Global Research Journal of Medical Sciences Vol.2(4) pp.048 – 053 December 2012
Available online http://www.globalresearchjournals.org/journal/?id=GRJMS

Full Length Research.

THE PREVALENCE OF ASYMPTOMATIC MALARIA PARASITAEMIA AT DELIVERY IN USMANU DANFODIYO UNIVERSITY TEACHING HOSPITAL SOKOTO NORTH WESTERN NIGERIA.

Panti AA[1x], Omokanye LO[2], Ekele BA[3], JIya NMA[4], Isah AY[3], Nwobodo EI.[1] Ahmed Y[1]

[1]Department of Obstetrics and Gynaecology, Usmanu Danfodiyo University Teaching Hospital Sokoto Nigeria.
[2]Department of Obstetrics and Gynaecology, University Teaching Hospital Ilorin Nigeria
[3]Department of Obstetrics and Gynaecology, College of Health Sciences, University of Abuja. Nigeria.
[4]Department of Paediatrics, Usmanu Danfodiyo University Teaching Hospital Sokoto Nigeria.
[1x] Corresponding author's E-mail: kapanti2002@yahoo.co.uk, Tel No: +2348035041074.

Accepted 20th December 2012.

Malaria is one of the leading causes of maternal and neonatal morbidity and mortality in Nigeria. This study aimed at determining the prevalence of asymptomatic maternal malaria parasitaemia at delivery and to establish the packed cell volume (PCV) of the study group. Two hundred parturients who satisfied the criteria for inclusion into the study were recruited between 1st July and 31st September, 2010. Data tool used for the study was interviewer-administered questionnaire. There were 25 asymptomatic parturients that had positive malaria parasite (MP) on the blood film giving a prevalence rate of 12.5%. Primigravidae and secondegravidae parturients constituted 60% of asymptomatic malaria positivity. Asymptomatic malaria parasitaemia was more in the unbooked than the booked parturients. (P = 0.0005, RR = 0.2857).The use of mosquito nets and malaria chemoprophylaxis during pregnancy were associated with significant protection against malaria parasitaemia (RR = 1.788. P= 0.0001 and RR = 0.1331, P = 0.0001 respectively). The mean packed cell volume of those with malaria parasite (MP positive) was 32.0%± 4.4 and those that were MP negative was 33.1%± 3.2. The difference was not statistically significant (P = 0.083). Malaria parasitaemia was associated with relative risk of developing Anemia (RR = 2.2107, P= 0.0631) but was not statistically significant. The prevalence of asymptomatic malaria parasitaemia at delivery was low. Routine use of insecticide treated mosquito nets, residual household spraying with insecticides and use of malaria chemoprophylaxis are recommended to further reduce the prevalence of asymptomatic malaria parasitaemia at delivery.

Key words: Asymptomatic, malaria parasitaemia, Delivery, Sokoto.

Introduction

Malaria remains a major health concern worldwide, causing 216 million infections and approximately 655,000 deaths in the year 2010 (WHO, 2011). The disease is endemic in parts of Asia, Africa, Oceania, and Central and South America, with around 90% of the global malaria burden borne by Sub-Saharan Africa. Women are more susceptible to malaria during pregnancy and in the puerperium (Diagne *et al*., 2000, Ter Kuile *et al*., 2003; Nnaji *et al*., 2006, Raim *et al.,* 2010.).

Prevention of malaria in pregnancy is a major public health challenge and a priority for the roll back malaria partnership. Each year in sub-Saharan Africa, where 80-90% of the world's malaria cases occur, approximately 19-24 million women are at risk of malaria and its adverse consequences during pregnancy (Guyatt and Snow, 2001, Nnaji *et al*., 2006.). In areas with stable malaria transmission like ours, the vast majority of infections with *P. falciparum* in pregnancy remain asymptomatic, undetected and untreated (Desowitz and Alpers, 1992; Shulman, 1993). Transmission in Sokoto State in Nigeria is fairly stable and perennial in all parts of the state, even though it falls within Sahelian belt with high out breaks of epidemics (RBM, 2004). Endemicity in this state is therefore high, being hyper endemic in both rural and urban areas (RBM, 2004). During pregnancy, especially in first pregnancies, women are more susceptible to *Plasmodium falciparum* infection and experience a higher frequency and density of parasitaemia than non pregnant women (Omokanye *et al.,* 2012).

The mechanism underlying this susceptibility is not fully understood. It has been suggested that despite the acquired antimalarial immunity of these pregnant women, the uteroplacental vascular space apparently provides a site for parasite sequestration and development (Fried and Duffy, 1996). This parasite replication presumably reduces nutrient transport across the placenta and allows for passage of parasitized red blood cells to the fetus that may

compromise fetal growth and infant survival. Malaria in pregnancy has serious health consequences, in particular, maternal anaemia, prematurity, intrauterine growth restriction, and low birth weight, maternal or fetal death (Fried and Duffy, 1996, Rijkem *et al* 2012.). Low birth weight (LBW) as occurs in small-for-date babies or babies born prematurely, is the greatest risk factor for neonatal morbidity and mortality and a major contributor to infant mortality (Van Geertynyden *et al*., 2004). Malaria is one of the causes of severe anaemia in pregnancy in Sokoto State and it was identified as the commonest cause of overall morbidity and mortality in the state during the year 2001 (RBM, 2004).

Early identification of the infected pregnant woman and prompt treatment may provide an opportunity to prevent the adverse effects of Malaria in pregnancy. The importance of asymptomatic carriers in malaria transmission has been stressed (Ogunledun *et al*., 1998). Sule-Odu *et al., 2002* has demonstrated a prevalence rate of maternal malarial parasitaemia at delivery in Sagamu to be 24.8 per cent. There is paucity of information about the level of malaria parasitaemia at delivery in the North West region of the country- Nigeria, hence the justification for this study. The study aimed at determining the prevalence of asymptomatic maternal malaria parasitamia at delivery and to establish the packed cell volume of the study group.

Material and Methods

This was a prospective and descriptive study in which 200 patients were enrolled at every consecutive delivery after fulfilling the inclusion criteria. The study was conducted during the rainy season from 1st July, 2010 to 31st September, 2010. Inclusion criteria were pregnant women that consented to participate in the study after adequate sensitization of the study objectives. Exclusion criteria were those that did not consent to the study, those who were HIV (Human immunodeficiency virus) positive, those that had symptoms of malaria and those that were treated for malaria at least two weeks to delivery.

A pilot study was conducted to evaluate the study process. The study population was composed of pregnant women that presented for delivery at the labour ward of the department of Obstetrics and Gynaecology, Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto. A semi-structured questionnaire was administered to all the volunteers to obtain information on age, educational status, and use of chemoprophylaxis during the index pregnancy.

The maternal assessment comprised a thorough history and detailed physical examination. Information was obtained as to the occurrence of symptoms of malaria in the one week preceding parturition and the use of antimalarial drugs both for the acute treatment and prophylaxis of malaria. blood samples were obtained from mothers within 4hrs of delivery by a finger prick. A laboratory scientist assisted in examining the slides and also to carry out packed cell volume (PCV) estimation. The laboratory technician prepared thick and thin film samples of the peripheral blood on the glass microscope slides which were labeled “A” and “B” respectively. The slides were air-dried for 30 minutes to one hour and 15 minutes to 30 minutes for thick and thin films respectively. The thin films were then placed in a slide container, covered with acetone and left for a minute. The slides were then tip off the acetone and left to dry. A dilute Giemsa stain at pH 7.2 was added to the slides and left for 10 to 40 minutes. The stain was subsequently poured off and the slides were washed with tap water for a few minutes and air-dried. Each slide was examined under the light microscope using x100 oil immersion objective. A positive smear is the one that contains any of the parasites (WHO 1991). Ethical approval to conduct the study was obtained from UDUTH ethical committee.

Results.

During the study period of 1st July and 31st September 2010, a total of 200 parturients were tested for malaria parasitaemia of whom 25 were positive, giving a prevalence rate of 12.5%. All the patients were resident in Sokoto metropolis. The modal age group was 20-24. Less than 9% of the study groups were teenagers while 81% were aged between 20 and 39 years. Seventy one (35.5%) of the study group were primigravidae (nulliparae) while 57% were primigravidae and secondegravidae. Other socio-demographic variables are shown in table 1.

Table 2 showed the prevalence of asymptomatic malaria parasitaemia at delivery. Majority of the asymptomatic malaria positive parturient 21(84%) were aged between 20 and 34 years. There was a steady decline in the prevalence of parasitaemia with age from 52% in those less than 25 years to 8% in those above 35 years. Primigravida and secondigravidae constitute 60% of malaria positive parturients.

Table 3 showed the factors influencing malaria parasitaemia at delivery. Out of one sixty eight booked parturients, 15 (8.9%) were positive for malaria parasitaemia while out of thirty two unbooked parturients, 10 (31.3%) were positive for malaria parasitaemia. There was significant difference between malara parasitaemia and booking status of the parturients (p=0.00). Out of one hundred and thirty seven parturients that use mosquito net, 7(5.1) were parasitaemic. The use of mosquito nets was associated with significant protection against malaria parasitaemia (p=0.00). Majority of parturients 74.5% (149) used chemoprophylaxis, out of which 71.8% (107 out of 200) used sulphadoxine/ pyrimethamine combination at least once during pregnancy, the remaining used proguanil hydrochloride and pyrimethamine. The use of pyrimethamine was only observed among the unbooked parturients. Prior chemoprophylaxis was significantly associated with protection against the risk of malaria parasitaemia (p=0.00).

Malaria parasitaemia was shown to be associated with Relative risk (RR) of developing anaemia at delivery, the association was not statistically significant (p-value = 0.0631).

The mean packed cell volume of the study was 33.1% ± 3.40. The mean packed cell volume of those that were MP positive was 32.0 ± 4.4 while that of those that were MP negative was 33.1± 3.2. The difference between the two means was found not to be statistically significant (P = 0.083) as shown in table 4.

Discussion:

Malaria is a major cause of maternal and perinatal mortality and morbidity in the tropics (Dorman and Shulman, 2000, Garner and Gulmezoglu, 2003, Guyatt and Snow 2004, Ofili and Okojie, 2005, Gamble *et al*., 2006, Omo-Aghoja *et al*., 2008, Falade *et al*., 2008; Nwagha *et al*., 2008, Mwanziva *et al*., 2008 Mokuolu *et al*., 2009, Tayo *et al*., 2009, Abasiattai *et al*., 2009, Omokanye *et al* 2012). Several reports indicates that malaria in pregnancy has deleterious effects on the growth and subsequent survival of the fetus and this is even more pronounced in those who are not immune or partially immune and in primigravidae (Guyatt and Snow, 2001, RBM, 2004, Ofili and Okojie, 2005: Gamble *et al*., 2006, Nnaji *et al*., 2006, Omo-Aghoja *et al*., 2008 Rijkem *et al* 2012). Epidemiological evidence from cross-sectional surveys also indicates that parity influences susceptibility to malaria to an important degree (Bouyou-Akotet *et al*., 2003, Raim *et al* 2010).

In this study, the prevalence of asymptomatic malaria parasitaemia at delivery was 12.5%. Previous studies from Nigeria reported parasitaemia rates at parturition to be 24.8% (Sule-Odu *et al*., 2002) and 12% (Mokuolu *et al*., 2009). The difference in this prevalence rate may be due to multiple factors which include variations in intensity of transmission of malaria, variations in study population characteristics (HIV positive parturient were not excluded in previous studies), use of preventive measures (e.g., use of IPT, ITNs) were low in previous studies, variations in study design and sample size. This study had a smaller sample size.

Parasitaemia at delivery was found to be more prevalent in maternal age less than 25 years (52%) in this study (see Table 1). Several studies have reported similar association (Shulman, 2000, Dorman and Guyatt, 2004, Tako *et al*., 2005, Mokuolu *et al*., 2009). This may be due to the fact that pregnancy associated with acquired immunity is low in younger women than older ones who have obtained immunity from repeated exposures to malaria infections.

Primigravid and secondegravid patients constituted 60% of asymptomatic malaria positive patients in this study (see Table 2). This is in keeping with earlier observations that primigravidae and secondegravidae demonstrate more vulnerability to malaria parasitaemia and consequence development of malaria in pregnancy if neglected (Ogunledun *et al*., 1998; Saute *et al*., 2002, Sule-Odu *et al*., 2008, Rijkem *et al* 2010, Omokanye *et al* 2012).

Table 1: Socio-demographic characteristics of respondents (n= 200)

Variables	Number (%)
Age group	
15-19	18 (9.0)
20-24	67 (33.5)
25-29	58 (29.0)
30-34	32 (16.0)
35-39	17 (8.5)
>40	08 (4.0)
Total	**200 (100)**
Parity	
0	71 (35.5)
1	43 (21.5)
2	28 (14.0)
3	25 (12.5)
4	33 (16.5)
Total	**200 (100)**

Malaria parasitaemia was more prevalent at delivery in unbooked than booked patients in this study (P=0.0005, RR=0.2857). This may be due to the fact that unbooked patients are likely not to receive antenatal care or receive antenatal care from traditional birth attendants or primary healthcare centres who may not be knowledgeable about prevention and control of malaria in pregnancy (Ofili and Okojie, 2005, Omo-Aghoja *et al*., 2008). This is supported by the finding that more than 80% of the unbooked parturient did not receive malaria chemoprophylaxis in this study (see Table 3).

Table 2; Prevalence of asymptomatic malaria parasitaemia (n= 200)

Variables	Number (%)	Mp (+ve)
Age group		
15-19	18 (9.0)	2 (8.0)
20-24	67 (33.5)	11(44)
25-29	58 (29.0)	6 (24)
30-34	32 (16.0)	4 (16)
35-39	17 (8.5)	2 (8.0)
>40	08 (4.0)	0 (0)
Total	**200 (100)**	**25 (100)**
Parity		
0	71(35.5)	9(36)
1	43(21.5)	6(24)
2	28(14.0)	5(20)
3	25(12.5)	2(8.0)
4	33(16.5)	3(12)
Total	**200 (100)**	**25 (100)**

Table 3; Factors influencing malaria parasitaemia at delivery

Variable	Outcome		No (%)	x^2	p-value	RR
Booking status	**Mp(+ve)**	**Mp(-ve)**				
Booked	15 (8.9)	153 (91)	168 (84)	12.24	0.005	
Unbooked	10 (31)	22 (68.8)	32 (16)			0.29
Mosquito net						
Use of net	7 (5.1)	130 (95)	137 (68.5)	21.7	0.0001	
Non use of net	18 (28.6)	45 (71.4)	63 (31.5)			0.18
Chemoprophylaxis						
Use of chemop	7(4.7)	142(95.3)	149 (74.5)	35.5	0.0001	
Non use of chemop	18 (35.3)	33 (64.7)	51 (25.5)			0.133

Table 4; **Malaria Parasitaemia and Packed Cell Volume of parturients**

Variable PCV	Malaria parasitaemia Mp(+ve)	Mp(-ve)	No (%)	x^2	p-value	RR
< 30	6 (24)	19 (76)	25 (12.5)	3.45	0.06	
>30	19 (10.9)	156 (89.1)	175 (87.5)			2.211

The use of mosquito nets in this work was associated with significant protection against malaria parasitaemia (P=0.0001, RR= 0.1788). This observation was in keeping with the findings of a Cochrane review (Gamble et al., 2006) where the use of insecticide treated nets (ITN) reduced the frequency of peripheral and placental parasitaemia at the time of delivery. Majority of the parturient used ITN in the current study perhaps, because the study was conducted at a time when there was increased awareness and availability of the nets which were distributed free to all pregnant women in the study area.

Chemoprophylaxis during pregnancy has been shown to reduce the risk of malaria infection in pregnant women significantly (Garner and Glulmezoglu, 2003). This was corroborated in this study with a significant association of chemoprophylaxis and reduction of malaria parasitaemia (P= 0.0001, RR= 1.331). This finding may be due to the fact that out of 74.5% (149 out of 200) that used chemoprophylaxis 71.8% (107 out of 149) received sulphadoxine-pyrimethamine (SP) combination at least once during pregnancy. This has been proven to be the currently most effective single dose antimalarial drug for prevention of malaria during pregnancy in areas where transmission of *P falciparum* malaria is stable like ours (WHO, 2004, Tayo *et al*., 2009).

The mean packed cell volume (PCV) of the study group was 33.1%±3.40. This may be in keeping with the observed low prevalence rate of malaria parasitaemia. High malaria parasitaemia is usually associated with anaemia, increased uterine activity and low birth weight among others (Falade *et al*., 2008, Tayo *et al*., 2009). Such association appears to be corroborated in this study that demonstrated a relative risk of developing anaemia in the presence of parasitaemia (RR =2.2105, P= 0.0631). Earlier study reported that in areas of high malaria transmission the main presentation of malaria in pregnancy is anaemia (Shulman, 2000) . The sample size of this research may have not been enough to corroborate such conclusion. The mean PCV of those parturient that had malaria parasitaemia was lower than those without parasitaemia (32.0% ±4.4 Vs 33.1%±3.2) but the difference between the means was not statistically significant (P= 0.083),(see Table 4). This differs from an earlier report in which parasitaemia in the mother was found to be significantly associated with lower maternal haematocrit (Mokuolu *et al*., 2009). This may be due to the fact that majority of the patients in this study used malaria chemoprophylaxis and nets which have been shown in earlier studies to reduce the development of anaemia in pregnancy (Sule-Odu *et al*., 2002).

In this study the prevalence of asymptomatic parasitaemia at delivery was low. There should be increase in public awareness by relevant authorities on the need for antenatal care, use of ITN and chemoprophylaxis to further reduce the prevalence of malaria at delivery. Further research is required on the benefit of combining ITN and chemoprophylaxis to prevent malaria in pregnancy.

Acknowledgement

We acknowledge the contribution of Mr A. Momoh of the department of laboratory for his assistance.

References

Abasiattai AM, Etukumana EA, Umoiyoho AJ (2009): Awareness and Practice of Malaria Prevention Strategies among Pregnant Women in Uyo, South South Nigeria. *Internet J. Gynecol Obstet;* 11:1.

Bouyou-Akotet MK, Ionete-Collard DE, Mabika-Manfoumbi M. (2003) "Prevalence of Plasmodium falciparum infection in pregnant women in Gabon, *Malar J;* 2(1):18.

Desowitz RS, Alpers MP (1992). Placenta plasmodium falciparum parasitaemia in East Sepick (Papua New Guinea) women of different parity: the apparent absence of acute effects on mother and foetus. *Ann. Trop Med. Parasitol*; 86: 95-102.

Diagne N., Rogier C., Sokhna CS., Tall A., Fontenille D., Roussilhon C., Spiegel A., Trape JF.(2000). Increased susceptibility to malaria during early postpartum period. *N Engl J Med;* 343:598-603.

Dorman E, Shulman C (2000). Malaria in pregnancy. *Current Obstetrics and Gynaecology;* 10: 183-189.

Falade CO, Olayemi O, Dada-Adegbola HO, Aimakhu CO, Ademowo OG, Salako L A. (2008). Prevalence of malaria at booking among antenatal clients in a secondary health care facility in Ibadan, Nigeria. *Afr J. Reprod Health*; 12: 141-152.

Ter Kuile FO., Terlouw DJ., Philips-Howard PA., Hawly WA., Friedman JF., Kanuki SK., Shi YF., Kokzak MS., Lai AA., Vulule JM., Nahlem BL. (2003). 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;* 68(4 Suppl): 50-60.

Fried M, Duffy PE (1996). Adherence of plasmodium falciparum to chondrotin sulphate A. *human placenta. Sci*; 272: 1502-4.

Gamble C., Ekwane JP., ter Kulle FO (2006). Insectiticide treated nets for preventing malaria in pregnancy (Cochraine Review). In; The Cochraine Library, Issue 4.

Garner P., Gulmezoglu AM (2003). Drugs for preventing malaria related illness in pregnant women and death in the newborn. Cochrane Database of Systemic reviews: 4.

Guyatt HL, Snow RU (2004). Impact of malaria during pregnancy on low birth weight in Sub Saharan Africa. *Clini Microbiol Rev*; 14(7): 760-769.

Guyatt HL, Snow RW (2001): The epidemiology and burden of plasmodium falciparum related anaemia among pregnant women in Sub-Saharan Africa. *Am J Trop Med. Hyg;* 55 (1 Supp): 1-106.

Mokuolu OA., Folade CO., Orogade AA., Ukafor UH., Adedoyin OT., Oguonu TA. Oguntayo OA, Dada- Adegbola OH, Ernest SK, Hamer HD, Callahan MV. (2009). Malaria at parturition in Nigeria: Current status and delivery outcome. *Infectious Disease in Obstet Gynaecol.* Article ID 473971, 7 pages.

Mwanziva C, Shekalaghe S, Ndaro A, Mengerink B, Megiroo S, Mosha F., Sauerwein R., Drakeley C, Gosling R., Bousema T. (2008). Overuse of artemisinin-combination therapy in Mto wa Mbu (river of mosquitoes), an area misinterpreted as high endemic for malaria. *Malar. J;* 7: 232.

Nnaji GA, Okafor CI, Ikechebelu JI (2006). An evaluation of the effect of parity and age on malaria parasitaemia in pregnancy *J Obstet Gynaecol;* 26: 755-8.

Nwagha UI, Ugwu VO, Nwagha TU, Anyaehie BU (2008). Asymptomatic Plasmodium Parasitaemia in Pregnant Nigerian Women. *Trans R Soc Trop Med Hyg;* 103:16-20.

Ofili AN., Okojie OH (2005). Assessment of the role of traditional birth attendants in maternal health care in Oredo Local Government Area, Edo State. Nigeria. *J. Community PHC*; 17(1): 55-60.

Ogunledun A., Kofie BA., Adetunji A., Fakoya EAO., Bamgboye EA (1998). Prevalence and significance of asymptomatic malaria parasitaemia in Sagamu, Nigeria. *Nig J of Parasitol*; 9: 145-158.

Omo-Aghoja CO., Abe E., Feyi-waboso P., Okonofua FE (2008). The challenges of diagnosis and treatment of malaria in

pregnancy in low resource settings. *Acta Obstetricia et Gynaecol Scand;* 87(7): 693-696.

Omokanye LO, Saidu R, Jimmoh AAG, Salaudeen A, Lawal Si, Raji Ho, Ijaiya MA, Panti AA, Balogun YR (2012) The relationship between Socia Demographic Characteristics and Malaria parasite Density among pregnant women in Ilorin, Nigeria. *Int. J. Trop. Med.* 7(2): 64-68.

Rijken M, Mc Gready R, Boel ME, Poespoprodjo R, Singh N, Syafruddin D, Rogerson S, Nasten F. (2012) Malaria in Pregnancy in the Asia- Pacific Region. *Lancet Infect Dis. 12: 75-88.*

Raim OG and Kanu CP (2010). The prevalence of malaria infection in pregnant women livivg in sudurb of Lagos Nigeria. *Afr. J. Biochem Research 4(10): 243-245.*

Roll back malaria implementation (2004). Revised 2004 desk top review of implementation in Sokoto state, Nigeria. 3:3.1-3.2

Saute F, Menendez C, Mayor A. (2002) Malaria in pregnancy in rural Mozambique: the role of parity, submicroscopic and multiple Plasmodium falciparum infections, *Trop. Med. J. Internat Health;* 7(1): 19–28.

Shulman C (2000). Malaria in pregnancy. In: *Africa Health (Supplement)*; 26-29.

Shulman CE (1993). Malaria in pregnancy: It's relevant to Safe motherhood programmes. *Ann. Trop-Med Parasitol*; 93 (Supp 1): 559 –566.

Sule-Odu AO., Ogunledun A., Olatunji AO (2002). Impact of asymptomatic malaria paresitaemia at parturition on perinatal outcome. *J of Obstet Gynecol*; 22(1): 25-28.

Tako EA, Zhou A, Lohoue J, Leke R, Taylor DW, Leke RFG (2005). Risk factors for placental malaria and its effect on pregnancy outcome in Yaounde, Cameroon, *Am. J. Trop. Med. Hyg*; 72(3) 236–242.

Tako EA, Zhou A, Lohoue J, Leke R, Taylor DW, Leke RFG (2005). Risk factors for placental malaria and its effect on pregnancy outcome in Yaounde, Cameroon, *Am. J. Trop. Med. Hyg*; 72(3) 236–242.

Van Geertnyden JP., Thomos F., D'Alessendro U (2004). The contribution of malaria in pregnancy to perinatal mortality. *Am J Trop Med Hyg*; 71(supl 2): 35-40.

World Health Organization (1991). Basic Malarial Microscopy part 1 Learners Guide.

World Health Organization (2004): A strategic frame work for Malaria Prevention and Control during pregnancy in African Region. Vol 01. Brazzenville WHO Regional office for Africa.

World Health Organization (2011). World malaria report 2011 fact sheet.