DISTRIBUTION OF FREE UNTREATED BEDNETS BUNDLED WITH INSECTICIDE VIA AN INTEGRATED CHILD HEALTH CAMPAIGN IN LINDI REGION, TANZANIA: LESSONS FOR FUTURE CAMPAIGNS

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Abstract. Use of insecticide-treated bednets (ITNs) to prevent malaria remains low, and effective distribution strategies are needed. An integrated child health campaign with free distribution of 162,254 untreated bednets bundled with insecticide, measles vaccination, vitamin A, and mebendazole for children < 5 years old (“under-5s”) was conducted in Lindi Region, Tanzania. We conducted a representative household survey 3 months after the campaign. Altogether, 574 households with 354 under-5s were visited. In households with an under-5, possession of bednets and ITNs increased from 60.9% to 90.7% (P < 0.001) and from 16.5% to 37.3% (P < 0.001), respectively. Increases occurred in all wealth quintiles and equity improved. Reported bednet and ITN use the previous night among under-5s was 46.3% and 21.5%, respectively. Integrated campaigns rapidly and equitably increase bednet possession and use merit continued large-scale implementation. However, our study found that bednets were rarely treated; thus, future campaigns should provide factory-treated long-lasting ITNs. Low ITN use underscores the need for further efforts to increase use after campaigns.

INTRODUCTION

Malaria causes an estimated 350–500 million infections and over 1 million deaths per year, predominantly in children < 5 years old (under-5s) in sub-Saharan Africa.1 High levels of insecticide-treated bednet (ITN) use have been shown to reduce malaria mortality by 17% in children 1–59 months old in African study settings,2 and achieving high levels of ITN use is a key goal of global malaria control efforts by the Roll Back Malaria Partnership.3 However, despite efforts to increase ITN use through the development of commercial markets, social marketing interventions, and distribution through health facilities and community groups, most sub-Saharan countries continue to show low levels of ITN possession and use.4,5–8

Mass vaccination campaigns provide a unique opportunity to distribute ITNs and other child health interventions widely and equitably to the target population of under-5s. Campaigns that integrate measles and polio vaccination, mass treatment of helminths, mass drug administration for lymphatic filariasis, and ITN distribution have been conducted in sub-Saharan Africa.6–10 These campaigns rapidly and equitably increased ITN possession and use.6,8,9,10 Evaluations of these campaigns continue, as donors are keen to demonstrate the effect of their investments; they represent important opportunities to learn how to further improve these campaigns.

In Tanzania, bednets (primarily untreated) are manufactured and distributed; long-lasting ITNs (LLITNs) were not available widely at the time of this study. Insecticide is either sold separately or bundled with bednets, and all bednets need insecticide treatment for maximal benefit. Untreated bednets bundled with insecticide and individual insecticide retreatment kits are widely available for purchase in general shops and markets. Health facility-based distribution of discount vouchers for purchasing bednets bundled with insecticide occurs through the Tanzania National Voucher Scheme (TNVS). The TNVS delivers a voucher worth 2,700 Tanzanian shillings (∼US $2.45) as partial payment toward an untreated bednet bundled with insecticide (retail price ∼US $4.00) to women attending their first antenatal care visit. Vouchers are obtained at health facilities and can be redeemed at TNVS-participating bednet retailers. The TNVS was launched in April 2005 in Lindi Region but had not been fully implemented at the time of this study.

Lindi Region includes one urban and five rural districts in southeastern Tanzania and has a total population of 791,306 according to the 2002 national census.11 The region was selected for an integrated campaign because it has high-intensity malaria transmission and experiences higher under-5 mortality (153 deaths per 1000 live births) than other regions in Tanzania.12 In 2004, bednet and ITN coverage were low, with 45% of households owning at least one bednet and 16% owning at least one ITN. Similarly, the use of bednets and ITNs among under-5s the previous night was only 17% and 8%, respectively.12

A collaborative effort by the National Malaria Control Program, Expanded Program on Immunization, Tanzania Food and Nutrition Center, National Institute for Medical Research, and UNICEF led to an integrated campaign to vaccinate for measles, treat for helminths, administer vitamin A, and distribute bednets bundled with insecticide in Lindi Region from July 30 to August 1, 2005 (3 days). For a target population of 165,000 under-5s, 162,254 bednets bundled with insecticide were distributed in Lindi’s six districts, achieving 98.3% administrative coverage for the region.13 Untreated bednets bundled with insecticide were distributed because they were available from local bednet manufacturers and a sufficient supply of LLITNs was not available in Tanzania at the time of the campaign. In addition to the other child health interventions, each under-5 attending a campaign post received a bednet bundled with insecticide. Campaign posts were set up at health facilities, village centers, markets, and other locations. Caretakers received written and illustrated...
instructions on treating the bednets with insecticide. However, there were no additional interventions during or after the campaign to encourage home treatment of bednets with insecticide or use of ITNs by under-5s.

UNICEF provided US $400,609 to purchase and distribute bednets bundled with insecticide in the campaign. The total cost per bednet distributed was US $2.47: this amount is broken down as US $2.18 for purchasing the bednet, and US $0.29 for distribution. These distribution costs included shipping to district capitals, advertising, and funding for National Malaria Control Program staff involved in the campaign. However, these costs did not include other campaign costs, such as local shipping from the district capital to distribution points. The authors did not participate in organizing or funding the campaign.

We report here the results of a household survey to evaluate the integrated campaign in Lindi Region. Although other campaigns in Africa have distributed LLITNs, untreated bednets are still produced. We are among the first to report on an evaluation of free distribution campaign of untreated bednets bundled with insecticide.

METHODS

We conducted a cross-sectional household survey from November 2 to 16, 2005, approximately 3 months after the integrated campaign. Malaria transmission was low, as this period was the end of the dry season before the seasonal short rains. The study was conducted in both urban and rural communities in each of the six districts of Lindi Region (Lindi Urban, Lindi Rural, Kilwa, Nachingwea, Ruangwa, and Liwale).

We used a two-stage cluster sampling design. The first stage was composed of enumeration areas (EAs) from the latest census, in 2002. Altogether, 30 EAs were chosen using systematic random sampling with selection probability proportional to estimated size. In the second stage, 20 households were randomly sampled in each EA regardless of the presence of under-5s. EAs ranged in size from 1 to 20 km², thus it was not feasible to fully map each EA. Twenty-two (73.3%) large EAs were segmented into their component subvillages, and one subvillage from each was randomly selected to be mapped and surveyed. In a given large EA that needed segmenting, all subvillages had the same probability of being selected. Population estimates for subvillages were unavailable, thus post-stratification weighting was not performed.

Using census maps that demarcated EA borders and personal digital assistants (PDAs; Dell Axim X50s, Dell Inc., Austin, TX) equipped with global positioning system units (Pocket GPS Navigator, Pharos Science and Applications Inc., Torrance, California), two surveyors mapped all households within a selected EA or sub-village each day. After mapping, 20 households were randomly selected while in the field using a PDA-based program developed by the U.S. Centers for Disease Control and Prevention (Atlanta, GA).

If members in selected households agreed to participate, they were asked standardized questions about the household, the campaign, children in the household, bednets in the household, and household assets. All questions were closed-ended, but the choices were not read to respondents. Responses were coded as “other” if the respondent’s answer did not match any of the anticipated categories. A customized questionnaire was designed and programmed into PDAs using Visual CE 9.1 (Syware Inc., Cambridge, MA). The survey questionnaire was translated into Swahili and back-translated to ensure translation accuracy. Skip patterns, internal logic checks, and informational pop-up screens were programmed into the PDA-based survey to improve the ease and accuracy of data entry. Households were defined as a head of household and all their spouses, children, and other dependents sleeping in the same compound. All households were eligible, including those without under-5s. If family members in a household were not home, the household was revisited at the end of the day. If no one was available after two visits, the household was not replaced.

Data analysis. All responses were entered directly into a PDA database in the field. Data were downloaded at the end of each day into a single database using Access 2000 software (Microsoft Inc., Redmond, WA). Analyses were performed using SAS version 9.1 (SAS Institute, Cary, NC) using the PROC SURVEY procedures, which use the Taylor expansion method to account for cluster sampling and unequal selection probabilities. Analyses were weighted, and weights equalled the inverse of the exact probability of selection. Percentages reported in this report reflect this weighting unless otherwise noted. An asset score calculated with an index developed and validated by the World Bank was used to create wealth quintiles. The equity ratio was calculated as the proportion (e.g., of an ITN coverage indicator) in the poorest quintile divided by the proportion in the least-poor quintile; a ratio of 1 indicates equal intervention coverage in the poorest and least-poor quintiles. Respondents were asked about when they purchased a bednet, whether it had been factory-treated with insecticide, whether they treated it with insecticide, and whether they treated it with insecticide. An ITN was defined as any bednet factory-treated with insecticide and obtained less than 12 months ago or any bednet treated with insecticide less than 12 months ago. We assumed no LLITNs were available in Lindi Region during the survey. Bednet and ITN use were defined as reportedly sleeping under a bednet or ITN the previous night. Statistical significance was defined as a P value ≤ 0.05.

Ethical considerations. This protocol was reviewed by the U.S. Centers for Disease Control and Prevention and considered exempt as a nonresearch program evaluation. Additionally, the protocol was reviewed and approved by the National Malaria Control Program in Tanzania. Oral informed consent was collected from each household head and individual participants. The survey did not collect any sensitive information, involved no invasive procedures, and conferred no significant risk or benefit to participants.

RESULTS

Characteristics of households and household members. Of 600 selected households, 574 (95.7%) participated in the survey. Reasons for exclusion were “nobody at home” or “refused to participate.” Of the 574 households surveyed, 305 (53.1%) had at least one under-5, 462 (80.5%) had at least one woman 15-45 years old, and 50 (8.7%) had at least one pregnant woman 15-45 years old. The mean number of individuals per household was 3.9.

Almost all households were in rural areas (93.4%) and used pit toilets (95.7%). Two-thirds (66.3%) of households ob-
tained drinking water from a shared hand-dug well. The most common forms of housing construction were floors made of dirt, sand, or dung (93.0%); walls made of poles and mud (72.9%); and roofs made of grass, leaves, or mud (77.3%). Almost no household (1.8%) had electricity, although almost half (44.2%) had a radio.

A total of 354 under-5s were surveyed. About half (46.7%) of participating children were female. Altogether, 482 women of age 15–45 years participated in the survey, and 50 (10.4%) of these women were pregnant.

**Campaign attendance and intervention coverage.** Nearly all [96.0% (95% confidence interval (CI): 93.1–98.8%)] household respondents surveyed were aware of the integrated child health campaign. The 554 household respondents aware of the campaign learned about it through local community leaders (76.0%), community mobilizers (22.2%), neighbors (19.8%), and the radio (18.5%).

Most [85.8% (95% CI: 81.6–89.9%)] under-5s surveyed attended the campaign. Of the 47 under-5s who did not attend the campaign, the most common reasons were being away from home during the campaign (29.4%) and not knowing about the campaign (15.5%). Of the 307 under-5s who attended the campaign, the most common reasons reported by caretakers for attending the campaign were to get a bednet (64.8%), measles vaccine (57.7%), vitamin A (39.3%), “to protect my child from illness” (12.9%).

Children in different age groups were eligible for each intervention during the integrated child health campaign regardless of prior administration: measles vaccine (9–59 months), mebendazole (12–59 months), vitamin A (6–59 months), and bednet (0–59 months). Of the 300 eligible children of age 9–59 months, 76.8% had received a measles vaccination before the campaign (Figure 1, first vertical hashed bar) with 59.1% (95% CI: 49.2–69.1%) confirmed by health card, and 82.4% received a measles vaccination during the campaign (Figure 1, first vertical gray bar). In summary, overall measles vaccination coverage increased significantly with 90.9% of eligible children having received at least one dose of measles vaccination either before the campaign or during the campaign (Figure 1, first vertical dotted bar). Of the 23 eligible children who did not receive measles vaccine during the campaign, caretakers of 8 children reported that the child was previously vaccinated, caretakers of 7 children reported that the vaccinator said the child was not the right age for the vaccination, and caretakers of another 8 children reported other reasons for not receiving the vaccination.

Of the 283 eligible children of age 12–59 months, 39.4% received mebendazole before the campaign (Figure 1) with 20.1% (95% CI: 9.8–30.3%) confirmed by health card, and 80.5% received mebendazole during the campaign. Overall mebendazole coverage increased significantly with 86.4% of eligible children having received at least one dose of mebendazole either before or during the campaign. Of the 61 eligible children who did not receive mebendazole, caretakers of 8 children reported the child had already received a dose, caretakers of 5 children reported that the pills were not available at the campaign post, caretakers of 4 children reported being afraid of side effects, one caretaker reported that the queue was too long, and caretakers of 43 children reported other reasons for not receiving the intervention.

Of the 313 eligible children aged 6–59 months, 67.0% of eligible children received vitamin A before the campaign (Figure 1) with 46.0% (95% CI: 36.7–55.3%) confirmed by health card, and 84.9% received vitamin A during the campaign. Overall vitamin A coverage increased significantly with 93.0% of eligible children having received at least one dose of vitamin A either before the campaign or during the campaign. Of the 18 eligible children who did not receive vitamin A, caretakers of 4 children reported that the child had already received a dose, a caretaker of 1 child reported being afraid of side effects, another caretaker of 1 child reported that the queue was too long, and caretakers of 12 children reported other reasons.

All 354 under-5s were eligible to receive a bednet from the campaign. Of these, 79.6% (95% CI: 68.7–90.6%) received a bednet during the campaign (Figure 1). Of the 17 children who did not receive a bednet, caretakers of 11 children reported that the vaccination post was out of bednets at the time they went and caretakers of 6 children reported other reasons.

**Bednet and ITN possession in all households.** Before the campaign, half of all households (52.9%) (including households with and without under-5s) owned at least one bednet (Table 1). Bednet possession before the campaign was substantially lower in the poorest quintile (47.0%) compared with the least-poor quintile (78.7%) with an equity ratio of 0.60 (i.e., 0.470/0.787). Almost half of all surveyed households (45.0%) had received at least one bednet from the campaign. Bednet possession rose significantly from 52.9% to 69.3% as a result of the campaign. Post-campaign, the discrepancy in bednet possession between the poorest quintile (70.4%) compared with the least-poor quintile (82.0%) improved, with an equity ratio of 0.86. Bednet possession increased in all wealth quintiles as a result of the campaign (Figure 2a).

Household possession of at least one ITN increased significantly from 13.3% pre-campaign to 24.7% post-campaign (Table 1). As was seen with bednets, ITN equity ratio improved (from 0.30 to 0.48) and ITN possession increased in all wealth quintiles (Figure 3a).
Bednet and ITN possession in households with at least one under-5. Under-5s were the target population for the free distribution of bednets via the integrated child health campaign. Only the 53.1% of all surveyed households that had at least one under-5 were eligible to receive a bednet from the campaign. The findings below are for these 305 households.

Of these households, at least 81.0% (95% CI: 69.9–92.1%) received at least one campaign bednet; bednet possession increased significantly from 60.9% pre-campaign to 90.7% post-campaign (Table 2). The bednet possession equity ratio improved (from 0.59 to 0.90), and bednet possession increased in all wealth quintiles (Figure 2b). Among households with an under-5, ITN possession rose significantly from 16.5% pre-campaign to 37.3% post-campaign (Table 2). Similarly to bednet possession, ITN possession equity improved and possession increased in all wealth quintiles (Figure 3b).

Among the 276 households that had received at least one bednet from the campaign, nearly all [99.4% (95% CI: 98.9–100%)] had retained all campaign bednets by the time of the survey (≈ 3 months after the campaign). Of the five households...

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**Table 1**

Possession of bednets and insecticide-treated bednets by all households surveyed (N = 574), Lindi Region, Tanzania

<table>
<thead>
<tr>
<th></th>
<th>Pre-campaign % (95% CI)</th>
<th>Post-campaign % (95% CI)</th>
<th>P value*</th>
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</thead>
<tbody>
<tr>
<td><strong>Any bednet by group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All households</td>
<td>52.9 (42.7–63.2)</td>
<td>69.3 (61.9–76.8)</td>
<td>&lt; 0.001</td>
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<td>Poorest quintile households</td>
<td>47.0 (26.5–67.5)</td>
<td>70.4 (51.2–89.5)</td>
<td>0.004</td>
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<tr>
<td>Least-poor quintile households</td>
<td>78.7 (69.7–87.7)</td>
<td>82.0 (73.5–90.4)</td>
<td>0.1</td>
</tr>
<tr>
<td>Equity ratio</td>
<td>0.60</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td><strong>Insecticide-treated bednet by group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All households</td>
<td>13.3 (9.1–17.4)</td>
<td>24.7 (19.8–29.7)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Poorest quintile households</td>
<td>7.1 (2.6–11.7)</td>
<td>18.9 (10.8–27.0)</td>
<td>0.003</td>
</tr>
<tr>
<td>Least poor quintile households</td>
<td>23.4 (13.6–33.2)</td>
<td>39.3 (28.6–50.1)</td>
<td>0.005</td>
</tr>
<tr>
<td>Equity ratio</td>
<td>0.30</td>
<td>0.48</td>
<td></td>
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</tbody>
</table>

* Compares possession pre- versus post-campaign using the Wald chi-square test accounting for weighting and clustering of data.

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**Figure 2.** Household bednet possession pre- and post-campaign by wealth quintile among all households (a) and by households with a child under 5 years old (under-5) (b), Lindi Region, Tanzania. Because under-5s were the target population for the free distribution of bednets via the campaign, only households with an under-5 were eligible to receive a bednet from the campaign.

**Figure 3.** Household insecticide-treated bednet possession pre- and post-campaign by wealth quintile among all households (a) and by households with a child under 5 years old (under-5) (b), Lindi Region, Tanzania. Because under-5s were the target population for the free distribution of bednets via the campaign, only households with an under-5 were eligible to receive a bednet from the campaign.
holds that had not retained all campaign bednets, two reported losing the bednets, one reported having the bednet stolen, and two reported other reasons.

**Bednet and ITN use by under-5s.** Use of bednets and ITNs by under-5s was considerably lower than household possession. Among under-5s, almost half [46.3% (95% CI: 34.7–58.0%)] reportedly slept under any bednet the previous night, and only 21.5% (95% CI: 15.4–27.6%) used an ITN the previous night. Among under-5s, 35.9% (95% CI: 24.9–46.9%) used any bednet provided by the campaign the previous night, and 17.7% (95% CI: 11.3–24.2%) of under-5s used an ITN provided by the campaign the previous night. Thus, a large proportion of all bednets and ITNs actually used came from the campaign. Of 173 under-5s who reportedly did not use a bednet, the most common reasons were lack of mosquitoes (66.9%) and bednet not hanging (31.9%).

**Bednet and ITN use by pregnant women.** Of 50 pregnant women who slept in a surveyed household the previous night, 19.9% (95% CI: 7.0–32.8%) slept under any bednet, and 5.5% (95% CI: 0–11.3%) slept under an ITN. As with under-5s, most bednets and ITNs used were provided by the campaign.

**Characteristics of bednets.** Altogether 797 bednets were identified in the 574 households surveyed. Most bednets (87.9%) were visually inspected by the survey team. Only 25.6% of bednets were ITNs (Table 3). Few (5.1%) bednets were reportedly factory-treated with insecticide, but over half of all bednets (53.6%) were obtained bundled with insecticide. Although, 35.0% of all bednets were treated with insecticide, only 24.6% were treated with insecticide in the last 12 months. Of the 495 bednets not treated with insecticide, the most common reasons for not treating a bednet were not using the bednet at the time (36.1%), not having insecticide (34.8%), and not knowing to treat the bednet (8.4%). About half (45.4%) of all bednets were used the previous night. Of the 407 bednets not used the previous night, the most common reasons for not using a particular bednet were no mosquitoes at the time (53.4%), bednet not hanging (32.0%), and bednet damaged (5.8%). The most common source of bednets (42.8%) was the integrated campaign, and < 1% of bednets were obtained via the TNVS.

**DISCUSSION**

The integrated child health campaign successfully reached the population, with 96% of households aware of the campaign and 86% of under-5s attending the campaign. The campaign delivered key child health interventions (measles vaccine, mebendazole treatment, vitamin A, and a bednet) to ~ 80% of children in the target age groups, including a substantial number of children that had not received these interventions before the campaign. Although the campaign failed to meet the supplemental immunization activity target of > 90% for measles vaccination, it rapidly increased household bednet and ITN possession in both households with an under-5 and all households. Considering that the campaign took 6 months to plan and only 3 days to conduct, few bednet distribution strategies can increase household possession this rapidly.

Bednet distribution via mass vaccination campaigns targeting households with an under-5 is useful, but bednet distribution alone might not be sufficient to adequately increase population coverage. Prior studies have shown that increasing community levels of ITN use to > 50% is beneficial in producing a community effect of reduced mosquito vector populations and malaria transmission. We found that only 53% of all households had an under-5 and were thus eligible to receive a bednet from the campaign. Although under-5s are a key vulnerable group, other distribution strategies are needed to provide ITNs to adults and children to maximally increase community-wide ITN use and reduce malaria transmission and mortality (Killeen and others, manuscript in preparation).

Evidence from this evaluation and others show that free bednet distribution via integrated campaigns increases household bednet and ITN possession in all wealth quintiles and reduces the disparity in bednet and ITN possession between the poorest and least poor (increased equity ratio). Despite these improvements, household ITN possession re-

### Table 2

| Possession of bednets and insecticide-treated bednets among households with a child under 5 years old (under-5s) (N = 305), Lindi Region, Tanzania* |
|-------------------------------------------------|-----------------|-----------------|---------------|
|                                               | Pre-campaign % (95% CI) | Post-campaign % (95% CI) | P value†       |
| Any bednet by group                           |                       |                             |               |
| Eligible households                           | 60.9 (48.3–73.5)     | 90.7 (83.5–97.8)           | < 0.001       |
| Poorest quintile eligible households          | 50.6 (27.5–73.7)     | 83.3 (66.3–100)            | 0.006         |
| Least-poor quintile eligible households       | 86.3 (74.9–97.8)     | 92.8 (86.7–98.8)           | 0.1           |
| Equity ratio                                  | 0.59                | 0.90                       |               |
| Insecticide-treated bednets by group           |                       |                             |               |
| Eligible households                           | 16.5 (10.9–22.0)     | 37.3 (29.9–44.7)           | < 0.001       |
| Poorest quintile eligible households          | 9.4 (3.4–15.6)       | 26.1 (16.4–35.7)           | 0.004         |
| Least-poor quintile eligible households       | 30.5 (16.7–44.3)     | 59.8 (40.6–79.0)           | 0.006         |
| Equity ratio                                  | 0.31                | 0.44                       |               |

* Under-5s were the target population for the free distribution of bednets via the integrated child health campaign. Thus, only households with at least one under-5 were eligible to receive a bednet from the campaign.

† Compares possession pre- versus post-campaign using the Wald chi-square test accounting for weighting and clustering of data.

### Table 3

<table>
<thead>
<tr>
<th>Characteristics of all bednets (N = 797)</th>
<th>% (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticide-treated bednet</td>
<td>25.6 (20.7–30.4)</td>
</tr>
<tr>
<td>Factory-treated with insecticide</td>
<td>5.1 (2.2–8.1)</td>
</tr>
<tr>
<td>Bundled with insecticide</td>
<td>53.6 (47.0–60.2)</td>
</tr>
<tr>
<td>Treated with insecticide</td>
<td>35.0 (28.3–41.7)</td>
</tr>
<tr>
<td>Treated with insecticide in the last 12 months</td>
<td>24.6 (20.1–29.0)</td>
</tr>
<tr>
<td>Used the previous night</td>
<td>45.4 (36.3–54.5)</td>
</tr>
<tr>
<td>Obtained from campaign</td>
<td>42.8 (36.3–46.3)</td>
</tr>
<tr>
<td>Obtained via Tanzania National Voucher Scheme</td>
<td>0.8 (0.1–1.4)</td>
</tr>
</tbody>
</table>
mained significantly higher in least-poor households compared with the poorest households. A key reason for this disparity appears to be that poorer households were less likely to treat their bednets with insecticide (results not shown).

Moreover, our discussion of equity needs to address the methods used to assess socioeconomic status. As in other studies, we used a World Bank asset score to assess socioeconomic status. However, given the homogeneously poor economic status of the majority of the population of Lindi Region, economic stratification was difficult. Household possession or access to electricity, televisions, telephones, sofas, clothes cupboards, motorcycles, cars, and bank accounts was < 5%. The majority of those surveyed lived in rural areas in mud and thatch houses and primarily used traditional pit toilets and shared hand-dug wells. Given this relative homogeneity, an asset score might stratify households based on relatively minor characteristics and will reflect only relative differences in wealth among a universally impoverished and underserved community. With the current focus on assessing and understanding the equity of different distribution strategies, we should not lose sight of the overwhelming poverty of nearly all residents in Lindi Region.

Although household bednet and ITN possession were significantly increased by the integrated child health campaign, ITN possession was much lower than any bednet possession. Only about a quarter of bednets distributed were treated with insecticide 3 months after the campaign and converted into ITNs. This almost certainly diminished the campaign’s impact on malaria. Lack of bednet treatment could be related to seasonality. Prior work in Tanzania has shown that people often wait until the rainy season before treating a bednet with insecticide. Promotion of insecticide treatment is one way to increase the effectiveness of the campaign, but it will likely take great effort to achieve high treatment rates. Although LLITNs were not available in sufficient quantity for this campaign, future campaigns should distribute LLITNs to maximize household possession and use of ITNs. Campaigns that distributed LLITNs have had striking success in increasing possession and use of ITNs.

Additionally, use of bednets and ITNs was lower than expected, even following a successful child health campaign and even in households that had received a bednet. Only 46% of under-5s slept under a bednet and 22% slept under an ITN the previous night. Campaign bednets and campaign ITNs represented a large portion of all bednets used by under-5s, but overall use of ITNs was still well below the 2005 Roll Back Malaria target of 60%, and even further below the revised goal of > 80%. The campaign and our survey were conducted during low-transmission season, and lack of mosquitoes was the most common reason for not using a bednet. Use by under-5s has been shown to increase during high transmission season, and low the usage rates seen in this study might reflect seasonal variation. However, seasonality is insufficient to fully explain the gap between ITN possession and use. In other studies, even during the rainy, high malaria transmission season, possession has been noted to be higher than use. Future campaigns and other distribution strategies will need to increase educational and outreach efforts to improve ITN use. Unfortunately, very little has been published on the costs and effectiveness of different strategies to increase ITN use in settings with high levels of possession. Further research in this area is critical.

This study had several limitations. The cross-sectional design did not allow us to understand how bednet use and possession might vary over time. Moreover, we only ascertained reported treatment of bednets with insecticide and use by under-5s, and we had no means to confirm this self-reported data. In addition, we were unable to fully explore the reasons for not treating or using bednets. Lastly, our evaluation focused on the end results of the campaign—ITN possession and use—but provided little information about improving the overall process of the campaign itself. Analysis of the planning and conduct of campaigns might yield important lessons for improving future campaigns.

In conclusion, free bednet distribution via integrated child health campaigns is effective in rapidly and equitably increasing household possession and use of bednets. Given the low rates of treatment of bednets with insecticide, future campaigns should distribute LLITNs. Use of ITNs by under-5s remained low despite increased household possession, highlighting the need for further efforts to increase ITN use.

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