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Abstract. Mosquito net ownership is rising in sub-Saharan Africa but will substantially reduce malaria only if nets are used and the most vulnerable household members sleep under them. We used data from 9 large-scale household surveys conducted in 6 African countries from 2000 to 2004 that enumerated all household members and nets owned, analyzing only net-owning households. Across countries, women of reproductive age and children under 5 (without gender bias) were most likely to use the net; least likely were children of age 5–14 and adult males. Nets commonly covered 2–3 people. If a baby net was used, fewer people used the family net. Pregnant women were more likely to use a net in 2004 than in 2000. In several countries, a sizable minority of nets owned were not used. Understanding intra-household net-use patterns helps malaria control programs more effectively direct their efforts to increase their public health impact.

INTRODUCTION

In the past 5 years, there has been a tremendous increase in the number of households in Africa owning a mosquito net. Nets, particularly insecticide-treated nets (ITNs), have been promoted to protect those most susceptible to severe malaria: children under 5 and pregnant women. However, expanded ownership of mosquito nets will make a substantial reduction in malaria morbidity and mortality only if the nets are used and the most vulnerable household members are given priority for sleeping under them. But to what extent are nets that are owned actually used? If a household owns a net, which household members are most, and least, likely to sleep under it? How many family members sleep under a net, and what are the most common groupings under a net? What happens to these patterns when the family acquires more than 1 net? How does use of a baby net affect use of a household hanging net? The answers to these questions enable malaria prevention programs to plan or adjust their activities and communication strategies to maximize the public health impact of net ownership.

There is virtually no published data on these questions. It is important to distinguish between net ownership (possession of a net/ITN) and net use (actual use of nets owned). Most studies of “net use” actually report on net ownership. Of studies providing data on actual use, almost all report the percent of vulnerable groups sleeping under a net among all households sampled. The African Summit on Roll Back Malaria (RBM) held in Abuja, Nigeria, on April 25, 2000, set the target of having at least 60% of each vulnerable group sleep under an ITN. To monitor progress toward Abuja targets, RBM developed indicators using the number of under-5s or net use and the most vulnerable household members are given priority for sleeping under them. But to what extent are nets that are owned actually used? If a household owns a net, which household members are most, and least, likely to sleep under it? How many family members sleep under a net, and what are the most common groupings under a net? What happens to these patterns when the family acquires more than 1 net? How does use of a baby net affect use of a household hanging net? The answers to these questions enable malaria prevention programs to plan or adjust their activities and communication strategies to maximize the public health impact of net ownership.

Few studies look only among net-owning households and analyze if and by whom nets are used, which requires measuring use by family members besides under-5s or pregnant women to determine how use by vulnerable groups compares to that of other household members. A few studies do address some aspects of intra-household net use, with one in The Gambia concluding that vulnerable groups were more likely than other family members to use a net; another from The Gambia finding that, by a small margin, adults used nets more than children (but defined children as under 10 years of age) and girls were more likely than boys to use the net; and another from Burkina Faso finding that adult men were most likely to use the net (though the sample size was small at 103 households, all from 1 province). A study based on secondary analyses of the Demographic and Health Survey in Uganda concluded that young children were sleeping under a net only because their mothers were using the net. Several other studies focusing on who uses the household net were intervention studies where nets were given free to those living in a research area in Kenya or to pregnant women attending antenatal clinics in Kenya, or where nets were acquired via vouchers distributed to pregnant women in Tanzania. The first found that adults were slightly more likely than young children to be using the net; and the last 2 found that nets were being used by the groups targeted by the intervention: pregnant women and infants. Because these are intervention sites, however, we do not know whether these findings apply to the general population.

None of the studies indicates whether the data were collected during the rainy or dry season, although the Demographic and Health Surveys usually collect data during the dry season to avoid the logistical problems of collecting data during the rainy season. Net use is subject to seasonal variation and it is important to know the context of the findings.

Several characteristics of the present study distinguish it from other studies on net use:

1. It addresses actual use of nets within the household, rather than net ownership.
2. Analyses are based only on net-owning households so that net-use rates by household members are not affected by net ownership rates.
3. It uses large-scale and standardized survey data across multiple countries.

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4. For 3 of the countries, it has 2 data points that permit conclusions about changes over time.
5. In all but 1 country, the data were collected during the rainy season.
6. Data sets include all household members and all nets in net-owning households to permit analysis of the percent of nets, being used, comparison of use rates among various family members, the average number of people under a net, what the sleeping group patterns are, whether there is gender bias in childhood net use, the effect on coverage of owning more than 1 net, the effect of baby net ownership on the use of hanging nets, and whether there have been changes since 2000.

MATERIALS AND METHODS

The data for these analyses come from NetMark, a project of the Academy for Educational Development (AED) funded by the United States Agency for International Development. The aim of NetMark is to prevent malaria by increasing use of ITNs in sub-Saharan Africa by developing a sustainable commercial market while simultaneously ensuring that vulnerable groups have access to affordable ITNs. As part of monitoring and evaluation, NetMark collects household, retail, and market data on ITN-related topics in the countries in which it works.

NetMark conducted household surveys in Nigeria, Senegal, and Zambia in 2000 and again in 2004. In addition, NetMark conducted a survey in Mali in 2003 and in Ghana and Ethiopia in 2004. This paper compares results among the 6 countries surveyed in 2003/2004 and reports on changes over time in the 3 countries where both 2000 and 2004 data were collected.

The survey used population-based, multistage sampling. In each country, the sample was drawn from and divided equally among 5 primary sites, listed in Table 1. A site consists of an urban center along with surrounding rural areas, up to 200 km from the urban center. The sites were located in malarious areas and were purposively selected to reflect the geo-ethnic diversity of the country. The capital or main commercial city was included as a site in each country except in Ethiopia, because Addis Ababa is located at too high an altitude for malaria to be a significant problem.

Each site was stratified by urban or rural residence, with 40% of the sample selected from the city and 60% from surrounding rural areas. The 40:60 ratio approximates the urban–rural distribution in the countries surveyed. In each site, 20–40 sampling points were randomly selected using a sampling frame of census or other available lists, depending on the country. At the final stage, 10 households were selected in each sampling point.

Respondents were women of reproductive age (15–49) who were mothers or guardians of children under 5 years of age. Each potential respondent was read an informed consent statement that included the purpose of the project, the benefit to the community, the approximate amount of time it would take, and an assurance of confidentiality. The respondent was asked if she would like to participate, and if she responded affirmatively, the interviewer signed a statement saying the informed consent had been read and that the respondent agreed to participate.

In Nigeria, Senegal, and Zambia there were 2 rounds of data collection that were structured to enable a valid measure of change over time in the sites sampled. The same sites and the same sampling procedures within sites were used for all survey administrations, but the number of clusters was doubled in 2004 to permit more robust analyses. In each country, the fieldwork was conducted at the same time of year for each data collection round to control for seasonal variation. In all countries except Zambia, the data were collected during the rainy season. (All baseline data had to be collected before program start-up, which was just before the rainy season in Zambia.) The same basic instrument was used across countries and data collection waves.

The survey asked each respondent whether her household owned any hanging nets used for sleeping and, if so, how many. Information such as treatment status, size, shape, and brand was collected for up to 4 nets per household. Each respondent was also asked whether the household owned any baby nets. A baby net was defined as a small, umbrella-like net with a built-in frame.

The questionnaire enumerated household members and recorded the age and gender of each, as well as the pregnancy status of women of reproductive age. A household was defined as the interviewee, the children she is responsible for, her spouse, and any other dependents, such as parents, siblings, etc. This excludes co-wives and their children, although it may include other women of reproductive age, such as a sister living in the household. Table 1 shows, for each country, the number of households sampled and the resultant number of household members and nets, which constitute the denominators for the analyses here. The large increase in the number of people in net-owning households between 2000 and 2004 is due not only to the increased number of households sampled but also to increases in the percent of households owning a net.

The questionnaire section on household members and net use was organized into a grid of nets and family members, providing the means to indicate which family members, if any, slept under each net owned “last night.” This allowed us to identify nets that had not been used the prior night. In the

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Number of households, people, and nets in the sample: 2000 and 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country and sites (site = 40% urban + 60% rural)</td>
<td>No. of households sampled</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Nigeria: Lagos, Ibadan, Kano, Maiduguri, Nunuk</td>
<td>1000</td>
</tr>
<tr>
<td>Senegal: Dakar, Thies, St. Louis, Kaolack, Tambacounda</td>
<td>1000</td>
</tr>
<tr>
<td>Zambia: Lusaka, Choma, Kaoma, Kitwe Mansa</td>
<td>1000</td>
</tr>
<tr>
<td>Ghana: Accra, Keta, Kumasi, Wa, Tamale</td>
<td>(No survey)</td>
</tr>
<tr>
<td>Ethiopia: Bahir Dar, Nazreth, Dire Dawa, Dessie, Awassa</td>
<td>(No survey)</td>
</tr>
<tr>
<td>Mali: Bamako, Kayes, Segou, Mopti</td>
<td>(No survey)</td>
</tr>
</tbody>
</table>

* In 2003.
main data file, the unit of analysis was the household. The
data were organized and coded in such a way as to permit
generation of another data file with each family member as
the unit of analysis as well as a third data file with each net as
the unit of analysis.

Although this means of gathering data is more time con-
suming and complex than asking only about the youngest
child and pregnant woman or only asking “who slept under
the net,” the systematic enumeration of household members
and individual nets is likely to yield more accurate data about
who slept under the net(s) and allows comparison of use by
vulnerable groups with use by those less vulnerable. When
only use by vulnerable groups is reported, there is no way of
knowing if this is higher or lower than use by other household
members. The application of an identical methodology for all
surveys provides an opportunity to produce reliable and valid
comparisons among the 6 countries and, for 3 of them,
changes that have taken place between 2000 and 2004.

RESULTS

Percent of nets used the prior night. The net data file was
used to calculate the proportion of nets that were used—i.e.,
had someone sleeping under them—the night before. All
mosquito nets (but not baby nets) owned were included, re-
gardless of whether they were treated. Figure 1 shows the
percent of nets used the prior night for each country and data
collection wave.

In Senegal, nearly all nets (> 90%) had been used the prior
night. The percent of nets used was lower in the other 5
countries, ranging from 78% in Mali and Ghana to a low of
56% in Nigeria. In Zambia, 62% of nets were used, but it
should be recalled that (only in Zambia) the data were col-
clected in the dry season, when a net is less likely to be used.

Between 2000 and 2004, the percent of nets used the prior
night stayed about the same in Senegal and Zambia but de-
clined considerably in Nigeria: from 91% to 56%. Because, in
each country, the data were collected at the same time of year
in both 2000 and 2004, seasonal variation would not explain
Nigeria’s substantial drop in the percent of nets used.

Number of months per year nets were used. Another mea-
sure of net use is consistency of use during the year. Most
families do not use their nets year-round because of seasonal
variation in mosquito density and malaria frequency. How-
ever, nets should be used year-round because there can be
substantial risk of transmission even when there is low vector
density.9,10

Respondents were asked how many months per year the
family slept under the nets they owned. In 2004, Ethiopia and
Nigeria reported using nets for the shortest amount of time
during the year (5.8 and 5.9 months, respectively), and Zamb,
Ghana, and Mali the longest (7.1, 7.2, and 7.6, respec-
tively). Since 2000, there was an increase in the mean number
of months nets were used in Senegal from 5.6 to 6.3 months
(\(P = 0.002\)) and Zambia from 6.4 to 7.1 months (\(P = 0.009\)).
However, in Nigeria the number of months of net use
decided considerably, from 7.6 to 5.9 months of the year
(\(P = 0.000\)).

Number of people sleeping under 1 net. Each household
net that was used protected on average just over 2 people (see
Table 2). In 2004, the average number of people sleeping
under a net ranged from a low of 2.03 in Nigeria to a high of
2.37 in Mali. In Senegal and Zambia, the average number
of people sleeping under a net was about the same in both 2000
and 2004, but in Nigeria, the average number of people under
a net increased from 1.83 to 2.03 (\(P = 0.013\)). Across coun-
tries, rural households were somewhat more likely than urban
ones to have a third person under the net.

When a household owned only 1 net, more people slept
under that 1 net than slept under 1 net in a multiple-net
household. With the exception of Senegal, the net in a 1-net
household was much more likely to have a third or even
a fourth person under it than a net in a multiple-net house-
hold.

Some nets owned were single size, some double, and some
triple/king. The number of people under a net increased with
the size of the net. Ethiopia deviates from the pattern slightly
in that the average number of people under a single and
double net is about the same.

Percent of household members sleeping under a net. The
percent of household members sleeping under a net ranged
from 32% in Nigeria to 54% in Mali (see Figure 2). The
percent under a net in Zambia was also rather low (34% in
2000 and 38% in 2004), but Zambia was the only country

\[
\text{Figure 1. Percent of nets used the prior night.}
\]
Table 2

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1.83</td>
<td>2.03</td>
<td>2.12</td>
<td>2.20</td>
<td>2.21</td>
<td>2.19</td>
<td>2.29</td>
<td>2.32</td>
<td>2.37</td>
</tr>
<tr>
<td>Urban</td>
<td>1.74</td>
<td>1.86</td>
<td>2.10</td>
<td>2.16</td>
<td>2.18</td>
<td>2.14</td>
<td>2.15</td>
<td>2.23</td>
<td>2.24</td>
</tr>
<tr>
<td>Rural</td>
<td>1.89</td>
<td>2.11</td>
<td>2.13</td>
<td>2.23</td>
<td>2.28</td>
<td>2.30</td>
<td>2.44</td>
<td>2.52</td>
<td>2.50</td>
</tr>
<tr>
<td>Households owning 1 net</td>
<td>1.89</td>
<td>2.29</td>
<td>2.09</td>
<td>2.43</td>
<td>2.40</td>
<td>2.47</td>
<td>2.51</td>
<td>2.59</td>
<td>2.72</td>
</tr>
<tr>
<td>Households owning multiple nets</td>
<td>1.74</td>
<td>1.90</td>
<td>2.13</td>
<td>2.16</td>
<td>2.05</td>
<td>2.06</td>
<td>2.06</td>
<td>2.06</td>
<td>2.21</td>
</tr>
<tr>
<td>Single net</td>
<td>1.60</td>
<td>1.67</td>
<td>1.38</td>
<td>1.57</td>
<td>1.95</td>
<td>2.00</td>
<td>1.90</td>
<td>2.37</td>
<td>1.61</td>
</tr>
<tr>
<td>Double net</td>
<td>2.11</td>
<td>2.01</td>
<td>1.89</td>
<td>2.07</td>
<td>2.28</td>
<td>2.23</td>
<td>2.32</td>
<td>2.10</td>
<td>2.16</td>
</tr>
<tr>
<td>Triple/king net</td>
<td>2.39</td>
<td>2.38</td>
<td>2.44</td>
<td>2.39</td>
<td>2.57</td>
<td>2.35</td>
<td>3.04</td>
<td>2.56</td>
<td>2.82</td>
</tr>
</tbody>
</table>

* Unused nets were excluded when calculating the mean.

Figure 2. Percent of household members in net-owning households who slept under a net the prior night.
where the data were collected during the dry season, and rainy season data would show a higher use rate. The 32% for Nigeria is from 2004 and represents an unexplained drop from 2000, when 45% of family members slept under a net. Ethiopia is also rather low at 39%.

To find out who in the household was using the net, we classified each member into age-gender categories and calculated the percent of various categories sleeping under a net the night prior to the survey. For children under 5, we looked at the category as a whole, as well as the yearly cohorts within the category. We used the following classifications:

Children under 5
- 0-year olds (0–11 months)
- 1-year olds (12–23 months)
- 2-year olds (24–35 months)
- 3-year olds (36–47 months)
- 4-year olds (48–59 months)

Children 5–14
- Nonpregnant women of reproductive age (15–49)
- Pregnant women of reproductive age (15–49)
- Adult males 15+

Looking across countries in 2004, rather consistent and positive patterns emerged, as depicted in Figure 2. Generally, children under 5 as well as pregnant women—the two most vulnerable groups—were most likely to be under the net. The possible exception was Ethiopia, where a smaller percentage of pregnant than nonpregnant women of reproductive age slept under a net, although the difference was not statistically significant. In all countries, children under 2 were more likely than any other family member to be under a net (see Figure 3).

There was no evidence of gender bias in childhood net use; in all 6 countries, male and female under-5s were equally likely to be placed under the net. A typical case is Ghana,
where 68.8% of female and 67.4% of male children under 5 in net-owning households slept under a net. In all countries, the $P$ value for gender differences among under-5s was greater than 0.05. In all countries, the 2 groups least likely to sleep under a net were children aged 5–14 and adult males. Adult males were much less likely to sleep under a net than adult females (both pregnant and nonpregnant), although the difference is least pronounced in Ethiopia.

In the 2000 baseline in Zambia, pregnant women were least likely to be under the net; but in 2004 the situation greatly improved. The proportion of pregnant women under a net in Zambia increased from 17.6% in 2000 to 50.5% in 2004.

Nigeria presents a mixed picture. Although children under 5 and pregnant women are most likely to be using the household net, the percent of these groups under a net in net-owning households decreased between 2000 and 2004 due to the large increase in unused nets.

**Sleeping groups.** In all countries, the most common sleeping group by far was a woman of reproductive age and a child under 5 together under 1 net, often along with another child or the spouse (see Table 3). This pattern characterized both urban and rural households. The likelihood of various other family members sleeping under a household net depended principally on the number of nets the household owned. We ran analyses of the percent of various family member groupings under the net for households owning only 1 net and for households owning multiple nets. We also ran analyses looking at sleeping groups under a hanging net when the youngest slept under a baby net. Note that in these analyses, the figures represent the percent of *nets* rather than the percent of people.

In all countries except Senegal, at least 95% of nets in 1-net households had a woman of reproductive age and/or a child under 5 under the net—and most often it was both. In Senegal, the figure was 82%, as 18% of Senegalese households with only 1 net gave it to someone else, usually an older woman (50 or over) and/or an older man. In 1-net households, an older child aged 5–14 or the spouse was under the net along with the mother and young child for 36% of nets in Nigeria, 39% in Ghana, 45% in Senegal, 51% in Zambia, 61% in Ethiopia, and 38% in Mali.

When the family owned *more than 1 net*, others besides the mother and young child were more likely to be protected by

![Figure 3. Percent of under-5s in net-owning households who slept under a net the prior night, by yearly cohort.](image)

<table>
<thead>
<tr>
<th>Family members under one (hanging) net together</th>
<th>Nigeria</th>
<th>Senegal</th>
<th>Zambia</th>
<th>Ghana</th>
<th>Ethiopia</th>
<th>Mali</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 net in HH</td>
<td>&gt;1 net in HH</td>
<td>&gt;1 net in HH</td>
<td>&gt;1 net in HH</td>
<td>&gt;1 net in HH</td>
<td>&gt;1 net in HH</td>
<td>&gt;1 net in HH</td>
</tr>
<tr>
<td>Child(ren) under 5 and WRA (others possible)</td>
<td>66.9</td>
<td>28.3</td>
<td>65.4</td>
<td>35.1</td>
<td>76.6</td>
<td>35.3</td>
</tr>
<tr>
<td>Child(ren) under 5 with man and woman</td>
<td>23.9</td>
<td>2.5</td>
<td>20.0</td>
<td>8.2</td>
<td>41.3</td>
<td>12.8</td>
</tr>
<tr>
<td>Child(ren) under 5 only</td>
<td>3.1</td>
<td>4.1</td>
<td>6.6</td>
<td>4.0</td>
<td>2.4</td>
<td>2.7</td>
</tr>
<tr>
<td>Older child(ren) 5-14 only</td>
<td>.6</td>
<td>12.7</td>
<td>1.1</td>
<td>10.3</td>
<td>.3</td>
<td>15.5</td>
</tr>
<tr>
<td>Child(ren) up to age 14 only</td>
<td>5.5</td>
<td>26.3</td>
<td>6.3</td>
<td>18.5</td>
<td>9.7</td>
<td>25.5</td>
</tr>
<tr>
<td>WRA and man 15+ only</td>
<td>5.5</td>
<td>5.1</td>
<td>3.4</td>
<td>5.0</td>
<td>5.9</td>
<td>9.0</td>
</tr>
<tr>
<td>WRA only</td>
<td>16.6</td>
<td>12.1</td>
<td>5.7</td>
<td>7.8</td>
<td>4.4</td>
<td>8.0</td>
</tr>
<tr>
<td>Male(s) 15+ only</td>
<td>2.5</td>
<td>16.5</td>
<td>8.0</td>
<td>11.6</td>
<td>.9</td>
<td>6.0</td>
</tr>
<tr>
<td>Person(s) 50 or older (others possible)</td>
<td>7.4</td>
<td>7.6</td>
<td>22.9</td>
<td>19.2</td>
<td>8.8</td>
<td>8.3</td>
</tr>
<tr>
<td>No child under 5 or WRA under net</td>
<td>3.7</td>
<td>34.0</td>
<td>17.7</td>
<td>33.0</td>
<td>2.5</td>
<td>27.0</td>
</tr>
<tr>
<td>N (nets)</td>
<td>163</td>
<td>315</td>
<td>350</td>
<td>1999</td>
<td>320</td>
<td>748</td>
</tr>
</tbody>
</table>

Table 3: Sleeping groups under one net, in one-net and multiple-net households
TABLE 4
Mean number of each type of family member under the household net, when baby net is and is not used, in Nigeria and Ghana

<table>
<thead>
<tr>
<th>Family member under a hanging net (groups not mutually exclusive)</th>
<th>Baby net used</th>
<th>Baby net not used</th>
<th>Baby net used</th>
<th>Baby net not used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total mean number of people under family net</td>
<td>1.65</td>
<td>2.12</td>
<td>2.04</td>
<td>2.31</td>
</tr>
<tr>
<td>Number of children under 5 under net</td>
<td>0.30</td>
<td>0.75</td>
<td>0.40</td>
<td>0.84</td>
</tr>
<tr>
<td>Number of children 5–14 under net</td>
<td>0.37</td>
<td>0.40</td>
<td>0.44</td>
<td>0.41</td>
</tr>
<tr>
<td>Number of WRA under net</td>
<td>0.62</td>
<td>0.65</td>
<td>0.72</td>
<td>0.78</td>
</tr>
<tr>
<td>Number men 15+ under net</td>
<td>0.34</td>
<td>0.31</td>
<td>0.40</td>
<td>0.24</td>
</tr>
<tr>
<td>Number of people 50+</td>
<td>0.08</td>
<td>0.05</td>
<td>0.10</td>
<td>0.08</td>
</tr>
<tr>
<td>N</td>
<td>93</td>
<td>385</td>
<td>25</td>
<td>600</td>
</tr>
</tbody>
</table>

When the infant slept under a baby net, the average number of people sleeping under the family net decreased: from 2.12 to 1.65 in Nigeria, and from 2.31 and 2.04 in Ghana (see Table 4). This means that another family member was less likely to “substitute” for the infant under the family net in Nigeria than in Ghana. In Ghana, an adult male was much more likely to join the mother under the net when the infant slept under a separate baby net. When a baby net was used, there was no change in the number of older children under the family net in either Nigeria or Ghana. Few older adults used nets in Nigeria or Ghana, regardless of whether a baby net was used for the family infant.

DISCUSSION AND CONCLUSIONS

The use of standardized sampling procedures and indicators across countries and across time presents a unique opportunity to generate a valid and reliable comparison of intrahousehold net-use patterns among countries and over time. The findings document consistent and generally positive practices in all 6 countries surveyed. Most important, when nets were used, families gave priority to children under 5 and women of reproductive age.

Within the age segment “children under 5,” the younger the child, the more likely he or she was to sleep under a net. Those under 2 years had the highest net-use rates of any family member—a positive finding because younger under-5s are more vulnerable to malaria than older under-5s. It is also good that young boys and girls in the African countries surveyed are equally likely to be protected by a net. This may not be the case in other regions of the world.

Within the segment “women of reproductive age,” those who were pregnant were more likely to be under a net than those who were not (with the possible exception of Ethiopia, although the small number of net-owning households with a pregnant woman prohibits definitive conclusions). It is especially encouraging that pregnant women were much more likely to use a net in 2004 than they were in 2000, suggesting that ITN programs have been successful in educating people about the susceptibility of pregnant women to severe malaria and in allaying fears about the insecticide. Analysis of other variables in the AED/NetMark data sets shows that in 2000, a much greater proportion of women expressed fears about the safety of the insecticide than in 2004. Zambia made particularly impressive strides in this regard: in 2000, 27.3% of a pregnant woman prohibited definitive conclusions). It is especially encouraging that pregnant women were much more likely to use a net in 2004 than they were in 2000, suggesting that ITN programs have been successful in educating people about the susceptibility of pregnant women to severe malaria and in allaying fears about the insecticide. Analysis of other variables in the AED/NetMark data sets shows that in 2000, a much greater proportion of women expressed fears about the safety of the insecticide than in 2004. Zambia made particularly impressive strides in this regard: in 2000, 27.3% of respondents (all women of reproductive age) said that the chemical on the net could be dangerous to the fetus or pregnant woman; in 2004 only 6.5% said this. The priority given to pregnant women conforms to public health recommendations, as pregnant women are more vulnerable to malaria than nonpregnant women.

Although it is pregnant women specifically rather than women of reproductive age generally who are most at risk of severe malaria, it is nonetheless extremely desirable to have all women of reproductive age sleep under treated nets nightly. Because a woman may not know exactly when her pregnancy begins, or may not wish to make her pregnancy public for several months or more, nightly ITN use ensures that she will be protected from the beginning of her pregnancy. Furthermore, a woman may be especially vulnerable to malaria for 2 months post-partum and need the protec-
tion an ITN affords even after her pregnancy ends. Thus, high net use rates among women of reproductive age constitute another positive finding.

The consistency of net-use patterns across the 6 African countries surveyed lends strong credence to the results and is highly encouraging.

These findings run counter to a popular belief that the man of the house often takes the net for his own use.\textsuperscript{13,14} It is possible that in other countries not surveyed, or in particular localized areas, adult men are most likely to use the net; however, in the countries studied here, it is clear that men are actually least likely to be using the family net. Nor do the data here support the idea that the young child is put under the net principally because the mother is sleeping there.\textsuperscript{5} In all countries, children under 5 were as likely as or more likely than a woman of reproductive age to be sleeping under a net.

Ideally, there would be a sufficient number of nets to cover all family members, although the data suggest that as additional nets are owned, fewer people sleep under 1 net. Given limited nets, it is good to know that most nets are being used to directly protect 2–3 people. If the nets are treated, they will be indirectly protecting additional family members not under the net by repelling mosquitoes away from the general vicinity of the net. Therefore, families that use nets, especially ITNs, are gaining protection for multiple household members.

The data also point to practices that need to be changed to maximize the public health impact of expanded net coverage. Although the aggregated national data used here show that the most vulnerable family members are given priority for net use, subanalyses by site show that this is not the case in all areas of each country. For example, in the Maiduguri site in Nigeria, few pregnant women slept under a net. Other analyses on the AED/NetMark data show that Maiduguri respondents had high levels of fear about the insecticide for pregnant women. Work will be needed in targeted parts of some countries to assuage fears and encourage pregnant women to use treated nets.

The baby net analyses appear to have several implications. When a baby net is used, fewer people use the household hanging net. Baby nets separate mothers and infants who would normally sleep together. The separation can have detrimental effects, such as limiting breastfeeding and preventing the regulation of infant body temperature via skin-to-skin contact. Baby nets have not been tested for effectiveness against malaria, and they are rarely treated. The money a family spends on a baby net could be better used for a larger hanging net that would serve the child for a longer period than infancy, allow other family members to sleep under it, and be treated. In countries where baby nets are popular, notably Nigeria and Ghana, malaria control committees may want to consider whether to discourage use of baby nets at least for use at night.

Perhaps the most important net-use issue that needs to be addressed by ITN programs is that of nets that go unused. When nets go unused, the impact of increased net coverage is diminished. Other studies also found that use can be lower than ownership, even in areas where nets were given free and there were intensive efforts to get people to sleep under them.\textsuperscript{15,16} We need a better understanding of why some households do not use their nets even during the rainy season when there are many mosquitoes. The finding of a sizable proportion of unused nets in some countries was unexpected, and we are conducting separate analyses exploring factors related to use and non-use of nets that are owned. Preliminary bivariate analyses show that treated nets were used more than untreated nets; newer nets were used more than older ones; and nets that were paid for were used more than free nets. NetMark qualitative research as well as other variables in the data indicate that some people find nets to be hot, difficult to hang or ill-suited to the sleeping place, or believe themselves protected by other means such as coils or aerosols. Among the 6 countries included in this study, these perceptions as well as the proportion of unused nets was most marked in Nigeria. ITN programs are likely to find even rapid qualitative research helpful in identifying and overcoming the net-use barriers specific to the populations they serve.

These findings point to the overall conclusion that ITN programs can focus on increasing access to and ownership of hanging, treated nets; on getting people to use them, and on encouraging year-round use. Families are already giving priority to their most vulnerable members, so this practice needs only periodic reinforcement rather than major emphasis in an ITN program strategy.

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