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Sleeping arrangements under long-lasting impregnated mosquito nets: differences during low and high malaria transmission seasons

S.D. Fernando^{a,*}, R.R. Abeyasinghe^b, G.N.L. Galappaththy^b,
N. Gunawardena^c, A.C.R. Ranasinghe^a, L.C. Rajapaksa^c

^a Department of Parasitology, Faculty of Medicine, P.O. Box 271, Kynsey Road, Colombo 8, Sri Lanka

^b Anti Malaria Campaign, 555/5 Elvitigala Mawatha, Colombo 5, Sri Lanka

^c Department of Community Medicine, Faculty of Medicine, P.O. Box 271, Kynsey Road, Colombo 8, Sri Lanka

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Summary Sleeping arrangements under long-lasting impregnated nets (LLIN) were recorded in 2467 households during the low malaria transmission season (May–June 2007) and the same families were followed up during the high malaria transmission season (December 2007–January 2008) in two malaria-endemic areas of Sri Lanka. Approximately 800 households each from the three main ethnic groups were studied. The number of families lost to follow-up was 68. A significant increase was seen in the proportion of households using LLINs the previous night during the high transmission season (96%) compared with the low transmission season (90%) ($P \leq 0.001$ for all three ethnic groups). When sleeping arrangements of the entire population were considered, priority to sleep under the LLIN was given to children under 5 years during both seasons. The percentage of children under five who slept under a LLIN increased from 75% during the low transmission season to 90% during the high transmission season. Utilisation of LLINs by pregnant women was low; only approximately 45% of pregnant women reported sleeping under a LLIN during both seasons. The study suggests the possible need for re-focusing of health education messages regarding the importance of LLIN use among pregnant women.
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1. Introduction

Malaria has been endemic in Sri Lanka for several centuries. Although only 196 cases of malaria were diagnosed in a population of 20.9 million in 2007 (Anti Malaria Campaign, personal communication), malaria remains a public health problem in Sri Lanka. Globally, the most vulnerable

* Corresponding author. Tel.: +94 11 269 5300x179;
fax: +94 11 269 9284.

E-mail address: deepfern@slt.lk (S.D. Fernando).

populations exposed to malaria have been identified as children and pregnant women.^{1–4} Owing to the prevailing low transmission of malaria in Sri Lanka during the past several years, immune levels in the population have decreased, rendering nearly the entire population vulnerable. One of the primary objectives of the Roll Back Malaria (RBM) movement launched in 1998 was to increase insecticide-treated net (ITN) use, specifically long-lasting insecticidal net (LLIN) coverage among these two vulnerable groups to >60%.¹ RBM has recently revisited this ITN objective to reach 80% coverage of young children and pregnant women by 2010 and 80% usage of nets the previous night.² Individual protection of target groups is a priority, but studies have shown that if ITNs are used by a majority of the target population it provides protection for all people in the community, including those who do not themselves sleep under them.^{5,6} A recent study has shown that relatively modest coverage (approximately 60%) of all adults and children can achieve equitable community-wide benefits.⁷

In keeping with the WHO guidelines, approximately 300 000 LLINs (Olyset; Sumitomo Chemical Co. Ltd., Japan) were purchased by a non-governmental organisation in Sri Lanka (Sarvodaya Shramadana Movement) on a request from the National Anti Malaria Campaign, using finances received from the Global Fund to fight Aids, Tuberculosis and Malaria (GFATM), and were distributed to malaria-endemic areas free of charge during the years 2005–2007.

Despite evidence demonstrating that the use of chemically impregnated nets decreases malaria-related morbidity and mortality, there have been many challenges to ITN distribution, acceptance, and consistent and appropriate use in implementing large-scale ITN programmes.^{8,9} Knowledge regarding LLINs, their proper use and maintenance practices were found to be poor in a sample of the population to which LLINs were distributed in Sri Lanka.¹⁰ As a further extension to this study, the actual use of LLINs the previous night, especially by pregnant women and children under 5 years, is reported here.

2. Materials and methods

2.1. Study design

A community-based cross-sectional survey of Grama Niladari (GN) divisions, the smallest administrative unit in the country, where LLINs had been previously distributed was carried out in the Northern and North Central Provinces of Sri Lanka.

Details of sample size calculation and sampling procedures used in the selection of households have been reported in a previous study.¹⁰

2.2. Data collection

Data collection was carried out at two time points. The first survey was carried out in May–June 2007, which is the low malaria transmission season (dry season in the malaria-endemic zone), where 2467 households distributed among the three major ethnic groups were visited. The second survey was carried out in December 2007–January 2008 during the Northeast Monsoons, which is the high transmission season. During this survey, 2399 (97%) of the previously visited households were available for follow-up.

During both surveys, the reported use of a LLIN the previous night was documented by visiting the house in the early morning (between 06:00 h and 09:00 h). If the household had not used the LLIN, the reason for non-use was recorded.

The questionnaires were designed in English and translated and back-translated independently to Tamil and Sinhalese. Data collectors were fluent in Sinhala or Tamil, and some in both languages.

Training of interviewers regarding identification of LLINs was carried out in a GN division not included in the study sample. Data were collected in Sinhalese in the Sinhalese households and in either Tamil or Sinhalese from Muslim households (depending on the language they preferred). Data collection was in Tamil from the Tamil households.

The mother, or in the absence of the mother an adult 'mother figure' in the family, or in the absence of either the chief householder, was interviewed after informed consent was obtained. Verbal informed consent was obtained from all individuals enrolled in the study after explaining the purpose of the study.

2.3. Data analysis

Data were entered into an SPSS version 15 database (SPSS Inc., Chicago, IL, USA) and analysed using Epi Info (CDC, Atlanta, GA, USA) and SPSS software packages. Sleeping habits were described using frequency distributions with special emphasis on children under 5 years of age and pregnant women. LLIN use was compared using paired data during the two seasons. The main unit of analysis was a household; however, individual analysis was also carried out for children under five and pregnant women separately.

3. Results

3.1. Characteristics of the study population

The first phase of the study included 2467 households (794 Sinhalese, 833 Tamil and 840 Muslim) (Table 1). Information could not be collected during the high transmission season from 68 households (24 Sinhalese, 36 Tamil and 8 Muslim), giving a non-response rate of 2.76%. The change in the distribution of the number of households in each ethnic group between the two seasons was not significant ($P=0.882$). The majority of respondents during both surveys were females (80%). During the first phase of the study, 1473 (13.4%) under fives and 46 (0.4%) pregnant women from a total population of 10 957 individuals were identified in the households studied. This number had reduced to 1174 (11.9%) children under five and 29 (0.3%) pregnant women (from a total population of 9853 individuals) during the second phase.

3.2. Information regarding nets available in the household

During both surveys, nets available (including normal or insecticide-treated nets) in the household were physically checked by the interviewer and the type of net(s) possessed by the household was recorded. Over 90% of the population possessed at least one mosquito net in their household (Table 1). The proportion of households with a mosquito net

Table 1 Information regarding nets available and net use in the household by ethnic group

	Low transmission season	High transmission season	P-value
No. of households with a mosquito net			
Sinhalese	785 (98.9)	755 (98.1)	0.908
Tamil	753 (90.4)	785 (98.5)	0.227
Muslim	802 (95.5)	826 (99.3)	0.574
Mean no. of available nets in household			
Sinhalese	2.4	2.4	
Tamil	1.2	1.9	
Muslim	1.4	2.1	
Presence of LLINs in household			
Sinhalese	754 (95.0)	730 (94.8)	1.000
Tamil	725 (87.0)	689 (86.4)	0.684
Muslim	749 (89.2)	745 (89.5)	1.000
No. of households where LLINs are hung all the time ^a			
Sinhalese	587 (77.9)	607 (83.2)	0.035
Tamil	94 (13.0)	152 (22.1)	<0.001
Muslim	239 (31.9)	291 (39.1)	0.003
No. of households that used the LLIN the previous night ^a			
Sinhalese	708 (93.9)	715 (97.9)	<0.001
Tamil	615 (84.8)	645 (93.6)	<0.001
Muslim	679 (90.7)	709 (95.2)	0.001

LLIN: long-lasting impregnated net.

^a Only households with LLINs included in the analysis.

increased both in Tamil and Muslim households during the high transmission season, although these changes were not statistically significant. This is reflected in the increase in the mean number of nets per resident in these two ethnic groups (1.2 vs. 1.9 in Tamils and 1.4 vs. 2.1 in Muslims) (Table 1).

3.3. Information regarding availability of long-lasting impregnated nets

The number of LLINs available in the household during each survey was recorded. LLIN distribution in the three population groups had taken place at different time intervals, with most being distributed over a year prior to the first survey being carried out (Table 1).

Paired comparisons were made with respect to the presence of LLINs in the households, whether LLINs were hung all the time, and LLIN use the previous night (Table 1). The results demonstrate that no significant difference was observed in the number of LLINs available in the households during the two seasons, as seen by a paired sample test ($P=1.000$, 0.684 and 1.000 for Sinhalese, Tamils and Muslims, respectively). A significantly higher percentage of households in each ethnic group had their LLINs hung all the time during the high transmission season compared with the low transmission season ($P=0.035$, <0.001 and 0.003 for Sinhalese, Tamils and Muslims, respectively). In all households, the LLIN was used inside the house either above mats or beds. A significant increase was seen in the households that had used LLINs the previous night during the high transmission season compared with the low transmission season ($P \leq 0.001$ for all three ethnic groups) (Table 1).

3.4. Sleeping arrangements under the long-lasting impregnated net in the household

The study first investigated the sleeping arrangements of the entire population under LLINs during the two seasons (Figure 1). The percentage of individuals who did not sleep under a net reduced significantly in all three ethnic groups during the high transmission season ($P < 0.001$ for all three ethnic groups). In all households, priority to sleep under the LLIN was given to children under the age of 5 years during both seasons and the next highest priority was given to children between 5–12 years.

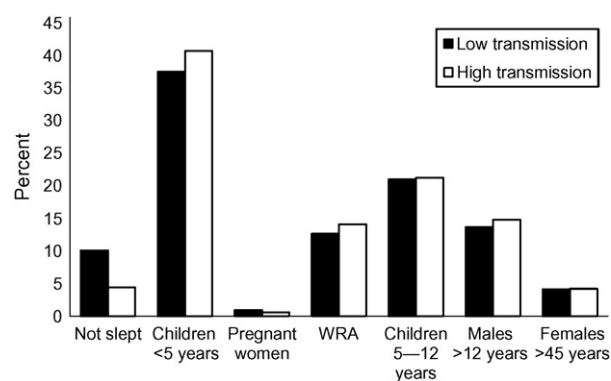


Figure 1 Sleeping arrangements of the entire population under long-lasting impregnated nets during the low and high transmission seasons. WRA: women of the reproductive age group.

Table 2 Sleeping arrangements of children under the age of 5 years.

	Low transmission season	High transmission season	P-value
No. of households with children under the age of 5 years			
Sinhalese	360 (45.3)	260 (33.8)	0.002
Tamil	279 (33.5)	272 (34.1)	0.887
Muslim	500 (59.5)	438 (52.6)	0.143
No. of households where children under 5 years slept under a LLIN ^a			
Sinhalese	289 (83.8)	242 (95.3)	0.283
Tamil	146 (59.1)	215 (82.1)	0.018
Muslim	400 (88.3)	423 (97.7)	0.296
Sleeping pattern of children under 5 years in households			
Sinhalese			
Child + mother	118 (40.8)	176 (72.7)	—
Child + mother + sibling(s)	102 (35.3)	22 (9.1)	—
Child + sibling(s)	33 (11.4)	28 (11.6)	—
Child + mother + father	29 (10.0)	11 (4.5)	—
Child + father	4 (1.4)	1 (0.4)	—
Child + other member	3 (1.0)	4 (1.7)	—
Tamil			
Child + mother	29 (19.9)	50 (23.3)	—
Child + mother + sibling(s)	8 (5.5)	7 (3.3)	—
Child + sibling(s)	52 (35.6)	121 (56.3)	—
Child + mother + father	42 (28.8)	31 (14.4)	—
Child + father	10 (6.8)	2 (0.9)	—
Child + other member	5 (3.4)	4 (1.9)	—
Muslim			
Child + mother	247 (61.8)	213 (50.4)	—
Child + mother + sibling(s)	99 (24.8)	56 (13.2)	—
Child + sibling(s)	31 (7.8)	141 (33.3)	—
Child + mother + father	16 (4.0)	11 (2.6)	—
Child + father	6 (1.5)	0 (0)	—
Child + other member	1 (0.3)	2 (0.5)	—

LLIN: long-lasting impregnated net.

^a Percentage calculated from number of households with children under the age of 5 years that possessed a LLIN ($n=345$ and 254 for Sinhalese, $n=247$ and 262 for Tamils and $n=453$ and 433 for Muslims during the high and low transmission seasons, respectively).

3.5. Sleeping arrangements of children under the age of 5 years

The sleeping arrangements of children under the age of 5 years were determined taking into the analysis only households with children in this age group (Table 2). There were households with children under the age of 5 years that did not possess an LLIN (8% during the low transmission season and 2% during the high transmission season). The percentage of households with children sleeping under a LLIN increased during the high transmission season compared with the low transmission season in all three ethnic groups (83.8% to 95.3% in Sinhalese, 59.1% to 82.1% in Tamils and 88.3% to 97.7% in Muslims), with the difference being statistically significant only among Tamils ($P=0.018$) (Table 2). The proportion of households with children under five sleeping under a LLIN in both seasons was highest amongst the Muslims and lowest amongst the Tamils (Table 2).

In all three ethnic groups, sleeping arrangements of children under 5 years were studied taking into consideration whether they slept alone or with another family member (Table 2). Children under the age of 5 years did not sleep

alone and the LLIN was shared with another family member. In the Sinhalese and Muslims households, children under 5 years slept mainly with the mother, compared with Tamil households where the LLIN was used by the child and one or more siblings. This pattern was observed both during the low and high transmission seasons.

In the Sinhalese households, the percentage of under fives sleeping with their mothers under LLINs was approximately double during the high transmission season compared with the low transmission season (40.8% vs. 72.7%). In the Tamil and Muslim households, the percentage of under fives sleeping under the LLIN with one or more siblings increased during the high transmission season compared with the low transmission season (35.6% to 56.3% in Tamils and 7.8% to 33.3% in Muslim households). In all three ethnic groups, it was observed that the LLINs were not used by the father alone and, if the father did sleep under it, it was always with the child or with the mother and the child (Table 2).

The study then analysed the sleeping arrangements of all the individual children under 5 years of age during the previous night (Table 3), recording the type of net used. During the low transmission season, of the 1473 children, 1099

Table 3 Seasonal variation in the sleeping arrangements of children under 5 years of age and of pregnant women.

	Low transmission season	High transmission season
Children under 5 years		
Total number	1473	1174
Slept under LLIN	1099 (74.6)	1054 (89.8)
Slept under normal net	127 (8.6)	56 (4.8)
Slept without a net	247 (16.8)	64 (5.5)
Pregnant women		
Total number	46	29
Slept under LLIN	21 (45.7)	14 (48.3)
Slept under normal net	9 (19.6)	9 (31.0)
Slept without a net	16 (34.8)	6 (20.7)

LLIN: long-lasting impregnated net.

(74.6%) slept under a LLIN, whilst 8.6% slept under normal nets and the rest slept without nets (16.8%). In contrast, during the high transmission season, of the 1174 children under 5 years, 1054 children (89.8%) slept under a LLIN, whilst 4.8% slept under a normal net and 5.5% without a net. During the low transmission season, 55 (43.3%) of the 127 children who slept under a normal net did so because they did not have a LLIN in the household. Similarly, of the 247 children who slept without a net, 51 (20.6%) did so because there was no LLIN in the household. In the high transmission season, the proportion of children who slept under a normal net owing to the absence of a LLIN in the household reduced to 21%, whilst the number of children who did not sleep under a net owing to the absence of a LLIN in the household reduced to 16%.

3.6. Sleeping arrangements of pregnant women

During the two seasons, usage of nets by pregnant women the previous night was recorded with respect to whether they slept under a net and, if so, the type of net used. If a LLIN had not been used when it was available, the reason for this was recorded (Table 3).

During the low transmission season, 21 (45.7%) of the 46 pregnant women slept under a LLIN, whilst 19.6% slept under normal nets and the rest (34.8%) slept without nets. During the high transmission season, 14 (48.3%) of 29 pregnant women slept under a LLIN, whilst 31.0% of women slept under a normal net and the rest (20.7%) slept without a net. During the low transmission season, of the nine women who slept under a normal net, four (44.4%) did so because they did not have a LLIN in their household. All 16 pregnant women who did not sleep under a net did so because they gave the LLINs in their households to another family member, especially children under 5 years. During the high transmission season, five women (55.6%) slept under a normal net owing to the absence of a LLIN in their household, whilst of the women who did not sleep under a net one did so as there was no LLIN in the household and the other five gave their LLINs to other family members.

3.7. Reasons for non-use

The main reason for LLIN non-use the previous night during the low transmission season in all three ethnic groups

was inability to sleep under a net due to the heat (52.2%, 61.8% and 58.6% for Sinhalese, Tamils and Muslims, respectively) and the fact that the respondents thought there was an absence of mosquitoes during this season (17% each for Sinhalese and Tamils, 20% for Muslims) (Table 4). During the high transmission season, the main reason for non-use in all three ethnic groups was the fact that there was no space to hang the LLIN over the sleeping area in their household. The percentage of individuals who did not use the LLIN owing to heat during the high transmission season was low (6.7%, 2.3% and 2.8% for Sinhalese, Tamils and Muslims, respectively).

4. Discussion

Malaria prevention efforts promoting ITNs often assume if a household gets a mosquito net that the most vulnerable will be protected. According to the results of this survey, supply coverage to the study area may be considered good as 90% of the households were in possession of at least one LLIN during the dry season, with net retention remaining high during the wet season, indicating that the LLINs were not given away or damaged during the intervening 6-month period. Furthermore, a significant increase in LLIN use was seen during the high transmission season, both in terms of the number of households where the LLIN was hung all the time and the number of households that used the LLIN the previous night in all three ethnic groups. Heat was the commonest reason for non-use of the LLIN during the low transmission season. It should be noted that the ambient temperatures in these districts during this season is approximately 30 °C, whilst the temperature drops considerably during the wet high transmission season. Although LLINs were not possessed by some households that had children under the age of 5 years and/or pregnant women, the high coverage and usage of LLINs in the community has been achieved through grass-root level programmes encouraging the use of nets by communities that possess them and this has been built on by a population having an unusually high literacy rate for a third world country (95% literacy rate).

The number of households where children under the age of 5 years slept under a LLIN was high during the low transmission season (80%), and this percentage increased to 93% during the high transmission season. In the Sinhalese households, the percentage of children under the

Table 4 Reason for non-use of long-lasting impregnated nets (LLIN)

	Low transmission season	High transmission season
Sinhalese		
Too hot	24 (52.2)	1 (6.7)
Absence of mosquitoes	8 (17.4)	0 (0)
No space to hang	6 (13.0)	5 (33.3)
Absence of children	1 (2.2)	4 (26.7)
Net torn	4 (8.7)	3 (20.0)
Harmful effect of LLIN	2 (4.3)	1 (6.7)
Not answered	1 (2.2)	1 (6.7)
Tamil		
Too hot	68 (61.8)	1 (2.3)
Absence of mosquitoes	19 (17.3)	6 (13.6)
No space to hang	14 (12.7)	18 (40.9)
Absence of children	3 (2.7)	10 (22.7)
Net torn	5 (4.5)	4 (9.1)
Harmful effect of LLIN	1 (0.9)	2 (4.5)
Not answered	0 (0)	3 (6.8)
Muslim		
Too hot	41 (58.6)	1 (2.8)
Absence of mosquitoes	14 (20.0)	1 (2.8)
No space to hang	8 (11.4)	15 (41.7)
Absence of children	1 (1.4)	6 (16.7)
Net torn	3 (4.3)	11 (30.6)
Harmful effect of LLIN	2 (2.9)	1 (2.8)
Not answered	1 (1.4)	1 (2.8)

age of 5 years who slept with their mother increased by almost two-fold during the high transmission season, indicating that preference was given to the mother to sleep under the net during this period. However, in the Tamil and Muslim households it is evident that the parents who slept with the children under the age of 5 years during the low transmission season moved out to give room to the siblings to sleep under the LLIN during the high transmission season.

When the ethnic groups were considered separately, during the low transmission season the percentage of children under 5 years of age who slept under LLINs in the Tamil households was significantly lower compared with the Muslim and Sinhalese households. The respondents of the Tamil households were mainly from internally displaced populations of the Northern Province and it is assumed that conditions within the household would have made it difficult to utilise LLINs during the dry season when the weather is hot. However, since the utilisation of LLINs for children under 5 years of age increased significantly during the high transmission season, should malaria transmission occur it is possible that malaria-related morbidity will be prevented.

Usage of LLINs by pregnant women was less satisfactory in all three ethnic groups. It is noted that at the time of handing over the LLINs in these areas, no programmes had been conducted in these localities highlighting the benefits of using LLINs specifically by pregnant women. Amongst the Sinhalese, over 50% of the pregnant women did not use a LLIN during the low transmission season because other family members used the LLIN. A similar situation was seen

among the Muslim women. In these circumstances, the pregnant women in households provided with LLINs had opted not to use these owing to possible ignorance of the benefits. Therefore, the findings of this study could be used to suggest the possible need for re-focusing of health education messages regarding the importance of net use among pregnant women. The increase in net use among pregnant women during the high transmission season is probably a result of the overall increase in the availability of nets as well as ambient temperatures being more conducive to net use.

Based on the findings of this study, it is recommended that messages on LLIN use should be modified to raise awareness of the family members most in need of protection as well as the benefits of having the net hanging all the time.

The results of this study conclude that LLIN use among the population is high and increases further during the high transmission season. The prevalence of LLIN use for children under five is above the target set by the RBM guidelines. During the low transmission season, 90% of households used the LLIN the previous night and this percentage increased to 96% during the high transmission season. Based on studies carried out in other countries, this percentage can be regarded as being sufficient to provide protection to the rest of the community in this study population.

Authors' contributions: All authors contributed to the concept and design of the study and carried out field work during the study period of 8 months in rotation; ACRR entered the data; SDF, NG and LCR analysed the data. All authors contributed to preparing the manuscript and read and approved the final version. SDF is guarantor of the paper.

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Conflicts of interest: None declared.

Ethical approval: Ethical clearance was obtained from the Ethical Review Committee of the Faculty of Medicine, University of Colombo, Sri Lanka. Permission to conduct the study was obtained from the Ministry of Healthcare and Nutrition, Sri Lanka, and the Provincial Health Authority of the North Central and Northern Provinces of Sri Lanka.

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