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Effectiveness of Insecticide Treated Mosquito Nets on the Death of *Anopheles subpictus* Mosquitoes

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Abstract: The prevalence of malaria in East Nusa Tenggara based on positive diagnosis results containing malaria parasites and symptoms in the 2013 - 2015 period decreased but has not yet reached the National Strategic Plan target, namely in 2013 it was 21 per 1,000 population (o/oo), in 2014 it was 14 o/oo, and in 2015 it became 8 o/oo (NTT Health Office, 2016). In 2017 there was a spike in malaria cases to 211,409 cases (API = 44.96 o/oo). Kupang Regency with 1,108 cases (API = 24.87 o/oo). Malaria cases in the Tarus Community Health Center work area are the eighth highest, namely 7 cases. This study aims to analyze the effectiveness of insecticide-treated bed nets on the death of *Anopheles subpictus* mosquitoes. The variables observed were the length of time the mosquito net was used, the frequency of washing the mosquito net, the method of washing the mosquito net, and the percentage of *Anopheles subpictus* mosquito deaths. The effectiveness of insecticide-treated bed nets on the death of *Anophles subpictus* mosquitoes with usage time < 3 years (100%), usage time 3 – 5 years (70%) and usage time > 5 years (40%). The effectiveness of insecticide-treated bed nets that have never been washed reaches 100% mortality within 24 hours of observation. Meanwhile, mosquito nets with a washing frequency of 1 – 10 times (70%) kill mosquitoes, and a washing frequency of > 10 times (50%). The method of washing mosquito nets carried out by the community in the Puskesmas Working Area is 100% using detergent. In the control group that used mosquito nets that did not contain insecticide, no *Anopheles subpictus* mosquito deaths occurred (0%). Suggestions for health workers to increase education regarding the correct use of mosquito nets, so that a higher level of effectiveness of mosquito nets is obtained as a means of personal protection in avoiding mosquito bites.

Keywords: *Anopheles subpictu*; Bed net; Insecticide

Introduction

Malaria is an infectious disease transmitted by Anopheles sp mosquitoes. females, which is a public health problem and can be the main cause of death in developing countries, especially in infants, toddlers and pregnant women (Bauserman et al., 2019; Djihinto et al., 2022). Apart from that, malaria can cause anemia (Rivera-Correa & Rodriguez, 2020) and high cases of malaria can have an impact on the welfare of individuals and families affected by malaria and the government because it can result in decreased work productivity and in the long term, malaria can have an impact on reducing the quality of human resources. human resources and a large economic burden due to the loss of opportunities for households to pay for education and the burden of high health costs (Natalia, 2010).

World Health Organization (WHO, 2014) world malaria report states that based on an assessment of reported cases, 64 of 106 countries with malaria transmission have achieved the MDGs target of

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reducing malaria cases, but WHO data also shows that there are still 198 million malaria cases worldwide. world and caused 584,000 deaths in 2013 (WHO, 2014). Indonesia is one of the countries that is still at risk of malaria. It can be seen that currently there are still cases of malaria. In 2013, as many as 14% of districts/cities in Indonesia were in the high endemicity category. In 2014 the Annual Parasite Incidence (API) figure for malaria in Indonesia was 0.95 per 1,000 population and in 2015 it was 0.85 per 1,000 population, while in 2016 the API figure was 0.88 per 1,000 population at risk of malaria. In 2017, the Annual Parasite Incidence (API) figure for malaria in Indonesia was 0.95 per 1,000 population (Kemenkes R I, 2017).

The prevalence of malaria in East Nusa Tenggara based on positive diagnosis results containing malaria parasites and symptoms in the 2013 - 2015 period decreased but has not yet reached the National Strategic Plan target, namely in 2013 it was 21 per 1,000 population (o/oo), in 2014 it was 14 o/oo, and in 2015 it became 8 o/oo (Dinkes Prov NTT, 2016). In 2017 there was a spike in malaria cases to 211,409 cases (API = 44.96 o/oo) (BPS Provinsi NTT, 2017). Kupang Regency with 1,108 cases (API = 24.87 o/oo), the highest cases were in the working area of the Naikliu Health Center, namely 364 cases, and the Tarus Health Center was the eighth highest number of cases, namely 7 cases, while Batakte did not find any positive cases of malaria parasites (Dinkes Kab Kupang, 2016). Apart from occurring in adults, cases also occur in children aged less than 15 years.

One of the main intervention efforts that is considered effective in preventing and controlling malaria recommended by WHO in the global malaria program to overcome malaria with the aim of achieving the Millennium Development Goals (MDGs) target in 2015 is the distribution and use of insecticide treated nets (ITNs), especially Long Lasting Insecticidal Nets (LLINs) (Ikawati et al., 2010). Insecticide-treated bed nets can also be an alternative for controlling malaria vectors in areas where people reject the Indoor Residual Spraying (IRS) method or can also be an additional measure in efforts to prevent malaria transmission (Rahmadiliyani & Noralisa, 2013).

Insecticide-treated mosquito nets are an effective way to prevent vector mosquito bites and malaria transmission, especially to pregnant women, babies and toddlers because apart from being a physical barrier against mosquitoes, the insecticide activity contained in them can also kill mosquitoes (Herrera-Bojórquez et al., 2020; Ng'ang'a et al., 2021). The use of insecticide-treated bed nets has a major impact on malaria vectors and incidence rates, so it is recommended as an effective personal protection tool for malaria control. The results of research conducted in South Sumatra Province show that there is a relationship between the use of insecticide-treated bed nets and the incidence of malaria, people who do not use nets are more at risk of contracting malaria than those who use nets (Hadi et al., 2011). Long Lasting Insecticidal Nets (LLINs) can also be used for at least three years and can last after 20 washes for protection against contact with malaria-transmitting mosquitoes (Ikawati et al., 2010).

Elimination of malaria in Indonesia, through efforts to distribute/distribute insecticide-treated bed nets, has been implemented and is expected to be supported by high commitment from the local government. Since 2006, UNICEF in collaboration with the Indonesian Ministry of Health has introduced insecticide-treated bed nets, especially LLINs, for use in Indonesia (Bandzuh, 2023). The main targets for distributing insecticide-treated mosquito nets to prevent malaria are people who are at high risk of contracting malaria, such as pregnant women, babies and children (Ikawati et al., 2010).

In 2017 and 2018, the Indonesian Ministry of Health distributed 1,124,000 anti-mosquito nets in NTT Province (Fauziah et al., 2022). The results of monitoring by health cadres showed that 90% of the mosquito nets distributed had been used by the community. Based on this background, researchers wanted to examine the effectiveness of insecticide-treated mosquito nets on the death of Anopheles subpictus mosquitoes based on length of use, frequency of washing the nets, and how the nets were washed. This research aims to determine the effectiveness of insecticide-treated mosquito nets used by the community in the Tarus Community Health Center Working Area, Kupang Regency, as well as identifying insecticide-treated mosquito nets in terms of the length of time they are used and the frequency of washing, as well as how to wash the nets. The research location was chosen with the consideration that the Tarus Community Health Center working area is an endemic malaria area and the local community has been distributed insecticide-treated bed nets. The mosquito used in the research was Anopheles subpictus which is the dominant malaria vector in Kupang Regency, East Nusa Tenggara.

Method

Retrieval of Mosquito Nets

The collection of mosquito nets was carried out in the Tarus Health Center Working Area, Kupang Regency, namely insecticide-treated nets that had been distributed to the community made from polyester and ordinary nets made from polyester which do not contain insecticides. Mosquito nets taken for research from each community were replaced with new nets.

Insecticide-treated bed nets were selected randomly, based on 8 categories of nets tested, namely based on length of use (less than 3 years, 3-5 years and more than 5 years), washing frequency (not washed, 1 - 10 times, 11 - 20 times), and washing method (not using detergent and using detergent). In each category, 1 mosquito net was used, so the total sample was 8 mosquito nets.

Catching Anopheles subpictus Mosquitoes

Catching mosquitoes using an aspirator using the bait and resting method. The arrest time was 18.00 – 24.00 around the resident's house, carried out by 6 field assistants. The mosquitoes obtained were identified visually and female *Anopheles subpictus* species were selected. Mosquitoes were left in paper cups for 12 – 14 hours in the Entomology Laboratory of the Sanitation Study Program to adapt to the test room and given 10% sugar liquid as food.

After the adaptation period, healthy mosquitoes are selected that are full of sugar and can move actively, which can be used for research. The mosquito used during testing was the An. subpictus caught at the research location, as many as 10 individuals per test and control category, so that 240 individuals were used for the test group and 30 individuals for dicks in 3 repetitions.

Testing Stage

Testing (Bioassay) using the contact method was carried out at the Entomology Laboratory, Sanitation Study Program, Health Polytechnic, Ministry of Health, Kupang. Bioassay tests were carried out on insecticide-treated bed nets and as a control group were bed nets that were not treated with insecticide (Bamou et al., 2021; Barreaux et al., 2022). Each mosquito net was cut to a size of 30cm x 30cm according to the size of the bioassay board. The number of bioassay cones attached to each mosquito net is 3 cones.

Furthermore, the mosquito An. Subpictus caught in a healthy condition full of sugar are put into the bioassay cone to be contacted with insecticide-treated mosquito nets. One bioassay cone included 10 mosquitoes with an exposure period to a mosquito net for 30 minutes. After the test mosquitoes and control mosquitoes were in contact for 30 minutes, the mosquitoes were transferred into a paper cup using an aspirator.

Room temperature and humidity during exposure of mosquitoes to insecticides were recorded. This measurement is to ensure that the temperature of the test room is the optimal temperature for mosquito life.

Observation

After 1 hour, 2 hours, 3 hours, 4 hours, 5 hours and 6 hours, knockdown was observed and after 24 hours death was observed. If the percentage of mosquito deaths in the control group ranges from 5-20%, correction is carried out using the Abbot formula. However, if mosquito mortality in the control group is above 20%, then the test must be repeated. Abbot's Formula 1 (Ahogni et al., 2020; Kibondo et al., 2022).

$$M = \frac{(A-B)}{100-B} \quad (1)$$

Information:
M = death rate after correction (%)
A = death rate of test group (%)
B = death rate of control group (%)

Data Analysis

The data that was obtained was then analyzed descriptively and compared with standards for the effectiveness of insecticide-treated bed nets. According to Nash et al. (2021), these insecticide-treated nets can cause at least ≥ 95% of mosquitoes to be knocked down and/or ≥ 80% of mosquitoes to die if exposed to these nets.

Result and Discussion

The Effectiveness of Insecticide-Treated Bed Nets on the Death of Anopheles subpictus Mosquitoes is Based on the Length of Time the Bed Nets are Used

The results of research on the effectiveness of insecticide-treated mosquito nets on the death of *Anopheles subpictus* mosquitoes are based on the length of use of the nets, namely < 3 years, 3 - 5 years and > 5 years as well as control nets. Mosquito contact time with mosquito nets is 30 minutes and observation of mosquito death after 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours and 24 hours. It can be clearly seen from the average percentage of deaths of *Anopheles subpictus* mosquitoes after three repetitions, namely in Table 1 and Figure 1.

Table 1 shows that the effectiveness of insecticide-treated mosquito nets on the death of *Anophles subpictus* mosquitoes reached 50%, namely nets with a usage time of <3 years at the time of observation after 3 hours of mosquito contact with the net. After 24 hours the death of the *Anophles subpictus* mosquito reaches 100% death in mosquito nets with a usage time of 1 – 3 years. Meanwhile, mosquito nets with a usage period of 3 - 5 years only achieve 70% mosquito mortality, and mosquito nets with a usage period of > 5 years are lower, namely 40%.

The results of observations of the death of the *Anopheles subpictus* mosquito showed that insecticide-treated mosquito nets with a usage period of <3 years resulted in 100% death after 24 hours of mosquitoes

landing on or coming into contact with the mosquito net (Table 1). This mortality was the highest compared to mosquito nets with a usage time of 3 – 5 years and > 5 years.

Table 1. Death of *Anopheles subpictus* Mosquitoes After Contact with Mosquito Nets

Time (Hours)	Mosquito Death in Mosquito Nets							
	Control		< 3 years		3-5 years		> 5 years	
	Average	%	Average	%	Average	%	Average	%
1	0	0	3	30	1	10	0	0
2	0	0	3	30	2	20	1	10
3	0	0	5	50	3	30	2	20
4	0	0	5	50	3	30	2	20
5	0	0	5	50	3	30	2	20
6	0	0	7	70	4	40	3	30
24	0	0	10	100	7	70	4	40

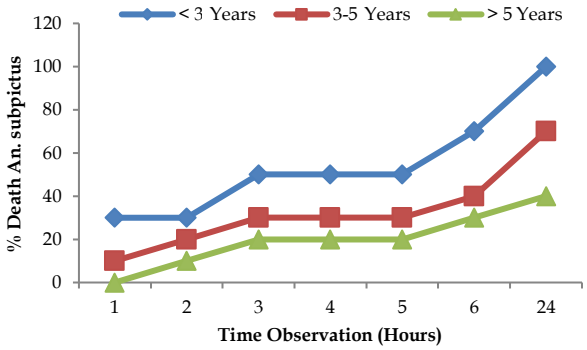

Figure 1. Graph of the effectiveness of insecticide-treated mosquito nets on the death of *Anophles subpictus* mosquitoes based on time of use

After conducting research with three repetitions, the average death of mosquitoes occurred after 1 hour of contact with insecticide-treated mosquito nets, namely mosquito nets with a usage time of < 3 years (20%), a usage time of 3 – 5 years (10%) and > 5 years (0%). The average increase in mosquito deaths at 3 hours and 24 hours observation time can be seen in Figure 2.

Figure 2 shows insecticide-treated mosquito nets with a usage period of <3 years, effective against the death of the *Anopheles subpictus* myomous up to 100%. These results can be concluded that the insecticides contained in mosquito nets that have been used for < 3 years are still effective in killing *Anopheles subpictus* mosquitoes. Meanwhile, mosquito nets that have been used for 3 – 5 years and > 5 years have decreased in effectiveness (70% and 40%) or are no longer effective according to standards. This refers to Mechan (2022), that insecticide-treated bed nets can cause at least ≥ 95% of mosquitoes to be knocked down and/or ≥ 80% of mosquitoes to die if exposed to these nets. So it can be concluded that the mosquito nets that were tested and were still effective in killing mosquitoes were nets with a usage time of 3 – 5 years. This is in line with the statement..., mosquito nets that contain insecticide in their fibers can be used for 3-5 years.

The results of this research are different from research by Nurmaliani et al. (2016) in Ogan Komering Ulu (OKU) Regency, South Sumatra Province, that insecticide-treated mosquito nets with a duration of use of 2-3 years (8.8%) and more than 3 years (4.44%) in observation time 24 hours after contact. The test results showed that all the mosquito nets tested had a mosquito knockdown rate of less than 95% and a mosquito death rate of less than 80%. This figure shows that all insecticide-treated bed nets tested are no longer effective in killing mosquitoes (Salim et al., 2017).

However, insecticide-treated bed nets with a usage period of more than five years can still be used to control Anopheles mosquitoes as mosquitoes that transmit (vector) malaria. Because it can protect mechanically, apart from the chemical effects of insecticides. Insecticide-based control measures are the primary way to kill biting mosquitoes inside the home. However, after prolonged exposure to insecticides over several generations, mosquitoes can develop resistance. Mosquito resistance is an increase in the capacity of mosquitoes to survive after coming into contact with an insecticide (Andreazza et al., 2021). Because mosquitoes can have many generations per year, high levels of resistance can arise very quickly.

The Effectiveness of Insecticide-Treated Bed Nets on the Death of Anopheles subpictus Mosquitoes is Based on the Frequency of Washing the Bed Nets

The results of research on the effectiveness of insecticide-treated mosquito nets on the death of *Anopheles subpictus* mosquitoes are based on the frequency of washing the nets, namely never washed, 1 - 10 times washed and > 10 times washed as well as control nets. Mosquito contact time with mosquito nets is 30 minutes and observation of mosquito death after 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours and 24 hours. It can be clearly seen from the average percentage of deaths of Anopheles subpictus mosquitoes after three repetitions, namely in Table 2 and Figure 2.

Table 2. Death of *Anopheles subpictus* Mosquitoes After Contact with Insecticide-Treated Bed Nets Based on Washing Frequency

Time (Hours)	Mosquito Death in Mosquito Nets							
	Control		Haven't washed it		1-10 Times		> 10 Times	
	Average	%	Average	%	Average	%	Average	%
1	0	0	3	30	1	10	0	0
2	0	0	3	30	2	20	1	10
3	0	0	5	50	3	30	2	20
4	0	0	5	50	3	30	3	30
5	0	0	5	50	3	30	3	30
6	0	0	8	80	4	40	4	40
24	0	0	10	100	7	70	5	50

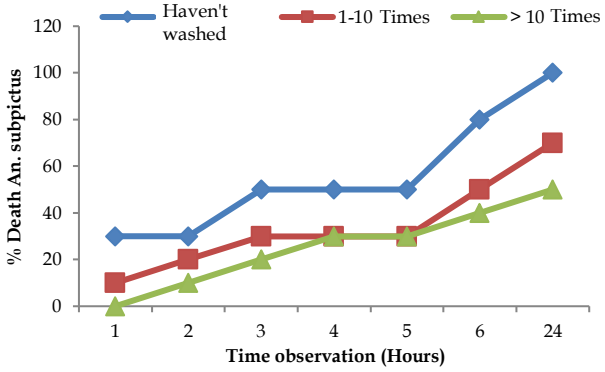

Figure 2. Graph of the effectiveness of insecticide-treated mosquito nets on the death of *Anophles subpictus* mosquitoes based on time of use

Table 2 shows the effectiveness of insecticide-treated mosquito nets that have never been washed to achieve 80% death of *Anophles subpictus* mosquitoes, after the mosquitoes were in contact for 1 hour with the mosquito nets observed at a 6-hour observation time. Then, within 24 hours of observation, the death of the *Anophles subpictus* mosquito reached 100%. Meanwhile, mosquito nets that have been washed 1 - 10 times have 70% mosquito deaths, and mosquito nets that have been washed > 10 times have lower mosquito deaths, namely 50% after 24 hours of observation. In the control group that used mosquito nets that did not contain insecticide, no *Anopheles subpictus* mosquito deaths occurred (0%)

The Effectiveness of Insecticide-Treated Bed Nets on the Death of Anopheles subpictus Mosquitoes is Based on How to Wash the Bed Nets

The method of washing insecticide-treated mosquito nets carried out by the community in the Tarus Health Center Working Area can be seen in Table 3. The results of research on the effectiveness of insecticide-treated nets on the death of *Anopheles subpictus* mosquitoes are based on the method of washing the nets, namely not using detergent and using detergent and control nets. Mosquito contact time with mosquito nets is 30 minutes and observation of mosquito death after 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours and 24 hours. It can be clearly seen from the average percentage of deaths of Anopheles subpictus mosquitoes after three repetitions, namely in Table 3.

Table 3. How to wash Insecticide-Treated Mosquito Nets Used in Research in the Tarus Community Health Center Working Area

Category	Amount	Percentage %
With Detergent	8	100
No detergent	0	0
Checked	8	100
Not Checked	0	0
Sunlight	8	100
Protected from sunlight	0	0

Table 3 shows that insecticide-treated mosquito nets that have never been washed are effective against the death of *Anopheles subpictus* mymosas up to 100%. These results can be concluded that the insecticide contained in bed nets that have never been washed is still effective in killing *Anopheles subpictus* mosquitoes when observed 24 hours after contact. Meanwhile, mosquito nets that have been washed with a frequency of 1 – 10 times and washed > 10 times, their effectiveness has decreased or are no longer effective (70% and 50%). This refers to Mauladi et al. (2021), that insecticide-treated bed nets can cause at least ≥ 95% of mosquitoes to fall (knockdown) and/or ≥ 80% of mosquitoes to die if exposed to these nets.

The mosquito net studied was the Long Lasting Insectiside Net (LLIN) type of mosquito net, which is a mosquito net that contains insecticide in its fibers. The insecticide lasts a long time even if washed 20 times. This is because the net fiber material in this mosquito net is of good quality. These fibers are multifilament polyester with an insecticide in the form of deltamethrin and monofilament polyethylene with the insecticide permethrin.

The results of the research show that the insecticide-treated mosquito nets used by the community in the Tarus Health Center Working Area, which have been washed either 1 - 10 times or more than 10 times, can still kill *Anopheles subpictus* mosquitoes by 50% - 70%. This is

in accordance with the WHOPES statement (2005), that the insecticide contained in LLIN mosquito nets lasts a long time even if washed 20 times (Kilian et al., 2008).

However, insecticide-treated bed nets that have been washed are no longer very effective in killing *Anopheles subpictus* mosquitoes, which are malaria vectors in Kupang Regency. These mosquito nets can still be used to control Anopheles mosquitoes, because they can protect mechanically, apart from the chemical effects of insecticides.

The method of washing mosquito nets carried out by the community in the Puskermas Working Area is 100% using detergent and by rubbing. When drying, 100% of the mosquito nets are dried in the sun (exposed to sunlight). Next, to see the effectiveness of insecticide-treated bed nets based on the washing method which is linked to the frequency of washing, it is depicted in Table 4.

Table 4. Death of *Anopheles subpictus* Mosquitoes After Contact with Insecticide-Treated Bed Nets Based on Washing Method and Washing Frequency

Time (Hours)	Mosquito Death in Mosquito Nets					
	Haven't washed it		Washed With Detergent			
			1-10 Times		> 10 Times	
	Average	%	Average	%	Average	%
1	3	30	1	10	0	0
2	3	30	2	20	1	10
3	5	50	3	30	2	20
4	5	50	3	30	3	30
5	5	50	3	30	3	30
6	8	80	4	40	4	40
24	10	100	7	70	5	50

The research results (Table 4) show that mosquito nets that have never been washed are more effective (100% death of *Anophles subpictus* mosquitoes) compared to nets that have been washed, both with a frequency of 1 – 10 times (70%) or > 10 times washing (40%). The insecticide-treated mosquito nets studied were mosquito nets that had never been washed and nets that had been washed. The washing of mosquito nets carried out by the community in the Tarus Community Health Center Working Area is using detergent by rubbing them and drying them in the sun or exposed to the sun.

The research results (Table 4) show that mosquito nets that have never been washed are more effective (100% death of *Anophles subpictus* mosquitoes) compared to nets that have been washed, both with a frequency of 1 – 10 times (70%) or > 10 times washing (40%). These results are in accordance with the (Kilian et al., 2008), that the insecticide contained in LLIN mosquito nets lasts a long time even if washed 20 times. The decrease in the effectiveness of mosquito nets that have been washed can be caused by washing using detergent and washing them. This can reduce the insecticide content in mosquito nets. Likewise, when drying in direct sunlight, the insecticide content in the mosquito net evaporates.

The results of this research are in line with the results of research by Indriyati et al. (2016) in Kotabaru Regency, South Kalimantan, that washing mosquito nets with 95% detergent, drying LLINs in a hot place was 66.67%. Ownership and use of LLIN is high and supports malaria control in Kotabaru Regency, however, the habit of washing insecticide-treated bed nets too often and drying insecticide-treated nets in a hot place can accelerate the risk of loss of insecticide content in the net and can reduce the effectiveness of LLIN usage time (Briet et al., 2020).

Similar research results obtained by Friskarini et al. (2017) in Mariat District, Sorong Regency, West Papua Province in 2017 were the washing behavior of LLINs mosquito nets, as many as 98.6% of respondents in Sorong stated that the mosquito nets would be washed if they were dirty. The behavior of washing mosquito nets by soaking them with detergent, checking and rinsing was 63.0% of respondents. As much as 58.7% respondents have the behavior of drying mosquito nets by drying the mosquito nets directly under sunlight (Friskarini & Ariati, 2017).

Based on observations in the field, most of the mosquito nets used by the community had holes and tears because according to the community they were washed frequently and had been used for a long time. Correct washing of mosquito nets is by washing without using detergent, just dip the mosquito net in water without checking. Proper drying must be protected from the sun or in a shady place. Suggestions require counseling involving cadres and health workers regarding how to wash and dry mosquito nets to maintain the insecticide content in the nets.

If the insecticide-treated mosquito nets are in good condition or not torn, then the existing mosquito nets in the community in the Tarus Community Health Center Work Area can still be used to control Anopheles mosquitoes as malaria vectors. Because it can protect

mechanically, apart from the chemical effects of insecticides.

Factory-made insecticide-treated bed nets (LLINs) distributed to the public are expected to maintain biological activity for a certain period of time. Mosquito nets are processed to store insecticide in the fibers, so that apart from protecting against mosquito bites, they can also weaken/kill mosquitoes when mosquitoes come into contact with the net. It is known that ordinary mosquito nets that do not contain insecticides are also effective, but they only protect the person sleeping in them, they cannot kill mosquitoes (Dye et al., 2010).

Insecticide-based control measures are the primary way to kill biting mosquitoes inside the home. The use of Long Lasting Insecticide Net is generally more effective than ordinary mosquito nets that do not contain insecticides. Long Lasting Insecticidal Nets (LLIN) have played an important role in successfully reducing malaria over the last decade. LLINs are the main means of preventing malaria and are widely used by people at risk. WHO recommends that countries with malaria health problems distribute and teach the use of LLINs to all people at risk (WHO, 2014). Mass distribution of LLINs should be distributed to every person at risk of malaria. The distribution of LLINs must also be accompanied by information about its use and maintenance. Mass outreach is an effective method for achieving widespread and even coverage of objects. This requires the initiative of regional health services where malaria is endemic.

The results of research in Sorong Regency by Friskarini et al. (2017) show that sources of information regarding knowledge related to the benefits of mosquito nets, as many as 56.9% of respondents stated that they received information on the benefits of mosquito nets from health workers. Information from cadres was 37.5% and from family/neighbors was 30.6%. As many as 98.6% stated that the benefits of mosquito nets are to prevent mosquito bites and that the insecticides in LLIN nets are not dangerous for humans but only kill mosquitoes.

Therefore, education is needed involving cadres and health workers regarding how to wash and dry mosquito nets to maintain the insecticide content in the mosquito nets. So that it can increase the use of insecticide-treated bed nets in rural areas and can be accepted by the community as a means of self-protection in avoiding malaria mosquito bites.

In accordance with research results in Mamuju (Harpenas et al., 2017) and South Sumatra (Hasyim et al., 2014), the reflection of awareness of the use of mosquito nets is a form of a person's responsibility for their health. A person's attitude greatly influences their healthy behavior, healthy behavior and people's ability to choose and obtain health services greatly determine the success of Health Development with the mission of making people healthy.

Conclusion

The effectiveness of insecticide-treated bed nets with a usage period of <3 years is still effective in killing *Anopheles subpictus* mosquitoes, while bed nets with a usage period of 3 – 5 years and > 5 years are not effective in killing *Anopheles subpictus* mosquitoes. The effectiveness of insecticide-treated bed nets that have never been washed is effective in killing *Anophles subpictus* mosquitoes, while bed nets that have been washed 1 – 10 times and > 10 times are not effective in killing *Anopheles subpictus* mosquitoes. The effectiveness of insecticide-treated bed nets that have been washed using detergent is not effective against the death of *Anopheles subpictus* mosquitoes.

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In writing this article, the authors do not have any conflict of interest.

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