Original Research Article

Plasmodium falciparum infection and Associated Risk Factors in Pregnant Woman attending Bafang District Hospital, Semi-Rural area, West Region of Cameroon: A cross-sectional study

ABSTRACT

Background: Malaria is a major public health problem in countries with limited resources. This morbid and fatal infection mainly affects vulnerable groups with weak immunity, such as children and pregnant women. In pregnant women, malaria leads to the occurrence of anaemia with the consequences of abortion, low birth weight (LBW) of the child and death of the baby. The objective of this study was to determine the *Plasmodium falciparum* (*P. falciparum*) infection and associated risk factors among pregnant women attending the Bafang District Hospital (BDH).

Methods: A hospital based quantitative cross-sectional and descriptive study were conducted from May 30th, to June 24th, 2022 among 156 pregnant women attending the BDH, West Region of Cameroon. All pregnant women consented to participate in the study without any constraint. Blood samples were collected, thick film and stained blood smear examined for Plasmodium trophozoites and gametocytes respectively. Statistical analyses were performed using Epi Info version 7 software with any p-value<0.05 considered statistically significant.

Results: The age of the study participants ranged from 14 to 48 years (mean age of 27.41 ± 6.67 years). Of the 156 pregnant women tested, 25% (95% CI: 18.42%-32.55%) were infected with *P. falciparum*, a species found in the blood. *P. falciparum* infection was high in pregnant women aged < 30 years (66.67%), in non-salaried (82.05%), in pregnant women in the second trimester of pregnancy (48.72%) with no difference statistically significant (p-value<0.05). Furthermore, the use of mosquito nets (OR= 3.88, 95% CI: 1.78-8.43, p-value=0.0003), taking intermittent preventive treatment (IPT) (OR= 2, 95, 95% CI: 1.31-6.59, p-value=0.006) and the number of IPT doses (p-value=0.0006) were risk factors statistically associated with *P. falciparum* infection.

Conclusion: This study revealed a high prevalence of *P. falciparum* among pregnant women attending BDH. The use of mosquito nets, the taking of IPT were the factors statistically associated with the infection.

Keywords: *P. falciparum,* infection, risk factors, pregnant women, BDH

1. INTRODUCTION

Malaria is the most widespread parasitic disease worldwide mainly in sub- Saharan African (SSA) such as Cameroon. The disease is caused by intracellular erythrocyte parasites of the genus Plasmodium and transmitted to human by the bite of female Anopheles mosquitoes [1]. Of note, there

are five different human malaria species worldwide such as *P. falciparum*, *P. vivax*, *P. malariae*, *P. knowlesi* and *P. ovale* with *P. falciparum* as main species found in SSA [2]. Low and middle-income countries of Asia, Western pacific and SSA bear the brunt of the disease with high prevalence [1]. Of the 91 countries recording malaria cases worldwide, around 80% of the total cases were from SSA countries [3]. An estimated about 229 million cases and 409,000 deaths worldwide in 2019 [4]. Malaria leads to the occurrence of anaemia which can have serious consequences in pregnant women, the foetus and the new-born [5]. This anaemia which could lead to hypoxia in the tissues, LBW with risk of neonatal death. Moreover, the anaemia could lead to a decrease in immunity, abortion, intrauterine growth retardation, premature delivery and increase the risk of death in the mother [5-6]. According to the WHO, about 11.6 million (34%) pregnancies exposed to malaria infection in the WHO African Region, which resulted in 900,000 to LBW, 25,000 maternal deaths, and 100,000 neonatal deaths [7]. Confronted with this situation, the intermittent preventive treatment of malaria with sulfadoxine pyrimethamine (IPT-SP) in all pregnant women attending the antenatal care (ANC) for the first time, the use of the long-lasting impregnated mosquito net (LLIMN) and the hygiene of the surroundings of the endemic areas such as Cameroon [7].

Despite all its prevention measures and the national malaria control program set up, the prevalence of malaria in Cameroon has been reported at 30.3% with more than one million cases and about 10,000 deaths recorded each year in health facilities [8]. Malaria is the first reason for consultation, the main cause of death among children and pregnant women in health facilities in Cameroon. According to the 2018 world report, the WHO estimates 6,228,154 cases and Cameroon is among the eleven SSA countries most affected by malaria [4]. Moreover, several studies have found high prevalence of malaria in pregnant women attending ANC in the North-West region in 2020 by Calvin et al., [9] and by Anchang et al. [10] in the South-West region with 18.0% and 16.0% respectively. However, data on the characteristics of malaria in pregnancy are sparse, particularly in rural areas, and it is an obstacle for adequate control strategies planning and implementation. The aim of this study was to determine the *P. falciparum* infection and associated risk factors among pregnant women attending the BDH in the semi-rural area West region of Cameroon.

2. MATERIALS AND METHODS

2.1 Study population and design

We conducted a hospital based quantitative cross-sectional and descriptive study during one month (May to June) period among 156 pregnant women attending BDH, West region of Cameroon. BDH is located in the town of Bafang, capital of haut Nkam division, West-Cameroon. Bafang is a cosmopolitan city with more than 62. 800 inhabitants with agriculture and trade as activities. Data were collected using a standard questionnaire with dependent variable such as malaria infection status and independent variable such as age, matrimonial status, economic conditions, level of education, gestational age, and sector of activity.

Fig 1. Map showing the localisation of study site [11]

2.2 Blood sample collection and laboratory procedure

The search for the plasmodial species was performed using a capillary blood. Pregnant women's finger was cleaned with 70% ethyl alcohol and the side of fingertip was pricked with a sterile lancet. The first drop of blood which contains tissue fluids was wiped away. One µl and 2 µl of blood were used for preparation of thin and thick blood films, respectively. The prepared blood films were air dried and thin films were fixed with absolute methanol (95%). The smears were then stained by 10% giemsa stain during ten minutes and examined under light microscope following standard operating procedures. A negative result was reported after checking at least 50 oil immersion fields. Thick blood films were used for parasite detection and thin blood films were used for species identification.

2.3 Statistical analysis

Data collected and laboratory results obtained were entered in an Excel sheet and analysed using Epi-Info version 7.0. Chi-square or Fisher's exact tests was used to evaluate differences in proportions. Meanwhile, Odds Ratios (OR) were calculated to compare the susceptibility of individuals or groups to different parameters. The level of significance was set at p-value$<$0.05.

3. RESULTS

3.1 Baseline characteristics of study population

This study included consecutively a total of 156 pregnant women consulting the BDH. The age of the participants ranged from 14 to 48 years, with a mean age of 27.41 years (Standard Deviation ± 6.67), and a median age of 28 years (IQR: 23-32). The majority of participants, were under 30 years old (64.10%), were single (40.38%), were self-employed (76.92%), had a secondary level (82.05%), were in the second trimester of pregnancy (41.03%) and 76.28% had a secondary sector of activity **(Table 1).**

Table 1. Baseline characteristics of Study population

Variables	Total (N=156)	Percentage (%)
Age (min-max: 14-48 years)		
< 30 years	100	64.10
≥ 30 years	56	35.90
Matrimonial status		
Single	63	40.38
Cohabiting	44	28.21
Divorced	2	1.28
Married	47	30.13
Economic conditions		
Salary	36	23.08
No salary	120	76.92
Level of education		
No formal education	2	1.28
Primary	4	2.56
Secondary	128	82.05
Higher	22	14.10
Age of pregnancy		
First trimester	54	34.62
Second trimester	64	41.03
Third trimester	38	24.36
Activity sector		
Primary	13	8.33
Secondary	119	76.28
Tertiary	24	15.38

3.2 Distribution of associated risk factors among study population

Regarding the associated risk factors, the majority of participants were not on intermittent preventive treatment (55.77%), 56.42% had no IPT dose, 73.08% did not use a mosquito net **(Table 2)**.

Table 2. Distribution of associated risk factors among study population

Variables	Total (N=156)	Percentage (%)
Intermittent Preventive Treatment (IPT)		
No	87	55.77
Yes	69	44.23
Number of doses (IPT)		
No dose	88	56.42
One dose	63	40.38
Two doses	4	2.56
Three doses	1	0.64
Use of the mosquito net		
No	42	26.92
Yes	114	73.08
Stagnant water around the house		
No	98	62.82
Yes	58	37.18

%: Percentage

3.3 Distribution of *P. falciparum* prevalence among study population

Out of 156 pregnant women included in this study, 25% (n=39, 95%CI: 18.42-32.55) were infected **(figure 2).**

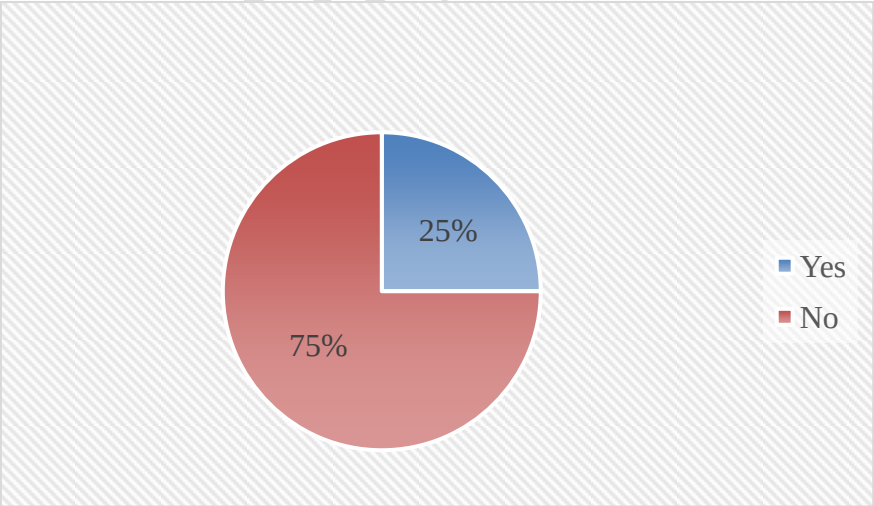

Fig 2. Prevalence of *P. falciparum* among study population

3.4 Distribution of *P. falciparum* infection among study population

Table 3 shows a high prevalence of *P. falciparum* in pregnant women aged less than 30 years (66.67%) vs. 33.33% for those aged 30 and over (p-value=0.69). Regarding economic conditions, the prevalence of *P. falciparum* was four times higher in non-salaried pregnant women (82.05%) vs. 17.95% for employees (p-value=0.51). Pregnant women with a level of education (secondary) were

more infected with 87.18%, followed by those with a higher level (10.26%), p-value=0.71. In addition, participants in the first second trimester of pregnancy were more infected (48.72%) vs. 33.33% and 17.95% for those in the first and third trimester respectively (p-value=0.44).

Table 3. **Distribution of *P. falciparum* infection among study population**

Variables			***P. falciparum* Infection**					
	Total		Yes		No		Khi-square	p-value
	N=156	%	n= 39	%	n=117	%		
Age (min-max: 14-48 years)								
< 30 years	100	64.10	26	66.67	74	63.25	0.14	0.69
≥ 30 years	56	35.90	13	33.33	43	36.75		
Marital status								
Single	63	40.38	13	33.33	50	42.74	1.97	0.58
Cohabiting	44	28.21	13	33.33	31	26.50		
Divorced	2	1.28	0	0	2	1.71		
Married	47	30.13	13	33.33	34	29.05		
Economic conditions								
Salary	36	23.08	7	17.95	29	24.79	0.77	0.38
No salary	120	76.92	32	82.05	88	75.21		
Level of education								
No formal education	2	1.28	0	0	2	1.71	1.38	0.71
Primary	4	2.56	1	2.56	3	2.56		
Secondary	128	82.05	34	87.18	94	80.34		
Higher	22	14.10	4	10.26	18	15.38		
Age of pregnancy								
First trimester	54	34.61	13	33.33	41	35.04	1.65	0.44
second trimester	64	41.03	19	48.72	45	38.46		
Third trimester	38	24.36	7	17.95	31	26.5		
Activity sector								
Primary	13	8.33	3	7.69	10	8.55	2.40	0.29
Secondary	119	76.28	33	84.62	86	73.50		
Tertiary	24	**15.**38	3	**7.**69	21	**17.**95		

%: Percentage

3.5 Distribution of *P. falciparum* infestation and associated risk factors

It appears from this distribution that pregnant women on intermittent preventive treatment (IPT) were less infected (25.64%) vs. 74.36% for those who did not take IPT (OR=2.95; 95% CI: 1.31-6.59, p-value=0.006) **(Table 4)**. *P. falciparum* infection varied significantly depending on the number of IPT doses, going from 76.92% for zero doses to 2.57% for those who took three doses (p-value=0.0001). Strangely, the infestation was slightly high among participants who used the mosquito net with 51.28% vs. 48.72% for those who did not use (OR=3.88; 95% CI: 1.78-8.43, p-value=0.0003) **(Table 4)**.

Table 4. Distribution of *P. falciparum* infestation and associated risk factors

Variables			*P. Falciparum* Infestation					
	Total		Yes		No		Khi-square	p-value
	N=156	%	n= 39	%	n=117	%		
Intermittent Preventive Treatment (IPT)								
No	87	55.77	29	74.36	58	49.57	7.28	**0.006**
Yes	69	44.23	10	25.64	59	50.43		
Number of doses (IPT)								
No dose	88	56.42	30	76.92	58	49.57	21.99	**0.0001**
One dose	63	40.38	5	12.82	58	49.57		
Two doses	4	2.56	3	7.69	1	0.86		
Three doses	1	0.64	1	2.57	0	0		
Use of the mosquito net								
No	42	26.92	19	48.72	23	19.66	12.55	**0.0003**
Yes	114	73.08	20	51.28	94	80.34		
Stagnant water around the house								
No	98	62.82	24	61.54	74	63.25	0.03	0.84
Yes	58	37.18	15	38.46	43	36.75		

4. DISCUSSION

In Cameroon, Malaria still remains a major public health problem. This quantitative, cross-sectional study was performed to determine the *P. falciparum* infection and associated risk factors among pregnant women attending the BDH, West region of Cameroon. Out of 156 pregnant women recruited, 39 were infected with a prevalence of 25% (95%CI: 18.42-32.55) **(figure 2)**. Compared with previous studies conducted in Cameroon, this result is higher than those observed by Calvin et al., (2020) in the North-West region, Anchang et al. (2015) in the South-West region and Tonga et al., (2013) in Sanaga-Maritime who found the prevalence of 18.0% 16.0% and 22,9 % respectively [9, 10, 12]. Meanwhile, this finding is lower than that observed by the WHO in 2018 which found a prevalence of malaria of 30.3% with more than one million cases and about 10,000 deaths recorded each year in health facilities in Cameroun [8]. Moreover, several studies conducted in Cameroon reported a high prevalence of malaria among pregnant women in West and North region with 39.4% (95%CI; 33.5-45.5) and 53.4% respectively [13,14]. This result could be justified by the geolocation of Cameroon, classified as a zone of high malaria endemicity. This high prevalence could also be explained by the fact that pregnant women are more vulnerable to infections because of their immune depression caused by pregnancy. Compared to other endemic countries in SSA, it appears that the prevalence of malaria in Cameroon is high. Several studies conducted among pregnant women in Africa have found

high prevalence of malaria in Zambia (31.8%) [15], in Navrongo, Ghana (42.0%) [16]. This difference may be due to the difference in study period, type of study, and sample size.

Regarding socio-demographic factors, none have been associated with *P. falciparum* infestation in pregnant women (Table 3). These results are contrary to those of Judith et al. [10] and Girma et al. [17] who found that age, stage of pregnancy, economic factors and marital status are associated with *P. falciparum* infestation. This difference could be due to the small size of our sample. In this study, pregnant women in the first and second trimester of pregnancy were more infected than those in the third trimester (p-value= 0.44). This result corroborates with studies conducted in the Republic of Ethiopia by Almaw et al. [18], Tilahun et al. [19] and Girma et al. [17] which found that pregnant women in the first trimester of pregnancy had an increased risk of having malaria than women in the third trimester.

Multivariate analysis of factors associated with malaria in pregnant women in this study showed a statistically significant association between intermittent preventive treatment and *P. falciparum* infection. Women on IPT were less infected, 25.64% vs. 74.36% for those without IPT (OR= 2. 95; 95% CI: 1.31-6.59, p-value=0.006) meaning that pregnant women who did not take IPT are three times more likely to be infected. In addition, the incomplete dose of IPT was found to be associated with the development of malaria. Our results showed that the infection with *P. falciparum* decreased drastically according to the number of doses thus going from 76.92% in pregnant women without doses of IPT to 2.57% in pregnant women who were on their third dose of IPT (p-value=0.0001) meaning that IPT has a positive impact on reducing malaria in pregnant women. Similar results were reported in a clinical study that the prevalence of malaria in pregnant women was associated with non-use of Fansidar during pregnancy for IPT [20, 21]. Several studies have shown that preventing malaria infection with IPT in pregnancy reduces the risk of anaemia [22, 23]. Alarming fact, the use of the mosquito net was statistically associated with the infection but with a high prevalence among pregnant women who declared using the mosquito net, with 51.28% vs. 48.72% for those who declared not using the mosquito net (OR=3.88; 95% CI: 1.78-8.43, p-value=0.0003). In the first hand, this result could be justified by the type of study (cross-sectional study) and the statements given by the pregnant women in the study because we did not conduct in-depth investigations with pregnant women to verify these statements. Secondly, this result could be explained by the use of mosquito nets by these pregnant women. Of note, the most widely used interventions to prevent malaria in pregnancy are insecticide-treated bed nets, including long-lasting insecticide-treated bed nets (LLINs) and IPT in pregnancy. These interventions have shown a considerable reduction in morbidity and mortality due to malaria in children and pregnant women. Furthermore, these interventions were associated with a decrease in maternal parasitaemia and a reduction in maternal anaemia. [24, 25, 26].

5. CONCLUSION

Malaria remains a real public health problem in Cameroon despite the measures put in place to fight against the disease. Vulnerable population such as pregnant women and children are groups at risk. The present study reported a *P. falciparum* prevalence of 25% (95%CI: 18.42-32.55) among pregnant women attending the BDH. This prevalence was high in pregnant women aged under 30 years old, in the self-employed, in those with a secondary education, in those in the second trimester of pregnancy

and in those in the secondary sector, with no statistically significant difference. However, the risk factors statistically associated with the development of malaria during pregnancy were the administration of intermittent preventive treatment as methods of malaria prevention and the use of mosquito nets.

CONSENT AND ETHICAL APPROVAL

Research proposal was approved by the Ethics Committee of the Regional Delegation of Public Health for the Centre Region, Yaounde-Cameroon and Ethic clearance was issued (Identification: CEN°451CRERSHC/2022 from 15 April 2022). Both official's language (French and English) were used to explain the objectives of the study. Only volunteer pregnant women who signed an informed consent form for their participation and that of their newborn were enrolled. Participants found infected were referred to clinicians of the health facility concerned for appropriate treatment.

REFERENCES

1. WHO**.** World Health Organisation. World malaria report 2020: 20 years of global progress and challenges. Geneva: Licence: CC BY-NC-SA 3.0 IGO. World Health Organization 2020; 2020:18–34.

2. Oddoux O, Debourgogne A, Kantele A, Kocken C, Jokiranta T, Vedy S, et al. Identification of the five human *Plasmodium* species including *P. knowlesi* by real-time polymerase chain reaction. Eur J Clin Microbiol Infect Dis. 2011; 30(4):597–601. https://doi.org/10.1007/s10096-010-1126-5 PMID: 21161559

3. WHO. World Health Organisation. World malaria report 2016. 2016

4. WHO. World Health Organization. World malaria report 2019 World health organization 2019.

5. Eisele TP, Larsen DA, Anglewicz PA, Keating J, Yukich J, Bennett A, Hutchinson P, Steketee RW. Malaria prevention in pregnancy, birthweight, and neonatal mortality: a meta-analysis of 32 national cross-sectional datasets in Africa. Lancet Infect Dis. 2012 Dec;12(12):942-9. doi:

6. Dombrowski JG, de Souza RM, Lima FA, Bandeira CL, Murillo O, de Sousa Costa D, et al. Association of malaria infection during pregnancy with head circumference of newborns in the Brazilian Amazon. JAMA 2019; 2(5):193–300. https://doi.org/10.1001/jamanetworkopen.2019.3300 PMID: 31050780

7. WHO. World Health Organisation. World malaria report 2021. https:// www. who. int/ publi catio ns/i/item/ 97892 40040 496 (2021). Accessed March 14th, 2022.

8. WHO. World Health Organisation. World malaria report 2018. Geneva: World Health Organization; 2018. Licence:CCBY-NC-SA3.0

9. Calvin Bisong Ebai, Felicite Natacha Etindele Ebongue, Odelia Kwende-Tanjong Lum, Jammbe Z. Musoro, Cedric Yamssi and Helen Kuokuo Kimbi. Plasmodium falciparum Parasitaemia during Pregnancy and the Use of Malaria Prevention Methods by Women Attending Antenatal Consultation at the Regional Hospital Bamenda, Northwest Cameroon. *International Journal of Tropical Disease & Health. 41(20): 46-56, 2020; Article no.IJTDH.63874 ISSN: 2278–1005, NLM ID: 101632866*

10. Judith K. Anchang-Kimbi, Vera Ngenwie Nkweti, Helen Ngum Ntonifor, Tobias O. Apinjoh, Rolland Bantar Tata, Hanesh Fru Chi, Eric Akum Achidi (2015) Plasmodium falciparum parasitaemia and

malaria among pregnant women at first clinic visit in the mount Cameroon Area Anchang-Kimbi et al. BMC Infectious Diseases, 15:439 DOI 10.1186/s12879-015-1211-6
11. https://mapcarta.com/fr/W894942019/Carte accessed September 10th, 2022
12. Tonga C, Kimbi HK, Anchang-Kimbi JK, Nyabeyeu HN, Bissemou ZB, Lehman LG.
Malaria risk factors in women on intermittent preventive treatment at delivery and their effects on pregnancy outcome in Sanaga-Maritime, Cameroon. PLoS ONE. 2013;8:e65876.
13. Ngouyamsa N. A. Sidiki, Vincent Khan Payne, Yamssi Cedric, Noumedem A. C. Nadia, "Effect of Impregnated Mosquito Bed Nets on the Prevalence of Malaria among Pregnant Women in Foumban Subdivision, West Region of Cameroon", Journal of Parasitology Research, vol. 2020, Article ID 7438317, 10 pages, 2020. https://doi.org/10.1155/2020/7438317
14. Felix Amate Elime, N. Rene Nkenyi, Luis Ako-Egbe, Ann Njunda and Dickson Nsagha. Malaria in Pregnancy: Prevalence and Risk Factors in the Mamfe Health District, Cameroon
Journal of Advances in Medicine and Medical Research. 30(1): 1-11, 2019; Article no. JAMMR.49667 ISSN: 2456-8899
15. Chaponda EB, Chandramohan D, Michelo C, Mharakurwa S, Chipeta J, Chico RM. High burden of malaria infection in pregnant women in a rural district of Zambia: a cross-sectional study. Malar J. 2015;14:380.
16. Berry I, Walker P, Tagbor H, Bojang K, Coulibaly SO, Kayentao K, et al. Seasonal dynamics of malaria in pregnancy in West Africa: evidence for carriage of infections acquired before pregnancy until first contact with antenatal care. Am J Trop Med Hyg. 2018;98:534–42.
17. Girma Bekele Gontie, Haileab Fekadu Wolde, Adhanom Gebreegziabher Baraki (2020) Prevalence and associated factors of malaria among pregnant women in Sherkole district, Benishangul Gumuz regional state, West Ethiopia BMC Infectious Diseases https://doi.org/10.1186/s12879-020-05289-9
18. Almaw A, Yimer M, Alemu M, Tegegne B (2022) Prevalence of malaria and associated factors among symptomatic pregnant women attending antenatal care at three health centers in north-west Ethiopia. PLoS ONE 17(4): e0266477.https://doi.org/10.1371/journal.pone.0266477
19. Tilahun A, Yimer M, Gelaye W, Tegegne B. Prevalence of asymptomatic Plasmodium species infection and associated factors among pregnant women attending antenatal care at Fendeka town health facilities, Jawi District, North west Ethiopia: A cross-sectional study. PLoS ONE 2020;15(4):0231477. pmid:32315341
20. Azubike K, Lucky O, Chukwuemeka A, Chukwudi R, Nwabunike E. Adherence to intermittent preventive treatment for malaria with sulphadoxine-pyrimethamine and outcome of pregnancy among parturients in South East Nigeria. Patient Preference and Adherence. 2014;8:447– 51.
21. Bako BG, Audu BM, Geidam AD, Kullima AA, Ashiru GM, Malah MB, et al. Prevalence, risk factors and effects of placental malaria in the UMTH, Maiduguri, North-eastern, Nigeria: A cross-sectional study. J Obstet Gynaecol. 2009;29(4):307–10.
22. Wilson NO, Ceesay FK, Obed SA, Adjei AA, Gyasi RK, Rodney P, Ndjakani Y, Anderson WA, Lucchi NW, and Stiles JK, Intermittent preventive treatment with sulfadoxine-pyrimethamine against

malaria and anemia in pregnant women. Am J Trop Med Hyg. 2011; 85(1): 12-21. http://dx.doi.org/10.4269/ajtmh.2011.10-0512 PMid:21734118 PMCid:3122337

23. Gies S, Coulibaly SO, Ouattara FT, and D'Alessandro U, Individual efficacy of intermittent preventive treatment with sulfadoxine-pyrimethamine in primi- and secundigravidae in rural Burkina Faso: impact on parasitaemia, anaemia and birth weight. Trop Med Int Health. 2009; 14(2): 174-82. http://dx.doi.org/10.1111/j.1365-3156.2008.02215.x PMid:21176056 PMCid:3499407

24. Jayasooriya S, Hislop A, Peng Y, Croom-Carter D, Jankey Y, Bell A, Dong T, Rowland-Jones S, Rickinson A, Walther M, and Whittle H, Revisiting the effect of acute P. falciparum malaria on Epstein-Barr virus: host balance in the setting of reduced malaria endemicity. PLoS ONE. 2012; 7(2): e31142. http://dx.doi.org/10.1371/journal.pone.0031142 PMid:22347443 PMCid:3275582

25. ter Kuile FO, Terlouw DJ, Phillips-Howard PA, Hawley WA, Friedman JF, Kariuki SK, Shi YP, Kolczak MS, Lal AA, Vulule JM, and Nahlen BL, Reduction of malaria during pregnancy by permethrin-treated bed nets in an area of intense perennial malaria transmission in western Kenya. Am J Trop Med Hyg. 2003; 68(4 Suppl): 50-60. PMid:12749486

26. Njagi JK, Magnussen P, Estambale B, Ouma J, and Mugo B, Prevention of anaemia in pregnancy using insecticide-treated bednets and sulfadoxine-pyrimethamine in a highly malarious area of Kenya: a randomized controlled trial. Trans R Soc Trop Med Hyg. 2003; 97(3): 277-82. http://dx.doi.org/10.1016/S0035- 9203(03)90141-6