The Bioscientist Journal Vol. 13 (2): 39 – 48, December 2025
Journal of the Faculty of Biosciences, Nnamdi Azikiwe University, Awka, Nigeria
Available online at http://www.bioscientistjournal.com
DOI 10.54117/the_bioscientist.v13i2.191



OPEN ACCESS

Full Length Research Article

MALARIA DURING PREGNANCY AND EFFECTS ON WHITE BLOOD CELL COUNTS: A STUDY OF PREGNANT WOMEN IN A MAJOR TERTIARY INSTITUTION IN ABA, ABIA STATE, NIGERIA

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***Article History**: Received: 6th November, 2025 Accepted: 23rd December, 2025*

Abstract

Malaria remains a major mosquito-borne public health concern in Nigeria, and pregnant women are particularly vulnerable due to altered immunity. A cohort study was conducted to understand the effect of malaria on white blood cell counts among pregnant women in Aba metropolis, Abia state. Blood samples were collected from consented pregnant women to test for malaria parasites using Giemsa stained thick and thin films. Full blood count was done to determine their haematological parameters. Low and high white blood cell counts was defined as WBC<$6.0x10^3$µL and WBC > 12-16 $x10^3$ µL respectively according to WHO standard. Data on absolute lymphocytes, monocytes and granulocytes were also collected. Semi-structured questionnaires were administered to the women to obtain information on their socio-demographic and obstetric data. Out of a total of 225 pregnant women examined, 34 tested positives resulting to 15.1% prevalence. Age related prevalence showed that women in their late reproductive age, 45-54 years had the highest rate (23.8%) of malaria infection, while women in their mid-reproductive age 35-44 years had the lowest rate (9.3%); though there was no statistical association (χ^2=1.259, *P*=0.739). Malaria prevalence in relation to gravidity varied significantly among the study participants (χ^2=14.306, *P*<0.0001) as primigravid women showed a higher rate 16(17.2%) than the multigravidae 18(13.6%). Women in their first trimester showed a significantly higher prevalence rate (21.6%) than women in their second 1(14.6%) and third trimesters 6(8.7%) (χ^2=15.193, *P*<0.0001 and χ^2=9.085, *P*=0.011 respectively). The mean values of total WBC count, lymphocytes and granulocytes were

shown to be higher in the malaria infected participants than in the non-infected group except for the monocyte counts. Differences in the mean values were statistically significant ($p<0.05$) with exception to total WBC count and granulocytes (P=0.131 and P=0.063 respectively). Malaria during pregnancy is linked with an increase in total and differential white blood cells among pregnant women, even though they are still within normal range. These findings are useful for malaria diagnosis, prognosis and guiding therapeutic interventions.

Keywords: Malaria, white blood cells, pregnant women, Aba, south-eastern Nigeria

Introduction

Pregnancy brings significant changes in a woman's body including alterations in the blood composition (Huffman, 2025). It may trigger an increase in white blood cell (WBC) production to protect the mother and the baby from infections (Mckenzie, 2005). This is a normal physiological response, however, certain conditions such as severe infection, anemia, autoimmune diseases, chronic inflammation, gestational diabetes or hypertension may contribute to a high WBC (Baird, 2009). Malaria in pregnancy can occur in any locality in which transmission of *Plasmodium* occurs. According the World Health Organization's (WHO) report in 2021, among the estimated 33.8 million pregnancies that occur worldwide annually, 34% (11.6 million) were exposed to malaria infection in sub-Sahara Africa alone. Pregnancy associated with malaria is responsible for maternal anemia and low birth weight, both increasing the risk of maternal and infant mortality (Stephen *et al*., 2003). Studies have shown that pregnant women with malaria often exhibit a higher total WBC count compared to non-infected pregnant women, although WBC may remain within the normal reference range in most cases (Obebe *et al*., 2018: Ogbodo *et al*., 2018; Ejike *et al*., 2022). Specific white blood cell differentials such as neutrophils, eosinophils, and lymphocytes may also be affected. White blood cell quantitative abnormalities may impact the estimation of parasites densities in population-based studies and therefore in the interpretation of particular interventions (Jadhav *et al*., 2003). Furthermore, it has been a widely accepted assumption that these WBC count variations are similar in all four human *Plasmodium* infections. However, the relationship between WBC count abnormalities and the determination of parasites densities needs to be specially evaluated according to each particular region or epidemiological settings (Modiano *et al*., 2001). Malaria in human leads to muscle weakness, muscle fatigue, respiratory distress, kidney and liver failure and can lead to cardiac myopathies (Ogbodo *et al*., 2009). These severe complications can be linked to skeletal muscle damage, besides the more readily recognized effects on erythrocytes and leucocytes (Igbeneghu and Odaibo, 2013). The pathogenesis and clinical significance of these hematological abnormalities deserve further evaluation (Iqba, 2010). Remarkably few published studies have compared WBC counts in malarial parasite-infected and uninfected pregnant women in Aba metropolis, Abia State. This study was aimed to understand the association between

malaria and changes in white blood cell counts among pregnant women attending antenatal care in Aba metropolis, Abia state.

Materials and Methods

Study Area

The study was conducted in Aba South Local Government Area, Abia State. Aba South is one of the seventeen Local Government Areas in Abia State, South-East Nigeria, with a total area of about 49km^2 and a population of 423,852 as at 2006 census (NPC, 2006). It lies between Longitude 5.06°- 5.10°N and Latitude 7.21°- 7.35°E of the equator. The main occupation of the inhabitants is trading and farming with a few civil servants. Flooding is widespread in the rainy season creating breeding sites for mosquitoes and ideal transmission conditions for malaria.

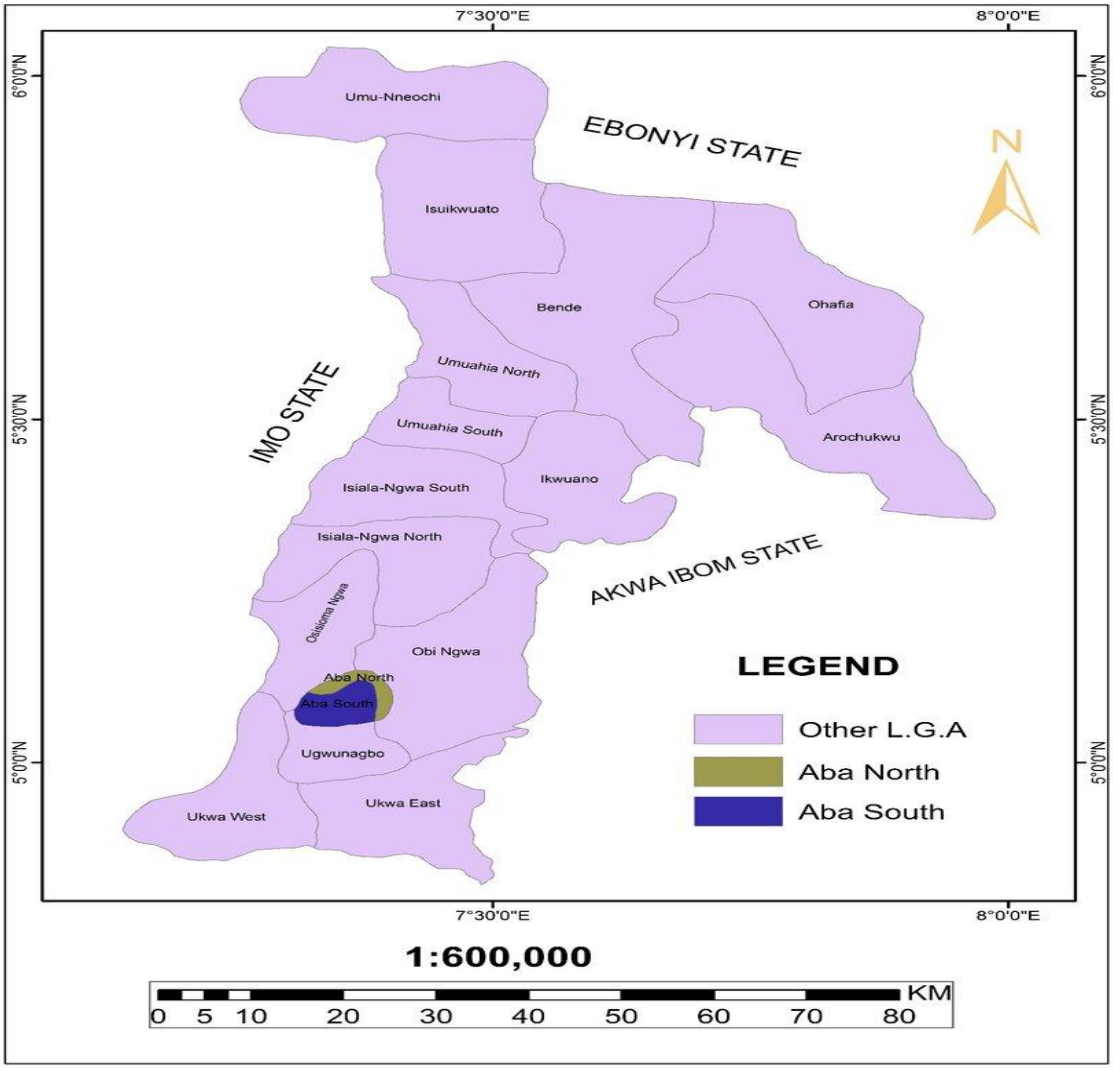


Fig 1: Map of Abia State, showing Aba South and Aba North

Study Design
The research has a cohort study designed with the primary interest of investigating how exposure to a risk factor, malaria affects the primary outcome, white blood cell counts among pregnant women in Aba metropolis, Abia state.

Sample Size Determination
Sample size was determined using the Cochran's sample size formula

$$\text{Sample size} = \frac{z^2 * p * (1-p)}{e^2}$$

where..,
z represents the z-score, using a confidence level of 95%
p represents population proportion (540) and
e represents the margin error (5%)

Study Population/ Selection Of Study Participants
Two hundred and twenty-five (225) pregnant women of different parity, gravidity and trimester; who attended Abia State Teaching Hospital Aba for their routine antennal care were randomly selected for the study.

Inclusion and Exclusion Criteria
Only pregnant women between the ages 15 and 54years were enrolled for the study. Pregnant women who were sick, or supposed pregnant women believed to be in their very early stage, who could not remember their last menstrual period, and have not confirmed their status through pregnancy test were excluded from the study.

Ethical Approval
Ethical approval was obtained from the Chairman, Ethical Committee Abia State Teaching Hospital, Aba (Reference Number:
ABSUTH/MAC/117/VOL.1/56).
Participation in the research was voluntary as participants could decline to participate or withdraw from participation after giving consent at any stage of the research. The participants were briefed on the nature of the research and those who were willing gave their informed consent and filled the questionnaire.

Blood and Data Collection
Venous blood sample of each study participant was collected into EDTA tubes for preparation of the thick and thin films and for determination of complete blood counts (CBCs). The blood samples were used for the screening of malaria parasitaemia and other haematological parameters. Structured questionnaire was administered to each pregnant woman to obtain socio-demographic and obstetrical data (age, level of education, gestation age and gravidity).

Laboratory Procedures
Thick and thin blood smears from each of the study individuals were made on grease-free slides and stained with 10% Giemsa stain (1:10 dilutions, buffered at pH 7.2). Thick smear was done to determine the parasite density while thin smear was done to determine species of malaria parasites (Cheesbrough, 2009). All stained slides were examined by microscopy and read by two competent microscopists using ×100 power fields under oil immersion. Complete blood count was carried out using Sysmex XP-300™ automated hematology analyzer (Sysmex corporation, Kobe, Japan) with strict adherence to the manufacturer instruction. Low white blood cell count was defined as WBC<$6.0x10^3$µL while high white blood cell counts was defined

as WBC >12-16 x10^3 µL (depending on trimester) according to World Health Organization standard.

windows. Test of statistical significance was done using Chi-square test to analyze malaria parasite prevalence in relation to the socio-demographic characteristics of the participants. For

Statistical Analysis

Data generated were entered into Excel spreadsheet (Microsoft 2007) and imported into SPSS version 21 (IBM corporation, Chicago, USA) software for the continuous variables (hematological parameters), student's t–test was used to compare the mean values between the two groups (malaria infected and non-infected participants).

Results

Out of a total number of two hundred and twenty-five (225) pregnant women examined for the study, 34 (15.1%) tested positive for malaria parasite in the study area. *Plasmodium falciparum* was the only species identified in all the malaria cases. From the result in Table 1, age related prevalence revealed that women in their late reproductive age, 45-54 years had the highest rate of malaria infection, 5(23.8%) while women in their mid-reproductive age 35-44 years had the lowest rate, 8(9.3%). Prevalence, however, did not vary significantly with respect to their ages (χ^2=1.259, *P*=0.739). Malaria prevalence in relation to gravidity varied significantly among the study participants (χ^2=14.306, *P*<0.0001) as first-time gravid women showed a higher rate, 16(17.2%) than the multigravidae, 18(13.6%). Majority of the participants were in their second trimester (82/225), nevertheless, women in their first trimester showed a significantly higher prevalence rate (21.6%) than women in their second 1(14.6%) and third trimesters 6(8.7%) as shown in Table 2 (χ^2=15.193, *P*<0.0001 and χ^2=9.085, *P*=0.011 respectively. The mean values of total WBC count, lymphocytes and granulocytes were shown to be higher in the malaria infected participants than in the non-infected participants, although values remained within the normal range, however, the mean monocyte counts were lower in the malaria infected participants than in the non-infected group. Differences in the mean values were statistically significant (p<0.05) except for the total WBC count and granulocytes (*P*=0.131 and *P*=0.063 respectively).

Table 1: Age-related prevalence of malaria among the study participants

Age (years)	Number Examined	Number Positive (%)
15-24	64	9 (14.1)
25-34	54	12 (22.2)
35-44	86	8 (9.3)
45 -54	21	5 (23.8)
Total	**225**	**34(15.1)**

Table 2: Prevalence of malaria in relation to gravidity and trimesters

Variable	Categories	Number Examined	Number positive (%)
Gravidity	Primigravidae	93	16 (17.2)
	Multigravidae	132	18 (13.6)
Trimester	First	74	16 (21.6)
	Second	82	12 (14.6)
	Third	69	6 (8.7)
Total		**225**	**34(15.1)**

Table 3: Hematological profile of the study participants

Haematological Parameters ($x10^3/\mu L$)	Malaria infected	Malaria negative	t -value	P- value
Total WBC	8.33±0.94	8.07±1.02	1.518	0.331
Lymphocytes	2.36 ± 0.22	2.16± 0.54	9.867	<0.0001
Monocytes	0.61±0.41	0.72±0.32	-2.357	0.024
Granulocytes	4.59± 0.63	4.44± 0.92	-1.872	0.063

Discussion

Malaria during pregnancy has deleterious impact not only on pregnant women but also on the fetus (WHO, 2014). Studies have shown that malaria infection can alter white blood cell count as being low, normal or high (McKenzie *et al*., 2005). An overall malaria prevalence of 15.1% was obtained. This result is higher than the report of Agomo *et al*. (2009) who observed a prevalence of 7.7% among pregnant women attending ante-natal clinic in Lagos, southwest, Nigeria but lower than the report of Umeanaeto *et al*. (2022) with a prevalence of 21.3% in Awka and Okoye *et al*. (2024) with a prevalence of 27.5% in Enugu-Ukwu both among pregnant women in southeast, Nigeria. Prevalence rate of malaria observed in the study area may be attributed to inadequate use of preventive measures such as insecticide treated bed nets (ITNs), poor living/environmental condition which favors the breeding of *Anopheles* mosquito that facilitates malaria transmission (Huffman, 2025). From the result, age related prevalence revealed that women in their late reproductive age, 45-54 years had the highest rate of malaria infection while women in their mid-reproductive age 35-44 years had the lowest rate. Statistical insignificance on the rate of infection with respect to age groups may suggest that all pregnant women of all age groups are exposed to mosquito bites, mostly due to their lifestyle and/or poor environmental conditions (van Eijk *et al*., 2003) as majority of cases of malaria in pregnancy in the country are asymptomatic and untreated (Ukibe *et al*. 2016). Malaria prevalence in relation to gravidity varied significantly among the

first-time gravid women than the multigravidae. This result is comparable to the works of Stekette (2001) who reported that multigravida pregnant women acquire immunity from previous infections and may have also experienced physiological changes caused by pregnancy. This could be attributed to the production of antibodies against infected placental erythrocytes in gravidity dependent and this mechanism of protection is often absent in the first and sometimes second pregnancies (Enato *et al*., 2007). In areas endemic for malaria, it is estimated that at least 25% of pregnant women are infected with malaria, with the highest risk for infection and morbidity in primigravid adolescents (Desai *et al*., 2007). Susceptibility to malaria is usually high in the first pregnancies especially in young primigravidae. This is characterized by accumulation of parasitized red blood cells in the placenta (Cutts *et al*., 2020). From the study, women in their first trimester showed a significantly higher prevalence rate than those in their second and third trimesters. This could be due to the fact that women in their first trimester could have just had their first antenatal visit and were yet to be administered sulfadoxine-pyrimethamine (SP) used as the intermittent preventive treatment (IPT) advocated for women at their second and third trimesters (Okafor *et al*., 2019) supporting the need for ante-partum care as part of malarial prevention and treatment efforts (Warimwe *et al*., 2013).

The mean values of total WBC counts, lymphocytes and granulocytes in the study were shown to be higher in the malaria infected participants than in the non-infected participants. This finding agrees with the works of Osaro *et al*. (2019) and Foghi, *et al*., (2021) but contradicts the works of Sahle *et al*. (2017) and Kotepui *et al*. (2014) who observed that the mean hematological profiles were lower in participants with malaria infection than those without malaria infection. Leukocytosis is typically reported in a fraction of cases and may be associated with concurrent infections (Ozougwu, 2018) increasing at roughly the same time that fever begins (Ogbodo *et al*., 2018), nevertheless, alterations in the total WBC counts among malaria positive participants in this study remained within normal limits.

Neutrophils and lymphocyte counts are the most important leukocytic changes associated with malaria infection. It has been suggested that neutrophils play major roles in the pathology of the liver during *Plasmodium spp.* infections (Rocha *et al*., 2015). The increase in lymphocyte counts associated with malaria observed in this study may due to redistribution of lymphocytes with sequestration in the spleen (Erhart *et al*., 2004). The increase in neutrophil count associated with malaria infection suggests an activated neutrophil production or release from the bone marrow (Chua *et al*., 2015).

Conclusion

The consequences of malaria in pregnancy are severe both to the mother and her unborn child. This study demonstrates that malaria infection correlates with an increase in total and differential white blood cell counts among pregnant women in the study area, although mean values remain within normal limits. These dynamics are useful for malaria diagnosis, prognosis and guiding therapeutic interventions. For further studies, white blood cell counts

in relation to parasite density and variability in relapse pattern could be assessed.

References

Agomo, C. O., Oyibo, W. A., Anorlu, R. I. and Agomo, P.U. (2009). Prevalence of malaria in pregnant women in Lagos, Southwest Nigeria. *Korean Journal of Parasitology*, 47(2):179-183

Baird, J. K. (2009). Malaria zoonoses. *Travel medicine and infectious disease* 7(5): 269–77.

Cheesbrough, M. (2009). District Laboratory Practice in Tropical Countries, vol.1 2, part 1-2, Cambridge University Press, Edinburg Building, UK

Chua, C. L., Robinson, L. J., Baiwog, F., Stanisic, D. I., Hamilton, J. A., Brown, G.V. Rogerson, S. J. and Boeuf, P. (2015). High numbers of circulating pigmented polymorphonuclear neutrophils as a prognostic marker for decreased birth weight during malaria in pregnancy. *International Journal of Parasitology*. 45:107–11.

Cutts, J. C., Agius, P. A., Zaw, L., Powell, R., Moore, K., Draper, B., Simpson, J. A. and Fowkes, F. J. I. (2020). Pregnancy specific malarial immunity and risk of malaria in pregnancy and adverse birth outcomes: a systematic review. *BMC Medicine* 18 :14

Desai, M., O ter Kuile, F., Nosten, F., McGready, R., Brabin, B. and Newman, R. D. (2007). Epidemiology and burden of malaria in pregnancy. *The Lancet infectious Diseases*, 7(2):93-104

Ejike, B. U., Ukpai, O. M., Ihemanma, C. A., Ajuga, M. U. and Eme, G. F. (2022). Impact of malaria infection on the haematological profile of pregnant women in southeastern, Nigeria. *Nigerian Journal of Parasitology.*43(1): 78-84

Enato, E., Okhamafe, A., Okpere, E., and Oseji, F. (2007). Prevalence of Malaria during Pregnancy and Antimalarial Intervention in an Urban Secondary Health Care Facility in Southern Nigeria. *Medical principles and Practice*; 16(3): 240–3.

Erhart, L. M., Yingyuen, K., Chuanak, N., Buathong, N., Laoboonchai, A., Miller, R. S., Meshnick, S. R., Gasser, R. A. Jr. and Wongsrichanalai, C. (2004). Hematologic and clinical indices of malaria in a semi-immune population of western Thailand. *American Journal of Tropical Medicine and Hygiene*, 70:8–14.

Foghi, B.O., Nduka, F.O. and Nzeako, S.O. (2021). Effect of malaria on some haematological parameters among pregnant women in Delta state, Nigeria. *International Journal of Tropical Diseases and Health*; 42(16):21-29

Huffman, J. W. (2025). Pregnancy. *Encyclopaedia Britannica*

Editors. Health and Medicine. Accessed 25th November, 2025

Igbeneghu, C. and Odaibo, A. B. (2013). Impact of Acute Malaria on Some Haematological Parameters in a Semi-Urban Community in Southwestern Nigeria, IDOSI Publications, *Acta Parasitologica Globalis,* 4(1): 1-5

Iqbal, W. (2010). Hematological manifestations in malaria. *Haematology Update*. 2:35–37.

Jadhav, U. M., Singhvi, R. and Shah, R. (2003). Prognostic implications of white cell differential count and white cell morphology in malaria. *Journal of Postgraduate Medicine*, 49:218-221

Kotepui, M., Phunphuech, B., Phiwklam, N., Chupeerach, C., Duangmano, S. (2014). Effect of malaria infection on haematological parameters in population near Thailand-Myanmar border. *Malaria Journal*; 13:218

McKenzie, F. E., Prudhomme, W. A., Magill, A. J., Forney, J. R., Permpanich, B., Lucas, C., Gasser, R. A., Jr. and Wongsrichanalai, C. (2005). White blood cell count and malaria. *The Journal of Infectious Diseases*, 192(2): 323-330

Modiano, D., Sirima, B. S. Konate, Sanou, I. and Sawadogo, A. (2001). Leucocytosis in severe malaria. *Transactions of the Royal Society of Tropical Medicine and Hygiene*.95: 175-176

Obebe, O. O, Falohun, O., Olajuyigbe, O. O., Lawani, M., Ajayi, O. (2018). Impact of asymptomatic *Plasmodium falciparum* on haematologcal parameters of pregnant women at first antenatal visit in south-western, Nigeria. *Tanzania Journal of Health Research* 20(2): 4

Ogbodo, E., Ezeugwunne, I., Eze B., Njoku, C., Oguaka, V., Amah, A., Akunneh-Wariso, C., Ejiofor, D., Iheukwumere, C., Ebere, M. (2018). The effect of malaria on some haematological parameters of pregnant women in Nnewi Anambra State, Nigeria. *International Journal of Development Research*, 8(10):23353-23358

Ogbodo, S. O., Nwagha, U. I., Okaka, A. N., Ogenyi, S. C., Okoko, R. O. and Nwagha, T. U. (2009). Malaria parasitaemia amongst pregnant women in a rural community of eastern Nigeria; Need for combined measures. *Nigerian Journal of Physiological Science*, 24:95-100.

Okafor, I. P., Ezekude, C., Oluwole, E. O., and Onigbogi, O. O. (2019). Malaria in pregnancy: A community-based study on the knowledge, perception and prevention among Nigerian women. *Journal of Family Medicine and Primary care*, 8(4): 1359-1364

Okoye, C. R, Umeanaeto, P. U, Umeh, S. O, and Obijiofor, E. O. (2024). Association of Malaria in Pregnancy to Socio-Demographic Factors and Utilization of Preventive Measures in Awka Metropolis,

South-Eastern, Nigeria. *South Asian Journal of Parasitology*, 7 (2):152–164.

Osaro, E., Abdulrahaman, A. and Erhabor, T. (2019). Effect of malaria parasitaemia on some haematological parameters of pregnant women of African Descent in specialist hospital Sokoto, North Western Nigeria. *JOJ Nurse Health Care*; 10(4):555795

Ozougwu (2018). Changes in White Blood Cells Differentials associated with adult malaria-infected patients. *Journal of Advances in medical and pharmaceutical sciences* 16(1): 1-5

Rocha, B. C., Marques, P. E., Leoratti, F. M. S., Junqueira, C., Pereira, D. B. and Antonelli, L. (2015). Type I interferon transcriptional signature in neutrophils and low-density granulocytes are associated with tissue damage in malaria. *Cell Reports*. 13:2829–41.

Sahle, T., Yemane, T. and Gedefaw, L. (2017). Effect of malaria infection on hematological profiles of people living with human immunodeficiency virus in Gambella, southwest Ethiopia *BMC Hematology* 17:2

Schantz-Dunn, J. and Nour, N. M. (2009). Malaria and pregnancy: a global health perspective. *Reviews in Obstetrics and Gynecology*, 2(3):186-92

Steketee, R. W. (2001). The burden of malaria in pregnancy in malaria-endemic areas. *American Journal of Tropical Medicine and Hygiene*, 64(2):28-35.

Stephen, S. J. Pollina E., Getachew, A., Taesse, E., Lema, V. M. and Molyneux, M. E. (2003). Placental monocyte infiltrates in response to *Plasmodium falciparum* malaria infection and their association with adverse pregnancy outcomes. *American Journal of Tropical Medicine and Hygiene* 68: 115-119

Ukibe, S. N., Ukibe, N. R., Mbanugo, J. I. and Ikeakor, L. C. (2016). Prevalence of malaria among pregnant women attending antenatal clinics in hospitals in Anambra State, south-east, Nigeria. *Nigerian Journal of Parasitology* Volume 37(2): 240-244

Umeanaeto, P. U., Odagwe, C., Onwuagana, I. C., Irikannu, K. C., Onwuachusi, G. L., Akulue, J. C. and Afulukwe, S. C. (2022). Malaria Parasitemia and Anemia Among Pregnant Women Attending General Hospital, Enugwu-Ukwu, Southeastern Nigeria. *International Journal of Pathogen Research,* 11 (1-2):1–7.

Van Eijk, A. M., Ayisi, J. G., Ter Kuile, F. O. Misore, A. O. Otieno, J. A., Rosen, D. H., Kager, P.A., Steketee, R. W. and Nahlen, B. L. (2003). "HIV increases the risk of malaria in women of all gravidities in Kisumu, Kenya," *AIDS*, 17(4), 595–603,

Warimwe, G. M. Murungi, L. M., Kamuyu, G., Nyangweso, G. M., Wambua, J., Naranbhai, V., Fletcher, H. A., Hill, A.V.S.,

Bejon, P., Osier, F.H., and Marsh, K. (2013). The ratio of monocytes to lymphocytes in peripheral blood correlaes with increased susceptibility to clinical malaria in Kenyan children. *PLoS ONE*, 8(2)

World Health Organization (2014). Malaria. Fact Sheet Accessed 12th December, 2025.

World Health Organization (2021). World Malaria Report 2021. Accessed 12th November, 2025.