Prevalence and Associated Factors of Asymptomatic Malaria among Pregnant Women at Boset District in East Shoa Zone, Oromia Region, Ethiopia, 2022

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Abstract

Background: Malaria is caused by protozoan parasites of the genus Plasmodium infecting red blood cells. Malaria infection during pregnancy is a significant public health problem that puts pregnant women at risk. Due to the asymptomatic nature of malaria patients, diagnosis has been difficult, definitions have been inconsistent, and there has been a general lack of urgency to explore this illness outcome. Because asymptomatic malaria represents a challenge in interrupting transmission in a population and the asymptomatic host serves as a reservoir for the malaria parasite, it is now recognized as a major barrier to malaria elimination. This study aims to assess the prevalence of asymptomatic malaria and associated factors among pregnant women in the Boset District, East Shoa Zone, Oromia, Ethiopia.

Methods: A community-based cross-sectional study was conducted to assess the prevalence and associated factors of asymptomatic malaria in pregnant women from February to March 2022. Using multistage sample techniques, 328 asymptomatic pregnant women were enrolled. Data were collected using a structured questionnaire. A rapid test and Giemsa-stained blood smear microscopy were used to diagnose Plasmodium infections. Epi info version 7 was used to code, enter, and clean data before being uploaded to SPSS version 25.0 for analysis. Bivariable and multivariable binary logistic regression were utilized to find the associated factors.

Results: Of the total 328 pregnant women who participated in this study, 9 (2.74%) and 10 (3.05%) were confirmed to be infected with Plasmodium species by microscopy and rapid diagnostic tests, respectively. Malaria during pregnancy was found to be significantly associated with not using an insecticide-treated bed net [AOR: 9.66; 95% CI: (2.03-45.98), lack of consultation and health education about malaria prevention during Antenatal care attendance [AOR: 4.19; 95% CI: (1.07, 16.44), and living close to stagnant water [AOR: 7.58; 95% CI: (1.06, 18.66).

Conclusions: The current study showed asymptomatic malaria is prevalent in pregnant women. Insecticide-treated bed nets, health education during Antenatal care, and living close to stagnant water had a significant association with malaria. This indicates pregnant women have to be screened for asymptomatic malaria and educated on malaria preventive methods during Antenatal care services.

Background

Malaria is a disease caused by protozoan parasites of the genus Plasmodium, which are transmitted to humans by a feeding female Anopheles mosquito. Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, and Plasmodium malariae are the four human Plasmodium species that are transferred from person to person (1). Increasingly, human infections with the monkey malaria parasite P. knowlesi are being reported from the forested areas of Southeast Asia and in particular from the island of Borneo. Plasmodium falciparum is found in most of the tropical regions of the world and is the most dangerous of the five areas in terms of both its lethality and morbidity (2).

Malaria infection during pregnancy is a significant public health problem that poses a significant risk to the pregnant woman, fetus, and newborn. In sub-Saharan Africa, malaria mainly affects children and pregnant women (3). Malaria is predominantly asymptomatic during pregnancy in these regions of Africa, yet it causes severe maternal anemia and babies with low birth weights. Because of this strong association between low birth weight and child survival, successfully combating malaria during pregnancy could prevent 75,000–200,000 infant deaths each year. Malaria during pregnancy affects the mother, fetus, and neonates (4). It increases the risk of stillbirths, spontaneous abortion, premature delivery, and low birth weight (4,5). In areas with high transmission, malaria is often asymptomatic in adults. This is due to acquired immunity from constant exposure and previous childhood infections (6). This immunity does not cover infection, but it does reduce the risk of serious illness (7). The acquired immunity also protects pregnant women and malaria infections are often asymptomatic. However, pregnant women are still predisposed to malaria and the risk of severe symptomatic disease is higher than that of non-pregnant women (6,7). Although malaria is mostly asymptomatic during pregnancy and serious...
illness is rare, infection with malaria during pregnancy has notable negative consequences, affecting not only maternal health but also birth outcomes (8).

Malaria is one of the most widespread human parasitic diseases that ranks first in terms of its socio-economic and public health importance in the tropical and subtropical regions of the world, particularly in sub-Saharan African and Southeast Asian countries(2,9). As stated by World Health Organization (WHO), approximately 228 million cases of malaria, and the death toll reached 435,000 in 2018. However, malaria still causes a remarkable global burden (10).

In Ethiopia, an estimated 55.7 million people (68% of the population) are at risk of malaria, and three fourth of the landmass is considered malarious(11). The Federal Ministry of Health (FMOH) estimates the annual cases of clinical malaria as 5–10 million, which corresponds to 12% of outpatient consultations and 10% of hospital admissions(12). In the country, P. falciparum and P.vivax are the main species that account for about 60 and 40% of malaria cases, respectively(12), Although recent reports indicate a shift in dominance from falciparum to vivax in highland areas(13,14).

Asymptomatic malaria is a new challenge to the national strategic plan for malaria prevention and control (2011–2015): a situation in which a human Plasmodium reservoir is maintained with individuals who are not treated because they are undiagnosed since they are asymptomatic(15). The use of long-lasting insecticidal nets (LLINs), the administration of intermittent preventive treatment with Artemisinin-based combination therapies (ACTs), and adequate case management through rapid and effective therapy for malaria in pregnant women are the current strategies recommended by The World Health Organization (WHO)(16). Currently, as part of the Antenatal Care(ANC) service package, WHO is working to improve access to ACT for pregnant women in all areas of moderate to high malaria transmission in Africa, but these activities are not used as ANC services to pregnant women in Ethiopia(16).

The presence of asymptomatic infections is less well-known in environments with pronounced seasonality (17). However, in recent years such cases have also been reported from areas with low endemics such as the Amazon basin malaria, as the detection and treatment of all sources of infection is very important at this stage in Brazil, Peru (18), Colombia(19), Solomon Island(20), and Principe(21). Any successful malaria elimination strategy depends on the ability to find and treat the asymptomatic reservoir. The importance of asymptomatic malaria infection in different endemic areas of the world, various studies have assessed the prevalence of asymptomatic infections in the control and elimination phase (22).

Asymptomatic malaria is often observed in both stable endemic areas and unstable transmission areas. However, much attention has been given to acute malaria infections, but relatively little attention has been paid to asymptomatic malaria. Because the asymptomatic host serves as a reservoir for the malaria parasite, therefore, it is now recognized as an important obstacle to malaria elimination and a new challenge for a national strategic plan for malaria prevention and control.

Therefore, this study aims to assess the prevalence and associated factors with asymptomatic malaria parasites in pregnant women and treat those harboring the parasites in the community of Boset District, East Shoa Zone, Oromia, Ethiopia. The results of this study are also expected to be useful in initiating active surveys to identify asymptomatic carriers and treat the infectious parasite reservoirs and will guide policymakers in implementing a malaria eradication program and effective interventions in children's health and helping maternal morbidity and mortality in Ethiopia.

Methods And Materials

Study Area
This study was conducted in Boset District which is located 125 kilometers southeast of Addis Ababa and has a total landmass of 14050.27 square kilometers. It is one of the districts of the East Shewa Zone. The district is bordered on the south by the South Arsi Zone, the north by the North Amhara Regional State, the west by the West Adama District, and the east by the East Fentale District. The elevation of the District was 1050 meters above sea level and 2500 meters above mean sea level. The average annual rainfall and temperature range from 600 to 900 millimeters and 120 to 340 degrees Celsius, respectively. The district has three climate zones: 79 percent low-land "Kola," 20 percent mid-land "Woyinadega," and 1 percent high-land "Dega."

**Study Design And Period**

A community-based cross-sectional study was conducted from February to March 2022.

**Population**

**Source population**

The source population was all pregnant women living in the Boset district, East Shoa zone.

**Study Population**

All pregnant women who live in selected Villages of Boset District.

**Inclusion And Exclusion Criteria**

**Inclusion criteria**

All pregnant women with the absence of disease symptoms/signs of malaria within the past 48 hours, axillaries temperature ≤ 37.5°C, permanent residents in the study area.

**Exclusion criteria**

Pregnant women had taken antimalarial drugs in the last four weeks before the study period.

**Sample Size Determination And Sampling Technique**

The sample size was calculated for both prevalence and associated risk factors using Epi-Info Statcalc version 7. A sample of 149 pregnant women was estimated using the single population proportion, with a 95% confidence level, a 5% margin of error, and a malaria infection rate of 11.2% among pregnant women(26). Using the double population proportion, the sample size was computed for several relevant factors for asymptomatic malaria infection using a 95% confidence level, 80% power, and a 1:1 unexposed to exposed ratio. However, the sample size calculated for objective two was smaller than the sample size calculated for objective one. The final sample size was adjusted by adding a 10% non-response rate, using a design effect of 2, and finite population adjustment, resulting in a total sample size of 328.

A multistage sampling of the study subjects in 6 Study villages, from the known 42 villages in the District, was selected by using a simple random sampling method. The sample size was then distributed proportionally to the villages based on the size of their pregnant women population (Fig. 1).

**Study Variables**
Dependent Variable

Asymptomatic malaria among pregnant women

Independent Variable

Age, Residence, Gestational age, Previous infection with Plasmodium, Living close to stagnant water, Indoor residual spray, use of insecticide-treated bed net, Gravidity, ANC attendance, trimester.

Data Collection Procedures

Socio-demographic characteristics

Pre-tested and semi-structured questionnaires were administered by six (6) trained Nurses and Midwives interviewers to obtain data on socio-demographic characteristics and factors associated with asymptomatic malaria. They were supervised by one health professional with a qualification of BSc degree. The questionnaire was initially prepared in English and it was translated into Afan Oromo, the local language, and back into English by language experts, to check the consistency.

Blood Sample Collection And Processing

Capillary blood samples were collected by finger pricking using a disposable lancet. Giemsa-stained blood smear microscopy and RDTs were employed for the diagnosis of asymptomatic malaria parasitemia at Olenchity Primary Hospital, Olenchity Health Center, and Bole Health Center. Asexual plasmodium parasite density per microliter (µl) of blood was determined by counting the number of parasites per 200 white blood cells on a thick blood film assuming a total standard WBC count of 8000/µl. The degree of parasite density was graded as mild, moderate, and severe when the counts will be between 1–999 parasites/µl, 1000–9999/µl, and > 10,000/µl, respectively, following the method described elsewhere(27).

\[
\text{Parasite/}\mu l = \frac{\text{No. asexual stages} \times 8000 \, \text{Leukocytes}}{200 \, \text{Leukocytes}}
\]

Operational Definitions

- **Asymptomatic malaria**: the absence of malaria-related symptoms within the past 2 days and at the time of the survey, and the presence of malaria parasites in the blood
- **Residents**: An individual that lives in a selected study Village at least for six months before the start of the data collection time frame.

Data quality assurance

Quality Control

Two experienced laboratory technologists individually examined the microscopic slides. Hundred microscopic fields of the thin smear were examined before concluding as negative. The discrepancy between the first and second readings was settled by a third senior laboratory technologist. The manufacturer’s instructions were strictly followed for the RDTs. Blood smear microscopy readers will be blinded to the result of RDTs.

Data quality management
All laboratory materials such as rapid test kits, slides, thermometers, and sample transporting systems were checked by experienced laboratory professionals. The specimens were also checked for a serial number, quality, and procedures of collection. The laboratory professionals involved in RDT and light microscopy examination were trained in malaria diagnosis and quality assurance training. The rapid test kit was checked for the expiration date, correct collection procedures, and samples as well as inbuilt control appearances. Inconsistent results of light microscopy were checked again to confirm the findings.

**Data Processing And Analysis**

Data were coded, entered into, and cleaned using Epi info version 7.2 and transferred to SPSS version 25.0 for analysis. Both descriptive and inferential statistics were employed for the analysis of data. Frequencies were used to determine the prevalence of asymptomatic Plasmodium infection in pregnant women. The Chi-square assumption was checked for all categorical independent variables. Both bi-variable and multi-variable logistic regressions were used to assess the association between outcome and explanatory variables. Factors with p-value $\leq 0.25$ from the bi-variable model were included in the final model. Variables having a p-value $< 0.05$ from the multivariable model were considered as having a statistically significant association with the outcome. An adjusted Odds ratio with 95% CI was used as a measure of association. The model goodness of fit was assessed using the Hosmer-Lemeshow test.

**Dissemination Of Results**

After conducting the research, results will be presented to the SPHMMC/Department of public health, EFETP Program, Boset district, research symposiums, scientific conferences, and meetings in both hard copy and electronic soft copy. The manuscript will be submitted to peer-reviewed journals for publication.

**Results**

**Socio-demographic, Obstetric, and malaria prevention methods characteristics of the pregnant women**

This study included a total of 328 pregnant women, with 252 (76.8%) of them living in rural areas. Participants in the study ranged in age from 16 to 36 years old, with a mean age of 25.52 ± 4.74 years. The majority of study participants were farmers 192(58.5%) and 314(95.7%) were married. About 219 (66.8%) of respondents owned at least one mosquito bed net, and 179 (54.6%) of them sleep under mosquito nets the previous night. Only 134 (40.9%), of the households, had Indoor Residual Spray (IRS) in the last 12 months. About 27.7% of the pregnant women were multigravidae, 47.3% of them were in their second trimester of pregnancy, and the majority 84.8% of them were following antenatal care (Table 1).

**Prevalence of malaria infection among asymptomatic pregnant women**

The prevalence of asymptomatic plasmodium infection was 9(2.74%) [95% CI: (1, 4.5)] and 10(3.05%) [95% CI: (1.2, 4.9)] by using microscopy and RDTs, respectively. The density of parasitemia, as determined from the thick blood smear, ranged from 790 to 5600 parasites $/\mu l$. The geometric mean of parasite density among the 7 parasitemic pregnant women was 3528.6$/\mu l$ [95% CI: (3310–3750)]. The majority of the study participants who were diagnosed with malaria cases had moderate parasitemia 5(71.4%), while 2(28.6%) had mild parasitemia (Table 1).

**Factors associated with asymptomatic Plasmodium species infection**

Socio-demographic characteristics, Obstetric characteristics, and other health-related factors were analyzed using bivariable binary logistic regression for the possible association. Then, gravidity, ITN utilization, ITN ownership, consultation about malaria prevention methods during ANC attendance, and Living close to stagnant water were variables that showed a possible association with Plasmodium infection at a P-value of $\leq 0.25$ and fit for multivariable logistic regression analysis.
In multivariable logistic regression analysis, ITN utilization, consultation about malaria prevention methods during ANC attendance, and living close to stagnant water had a statistically significant association with asymptomatic Plasmodium species infection at P-value < 0.05 after adjusting for possible confounders. This study also found that pregnant women who did not utilize ITN had 9.66 times [AOR: 9.66; 95% CI: (2.03, 45.98)] higher chance of having asymptomatic Plasmodium infection than those who did. Pregnant women who lived near stagnant water had 4.45 times [AOR: 4.45; 95% CI: (1.06, 18.66)] greater odds of having asymptomatic Plasmodium species infection than those who did not live near stagnant water. In addition, pregnant women who did not receive malaria prevention education during their ANC follow-up had a 4.19-fold higher risk of malaria infection than their counterparts [AOR: 4.19; 95% CI: (1.07, 16.44)] (Table 2).

Table 1: Socio-demographic characteristics and malaria prevention methods in boset district, Ethiopia, 2022

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency</th>
<th>Percent (%)</th>
<th>Variables</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
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<tbody>
<tr>
<td>Age groups in years</td>
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<td>Residence</td>
<td></td>
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<tr>
<td>15-19</td>
<td>38</td>
<td>11.6</td>
<td>Rural</td>
<td>252</td>
<td>76.8</td>
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<td>20-24</td>
<td>102</td>
<td>31.1</td>
<td>Urban</td>
<td>76</td>
<td>23.2</td>
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<td>25-29</td>
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<td>36.9</td>
<td>Gravidity</td>
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<td>30-34</td>
<td>52</td>
<td>15.9</td>
<td>Primigravidae</td>
<td>131</td>
<td>39.9</td>
</tr>
<tr>
<td>≥35</td>
<td>15</td>
<td>4.6</td>
<td>Secondigravidae</td>
<td>106</td>
<td>32.3</td>
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<td>Occupational status</td>
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<td>Gestational age</td>
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<tr>
<td>Daily wage laborer</td>
<td>51</td>
<td>15.5</td>
<td>1st trimester</td>
<td>104</td>
<td>31.7</td>
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<tr>
<td>Farmer</td>
<td>192</td>
<td>58.5</td>
<td>2nd trimester</td>
<td>155</td>
<td>47.3</td>
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<tr>
<td>Government</td>
<td>23</td>
<td>7.0</td>
<td>3rd trimester</td>
<td>69</td>
<td>21.0</td>
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<tr>
<td>Private</td>
<td>48</td>
<td>14.6</td>
<td>ANC Attendance</td>
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<tr>
<td>Other</td>
<td>14</td>
<td>4.3</td>
<td>Yes</td>
<td>278</td>
<td>84.8</td>
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<tr>
<td>Educational status</td>
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<td>50</td>
<td>15.2</td>
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<td>No formal education</td>
<td>102</td>
<td>31.1</td>
<td>ITN Ownership</td>
<td></td>
<td></td>
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<tr>
<td>Primary School</td>
<td>125</td>
<td>38.1</td>
<td>Yes</td>
<td>219</td>
<td>66.8</td>
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<tr>
<td>College/University</td>
<td>27</td>
<td>8.2</td>
<td>No</td>
<td>109</td>
<td>33.2</td>
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<td>Marital Status</td>
<td></td>
<td></td>
<td>ITN Utilization</td>
<td></td>
<td></td>
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<tr>
<td>Single</td>
<td>2</td>
<td>0.6</td>
<td>Yes</td>
<td>179</td>
<td>54.6</td>
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<tr>
<td>Married</td>
<td>314</td>
<td>95.7</td>
<td>No</td>
<td>149</td>
<td>45.4</td>
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<tr>
<td>Separated</td>
<td>5</td>
<td>1.5</td>
<td>IRS Use(past 1yrs)</td>
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<td></td>
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<tr>
<td>Divorced</td>
<td>7</td>
<td>2.1</td>
<td>Yes</td>
<td>134</td>
<td>40.9</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>No</td>
<td>194</td>
<td>59.1</td>
</tr>
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</table>

Table 2: Bivariable and Multivariable analysis of associated factors for asymptomatic Plasmodium species infection among pregnant women at Boset district, 2022 (N=337)
<table>
<thead>
<tr>
<th>Variables</th>
<th>Malaria status</th>
<th>COR(95% CI)</th>
<th>P-value</th>
<th>AOR(95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative (%)</td>
<td>Positive (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multigravidae</td>
<td>88(96.7%)</td>
<td>3(3.3%)</td>
<td>0.76[0.16,3.43]</td>
<td>0.722</td>
<td>1.13[0.22,5.80]</td>
</tr>
<tr>
<td>Primigravidae</td>
<td>129(98.5%)</td>
<td>2(1.5%)</td>
<td>0.23[0.04,1.34]</td>
<td>0.103</td>
<td>0.22[0.03,1.37]</td>
</tr>
<tr>
<td>Secondigravidae</td>
<td>101(95.3%)</td>
<td>5(4.7%)</td>
<td>1</td>
<td>1</td>
<td></td>
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<tr>
<td>ANC attendance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>46(92%)</td>
<td>4(8%)</td>
<td>0.019[0.05,0.74]</td>
<td>0.017</td>
<td>4.19[1.07,16.44]</td>
</tr>
<tr>
<td>Yes</td>
<td>272(97.8%)</td>
<td>6(2.2%)</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ITN ownership</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>108(99.08%)</td>
<td>1(0.92%)</td>
<td>0.05[0.006,0.46]</td>
<td>0.008</td>
<td>0.21[0.02,1.77]</td>
</tr>
<tr>
<td>Yes</td>
<td>210(95.9%)</td>
<td>9(4.1%)</td>
<td>1</td>
<td>1</td>
<td></td>
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<tr>
<td>ITN utilization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>142(95.3%)</td>
<td>7(4.7%)</td>
<td>10.45[2.49,43.79]</td>
<td>0.001</td>
<td>9.66[2.03,45.98]</td>
</tr>
<tr>
<td>Yes</td>
<td>176(98.3%)</td>
<td>3(2.7%)</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IRS use in the last year</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>No</td>
<td>187(96.4%)</td>
<td>7(3.6%)</td>
<td>2.21[0.53,9.18]</td>
<td>0.25</td>
<td>2.21[0.52,9.34]</td>
</tr>
<tr>
<td>Yes</td>
<td>131(97.8%)</td>
<td>3(2.2%)</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Living close to stagnant water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>269(97.8%)</td>
<td>6(2.2%)</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>49(92.5%)</td>
<td>4(7.5%)</td>
<td>4.46[1.16,17.15]</td>
<td>0.029</td>
<td>4.45[1.06,18.66]</td>
</tr>
</tbody>
</table>

**Discussions**

This study assessed the prevalence of asymptomatic malaria infection and associated factors among pregnant women in the Boset district, Oromia region, Ethiopia. This study showed that malaria infection was found to be significantly associated with ITN utilization, consultation about malaria prevention methods during ANC attendance, and living close to stagnant water.

In the present study, the prevalence of asymptomatic Plasmodium infection among pregnant women was 2.74% and 3.05% by using Giemsa-stained blood smear microscopy and RDT, respectively. This finding is lower compared to the results of similar studies conducted in the Republic of Congo (7%) (28), the rural district surrounding Arbaminch town, Ethiopia (9.1%) (25), and the global scenario (10.8%) (29). The study was done in South-West Nigeria (7.7%) (30), Southern Laos (8.3%) (31), and India (5.4%) (32) were all higher than the current study. The low prevalence of asymptomatic malaria infection among pregnant women in this study could be due to increased malaria control interventions in Ethiopia or the difference in malaria epidemiology between the study areas. The present study was conducted during a minor malaria transmission season which could also contribute to the lower prevalence of asymptomatic malaria infection among pregnant women reported in this study.

On the other hand, the prevalence of asymptomatic malaria infection documented in this study is similar to the findings of a study conducted in Bangladesh, which reported a 2.3% prevalence of malaria among pregnant women (33), and in Merti district, Oromia, Ethiopia (3.6%) (34). We may have underestimated the prevalence of asymptomatic malaria infection since we did not use molecular tools that can identify submicroscopic Plasmodium infection.

In this study, 77.78% of the cases were caused by P. falciparum species. This result was almost in line with the study conducted in Ethiopia which showed 65–75% of malaria infections are caused by P. falciparum (35). However, our result was higher than the study done in the Merti district, which was 46.2% (34). This high proportion of this malaria species in our...
study is a clear implication that there is a need for aggressive prevention and control of the disease, especially among pregnant women. Because P. falciparum causes the most severe form of the disease and it can cause devastating complications not only for the mother but also for the fetus. This finding also suggests that early screening of pregnant women is necessary for the early detection and treatment of cases to avoid problems. In contrast, the proportion of malaria cases caused by P. falciparum in our study was lower than the WHO malaria 2017 report, which stated that P. falciparum was responsible for almost 99% of malaria cases(2). The cause for these variations might be owing to significant seasonal, inter-annual, and geographical variability. Large climate changes (temperature, rainfall, and relative humidity), human habitation, and population mobility patterns could possibly be to blame.

In this study, not using ITN increases the odds of developing malaria infection during pregnancy. The findings of this study were also consistent with those of studies conducted in Malawi(36), Nigeria [30], Arbaminch, Ethiopia(25), and Sherkole district, West Ethiopia(37), all of which found that using bed nets significantly reduced malaria infection. This association could be explained by the fact that ITNs successfully minimize human-mosquito contact, which can help to prevent illnesses. In this study, we discovered that some people used ITNs for purposes other than mosquito prevention, such as storing maize temporarily rather than using them at night.

Pregnant women who lived near stagnant water were more likely to have an asymptomatic malaria infection than those who did not live near stagnant water. This is in line with research undertaken in Ethiopia's West Arsi Zone(38) and the Southwestern part of Ethiopia(39). This could be because stagnant water is ideal for malaria vector breeding, and those who live near stagnant water are more susceptible to the disease. Getting a consultation and health education about malaria prevention methods during ANC follow-up significantly reduced the risk of malaria infection during pregnancy, according to our research. In research conducted in other locations in Ethiopia, a similar link was discovered(37,40). The efficient use of antimalarial and other intervention measures is ensured by health education and counseling, specifically on the preventive and control program of malaria during pregnancy. The current study has its own limitations, such as the lack of a direct temporal association due to the use of a cross-sectional study design. Due to a lack of resources, this study was unable to diagnose all subjects using real-time PCR, and the data was collected during the minor transmission season. As a result, the prevalence of asymptomatic malaria in our study may be underestimated.

Conclusions

The present study showed asymptomatic malaria is prevalent in pregnant women and P. falciparum is the most predominant Plasmodium species in the area. Factors such as lack of ITN utilization, living close to stagnant water, and absence of consultation about malaria prevention methods during ANC attendance were the main associated factors of asymptomatic malaria infection among pregnant women.

The Health Facility should be screening pregnant women for asymptomatic Plasmodium infection and providing timely malaria treatment as part of the ANC care package. Such activities protect not just pregnant women but also the fetus and neonates from malaria-related morbidity and mortality. The District Health Office and health extension workers should be directed to work to increase ITN distribution in the community. The District Health Office should also focus on reducing or eradicating malaria breeding sites through community participation. In areas where light microscopy is unavailable, RDTs can be used to accurately diagnose asymptomatic malaria. Furthermore, greater research into more sensitive diagnostic technologies for malaria diagnosis, such as PCR, is recommended.

Abbreviations

ACT : Artemisinin-based Combination Therapies

AOR : Adjusted Odd Ratio

ANC : Antenatal Care
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Author Contributions

Fufa Balcha designed the study, developed the proposal, participated in the data collection, performed analysis and interpretation of data, and drafted the paper. Takele Menna and Fantu Lumbabo assisted in the design of the study, proposal writing, data analysis, and interpretation of the study and fufa Balcha carried out the manuscript preparation. Both authors reviewed and approved the final manuscript.

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Availability of data and materials

The data upon which the result is based could be accessed as a reasonable request.

Ethics Approval

The study protocol was approved by the Institutional Review Board (IRB) of St. Paul’s Hospital Millennium Medical College and the permission letter was also obtained from East Shoa Zone. Then this letter was delivered to the Boset District Health office and the respective villages. The purpose and importance of the study were explained to the participants and since the majority of our study participants cannot read and write, written consent was obtained from each participant above the age of 18. Participants under the age of 18 additionally need permission from their parents or guardians. Blood smears were taken by experienced laboratory technicians under an aseptic technique using sterile gloves and disposable sterile lancets. Codes were used to ensure the confidentiality of Laboratory results. Pregnant women with positive for malaria parasite were linked to the nearest health facilities for treatment according to the national malaria guideline.

Consent for publication

Not applicable.

Competing interests

Both authors declared that they have no competing interests.

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Figures
Figure 1

Flow chart indicating the sampling procedure for a study conducted on asymptomatic malaria among pregnant women in Boset District, Oromia, Ethiopia, 2022.