite densities were computed assuming a mean WBC count of 8000/μl. Slides were declared negative if no parasites were found after examining 100 high-power fields. Slide reading was blinded and the external quality control consisted of having all positive slides and 10% of the negative slides read again by an independent microscopist at the Wellcome Trust Laboratory in Blantyre.

Definitions

Social marketing was defined as the adaptation of commercial marketing techniques to increase the acceptability of desired health practices, services and products. *Households* were defined as a family, comprising the head of household (man or woman), husband or wife, children and immediate family members who shared income. ITN use was defined as owning and using a net that was 'ever treated'. Children using a net that had never been treated or no net were considered non-users of ITNs. Similarly, children living in households with ITNs but who were not themselves using ITNs were classified as non-users. SES was based on household material possessions. An SES score was derived for each household based on the presence (scored 1) or absence (scored 0) of the following items: radio, bed, mattress, cycle, refrigerator, telephone and car. The total score was used to classify households as either

poor (≤3 household possessions) or less poor (>3 household possessions). Knowledge of malaria was evaluated by asking the open-ended question: what are the signs and symptoms of severe malaria? Based on the number of correct answers, each respondent's knowledge was classified as either poor (no correct answer) or not poor (one or more correct answers). Malaria infection was defined as the presence of any density of malaria parasites in the peripheral blood. A child with haemoglobin concentration <11 g/dl was classified as anaemic, while those with haemoglobin <8 g/dl were classified as severely anaemic. The cut off point for severe anaemia was chosen to reflect the haemoglobin concentration, i.e. associated with increased mortality in sub-Saharan Africa (Stoltzfus 1997).

Analysis and statistical methods

Bivariate and multivariate analyses were carried out using SAS (SAS system for Windows 6.12; SAS Inc., Cary, NC, USA). Differences in means were compared using Student's *t*-test and differences in proportions were analysed using chi-square tests. Bivariate odds ratios (ORs) and 95% confidence intervals (CIs) were first calculated for individual risk factors. Then multivariate logistic regression was used on variables that were significant in the bivariate analysis. For all statistical tests, $P < 0.05$ was considered significant. Protective efficacy was calculated as (1-OR) × 100.

Results

Study population characteristics

A total of 2000 children were identified as candidates for study, of whom 1890 (94.5%) were enrolled. The reasons for children not being enrolled included unavailability of a parent/caregiver (78 children, or 3.9%) and refusal on the part of a parent/caregiver (for 32 children, or 1.6%). Complete data on ITN use was available for 1852 children (93%), who were included in the final analysis.

The mean age of the study participants was 28.6 months (SD = 14 months) and both genders were evenly represented. Most caregivers (91.1%) had some education (Table 1). Almost half of the heads of households were self employed as vendors or working as labourers in low paying jobs. Over half of the households were classified as poor with most of the houses being made of mud and only 41% having electricity. Ninety-nine per cent of the households knew what an ITN was but only 41.6% (771/1852) of children had used an ITN the previous night. Of the households with nets, 17.9% (138/771) had two or more ITNs.

Table 1 Characteristics of households and children less than 5 years old in Ndirande, Blantyre, Malawi, 2002

Household characteristic	Number	%
Caregivers education (years of schooling)		
0	162/1845	8.9
1–8	1015/1845	55.0
≥9	668/1845	36.1
Head of household occupation		
Unemployed	232/1793	12.9
Vendor/unskilled labourer	796/1793	44.4
Employed	765/1793	42.8
Socioeconomic status		
Poor (≤3 household items)	1106/1890	58.5
Households with electricity	764/1841	41.5
Houses of mud/sun dried bricks	1512/1840	82.1
Poor knowledge of severe malaria	881/1890	46.6
Child's age		
6–23 months	745/1890	39.4
Net use		
With treated net	771/1852	41.6
Child's nutrition		
Normal	1323/1609	82.2
Moderate Malnutrition (−3.0 ≤ WAZ < −2.0)	219/1609	13.6
Severe Malnutrition (WAZ < −3.0)	67/1609	4.2
Malaria prevalence	295/1721	17.1
Prevalence of anaemia (Hb < 11)	1263/1821	69.4
Prevalence of severe anaemia (Hb < 8)	270/1821	14.8

WAZ, weight for age *Z*-scores.

Predictors of net ownership

Bivariate analysis suggested that the following factors were associated with greater ITN ownership and use (Table 2): less poor households, parent/caregiver with more education, electricity in the house, higher quality housing, and

Table 2 Household characteristics associated in univariate and multivariate analysis with ITN ownership and use

	No. (%) with ITNs	Crude OR (CI)	Adjusted OR (CI)
Caregiver's education (years of schooling)			
1–8	348 (46)	1.5 (1.1–2.1)	1.2 (0.8–1.8)
≥9	366 (48)	3.5 (2.3–5.1)	1.8 (1.1–2.8)
Low socioeconomic status	305 (40)	0.2 (0.2–0.3)	0.4 (0.3–0.5)
Electricity in the house	441 (57)	3.1 (2.6–3.7)	1.1 (0.7–1.6)
Burnt brick wall of house	177 (23)	2.3 (1.8–2.9)	1.2 (0.8–1.7)
Kept medication in the house	345 (45)	2.4 (2.0–2.9)	1.8 (1.4–2.4)
Poor knowledge of malaria	441 (57)	0.8 (0.7–1.1)	0.9 (0.7–1.2)

CI, 95% confidence interval; OR, odds ratio; ITN, insecticide treated nets.

presence of antimalarial drugs in the house. In a multivariate logistic regression analysis that controlled for all variables significant in the unadjusted analyses, poor households were 60% less likely to have ITNs, and households in which the parents/caregivers had more education or in which antimalarial medications were kept in the house were 1.8 times more likely to own and use ITNs (Table 2). With this adjusted multivariate analysis, however, knowledge of malaria was not independently associated with ITN ownership. In 850/947 (89.8%) of households without nets, the respondent indicated that cost was the primary factor in the decision not to acquire a net (data not shown).

Predictors of *Plasmodium* infection

On the day of enrolment, 17.1% (295/1721) of the children had a positive malaria smear, and various risk factors were found to be associated with malaria infection (Table 3). Sleeping one or more nights in a rural malarious area outside the city, being of age 36–47 months, and coming from a poorer household were associated with increased risk of having malaria parasites in bivariate analyses. On the other hand, the presence of a caregiver with secondary school education or antimalarial medications in the house, and use of ITNs were associated with reduced risk of infection. Recent re-treatment of nets, knowledge of malaria, prompt use of health services and distance to nearest health unit were not independently related to positive malaria smears. In a multivariate logistic regression that controlled for variables significantly associated with infection by bivariate analysis, living in a poor household (OR = 1.5; 95% CI = 1.0, 2.2) and spending a night or more outside the city (OR = 3.7; 95% CI = 2.5, 5.6) remained associated with increased risk of infection. Similarly, use of ITNs (OR = 0.48; 95% CI = 0.34, 0.65) and having caregivers with secondary school education (OR = 0.6; 95% CI = 0.3, 1.0) remained protective factors against malaria. The protective efficacy associated with using a treated net was 52% (CI 35–66).

Predictors of haemoglobin levels

Haemoglobin concentrations ranged from 2.8 to 15.0 g/dl; the mean was 10.0 g/dl (SD = 1.6). There were 1263 (70%) anaemic children (haemoglobin <11 g/dl), of whom 270 (14.8%) were severely anaemic (Hb < 8 g/dl) (Table 1). In a multiple regression analyses, ITN use, age and keeping medication in the house were significantly associated with higher mean haemoglobin concentrations (Table 4). Children using ITNs had a mean haemoglobin concentration 3.2 g/dl (95% CI = 1.0, 5.4) higher than that in children who did not use ITNs. Children aged 24 months or more had significantly higher mean haemoglobin concentrations than did children between 6 and 11 months of age. Children from households in which medication was kept in the house had mean haemoglobin concentrations 0.5 g/dl (95% CI = 0.1, 0.8) higher than in children from households in which antimalarial medications were not kept. Severe malnutrition was inversely associated with haemoglobin levels (Table 4). The mean haemoglobin concentration in children with weight for age *Z*-scores <3 was 1.2 g/dl (95% CI = −2.2, −0.7) lower than haemoglobin concentrations in children with weight-for-age *Z*-scores ≥2. Sex of the child, education of the caregiver, SES, and duration of ITN use were not

Table 3 Predictors of malaria infection in urban Malawian children, Blantyre 2002

	No. with malaria infection (%)	Crude OR (CI)	Adjusted OR (CI)
Caregiver's education (years of schooling)			
1–8 years	197 (69)	1.1 (0.6–1.6)	1.1 (0.7–1.8)
≥9 years	59 (20)	0.4 (0.3–0.7)	0.6 (0.3–1.0)
Socioeconomic status			
Poor (≤3 household items)	221 (75)	2.3 (1.7–3.1)	1.5 (1.0–2.2)
Poor knowledge of malaria	180 (61)	1.1 (0.8–1.4)	0.9 (0.6–1.3)
Age of child			
12–23 months	66 (22)	1.1 (0.7–1.8)	1.0 (0.5–1.8)
24–35 months	87 (30)	1.4 (0.9–2.2)	1.1 (0.6–1.9)
36–47 months	75 (26)	1.6 (1.0–2.5)	1.4 (0.9–2.8)
48–59 months	32 (10)	1.2 (0.7–2.0)	0.9 (0.4–2.0)
Having medicines in the house	80 (27)	0.7 (0.5–0.9)	1.1 (0.8–1.7)
Slept in rural area in last 2 weeks	80 (27)	2.9 (2.1–3.9)	3.7 (2.5–5.6)
Use ITNs	69 (23)	0.4 (0.3–0.5)	0.5 (0.3–0.7)

CI, 95% confidence interval; OR, odds ratio; ITN, insecticide treated nets.

Table 4 Determinants of haemoglobin level in children aged less than 5 years old in Ndirande, 2002

Variable	Multivariate adjusted Hb (g/dl) difference between groups (CI)	*P**-value
Male sex	0.2 (−0.2, 0.5)	0.4
Age (months)		
12–23	0.1 (−0.3, 0.9)	0.3
24–35	1.0 (0.5, 1.7)	0.0006
36–47	1.1 (0.6, 2.1)	<0.0001
48–59	1.6 (1.0, 2.3)	0.0002
Caregiver's education (years of schooling)		
1–8 years	0.3 (−0.4, 1.0)	0.4
≥9 years	0.8 (−0.1, 1.5)	0.2
Socioeconomic status		
Poor (≤3 household items)	0.2 (−0.3, 0.5)	0.2
Kept medicines in house	0.5 (0.1, 0.7)	0.02
ITN use	3.2 (1.0, 5.4)	0.001
Length of ITN use		
12–23 months	−0.02 (−0.4, 0.6)	0.9
≥24 months	−0.2 (−0.6, 0.2)	0.3
Nutritional status		
Mild underweight (−3.0 ≤ WAZ < −2.0)	0.2 (−0.1, 0.7)	0.5
Severe underweight (WAZ < −3.0)	−1.2 (−2.2, −0.7)	0.0001

ITN, insecticide treated nets; *WAZ, weight for age *Z*-scores.

associated with haemoglobin concentrations in this analysis. Malaria infection was not included in this statistical model, as it had already been determined to be collinear with ITN use.

Discussion

Our results further demonstrate that the ITN social marketing programme in Blantyre is associated with measurable health benefits in children less than 5 years old. Treated nets offered at least 52% protective efficacy against malaria infection, which is comparable to other studies carried out in the region that assessed the impact of nets distributed through social marketing programmes (Abdulla *et al.* 2001). Indeed, our study suggests significantly higher protective efficacy than the estimated 19% obtained in the randomized trials in Kenya (ter Kuile *et al.* 2003). The disparity between our results and those from Kenya may reflect the low malaria transmission in Blantyre city where this study was undertaken. Recent re-treatment of nets in our study was not associated with reduced malaria prevalence, a finding that differs from those reported in other ITN studies (Lengeler 2006). Since we relied on verbal responses as to whether and when nets were treated, it is possible that our results were influenced by recall bias. Reported re-treatment could not be objectively measured, as there is presently no reliable field test to detect the presence and concentration of insecticide on treated nets (Drakeley *et al.* 1999).

Our study also demonstrated a high prevalence of anaemia in this area, with more than two thirds of children being anaemic and one in six suffering from severe anaemia. The impact of ITNs in reducing prevalence of anaemia suggests that malaria is a major contributor to anaemia in urban children, and that an ITN programme could reduce the prevalence of anaemia among urban children in this and perhaps other settings.

Various factors were associated with ITN ownership and use in Blantyre city. Since this is an urban area, where people may have more disposable income than in rural areas, the prevalence of ITN use in this study area was higher than that previously reported in rural Malawi (Holtz *et al.* 2002). Not surprisingly, ITN use was associated with proxy indicators of SES such as caregiver's education and number of household items. This inequity is consistent with the few other published studies of ITN social marketing programmes (Abdulla *et al.* 2001; Nuwaha 2001). Indeed, about nine in ten of the households without treated nets cited cost as the reason why they did not acquire one, which is not surprising considering that nearly two-thirds of households in Blantyre city are officially considered to be poor (NSO 2000) and most household heads are either unemployed (13%) or working only in low-paid occupations (44%). Households that kept medicines in the house more often owned and used ITNs, perhaps reflecting more frequent or attentive use of health services where advice on ITNs is given and nets are purchased at subsidized rates.

Another important finding of our study was that children who had recently slept a night or more in a rural area outside the city were three times more likely to be infected than those that had not. This suggests that some of the malaria morbidity in our study area resulted from infections acquired outside the city. This finding has important implications for ITN social marketing programmes and malaria epidemiology in urban areas. Although there is credible evidence of malaria transmission in urban areas (Robert *et al.* 2003), we know of no studies that have investigated the impact of population movement on the burden of malaria in African cities. If most of the malaria infections in Blantyre were imported from rural areas, malaria prevention and control activities should be directed towards this high-risk activity. Although our investigation has shown that ITNs are effective in reducing prevalence of anaemia and malaria infection in urban areas, more studies are needed in other epidemiological settings to determine both the burden of imported malaria in urban areas and the impact of malaria prevention methods for urban dwellers travelling to rural areas.

These results should be interpreted with the shortfalls of cross-sectional study design in mind. Since cross-sectional studies can only establish association and not causality, it is possible that some of the observed associations could have resulted from other unknown variables that were not measured or controlled for. While randomized study design is ideal for assessing the impact of malaria interventions, it is difficult to carry out such studies in a programme setting, as they would be both unethical and prohibitively expensive.

Implications of study findings for malaria control

Our results have shown that it is possible to attain a reasonable ITN coverage through an ITN social marketing programme and that health impacts of such a programme are measurable. However, for this intervention to benefit more people, issues of affordability must be addressed. Any programme that relies on individual purchases (of condoms, of bednets, etc.) will, almost by definition, exclude the very poor. Most people in Blantyre city earn less than $1.00 a day (NSO 2000), and for them, ITNs are unaffordable. Short of distributing ITNs for free to the very poor, it is difficult to imagine how social marketing programmes could be used to get interventions to the poorest of the poor.

Compounding this inequality in affordability of ITNs is the inequality in health needs. The poor in our study population were more likely to have malaria parasites and anaemia than were the rich. Hence, people that needed ITNs most were least likely to use them. To be successful, ITN programmes should target those with the highest risk of malaria and anaemia, the very poor. We suggest, as others have suggested before, that ITNs be treated like vaccines and be provided for free, at least to the vulnerable groups that include the very poor. Economic evaluations of ITNs have already shown that they rival childhood immunization programmes as the best use of public funds to improve health (Evans *et al.* 1997). Free ITN distribution that relies on existing channels such as the Expanded Programme of Immunization (EPI) or antenatal clinics should be affordable by the international community. In Kenya, a similar programme, distributing free ITNs to pregnant women, was found to be inexpensive, practical, simple and equitable (Guyatt *et al.* 2002).

Where free distribution of ITNs is not possible, other methods of extending ITN programmes to the poor must be explored. The poor could be encouraged to pay for ITNs through other means other than money, for example through ITN-for-work programmes. In Malawi, the poor already have experiences in food-for-work schemes, which could be extended to include ITNs. Our results suggest that offering ITNs to the most vulnerable people is an urgently needed programmatic shift if the very poor Africans in greatest need are to benefit from this effective anti-malarial tool.

Acknowledgements

We thank the parents, guardians and all children involved in this study for their cooperation and participation. Dr C Mkandala (District Health Officer) and the staff of Ndirande clinic provided critical support that made this study possible. We also thank late Professor Tim Cullinan for his support, and Drs Richard Steketee and Lawrence Marum of the Centres for Disease Control and Prevention, USA for their efforts to secure funding for this study. This research received financial support from the Blantyre Integrated Malaria Initiative, a CDC/USAID supported project in Malawi, a grant from Fogarty International Center of the NIH (1 D43-TW00908), and funding from the Global Health Programme at the University of Michigan.

References

Abdulla S, Schellenberg JA, Nathan R *et al.* (2001) Impact on malaria morbidity of a programme supplying insecticide treated nets in children aged under 2 years in Tanzania: a community cross sectional study. *British Medical Journal* **322**, 270–273.

Cham MK, Olaleye B, D'Alessandro U *et al.* (1997) The impact of charging for insecticide on the Gambian National Impregnated Bed net Programme. *Health Policy and Planning* **12**, 240–247.

Chandre F, Darriet F, Manguin S, Brengues C, Carnevale P & Guillet P (1999) Pyrethroid cross resistance spectrum among populations of Anopheles gambiae s.s. from Cote d'Ivoire. *Journal of the American Mosquito Control Association* **15**, 53–59.

Drakeley CJ, Armstrong-Schellenberg J, Abdulla S & Lengeler C (1999) Short report: lack of specificity of Beilstein test in detecting pyrethroid insecticide on colored mosquito nets. *Tropical Medicine and International Health* **4**, 639–640.

Evans DB, Azene G & Kirigia J (1997) Should governments subsidize the use of insecticide-impregnated mosquito nets in Africa? Implications of a cost–effectiveness analysis. *Health Policy and Planning* **12**, 107–114.

Guyatt HL, Gotink MH, Ochola SA & Snow RW (2002) Free bed nets to pregnant women through antenatal clinics in Kenya: a cheap, simple and equitable approach to delivery. *Tropical Medicine and International Health* **7**, 409–420.

Hawley WA, Phillips-Howard PA, ter Kuile FO *et al.* (2003) Community-wide effects of permethrin-treated bed nets on child mortality and malaria morbidity in western Kenya. *American Journal of Tropical Medicine & Hygiene* **68** (Suppl. 4), 121–127.

Holtz TH, Marum LH, Mkandala C *et al.* (2002) Insecticide-treated bed net use, anemia, and malaria parasitaemia in Blantyre District, Malawi. *Tropical Medicine and International Health* **7**, 220–230.

ter Kuile FO, Terlouw DJ, Phillips-Howard PA *et al.* (2003) Impact of permethrin-treated bed nets on malaria and all-cause morbidity in young children in an area of intense perennial malaria transmission in western Kenya: cross-sectional survey. *American Journal of Tropical Medicine and Hygiene* **68** (Suppl. 4), 100–107.

Lengeler C (2006) Insecticide-treated bed nets and curtains for preventing malaria. *Cochrane Database of Systematic Reviews* **2**, CD000363.

Mushi AK, Schellenberg JRM, Mponda H & Lengeler C (2003) Targeted subsidy for malaria control with treated nets using a discount voucher system in Tanzania. *Health Policy Planning* **18**, 163–171.

National Statistics Office (2000) *Population and Housing Census*. http://www.nso.malawi.net.

Nuwaha F (2001) Factors influencing the use of bed nets in Mbarara municipality of Uganda. *American Journal of Tropical Medicine and Hygiene* **65**, 877–882.

Robert V, Macintyre K, Keating J *et al.* (2003) Malaria transmission in urban sub-Saharan Africa. *American Journal of Tropical Medicine and Hygiene* **68**, 169–176.

Schellenberg JR, Abdulla S, Nathan R *et al.* (2001) Effect of large-scale social marketing of insecticide-treated nets on child survival in rural Tanzania. *Lancet* **357**, 1241–1247.

Snow RW & Marsh K (1995) Will reducing *Plasmodium falciparum* transmissions alter mortality among African children? *Parasitology Today* **11**, 188–190.

Stoltzfus RJ (1997) Rethinking anemia surveillance. *Lancet* **349**, 1764–1766.

World Health Organization (2000) *Roll Back Malaria*. http://www.rbm.who.int.

World Health Organization (2003) *Africa Malaria Report*. WHO, Geneva, pp. 26–27.

Corresponding Author **Mark L. Wilson**, Department of Epidemiology, University of Michigan, 109 Observatory St, Ann Arbor, MI 48109-2029, USA. E-mail: wilsonml@umich.edu

L'utilisation de moustiquaires imprégnées d'insecticide «socialement commercialisées» réduit efficacement la prévalence d'infections à *Plasmodium falciparum* et d'anémies chez les enfants d'une zone urbaine du Malawi

CONTEXTE L'utilisation de moustiquaires imprégnées d'insecticide (MII) est devenu l'une des priorités de la campagne "faire reculer le paludisme" (Roll Back Malaria). De nombreux pays d'Afrique ont désormais lancé des programmes à grande échelle pour rendre les MII disponibles pour les populations à risque. Cependant l'efficacité de ces programmes n'a été que très rarement évaluée.

MÉTHODE Nous avons mené une étude transversale visant à étudier l'impact de l'utilisation d'MII sur la prévalence d'infections à *Plasmodium Falciparum* et d'anémies chez les enfants d'une zone urbaine du Malawi.

RÉSULTATS Bien que leurs connaissances sur les MII soient satisfaisantes, l'utilisation d'une MII n'était rapportée que par seulement 42% des enfants interrogés. 17% (295/1721) des enfants présentaient un frottis positif à *P.falciparum* à l'inclusion. L'utilisation d'une MII étaient associée à un taux de protection vis a vis du *P. falciparum* de 52%. Plus de deux tiers des enfants étaient anémiés. Le taux moyen d'hémoglobine était significativement plus élevé dans le groupe des enfants utilisant une MII en comparaison de ceux n'en utilisant pas. L'utilisation de MII était associée au niveau social. En effet, on notait une réduction dans l'utilisation des MII de 60% parmi les familles les plus pauvres.

CONCLUSION Bien que les programmes de commercialisation sociale des MII aient la capacité d'améliorer le niveau de prévention et de contrôle du paludisme, des efforts supplémentaires doivent être consentis afin de toucher les populations pour qui, même subventionnées, les moustiquaires restent financièrement inaccessibles.

mots clés Moustiquaires Imprégnées d'Insecticide (MII), marketing social, efficacité, paludisme, anémie

Mosquiteros tratados con insecticidas de mercadotecnia social efectivamente reducen la infección por *Plasmodium falciparum* y la anemia entre los niños en el Malawi urbano

ANTECEDENTES La utilización de mosquiteros tratados con insecticidas (ITNs) se ha convertido en el centro de la campaña para "Hacer Retroceder la Malaria" (Roll Back Malaria), y varios países de África se han embarcado en programas de salud pública a gran escala con el fin de hacer llegar los ITNs a los más vulnerables. No obstante, la efectividad de estos programas ha sido rara vez evaluada.

MÉTODO Hemos realizado un estudio cruzado para evaluar el impacto de un programa de mosquiteros tratados con insecticidas de mercadotecnia social en infección por *Plasmoadium falciparium* y en anemia en niños en el Malawi urbano.

RESULTADOS El conocimiento de los ITNs era alto; no obstante, solamente el 42% de los niños evaluados informó que había utilizado un ITN la noche anterior. Sin embargo, 17% (295/1721) de los niños tenía una marca positiva de *P. falciparium* al inicio del estudio. El uso de los ITNs fue asociado a un 52% de eficacia de protección contra la *parasitemia de Plasmodium*. Más de dos tercios de los niños estaban anémicos, y sin embargo la concentración media de hemoglobina era significativamente más alta en niños utilizando los ITNs que aquellos que no utilizaban los mosquiteros. El uso de los ITNs se asociaba con riqueza, ya que en hogares más pobres existían 60% menos posibilidades de utilizar mosquiteros tratados.

CONCLUSIONES A pesar de que los programas de mosquiteros tratados con insecticidas de mercadotecnia social tienen el potencial de mejorar el control y la prevención de la malaria, se necesitan esfuerzos adicionales para poder llegar a aquellos a quienes hasta los mosquiteros subsidiados continúan siendo demasiado caros.

palabras clave Mosquiteros Tratados con Insecticidas (ITNs), mercadotecnia social, efectividad, infección por malaria, anemia