

## SUCCESSFUL INTEGRATION OF INSECTICIDE-TREATED BED NET DISTRIBUTION WITH MASS DRUG ADMINISTRATION IN CENTRAL NIGERIA

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**Abstract.** In Africa anopheline mosquitoes transmit malaria and lymphatic filariasis (LF); insecticide-treated bed nets significantly reduce transmission of both. Insecticide-treated bed net provision to children under 5 (U5) and pregnant women (PW) is a major goal of malaria control initiatives, but use in Africa remains low because of cost and logistics. We therefore integrated insecticide-treated bed net distribution with the 2004 LF/onchocerciasis mass drug administration (MDA) program in Central Nigeria. Community volunteers distributed 38,600 insecticide-treated bed nets, while simultaneously treating 150,800 persons with ivermectin/albendazole (compared with 135,600 in 2003). This was subsequently assessed with a 30-cluster survey. Among surveyed households containing U5/PW, 80% (95% CI, 72–87%) owned  $\geq 1$  insecticide-treated bed net, a 9-fold increase from 2003. This first linkage of insecticide-treated bed net distribution with mass drug administration resulted in substantial improvement in insecticide-treated bed net ownership and usage, without adversely affecting mass drug administration coverage. Such integration allowed two programs to share resources while realizing mutual benefit, and is one model for rapidly improving insecticide-treated bed net coverage objectives.

### INTRODUCTION

Malaria remains a major public health problem in sub-Saharan Africa.<sup>1</sup> Though all segments of society are afflicted, children under 5 years of age (U5) and pregnant women (PW) suffer most of the morbidity and mortality. The World Health Organization's Roll Back Malaria (RBM) initiative aims to decrease the burden of disease through 3 proven interventions: prompt management of presumed malaria cases, intermittent preventative treatment of pregnant women, and widespread use of insecticide-treated bed nets (ITNs). ITNs have been shown in multiple trials to significantly reduce malaria morbidity and mortality in these populations.<sup>2–6</sup> In the most recent large-scale trial, free ITN distribution to all persons in a Kenyan community reduced all-cause U5 mortality by 16%, severe pregnancy-associated anemia by 47%, and low birth-weight infants by 28%.<sup>5,6</sup>

In April 2000, RBM and African heads of state established the "Abuja targets," which include ITN use by  $\geq 60\%$  of PW and U5 in Africa by 2005.<sup>7</sup> However, few countries have met this target, and U5 ITN coverage in Africa is currently only 3%, with rates in Nigeria reflecting these regional figures.<sup>1</sup> Cost and logistical difficulties inherent to mass ITN distribution have prevented widespread use.<sup>1</sup> Many believe such coverage will be impossible unless nets are provided free of charge, especially to U5 and PW.<sup>8–11</sup> One method for achieving free, mass distribution of ITNs is linkage with other disease control programs; this has been successfully demonstrated in several recent reports.<sup>1,12,13</sup>

Integration of ITN distribution with the lymphatic filariasis (LF) elimination program is especially desirable in rural Africa, where *W. bancrofti*, the causative agent of LF, is spread largely by the same anopheline vectors as malaria.<sup>14</sup> LF afflicts  $> 120$  million people in 83 endemic nations, and is second among tropical diseases only to malaria in DALYs lost

worldwide.<sup>15</sup> Though there is less evidence demonstrating the effect of ITNs on LF, their use has been associated with lower anopheline densities and *W. bancrofti* transmission potential.<sup>16–18</sup>

Global efforts are underway to stop LF transmission using annual, single-dose mass drug administration (MDA). In sub-Saharan Africa, this consists of a combination of 2 drugs given free of charge: albendazole (donated by Glaxo-Smith-Kline) and ivermectin (Mectizan®, donated by Merck & Co.).<sup>19</sup> Accordingly, linkage of malaria and LF programs to promote free ITN distribution through MDA infrastructure has been proposed to achieve the goals of both programs: better malaria control and cessation of LF transmission.<sup>11,20</sup> However, no attempt at integrating these measures has been described to date.

Plateau and Nassarawa States in Central Nigeria have well-established LF/onchocerciasis MDA programs.<sup>21</sup> Despite a high prevalence of malaria in those states, ITN coverage is below 10% (O. Chirdan, unpublished data). We thus undertook a pilot project to distribute ITNs in one local government area (LGA) in each state, utilizing the combined resources of the LF and malaria programs.

### METHODS

**Study location.** Insecticide-treated bed nets were distributed in one LGA each in Plateau and Nassarawa States (Kanke and Akwanga LGAs, respectively). Most persons in these LGAs are subsistence farmers living in small, rural villages. Both are endemic for LF, onchocerciasis, and malaria. Kanke LGA (population 86,100) is a remote, arid area and Akwanga LGA (population 131,300) is a semi-rural area containing a town. Each LGA has a well-established LF/onchocerciasis MDA program, in which ivermectin and albendazole are distributed annually to the population. MDA is generally conducted house-to-house by volunteer community-directed distributors (CDDs). These areas had not previously been the target of a mass ITN distribution program.

**Insecticide-treated bed nets.** All nets were polyester and provided by the Nigerian Federal Ministry of Health's ma-

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laria program. About 60% measured 180 × 70 × 150 cm and were reportedly pretreated with insecticide. The other 40% were larger (190 × 170 × 160 cm) and packaged with individual insecticide-treatment sachets containing 6 ml of lambdacyhalothrin.

**Program integration.** For the 2004 MDA, state and local malaria health personnel worked in a coordinated fashion with counterpart state and local LF/onchocerciasis health personnel to develop the combined program. The infrastructure and distribution system of the LF/onchocerciasis MDA program was used, with tablets and ITNs delivered from LGA headquarters to each health district in the LGAs. CDDs then arranged transport of the drugs and ITNs to their respective villages. MDA consisted of albendazole (400-mg chewable tablets) and ivermectin (dosed by height to approximate 150 micrograms/kg orally), administered as directly observed therapy to all persons (except PW) in good health of height  $\geq$  90 cm (i.e., excluding U5s). CDDs were trained to give ITNs in addition to MDA during their house-to-house distribution.

Insecticide-treated bed net distribution was targeted to U5s and PW (who were excluded from MDA); persons not pregnant or under 5 were considered ineligible for ITNs. CDDs provided (free of charge) 1 ITN per sleeping space used by an U5 or PW ("vulnerable sleeping space," or VSS). CDDs ascertained the number of VSS during their household census, which is conducted annually during MDA. Appropriate ITN type (among the 2 available) was based on bed size, and large-sized nets were treated by CDDs prior to distribution, using the provided insecticide sachets. Recipients were taught to properly hang and use the nets.

**Assessment.** In April–May 2005, we assessed the combined program with a 30-cluster survey, using population-proportionate sampling as described for the Expanded Program on Immunization.<sup>22</sup> Fifteen clusters were selected from each LGA. The sampling frame excluded as yet untreated and sentinel villages (where ITN distribution was much more closely supervised), as well as the town in Akwanga LGA. Within each cluster, a household was randomly chosen as the starting point, and a "next-nearest-house" path was used to select 9 subsequent houses.<sup>22</sup> The head of household answered questions for all residents; if not available, another adult resident was interviewed. Households with no adult at home were not replaced. Surveys were reviewed daily for accuracy, and inconsistencies remedied with the interviewer.

Surveys consisted of a household census, assessment of MDA coverage, ITN ownership before and after the 2004 distribution, and ITN usage the previous night. For MDA coverage, 2004 survey data were compared with a statewide coverage survey from 2003 (E. Mathieu, unpublished data). Surveyors also inspected all sleeping rooms, and noted the number (and condition) of any bed nets.

A separate interview was conducted with 1 CDD per cluster. These questionnaires addressed time required for distribution in 2004 versus 2003 and other logistical and workload issues. Programmatic impacts of the integration were ascertained through semi-structured interviews with LF, onchocerciasis, malaria, and primary health care program managers from each LGA.

**Data management and analysis.** Survey results were entered using Epi Info version 6.04d (Centers for Disease Control and Prevention, Atlanta, GA). Univariate statistical analysis was conducted using SAS software version 8.2 (SAS

Institute, Cary, NC). Missing values in surveys were dropped from analysis, yielding slightly different denominators depending on response rate; 95% confidence intervals (Taylor series) were calculated for surveyed frequencies using SUDAAN software for the statistical analysis of correlated data version 8.0 (Research Triangle Institute, Research Triangle Park, NC).

## RESULTS

Integrated ITN/MDA distribution occurred in 159 (95%) of the 168 villages in Akwanga and Kanke LGAs from August–December 2004. Overall, 38,620 ITNs were distributed. The state LF/onchocerciasis programs reported 150,800 persons treated with ivermectin and albendazole, compared with 135,600 in 2003.

The 30-cluster survey and interviews were conducted in April–May 2005. We completed 290 household interviews, yielding information on 2,921 persons. A median of 9 persons lived in each household (range 1–50); the median age was 19 years (range 0–99), and 48% were male. There were 550 PW + U5 at the time of the survey, which together comprised 19% of the population; U5 comprised the majority of this group (86%).

**Mass drug administration coverage.** Overall, 1,916 of the 2,828 surveyed persons (68%; 95% CI 64–72%) reported taking ivermectin/albendazole during the 2004 MDA. Surveyed total population MDA coverage in Kanke LGA (66%; 95% CI, 59–72%) did not differ significantly from 2003 surveyed coverage in Plateau State (69%; 95% CI, 63–75%), and 2004 surveyed total population coverage in Akwanga LGA (70%; 95% CI, 65–75%) did not differ significantly from 2003 surveyed coverage in Nassarawa State (65%; 95% CI, 53–77%).

**Insecticide-treated bed net ownership.** Among households with a U5 or PW, 80% (95% CI 72–87%) owned an ITN, a 9-fold increase over predistribution ownership in such households (9%; 95% CI, 5–13%; Figure 1). We observed an ITN currently hanging in 61% of such households (95% CI, 50–71%), with significantly more in Akwanga (75%; 95% CI, 62–88%) than Kanke (46%; 95% CI, 34–58%). ITN ownership post-distribution among all households was 74% (95% CI, 67–82%), compared with 9% prior to distribution (95% CI, 5–12%); we observed an ITN hanging in 58% of all households (95% CI, 48–67%).

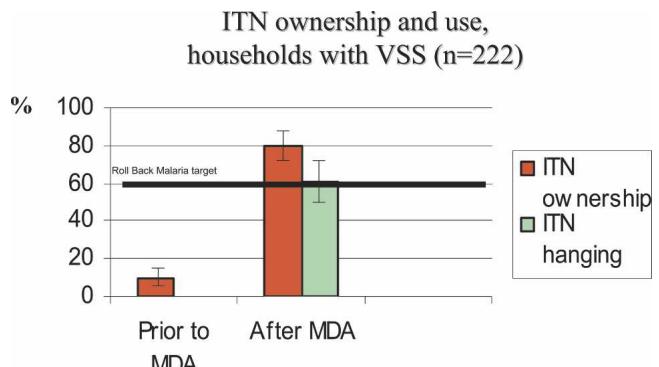


FIGURE 1. Insecticide-treated bed net (ITN) ownership and use, households with vulnerable sleeping space. (n = 222). This figure appears in color at [www.ajtmh.org](http://www.ajtmh.org).

**Insecticide-treated bed net usage.** Among PW and U5, 37% (95% CI, 30–44%) slept under an ITN the night before the survey; significantly more reported this in Akwanga (58%; 95% CI, 46–71%) than Kanke (19%; 95% CI, 7–30%; Table 1). This trend was noted for U5, currently pregnant women, and women pregnant during MDA (Figure 2). Among the target population, the lowest ITN usage rates were seen in currently pregnant women, and the highest among those pregnant during the MDA (see Table 1). Only 15% of all (eligible and ineligible) persons surveyed slept under an ITN the previous night.

**Insecticide-treated bed net deployment.** We surveyed 1,159 sleeping rooms (median 4 per household), of which 375 contained a VSS, and 271 (23%) contained an ITN (Table 2). There were 1,585 sleeping spaces (median 5 per household), of which 429 (27%) were VSS (see Table 2). Among the VSS, we observed 186 (43%) protected by nets, which differed significantly between Kanke (30%) and Akwanga (60%;  $P < 0.001$ , see Table 2). Far more VSS contained a U5 (92%) than a PW (18%). Among all sleeping spaces, 18% had an ITN hanging; 94 of 1,156 (8%) noneligible sleeping spaces had ITNs. Overall, 83% of observed nets were distributed by our program. Among households, 70% (95% CI, 62–77%) received at least enough ITNs to cover all VSS in their household; 29% of these received too many.

In Kanke LGA, conditions were hot and dry during the survey; in Akwanga, the rains had begun and we observed more mosquitoes. Significantly more persons reported sleeping outside the previous night in Kanke (23%; 95% CI, 6–41%) than Akwanga LGA (2%; 95% CI, 1–4%). Furthermore, 72% of Kanke respondents cited hot weather and lack of mosquitoes as the reason for ITN nonuse, while Akwanga nonusers were evenly distributed among never hanging (29%), recent washing (29%), and hot weather/lack of mosquitoes (24%). Among respondents, 4 (6%) no longer had their ITNs.

**Insecticide-treated bed net needs assessment.** In our survey, there were 591 U5 + PW. Given that there were 429 VSS, 0.75 (429/591) ITN per vulnerable person were required to cover all VSS.

**Community-directed distributors and program manager surveys.** The median number of ITNs distributed by CDDs was 117 (range 15–400). Among the 80% of CDDs reporting an increase in 2004 distribution time, the median increased from 5 to 8 days (Table 3). Only 7% of CDDs regarded their initial ITN consignment as sufficient, and just 29% were able to obtain more nets. Almost all CDDs reported pressure by ineligible persons to provide them with ITNs, and 43% admitted giving ITNs to ineligible persons (see Table 3).

## ITN use, pregnant women and children under 5

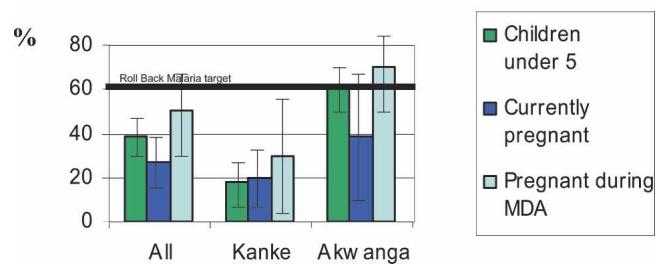


FIGURE 2. Insecticide-treated bed net (ITN) use, pregnant women and children under 5. MDA, mass drug administration. This figure appears in color at [www.ajtmh.org](http://www.ajtmh.org).

Program managers viewed ITN integration into the MDA program positively. However, they believed increased pressure on CDDs by ineligible persons led to inequitable distribution of ITNs. As ITNs were largely delivered only to the district level and CDDs and villages were left to transport them to the village level themselves, transportation, increased ITN bulk (compared with previous years, when only medications were given), and logistical difficulties were cited as other major problems.

## DISCUSSION

This first integration of ITN distribution into an LF/onchocerciasis MDA program resulted in a dramatic increase in ITN ownership among malaria-vulnerable groups. Over a 4-month period in 2 LGAs, we increased ITN ownership among households with U5 or PW from 9 to 80%, indicating good penetration of our program into the targeted communities. Importantly, the integrated campaign did not adversely affect the existing MDA program.

Our results are comparable to previous efforts in sub-Saharan Africa that have linked ITN distribution to campaign-style, community-based programs.<sup>23</sup> In Zambia and Ghana, 1 ITN given per U5 household as part of measles vaccination campaigns resulted in > 80% ITN ownership and use among these households in Zambia,<sup>1</sup> and 94% household ownership/65% U5 ITN coverage in Ghana.<sup>12</sup> In Togo, 1 ITN given per U5 presenting for measles vaccination resulted in 62% overall household ownership, 98% U5 household ownership, and 43% U5 ITN use.<sup>1,13</sup> Our results demonstrate that another method of achieving widespread ITN distribution is through an MDA campaign, and that such a program can

TABLE 1  
2005 coverage survey results—ITN usage, Kanke and Akwanga local government areas

Population	Slept under ITN previous night: Kanke			Slept under ITN previous night: Akwanga			Slept under ITN previous night: Kanke + Akwanga		
	n	%	95% CI	n	%	95% CI	n	%	95% CI
All persons	1569	8	3–13	1292	24	19–29	2861	15	13–17
Children < 5	240	18	7–29	223	61	49–72	463	39	32–45
Currently pregnant	45	20	5–35	28	39	11–68	73	27	15–39
Pregnant during distribution	57	30	4–56	59	70	52–86	116	50	34–66
Children < 5 + currently pregnant	285	19	7–30	251	58	46–71	536	37	30–44

ITN, insecticide-treated bed nets.

TABLE 2  
2005 coverage survey results—observational study

Population	Households	Sleeping spaces	VSS	ITNs covering VSS	Sleeping rooms	Sleeping rooms with VSS	Sleeping rooms with ITN
Kanke + Akwanga	290	1585	429	186 (43%)	1159	375	271 (23%)
Kanke	145	830	233	69 (30%)	613	203	103 (17%)
Akwanga	145	755	196	117 (60%)	546	172	168 (31%)

ITN, insecticide-treated bed nets; VSS, vulnerable sleeping space.

achieve results consistent with previous integrated campaigns. Both the current study and these other successful integrated programs demonstrate that campaign-style distribution programs have a large, immediate impact on ITN ownership, and seem more effective than local or regional public health systems for reaching established and accepted targets. For example, in our central Nigerian program where no mass distribution program had occurred previously, the ITN ownership (indeed any net ownership) and usage rates were extremely low prior to the integrated ITN/MDA distribution. Free ITNs, often integral to high community acceptance,<sup>8–11</sup> can result in excellent net retention.<sup>9,24</sup> Our study supports these findings, given the high community demand and 94% ITN retention at 6–8 months post-distribution. We believe free ITN distribution to at least U5 and PW can rapidly achieve both high ITN ownership and retention rates in sub-Saharan Africa, and given the comparability of our results to these previous campaigns, that ITN distribution through an MDA program is a viable means of achieving this.

Despite high rates of household ITN ownership, we observed ITNs hanging above only 43% of VSS, with only 37% of U5/PW reporting ITN use the previous night. This modest ITN usage likely resulted from seasonal factors, given the differing results between Kanke and Akwanga. In Kanke LGA, hot weather and low mosquito densities were disincentives to ITN use; other studies have found ITN use to vary similarly with climate.<sup>12,25</sup> Had the survey been performed during the rainy season, we believe cooler weather and maximal mosquito populations would have resulted in usage rates at least as high as seen in Akwanga (which was nearly at Abuja target). We suggest consistent seasonal timing for future ITN coverage surveys, preferably during the cool/rainy high transmission season, to standardize and accurately evaluate ITN usage.

**Distributing insecticide-treated bed nets based on vulnerable sleeping spaces.** Ours is the first reported program that allocated ITNs based on VSS. We found that the number of VSS can be estimated as 75% of U5 + PW; the latter can itself

can be estimated as 20% of a sub-Saharan African population. Thus, the number of ITNs needed for all VSS is approximately 15% ( $20\% \times 75\%$ ) of such a population. This approach is the most direct measure of ITN requirements for the malaria-vulnerable population, and allowed reduction of needs calculations by 25%. It also allowed all household members to derive benefit from distribution; U5 and PW received ITNs, whereas others received MDA. By encouraging all household members to be present, we believe this improved compliance for both ITNs and MDA. Though a household-level census and sleeping space assessment was necessary, this is well suited for an MDA program, in which an annual census is conducted as part of distribution.

On a community-wide basis, only 32% of sleeping rooms contained a VSS and coverage among all sleeping spaces was only 18%. The lower density of ITNs in our study (in contrast to ITN provision for the entire population) may not have provided the vector control necessary to significantly influence LF or malaria transmission. For malaria, benefits from ITN use have been shown to derive in part from a community effect that protects even those not sleeping under a net, and that this effect varies with the number of ITNs in a community and inversely with distance from ITNs.<sup>26</sup> However, this benefit has not been assessed when ITN distribution has been limited to the U5 and PW population. It is thus possible that in our study, 68% of sleeping rooms and their occupants experienced little protection from the ITNs. The impact of ITN distribution limited to VSS will be examined in a follow-up survey that will compare LF and malaria indices to baselines obtained prior to ITN distribution (B. Blackburn, unpublished data). While it would of course be preferable to distribute ITNs to the entire population, doing so in programs with limited resources would result in coverage of only one-fifth as many villages as with a VSS-oriented strategy such as ours. It is therefore understandable in a resource-constrained setting that the VSS approach would be taken.

**Distribution system problems.** In accord with the MDA distribution in previous years, CDDs were required to go to the local district headquarters to collect materials (ITNs and drugs) for distribution. Since the ITNs were considerably bulkier and heavier, a common concern was transportation and logistical difficulties. Therefore, the integrated program required more work by CDDs, who were charged with collecting, transporting, and distributing the medicines and bulky nets, as well as impregnating some of the nets. Providing better transport of the bulky ITNs remains a challenge to large-scale distribution programs. In addition, the popularity of the ITNs and the resulting pressures on CDDs to provide them to ineligible persons also resulted in shortages and inequitable ITN distribution, with 30% of households receiving too few nets and 29% too many. Better community education regarding the rationale for free ITN distribution to U5 and PW

TABLE 3  
2005 coverage survey results—CDD survey

As reported by CDDs	Response
Median number ITNs distributed (range 15–400)	117 nets
Distribution time increase noted in 2004	80%
Among those reporting lengthier 2004 distribution	
Median distribution time, 2004	8 days
Median distribution time, 2003	5 days
Received sufficient # ITNs in initial consignment	7%
Able to obtain more ITNs	29%
Asked by ineligible persons for ITNs	97%
Distributed ITNs to ineligible persons	43%

CDD, community-directed distributors; ITN, insecticide-treated bed nets.

might lead to less community pressure, though ITN distribution to the entire population would eliminate this problem altogether.

**Limitations.** Seasonal influences based on the timing of the cluster survey likely resulted in lower ITN use (especially in Kanke) and made it difficult to accurately assess some elements of our program's impact. Additionally, the 6–8-month interval between distribution and the survey resulted in shifts in the PW population rendering ITN coverage among PW falsely low, and U5 coverage correspondingly higher (due to parturition). Coverage surveys must account for these factors, though it is conceivable that they (timing surveys during rainy season versus closely after distribution) could be in conflict.

**Future directions.** The activities reported here are but the first step in the ITN/MDA integration effort. MDA occurs annually, and so should linked ITN activities, such as: (i) provision of ITNs to PW or U5s still without one; (ii) replacement of lost or damaged ITNs, and (iii) community-based ITN retreatment (which should occur every 6–12 months). Logistics, training, and resources for purchase of reimpregnation materials will remain challenges to the integrated program for the foreseeable future. As with all new technology, ITNs should be monitored for quality to assure the expected public health benefit. During distribution, 4 of the pretreated nets were obtained in a nonrandom manner and tested for insecticide levels; deltamethrin was detected on those nets at substandard levels. We are currently evaluating community-based reimpregnation of ITNs during MDA. However, the use of long-lasting ITNs would obviate much of the effort and cost required for reimpregnation, and should be used wherever possible. We hope to see expansion of this effort to a larger scale involving multiple LGAs/states in Nigeria.

We believe ITN/MDA integration is the best way forward among integrated campaigns for ITN distribution because it uses a community-based approach, placing much of the responsibility of the transport and distribution of nets on community resources, and obviates the need for the presence of skilled workers, transport, and equipment associated with vaccine campaigns. However, comparison of costs and ITN coverage achieved in ITN/MDA campaigns to those obtained with ITN/vaccination or other integrated campaigns should be done. The outcome of such studies could then be used to guide national policy to the end of meeting ITN objectives in Africa.

**Conclusions.** Our study demonstrates the feasibility of ITN distribution through an MDA program. The rapid and dramatic increase in ITN ownership and retention seen in our study demonstrates that this is an excellent means of increasing community penetration and use of these nets, and our program achieved these goals without adversely affecting the existing MDA program. We also piloted a new approach for ITN distribution to U5 and PW by targeting these groups at the sleeping space level, which could result in a 25% savings compared with targeting all vulnerable persons. This integration makes programmatic as well as logistical sense, since anopheline mosquitoes transmit both malaria and LF in large areas of rural sub-Saharan Africa and given that there is some evidence that treatment of intestinal parasites reduces the risk of severe malaria-related illness.<sup>27</sup> The annual nature of MDA and associated census updates lends itself well to mop-up ITN distribution and net reimpregnation ac-

tivities. This integrated program thus offers another option for mass ITN distribution, and serves as a model for others to emulate.

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## REFERENCES

1. Roll Back Malaria, World malaria report 2005. May 2005. Available at: <http://rbm.who.int/wmr2005/>. Accessed 6 Dec 2005.
2. D'Alessandro U, Olaleye BO, McGuire W, Langerock P, Bennett S, Aikins MK, Thomson MC, Cham MK, Cham BA, Greenwood BM, 1995. Mortality and morbidity from malaria in Gambian children after introduction of an impregnated bednet programme. *Lancet* 345: 479–483.
3. Nevill CG, Some ES, Mung'a VO, Mutemi W, New L, Marsh K, Lengeler C, Snow RW, 1996. Insecticide-treated bednets reduce mortality and severe morbidity from malaria among children on the Kenyan coast. *Trop Med Int Health* 1: 139–146.
4. Habluetzel A, Diallo DA, Esposito F, Lamizana L, Pagnoni F, Lengeler C, Traore C, Cousens SN, 1997. Do insecticide-treated curtains reduce all-cause child mortality in Burkina Faso? *Trop Med Int Health* 2: 855–862.
5. Phillips-Howard PA, Nahlen BL, Kolczak MS, Hightower AW, ter Kuile FO, Alaii JA, Gimnig JE, Arudo J, Vulule JM, Odhacha A, Kachur SP, Schoute E, Rosen DH, Sexton JD, Oloo AJ, Hawley WA, 2003. Efficacy of permethrin-treated bed nets in the prevention of mortality in young children in an area of high perennial malaria transmission in western Kenya. *Am J Trop Med Hyg* 68 (4 Suppl): 23–29.
6. ter Kuile FO, Terlouw DJ, Phillips-Howard PA, Hawley WA, Friedman JF, Kariuki SK, Shi YP, Kolczak MS, Lal AA, Vulule JM, Nahlen BL, 2003. Reduction of malaria during pregnancy by permethrin-treated bed nets in an area of intense perennial malaria transmission in western Kenya. *Am J Trop Med Hyg* 68 (4 Suppl): 50–60.
7. World Health Organization, The Abuja Declaration and Plan of Action. Excerpt from: The African summit on Roll Back Ma-

- laria, Abuja, Nigeria, April 2000. Available at: [http://www.rbm.who.int/docs/abuja\\_declaration.pdf](http://www.rbm.who.int/docs/abuja_declaration.pdf). Accessed December 6, 2005.
8. D'Alessandro U, Coosemans M, 2003. Is it feasible to give insecticide-treated bednets free to pregnant women? *Lancet* 362: 1515–1516.
  9. Guyatt H, Ochola S, 2003. Use of bednets given free to pregnant women in Kenya. *Lancet* 362: 1549–1550.
  10. Curtis C, Maxwell C, Lemnge M, Kilama WL, Steketee RW, Hawley WA, Bergevin Y, Campbell CC, Sachs J, Teklehaimanot A, Ochola S, Guyatt H, Snow RW, 2003. Scaling-up coverage with insecticide-treated nets against malaria in Africa: who should pay? *Lancet Infect Dis* 3: 304–307.
  11. Spencer S, Grant AD, Piola P, Tukpo K, Okia M, Garcia M, Salignon P, Genevier C, Kiguli J, Guthmann JP, 2004. Malaria in camps for internally-displaced persons in Uganda: evaluation of an insecticide-treated bed net distribution programme. *Trans R Soc Trop Med Hyg* 98: 719–727.
  12. Grabowsky M, Nobiya T, Ahun M, Donna R, Lengor M, Zimmerman D, Ladd H, Hoekstra E, Bello A, Baffoe-Wilmot A, Amofah G, 2005. Distributing insecticide-treated bednets during measles vaccination: a low-cost means of achieving high and equitable coverage. *Bull World Health Organ* 83: 195–201.
  13. Centers for Diseases Control and Prevention, 2005. Distribution of Insecticide-Treated Bednets During an Integrated Nationwide Immunization Campaign—Togo, West Africa, December 2004. *MMWR* 54: 994–996.
  14. The Global Alliance to Eliminate Lymphatic Filariasis. Available at: <http://www.filariasis.org/index.pl?iid=1768>. Accessed December 6, 2005.
  15. World Health Organization, 2002. *Annual Report on Lymphatic Filariasis 2001*. WHO, Geneva.
  16. Bogh C, Pedersen EM, Mukoko DA, Ouma JH, 1998. Permethrin-impregnated bed net effects on resting and feeding behaviour of lymphatic filariasis vector mosquitoes in Kenya. *Med Vet Entomol* 12: 52–59.
  17. Gimnig JE, Vulule JM, Lo TQ, Kamau L, Kolczak MS, Phillips-Howard PA, Mathenge EM, ter Kuile FO, Nahalen BL, Hightower AW, Hawley WA, 2003. Impact of permethrin-treated bed nets on entomologic indices in an area of intense year-round malaria transmission. *Am J Trop Med Hyg* 68 (4 Suppl): 16–22.
  18. Pedersen EM, Mukoko DA, 2002. Impact of insecticide-treated materials on filaria transmission by the various species of vector mosquito in Africa. *Ann Trop Med Parasitol* 96 (Suppl 2): S91–S95.
  19. Ottesen EA, 2002. Major progress toward eliminating lymphatic filariasis. *N Engl J Med* 347: 1885–1886.
  20. Manga L, 2002. Vector-control synergies, between 'roll back malaria' and the Global Programme to Eliminate Lymphatic Filariasis, in the African region. *Ann Trop Med Parasitol* 96 (Suppl 2): S129–S132.
  21. Hopkins DR, Eigege A, Miri ES, Gontor I, Ogah G, Umaru J, Gwomkudu CC, Mathai W, Jinadu M, Amadiengwu S, Oyenekan OK, Korve K, Richards FO Jr, 2002. Lymphatic filariasis elimination and schistosomiasis control in combination with onchocerciasis control in Nigeria. *Am J Trop Med Hyg* 67: 266–272.
  22. Bennett S, Woods T, Liyanage WM, Smith DL, 1991. A simplified general method for cluster-sample surveys of health in developing countries. *World Health Stat Q* 44: 98–106.
  23. Molyneux DH, Nantulya VM, 2004. Linking disease control programmes in rural Africa: a pro-poor strategy to reach Abuja targets and millennium development goals. *BMJ* 328: 1129–1132.
  24. Lindblade KA, Eisele TP, Gimnig JE, Alaii JA, Odhiambo F, ter Kuile FO, Hawley WA, Wannemuehler KA, Phillips-Howard PA, Rosen DH, Nahalen BL, Terlouw DJ, Adazu K, Vulule JM, Slutsker L, 2004. Sustainability of reductions in malaria transmission and infant mortality in western Kenya with use of insecticide-treated bednets: 4 to 6 years of follow-up. *JAMA* 291: 2571–2580.
  25. Alaii JA, Hawley WA, Kolczak MS, ter Kuile FO, Gimnig JE, Vulule JM, Odhacha A, Oloo AJ, Nahalen BL, Phillips-Howard PA, 2003. Factors affecting use of permethrin-treated bed nets during a randomized controlled trial in western Kenya. *Am J Trop Med Hyg* 68 (4 Suppl): 137–141.
  26. Hawley WA, Phillips-Howard PA, ter Kuile FO, Terlouw DJ, Vulule JM, Ombok M, Nahalen BL, Gimnig JE, Kariuki SK, Kolczak MS, Hightower AW, 2003. Community-wide effects of permethrin-treated bed nets on child mortality and malaria morbidity in western Kenya. *Am J Trop Med Hyg* 68 (4 Suppl): 121–127.
  27. Druilhe P, Tall A, Sokhna C, 2005. Worms can worsen malaria: towards a new means to roll back malaria. *Trends Parasitol* 21: 359–362.