Original Article

Contribution of a Program of Insecticide treated Nets for Reducing Malaria Prevalence in Kori Subdistrict, Southwest Sumba

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Abstract

Introduction: Malaria is endemic in Indonesia, especially in East Nusa Tenggara (ENT). To reduce its prevalence, the Ministry of Health has launched a program of insecticide-treated net (ITN) distribution to protect people from mosquito bites. The aim of this study was to evaluate the contribution of ITNs in reducing malaria prevalence in Kori Subdistrict, Southwest Sumba, ENT. **Materials and Methods:** This study used secondary data from the primary healthcare center in Kori. The data were the number of patients, gender, age, and presenting with fever and diagnosed by rapid diagnostic test in the year before and after the distribution of ITNs. The effects were evaluated using Chi-square test. **Results:** The prevalence of malaria in 2014 was 51.1% and consisted of 30.6% *Plasmodium falciparum*, 19.5% *Plasmodium vivax,* and 1% mixed infection. After the distribution of ITNs in 2015, the prevalence decreased to 41.3% ($P < 0.001$) with the fall occurring in infections by *P. falciparum*, though the prevalence of *P. vivax* and of mixed infections did not change identifiably. The decrease in the prevalence was most marked for women and children under the age of five. **Conclusion:** The prevalence of malaria in Kori subdistrict, Southwest Sumba, fell substantially from 51.1% to 41.3% in the year after ITN distribution.

Keywords: Anopheles, endemic, plasmodium, public health

Introduction

Malaria is a public health problem in Indonesia, especially in the eastern part of the country. In 2013, the overall prevalence of malaria in Indonesia was 6% and the highest regional prevalence was found in Papua (28.6%) and East Nusa Tenggara/ENT (23.3%).[1,2] Southwest Sumba district (SSD) is a district within ENT with a high prevalence of malaria, especially in the Kori subdistrict. Here, the people are poor and many live in permeable bamboo-walled houses over swampy areas. Annual parasite incidence (API) is the total number of positive slides for parasite in a year × 1000 per total population; API is used to stratify malarious areas and disease burden in community. Annual blood examination rate (ABER) is smears examined in a year × 100 per total population. ABER is a measure of the level of diagnostic monitoring activity. In 2012, the API was 32.7% and the ABER was 6.5%. In 2013, the API increased to 66.2% and the ABER to 9%. The increase in API and ABER values indicated that the prevalence of malaria in Kori subdistrict was increasing and needed to be addressed quickly. The mosquito *Anopheles barbirostris* is the principal local vector for the etiological agents of malaria, *Plasmodium falciparum* and *Plasmodium vivax* in SSD. Malaria causes symptoms such as fever, chills, heavy sweating, arthralgia, and headache, and if not treated quickly and appropriately, can be fatal. In addition, malaria can cause anemia, miscarriage in pregnancy, premature birth, low birth weight, and stillbirth.[3,4] The government policy for detecting malaria are: to use microscopic examination or rapid diagnostic test; and the disease is controlled by the treatment using artemisinin-based combination therapy; prevention of

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mosquito bites using insecticide-treated nets (ITNs), cross-sector cooperation, and community participation.[5,6] To reduce the prevalence of malaria, the government launched a program distributing ITNs to the community.[5,6] The program began in 2009 by distributing ITNs to all provinces based on their level of malaria endemicity, and in Kori subdistrict, the ITNs were distributed in 2014. To evaluate the effectiveness of ITNs in reducing malaria, it was necessary to compare the prevalence of malaria before and after the distribution of ITNs, i.e., in 2014 and 2015.

Materials and Methods

The study was approved by the Health Research Committee, Faculty of Medicine, Universitas Indonesia, through the certification of ethics review (No. 386/UN2. F1.D1/KBK/PDP. 01/2016) and research approval from the Regent of West Sumba through a letter of approval (No. 01/PK/SBD/V/2016). This was a cross-sectional study carried out in Kori subdistrict, SSD (location coordinate: 9° 29'48"S, 119° 1'52"E) by evaluating malaria data from 2014 to 2015. The participants of the study were patients with suspected malaria who were treated in the primary healthcare center (PHC) of Kori subdistrict in 2014 and 2015. The minimal sample size required to estimate the prevalence of malaria was calculated using the following formula:

$$n = \frac{(z \propto)^2 \, PQ}{d^2} = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384$$

P is the proportion of malaria assumed to be 0.5 because no previous study had been done in the area, Q = 1 − P, d is the 5% precision rate, and the 95% confidence interval represents an α of 0.05 and Zα of 1.96. This study used the medical records of the Kori subdistrict PHC as the source of the secondary data. The data included the number of patients, their gender, age, and malaria diagnoses recorded in 2014 and 2015. The minimum sample required to reliably estimating the prevalence of malaria infection based was calculated to be 384. We vastly exceeded this using all recorded data [Table 1]. Chi-square tests using SPSS (IBM SPSS Statistics for Windows, Version 20.0. Armonk, New York: IBM Corp) were used to compare the malaria prevalence in 2014 with that of 2015 and to evaluate any change in prevalence of malaria within different age groups and genders.

Results

The total population of Kori subdistrict in 2014 was 31,864 people, which increased to 32,364 people in 2015. A total of 2827 (8.9%) people visited the PHC in 2014 and 2334 (7.2%) people in 2015. Most of the people whose records contributed to this study were aged ≥5 years and there were more females than males [Table 1].

After ITN distribution, the number of subjects of both genders who visited the Kori subdistrict PHC fell (P = 0.006). The prevalence of malaria in those who visited the PHC before ITN distribution was 51.1% and fell to 41.3% in 2015 following ITNs distribution (P < 0.001) [Table 2]. The prevalence of malaria before ITN distribution was 51.1%. After ITN distribution, the prevalence of malaria reduced to be 41.3%. The reduction in malaria prevalence was similar in all demographics [Table 3]. At baseline in the 2014, the prevalence of *P. falciparum* was higher than that of *P. vivax*, with mixed infection constituting only 1% of all malaria infections. In 2015, the prevalence of *P. falciparum* species was lower (P < 0.001), but not that of *P. vivax* (P = 0.86) or of mixed infections (P = 0.58) [Table 4].

Discussion

Kori subdistrict is one of the areas in SSD in which malaria is endemic. To control the malaria vector mosquitoes, fogging with indoor residual spraying must be carried out every 3–6 months. However, because fogging is costly and there are increasing environmental concerns about the use of broad-spectrum insecticides, the World Health Organization (WHO) recommends that ITNs can be used to prevent mosquito bites.[5] The government enacted a national malaria elimination program involving the distribution of ITNs to communities in SSD in December 2014. The Kori subdistrict in SSD is very poor. Villagers live in stilt houses made of bamboo and mosquitoes can enter the houses through the gaps in between the bamboo. The malaria vector in SSD is mainly *A. barbirostris*, which breeds in swamps, rice fields, and shrubs. In Indonesia, the most common malaria parasite is *P. falciparum*, which accounts for nearly 350,000 confirmed

Table 1: Characteristics of the participants in Kori subdistrict before and after the distribution of insecticide-treated nets

Characteristics	Before (n=2827), n (%)	After (n=2334), n (%)	P
Age (years)			
<5	679 (24)	516 (22.1)	0.105
≥5	2148 (76)	1818 (77.9)	
Gender			
Male	1325 (46.9)	1006 (43.1)	0.006
Female	1502 (53.1)	1328 (56.9)	

Table 2: Prevalence of malaria before and after the distribution of insecticide-treated nets

RDT	Malaria prevalence		Prevalence ratio (95% CI)
	2014 before ITN, n (%)	2015 after ITN, n (%)	
Positive	1445 (51.1)	965 (41.3)	1.20 (1.14-1.26)
Negative	1382 (48.9)	1369 (58.7)	
Total	2827 (100)	2334 (100)	

CI: Confidence interval, ITN: Insecticide-treated net, RDT: Rapid diagnostic test

Table 3: The proportion of malaria before and after the distribution of insecticide-treated nets as a function of age group and gender

Characteristics	Malaria proportion		*P*	Prevalence ratio (95% CI)
	2014 before ITN, *n*/total (%)	2015 after ITN, *n*/total (%)		
Age (years)				
<5	321/679 (47.2)	185/516 (35.9)	<0.001	1.22 (1.12-1.35)
>5	1124/2148 (52.3)	780/1818 (42.9)	<0.001	1.19 (1.12-1.26)
Gender				
Male	711/1325 (53.7)	444/1006 (44.1)	<0.001	1.18 (1.10-1.27)
Female	734/1502 (48.9)	521/1328 (39.3)	<0.001	1.20 (1.12-1.29)

CI: Confidence interval, ITN: Insecticide-treated net

Table 4: The proportion of malaria before and after the distribution of insecticide-treated nets based on *Plasmodium* species

Plasmodium sp	Malaria proportion		*P*	Prevalence ratio (95% CI)
	2014 before ITN (*n*=2827), *n* (%)	2015 after ITN (*n*=2334), *n* (%)		
Plasmodium falciparum	866 (30.6)	478 (20.5)	<0.001	1.25 (1.19-1.32)
Plasmodium vivax	552 (19.5)	461 (19.8)	0.860	0.99 (0.93-1.06)
Mixed infection	27 (1)	26 (1)	0.582	0.93 (0.71-1.21)
Total	1445 (51.1)	965 (41.3)	<0.001	1.19 (1.14-1.25)

CI: Confidence interval, ITN: Insecticide-treated net

malaria cases and around 500 confirmed malaria deaths every year. *P. falciparum* can also cause serious complications such as cerebral malaria, severe anemia, renal failure, acute respiratory distress syndrome, shock, and disseminated intravascular coagulation.[7] Both *P. vivax* and *P. falciparum* have been detected in *A. barbirostris* in ENT.[8] Unlike *P. falciparum*, *P. vivax* can be in a dormant state during the liver stages of infection, and an infected patient may be asymptomatic. They can, however, relapse to acute infection though *P. vivax* infection has a low risk of death, but many studies have shown morbidity and mortality burdens in endemic zones.[9] This study identified a fall in the number of people presenting as symptomatic and the proportion diagnosed with *P. falciparum* infection malaria between 2014 and 2015, before and after ITN distribution. Our finding is similar to those of previous studies that also reported a decreased prevalence of *P. falciparum* infection after ITN distribution and use.[10,11] In contrast, the proportion of *P. vivax* infection was not seen to change. This could be related to the possibility of relapse of dormant *P. vivax* infection. A study in Papua New Guinea reported a difference between the bite cycle of *P. vivax*- and *P. falciparum*-infected mosquitoes, with *P. vivax* being associated with biting earlier in the evening than *P. falciparum*.[12] Moreover, *P. vivax* is known to have a dormant state in the form of hypnozoites that reside within the liver and can relapse months to years later and this effect could lead to a lag in an identifiable decline in this form of malaria.[13-15]

Our study found that the level of reduction in malaria prevalence was similar between men, women, and young children. Although the confidence intervals for all groups overlapped, a previous study in the Democratic Republic of Congo showed a greater protective effect of ITNs for pregnant women and children aged <5 years.[16] It is possible that a behavioral effect drives this, in that women and young children may retire to the shelter of their homes and bed nets earlier than men and thus reduce their risk of infectious bites to a greater extent. Moreover, male population in Indonesia usually socialize with friends outside the house until late at night which make them more exposed to mosquitoes. This is encouraging as it indicates that in time we may meet the 2006 WHO global objective to protect pregnant women and children aged <5 years from malaria using ITNs.[17] We advise the government to support and encourage the widespread use and distribution of ITNs in SSD and other areas with prevalent malaria as they have been shown in this and previous studies to lower the prevalence of malaria substantially. A neighboring country, Papua New Guinea, has achieved great success in reducing malaria prevalence to only 0.9% within 5 years of introducing ITNs.[1] Vulnerable individuals such as pregnant women and young children under the age of five are those who have the highest risk of infection and worst outcomes. It has been reported that malaria infection during pregnancy can cause abortion, prematurity, and intrauterine fetal death.[18] This is supported by a study from Uganda that found that pregnant women who did not use ITNs had a higher proportion of malaria infection and pregnancy complications.[19] In conclusion, the ITN program was effective in reducing the prevalence of malaria in Kori subdistrict, Southwest Sumba, Indonesia.

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Conflicts of interest

There are no conflicts of interest.

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