Artikel Penelitian

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Antenatal Care, Malaria Screening and Anopheles Breeding Habitat Identification as Risk Factor in Pregnant Women Timika, Papua

Novyan Lusiyana[1]*, Fitria Siwi Nur Rochmah[1]

[1]Departemen of Parasitologi, Faculty of Medicine, Universitas Islam Indonesia, Yogyakarta 55584, Indonesia

Kutipan: Lusiyana N., Rochmah FSN. Antenatal care, malaria screening and *Anopheles* breeding habitat identification as risk factor in pregnant women Timika, Papua. ASP. Desember 2024: 15(2): 53–64

Editor: Mara Ipa
Diterima: 25 November 2024
Revisi: 15 April 2025
Layak Terbit: 3 Mei 2025

Catatan Penerbit: Aspirator tetap netral dalam hal klaim yurisdiksi di peta yang diterbitkan dan afiliasi kelembagaan.

Abstract. *Pregnant women are vulnerable to malaria infection, especially in highly endemic regions. Malaria infection in pregnancy can cause fetal growth restrictions and increase the risk of maternal death. This study aimed to perform malaria screening as well as identify maternal and fetal development and environmental factors that contribute to malaria transmission. This was a cross-sectional design. The study was conducted from January to March 2024 at the Naena Muktipura health center, Mimika. Every pregnant woman who visited the health center for ANC was examined in terms of weight, blood pressure, mid-upper arm circumference, fetal heart rate, malaria screening, and larval mosquito surveillance around the house. Malaria screening was done using RDT (Rapid Diagnostic Test). The types of stagnant water were recorded; larvae and larval genus were identified. A total of 14 pregnant women had ANC (Ante natal care); there were 34 ANC examinations within three months. The results of the ANC examination showed that the mothers and fetuses were in normal condition. The compliance to ANC for the pregnant mothers in the first, second, and third trimester was 100%, 75% and 60%, respectively. In fact, 100% of the pregnant women were not infected with Plasmodium, but 6 out of 21 locations of stagnant water around the houses of these pregnant women were confirmed to contain Anopheles sp. larvae. All pregnant women were not infected with Plasmodium, but the house condition and the presence of stagnant water with confirmed Anopheles larvae caused a risk for malaria transmission.*

Keywords: *malaria, pregnancy, antenatal care, breeding site, Anopheles*

Abstrak. *Ibu hamil rentan terhadap infeksi malaria, terutama di daerah endemis tinggi. Infeksi malaria pada kehamilan dapat menyebabkan hambatan pertumbuhan janin dan meningkatkan risiko kematian ibu. Penelitian ini bertujuan untuk melakukan skrining malaria serta mengidentifikasi perkembangan ibu dan janin serta faktor lingkungan yang berkontribusi terhadap penularan malaria. Desain penelitian ini adalah cross-sectional. Penelitian dilakukan pada bulan Januari sampai Maret 2024 di Puskesmas Naena Muktipura, Mimika. Setiap ibu hamil yang datang untuk ANC ke puskesmas diperiksa berat badan, tekanan darah, lingkar lengan atas, denyut jantung janin, skrining malaria, dan pengawasan jentik nyamuk di sekitar rumah. Skrining malaria dilakukan dengan menggunakan RDT (Rapid Diagnostic Test). Jenis genangan air dicatat, larva dan genus larva diidentifikasi. Sebanyak 14 ibu hamil melakukan ANC (Ante natal care), dalam kurun waktu tiga bulan terdapat pemeriksaan ANC sebanyak 34 kali. Hasil pemeriksaan ANC menunjukkan ibu dan janin dalam keadaan normal. Kepatuhan ANC pada ibu hamil trimester I, II, dan III masing-masing sebesar 100%, 75%, dan 60%. Bahkan, 100% ibu hamil tidak terinfeksi Plasmodium, namun 6 dari 21 lokasi genangan air di sekitar rumah ibu hamil tersebut terkonfirmasi positif larva Anopheles sp. Semua ibu hamil tidak terinfeksi Plasmodium, namun kondisi rumah dan keberadaan genangan air yang terkonfirmasi mengandung larva Anopheles menyebabkan risiko penularan malaria.*

Kata Kunci: *malaria, kehamilan, perawatan antenatal, tempat perkembangbiakan, Anopheles*

*Korespondensi Penulis
Email: 107110411@uii.ac.id
Telp: +6281215951712

INTRODUCTION

Pregnancy is a condition that can cause the pregnant woman to be vulnerable to diseases, including infectious diseases. Malaria is a infectious diseases that can cause high mortality in endemic area. Malaria cases in 2023 was estimated at 263 billion all over the world.[1] The World Health Organization estimates 2.7 million pregnant women to be infected with malaria globally.[2] The total estimated pregnancies at risk of malaria in the WHO SEARO (Southeast Asia) region between 2017-2020 was around 52.9 million.[3] Pregnant women living in highly malaria-endemic areas are at risk of infection by Plasmodium with a probability of 33.9%.[4] Besides, the presence of *Anopheles* mosquito breeding sites near the house can increase the risk of malaria infection by 6 times.[5] Based on previous studies, pregnant women living in highly endemic areas are at risk of malaria infection due to the presence of mosquito breeding sites.[6] The breeding sites of *Anopheles* mosquito vary greatly depending on the location of the region. Some mosquitoes can live in brackish water; others can live in stagnant water covered by certain vegetation.[7] Malaria transmission in endemic areas can be affected by various factors, such as larval density, environmental conditions, and climatic factors.[8,9]

To anticipate the risk of *Plasmodium* infection in pregnant women, malaria screening can be performed in every pregnancy in highly endemic regions.[10] The clinical manifestations of malaria in pregnancy in highly endemic regions vary from symptomatic, asymptomatic or subclinical, to severe malaria.[10] One of the signs that pregnant women are infected with *Plasmodium* is weight loss and anemia.[11] Therefore, to monitor these conditions, pregnant women should be examined regularly through antenatal care (ANC). The rules of ANC may vary across countries, but the purpose is the same, i.e., to monitor the condition of the mother and fetus and identify conditions that may increase pregnancy-related risks such as fetal growth disorders and low birth weight.[2,12]

Papua as one of the most remote region in Indonesia, has an ANC compliance proportion of 60,9%, lower than other regions.[13] The Ministry of Health of the republic of Indonesia has issued a direction on ANC, in which pregnant women should have ANC for at least 6 times during the pregnancy.[14] With the issuance of this direction, pregnant women expectedly can monitor their health and the fetus properly. In fact, compliance to ANC can also be affected by several factors including age, marital status, previous birth history, distance to health services, transportation, and cost.[15] A pregnant woman will get quality ANC if it is done regularly.[16] Another challenge is that midwives have not implemented ANC programs properly due to limited resources, the absence of standard procedures, and lack of training.[17]

Antenatal care (ANC) during pregnancy aims to monitor both the mother and the fetus. Good pregnancy monitoring expectedly can prevent pathological conditions that possibly occur during pregnancy. ANC should include the examination of weight gain, fetal condition, identification of other risk factors related to pregnancy such as anemia.[18]

METHODS

Study design

This study used a cross-sectional design. This study received research approval from the health research ethics commission of the Faculty of Medicine, Universitas Islam Indonesia, number: 14/Ka.Kom.Et/70/KE/X/2023.

Study location

This study was conducted from January to March 2024 in Naena Muktipura village, particularly in two locations, namely at the Naena Muktipura health center both during routine ANC and posyandu (integrated health services). The Naena Muktipura health

center is 10 km from the Limau Asri health center and 40 km from the center of Mimika Regency. This health center is located in the middle of Naena Muktipura village; the village is surrounded by forests with large trees, shrubs, swamps, and sago trees. In terms of the population, there are around 1438 people who live in Naena Muktipura village; most of them are male in the productive age and work in the fields.

Population and sample

The subjects of this study were pregnant women who had antenatal care within a period of 3 months (January-March 2024). The sampling method was purposive sampling with the total sampling sample size. The time span was chosen to describe the development of the pregnancy process both in the mother and in the fetus. The study involved pregnant women who met both the inclusion and exclusion criteria. The inclusion criteria were all pregnant women who had antenatal care, willingness to have health checks and malaria screening, and willingness to have home visits. The exclusion criteria were multiple pregnancies, high-risk pregnancies and a history of malaria, post-treatment of malaria in the last 2 weeks.

Antenatal care for pregnant women

Antenatal care (ANC) was done to all pregnant women who visited the health center and posyandu, comprising the examination of vital signs (blood pressure and pulse), weight, mid-upper arm circumference, gestational age monitoring, fetal heart rate. Blood pressure measurement (mmHg) used a digital tensimeter ®Omron, while height (cm) and weight (kg) measurements used ®GEA. Fetal heart rate (times per minute) was measured using ®Bistos. The fundal height was measured using a meter, measured from the upper border of the symphysis pubis to the top of the uterus in cm. The ANC was conducted by the midwife in charge of the health center.

This study assessed the compliance to pregnant women in having ANC. The compliance was analyzed based on age, parity, and gestational age. In terms of age, the pregnant women were categorized into 4 groups: ≤ 20, 20-30, 31-40 and > 40 years. In terms of parity, they were grouped based on the lowest and highest number of gestations, namely 1-6 gestations. In terms of gestational age, they were divided into 3 groups: <12 weeks, 12-28 weeks, and >28 weeks. Non-compliance to ANC was identified if the frequency of ANC had not reached the minimum target as determined by the Ministry of Health according to gestational age.[14] The regularity of ANC was defined as the orderliness of carrying out ANC according to the Ministry of Health regulation, which is a minimum of 6 times during pregnancy with the intensity of frequency according to trimester.[14] Fisher's exact test was to assess the relationship between gestational age and ANC regularity.

Sampling and malaria screening

Malaria screening in the pregnant women were done using thin smear and RDT methods. The tools and materials used for capillary sampling, blood smear test, and RDT consisted of glass object, spreader, drying rack, staining rack, dropper, dry cotton, alcohol cotton, 3% Giemsa stain, absolute methanol, distilled water, lancet pen, lancet, and RDT cassette.

Blood sampling preparation for malaria testing was done by referring to the World health organization.[19] Prior to blood sampling, the lancet pen was filled with a lancet and the puncture depth was adjusted. Capillary samples were taken on the palm-up surface of the fingertip of the middle finger. The fingertip was gently massaged to the distal part, disinfected using alcohol cotton swabs once, and left to dry. Once the alcohol swab had dried, the lancet was inserted into the fingertip until it clicked. The first blood that came out was wiped using an alcohol swab and the next blood that

came out was used for thin smears and RDT tests.

One drop of blood was placed on the tip of the glass object for thin smears, and three drops were placed on another glass object for thick smears. One drop of blood was then smeared by moving the blood using a spreader with an angle of 30o in a forward direction until forming thick and thin sections. Three drops of capillary blood were then mixed to form a circle with a diameter of 1-1.5 cm using the tip of the spreader. Both thin and thick smears were then dried at room temperatures until completely dry. The thin smears were dried for about 1 hour, while the thick smears took longer.

The blood smear was stained after it was completely dry. The thin smears were dripped with methanol absolute until the entire smear was flooded and dried. The thick smears were not dripped with methanol but directly stained with 3% Giemsa. Similarly, the dry thin smears were then stained with 3% Giemsa. After 30 minutes, the thin and thick smears were then rinsed using distilled water, dried at room temperature, then read under a 100x magnification binocular microscope ®Olympus CX23.

Malaria testing using RDT was done by placing the capillary blood on the sample window in the RDT cassette, followed by placing the RDT buffer solution then left for 20 minutes. After 20 minutes, the indicator panel was observed and conclusion was drawn. The presence of more than one line (there is another line other than that on the control panel) means Plasmodium infection is confirmed. The presence of only one line on the control panel means Plasmodium infection is not confirmed. The sampling, smear making, staining, and reading were done by health analysts. If there are any differences in the result between microscopic and RDT examination, the result was refer to microscopic as the gold standard.

Environmental and mosquito surveillance in the neighborhood of the pregnant women

The environmental surveillance was conducted by observing the environment near the house (100 m distance) of the pregnant women to identify any stagnant water. The identification was checked once. Every stagnant water found in this environment was noted; the presence of larval mosquito and their genus were identified, but the number of larval density was not performed. The larval mosquito found were then taken for further examination at the health center for mosquito genus identification using an ®Olympus microscope. The mosquito genus identification was done using the identification key.[20] The environmental surveillance was done by the researcher with the assistance of the health center personnel, particularly those from the environmental health division.

RESULTS

Demographic characteristics and ANC

There were a total of 34 antenatal examinations at the Naena Muktipura health center in Mimika Papua during January to March 2024, which were done to 14 pregnant women. The pregnant women who had ANC were dominantly aged 20-30 years old (71.1%), primigravida (52.9%), and in the first trimester (55.8%) (Table 1). Based on Table 1 it seen that there was no relationship between age and gestational age with ANC regularity ($p>0.05$).

Three pregnant women had ANC only once in a 3-month period, so they did not continue with the measurement of weight gain, mean blood pressure, pulse rate, and MUAC. Eleven pregnant women had ANC more than twice in a three-month period. The examination of the vital signs during ANC, consisting of blood pressure and pulse, showed average results within normal limits (Table 2). The average weight of pregnant

women who had at least 2 ANC within a 3-month period varied; some had a decreasing trend while some had an increasing trend (Table 2). One pregnant woman experienced weight gain >20 kg within 3 months. On the other hand, 36.36% of them experienced weight loss during the three-month period. The weight loss was around 1-2 kg, but the average upper arm circumference was still within normal limits (Table 2).

Table 1. Antenatal care compliance of pregnant women

Characteristic	n (%)	ANC regularity		p
		Yes	No	
Age (year), n=14				
<20	1 (7.1)	1(100)	0	
21-30	10 (71.4)	7(80)	3(20)	0.547
31-40	2 (14.2)	1(50)	1(50)	
>41	1 (7.1)	1(100)	0	
Gestational age (weeks), n=14				
<12	1 (7.1)	1(100)	0	0.680
12-28	8 (57.1)	6(75)	2(25)	
>28	5 (35.7)	3(60)	2(40)	

Table 2. Vital sign and anthropometric examination of pregnant women

Examination	n (%)
Blood pressure, n=14	
Normal	14 (100)
Abnormal	0
Pulse, n=14	
Normal	14 (100)
Abnormal	0
Weight, n=14	
Descend	4 (29.58)
Steady	0
Increase	10 (71.42)
Mid-upper arm circumference, n=14	
Normal	14 (100)

Based on the results of the three-month monitoring, not all pregnant women had regular monthly ANC. Regarding the compliance to ANC, some pregnant women with parity >2 did not have ANC regularly, while all the pregnant women in the first trimester and parity ≤ 2 had ANC regularly. Based on the results of individual analysis, there were 34 antenatal examinations from 14 pregnant women. Four pregnant women with parity >2 who did not have ANC regularly since the beginning of pregnancy; two pregnant women only had ANC once in the third trimester; two pregnant women had ANC 1-2 times in the second trimester.

Obstetric examination and malaria screening

The obstetric examination of the pregnant woman showed normal results. The measurement of the fundal height based on gestational age was within the normal range. Similarly, the measurement of fetal heart rate was within the normal range.

All the pregnant women in this study were not infected with *Plasmodium*. The results of the blood smear test and RDT identified no Plasmodium parasites. In

addition, the pregnant women in this study did not complain of any symptoms of Plasmodium infection such as fever, chills, sweating, headache, and diarrhea.

Environmental surveillance

The environmental surveillance identified stagnant waters near the houses of all the pregnant women (Figure 1 a-b). A total of 21 locations of stagnant water were found, but only 6 (21.4%) of them were confirmed to contain larval mosquito. There were four types of larvae-confirmed stagnant water: ditch, unused water well, fish pond, and stagnant water caused by cow footprint (Table 3). Most of the larvae-containing stagnant water was ditch (50%); most of them were stagnant water that occurred naturally and covered by wild plants such as shrubs.

Table 3. The environmental survey and the mosquito genus identification

Types of water puddles	Total of positive flooding house	Breeding habitat with larvae		Mosquitoe's genus
		Positive	Negative	
Water gutter	14	3	11	*Anopheles, Culex*
Water flow	1	0	1	
Unused well	2	1	1	*Anopheles, Culex*
Fish pond	3	1	2	*Anopheles*
Cow footprints	1	1	0	*Anopheles*
Total	21	6	15	

Figure 1. Water puddles around the house, (a) negative for larvae, (b) positive for larvae

All the larvae found in the six locations of the stagnant water were placed in different larval plastics and labeled for laboratory identification. The identification results showed that there were two genera, namely *Anopheles* and *Culex* mosquitoes. Anopheles mosquitoes were found in four types of stagnant water: ditches, unused wells, fish ponds, and cattle footprints (Table 3). The locations of which were within a radius of 0-200 m from the pregnant women's houses. *Anopheles* larvae were found in all these types of stagnant water, but mostly was in ditch. Stagnant water in ditch was found in front of the house, while that in cow footprints was found in the back yard of the house. *Anopheles* larvae were found in cow footprints and ditch. In fact, there was one *Anopheles*-containing stagnant water that was exposed to direct sunlight (Figure 1a), while the others were covered by shrubs (Figure 1b). There were a lot of vegetation such as aquatic plants in the stagnant water.

Most of the houses of these pregnant women were non-permanent and semi-permanent houses. Non-permanent houses are characterized by walls made of

wood; semi-permanent houses are characterized by part of the walls made of brick and the top of the wall made of wood (Figure 2). Gaps between the wood in the walls had the potential to become the entry of mosquitoes into the house. In addition to houses made from wood, the houses did not have a ceiling, causing many gaps that serve as an entry for *Anopheles* mosquitoes into the house.

Figure 2. Semi-permanent house occupied by pregnant women

DISCUSSION

The results of this study showed that pregnant women with gestational age <12 weeks or in the first trimester had ANC according to the standard.[21] Meanwhile, a study in Uganda showed that compliance to ANC among pregnant women with gestational age <12 weeks (first trimester) was only 36.1%, while this study showed that the compliance to ANC was 100%. Some factors contributing to the compliance to ANC were: distance of the house to the health center, the attitude of health workers when performing ANC, transportation, cost, and knowledge.[15] In terms of distance, the houses of these pregnant women were located around 1-2 km from the village health center in Naena Muktipura Village. This study revealed that such distance increased the compliance of the pregnant women to ANC in Naena Muktipura village because there is a primary health facilitate near the house. This is because one of the factors contributing to compliance to ANC is distance between the house and the health center, in which distance also affects cost and ease of access to transportation.[15] Other factors that also influenced the compliance to ANC in first-trimester pregnant women were marital status and age.[22] Pregnant women with young age tend to have low compliance to ANC.[22] However, this is different from the results of this study, where pregnant women at young age had higher compliance to ANC as scheduled. The low awareness in young age to do ANC was influenced by knowledge,[23] so futher studies are needed to identify about knowledge factors and ANC compliance in young pregnant women in this region.

The results of this study showed that pregnant women with high parity did not have ANC according to the direction specified by the Ministry of Health of the Republic of Indonesia (Kemenkes RI). The Ministry of Health recommends 6 antenatal care visits, divided into three trimesters. Pregnant women who are in the first trimester (gestational age of 0-12 weeks) should have two ANC visits. In the second trimester (gestational age of 12-24 weeks), there should be three ANC visits. In the third trimester (gestational age of >24 weeks-birth), there should be 6 ANC visits.[21]

The lack of ANC visits in this study was found among the pregnant women with >3 parities. This result is in line with other studies showing that the higher the number of children, the lower the compliance to ANC visits according to standards.[24] The non-compliance to ANC among pregnant women in their third trimester may be influenced by motivation to have ANC. A study in Pakistan showed that the motivation to have ANC among pregnant women in the third trimester is to know fetal weight gain and receive supplements, but not to know fetal development.[25] Similar results are shown by a study in Jember, East Java, that pregnant women in the third trimester had low compliance to ANC visits. This is due to lack of knowledge about the importance of ANC for pregnant women.[26] The low number of ANC visits by pregnant women can also result in poor quality ANC.16 A study in Malawi showed that pregnant women who have regular ANC visits since the first trimester and have no less than 6 ANC visits are likely to receive the maximum benefits of ANC.[16] In addition, compliance to ANC also helps monitor the risk of anemia that pregnant women are prone to.[18]

The results of the weight gain measurement in this study showed that 63.64% of the pregnant women experienced weight gain, while the other 36.36% experienced weight loss. During pregnancy, the mothers ideally experience weight gain according to the gestational age. Weight gain in pregnant women is a condition that must occur; for example, there should be weight gain of > 1kg in the second trimester. However, this study found one pregnant woman who had weight gain >20 kg within 3 months. This condition indicated the need for referral to perform further monitoring by an obstetrician.[12,14] Abnormal weight gain in pregnant women is called obesity in pregnancy. This condition can cause various harmful complications for both the mother and the fetus, including diabetes in pregnancy, premature birth, preeclampsia, and hypertension in pregnancy.[27,28,29] This can also affect fetal development; obesity in pregnancy is one of the indications for section secarea.[30]

The results of this study showed that none of the pregnant women in Naena Muktipura village were infected with *Plasmodium sp*. In addition, all of them did not complain of malaria symptoms such as fever, cold, diarrhea, and headache. Malaria screening is highly recommended by the Ministry of Health, especially in highly endemic regions. Negative results of malaria screening do not exclude the possibility of *Plasmodium* infection because in highly malaria-endemic regions, there are many cases of asymptomatic malaria in pregnant women with a prevalence of around 24.10%.[11] Pregnant women with asymptomatic malaria in highly endemic regions have parasitemia that varies from low to moderate parasitemia.[11] Some studies have also shown that 75% of pregnant women with asymptomatic malaria have clinical manifestations of anemia.[11,31] This study, however, did not perform anemia screening on these pregnant women, so a follow-up examination of pregnant women is needed to confirm the presence of asymptomatic malaria. The sensitivity of microscopic and serological examination can also affect the results. Low level of parasite in the blood may not be detected, so further examination with molecular methods was neded.

Unfortunately, the negative results shown on RDT and microscopic examinations in pregnant women have not completely excluded the possibility of *Plasmodium* infection in highly endemic regions. This is in line with a study in Congo which showed that asymptomatic *Plasmodium* infection in pregnant women living in highly endemic regions could not be detected by RDT or microscopic examination. This is because the sensitivity of RDT to detect asymptomatic malaria in pregnant women only ranges from 3.4-9.2%, but the sensitivity of RDT will increase to 83-94%

if the pregnant woman shows symptoms such as fever.[32,33] Another study conducted in another highly malaria-endemic region in Ethiopia showed that only 5.7% of pregnant women with asymptomatic malaria could be detected by microscopic examination.[33] To increase the accuracy of malaria detection in pregnant women, it is more appropriate to use molecular testing rather than microscopic testing or RDT.[34]

The results of this study showed that the living environment of the pregnant women in Naena Muktipura village was an area with a high risk for malaria transmission as characterized by the presence of the breeding sites of *Anopheles* larvae around the houses (0-200m in distance). The mosquito breeding sites were mostly stagnant water emerging naturally, one of which was ditch. This is in line with a study in Ethiopia, which is also a highly endemic area, showing that there are many locations of stagnant water around the residence of pregnant women, which can increase the risk of malaria infection.[6] The presence of stagnant water has the potential to become a breeding site for *Anopheles* mosquitoes, especially in the rainy season.[35] In fact, *Anopheles* larvae in stagnant water need suitable natural conditions to grow.[35] The presence of *Anopheles* larvae in puddles must be supported by suitable natural conditions, for example stagnant water protected by trees and shrubs as also shown in this study.[7]

One of the unexpected breeding sites of *Anopheles* mosquitoes around the houses of the pregnant women was cattle footprint. The cattle footprint had a shallow diameter and depth compared to other types of stagnant water such as ditch, well, and fish pond. However, the stagnant water in the cattle footprint was also surrounded by shrubs and not exposed to direct sunlight, making it a potential breeding site for mosquitoes. *Anopheles* mosquitoes can also live in small amount of stagnant water when the breeding site conditions are suitable for their growth. The ability of *Anopheles* larvae to live in stagnant water in cattle footprint is due to hydromorphic and halomorphic soil,[8] which causes the soil to become saturated and unable to absorb water. In addition, the presence of suitable vegetation is also related to larval presence and larval density because it supports the breeding of Anopheles larvae.[7,36] High larval densities also contribute to a higher potential for malaria transmission, which is also affected by climatic factors.[9] This study was conducted in March, which was the end of the rainy season, so rainfall has decreased and many breeding sites have dried up.

All the pregnant women participating in this study were in good condition and did not suffer from malaria, but they lived in an environment with a high potential for malaria transmission. To prevent malaria transmission in pregnant women, several preventive measures can be taken such as the use of *insecticide-treated nets*.[37] A study in Kenya, which is also a highly malaria-endemic region, found that the use of bed nets among pregnant women can reduce the prevalence of malaria.[38] Beside that medication in some highly endemic area of malaria was needed.[39]

This study has some limitations. The study used a small sample size (pregnant women) during the study period. A high risk of malaria transmission in pregnancy requires intensive monitoring during the pregnancy process, especially regarding the fetal development, so prospective research can provide a more comprehensive picture of the condition of the mother and fetus. Besides, the mosquito larvae were only identified at the genus level, while it is also important to identify *Anopheles* species and *Anopheles* behavior to map preventive measures in accordance with *Anopheles* behavior.

CONCLUSION

The compliance to antenatal care in pregnant women with high parity in highly malaria-endemic region is still low, compared to pregnant women in the first trimester. There are environmental factors that contribute to malaria transmission such as the presence of stagnant water in which Anopheles larvae is confirmed as well as non-permanent and semi-permanent housing conditions. Further efforts are required to identify risk factors for malaria in pregnant women to determine appropriate preventive measures to prevent malaria transmission in pregnant women.

ACKNOWLEDGMENTS

Our gratitude goes to all those who have helped the completion of this study, including the village midwife, and nurses at the Naena Muktipura health center. We would also like to express our gratitude to the health analysts and environmental health officers at the Limau Asri health center, Mimika Papua who assisted us during the mosquito surveillance. We would also like to thank the Research and Community Service Unit of the Faculty of Medicine, Universitas Islam Indonesia for funding this research.

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