https://dx.doi.org/10.4314/dujopas.v9i4a.28
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 9 No. 4a December 2023*

Prevalence of Malaria among Pregnant Women Attending Muhammad Abdullahi Wase Teaching Hospital Kano State, Nigeria

[1*]Idris H.Y., [2]Umar A.M., [2]Auta T., [3]Abdulmalik U.

[1]Nigeria Institute for Trypanosomiasis (and Onchocerciasis) Research,
Kano State Liaison Office,
Bayero University
Kano

[2]Department of Biological Sciences,
Federal University Dutsinma, Katsina
PMB 5001,
Nigeria

[3]Department of Microbiology,
Federal University Dutsinma, Katsina
PMB 5001,
Nigeria

Email: hamzaidrisy@gmail.com

Abstract

Malaria in pregnant women remains a major public health problem especially in sub-Saharan Africa. Approximately twenty five million pregnant women in sub-Saharan Africa live at risk of malaria. The study was carried out between July and August 2021, to determine the prevalence of malaria parasite among pregnant women attending Mohammad Abdullahi Wase Teaching Hospital Kano. Microscopic examinations of both thick and thin smears were made using Giemsa Stained solution. Out of one hundred and forty blood samples examined, 60(42.9%) were positive for plasmodium falciparum parasite infection. Age group 18-22 years recorded the highest prevalence rate of (17.90%) and the difference between the age group of the pregnant women was statistically significant (P<0.05) .Primigravida women recorded highest infection rate (23.60%). However, those in first trimester recorded the highest prevalence of (25%) followed by those in the second trimester (13.57%). These results show that pregnant women are more predisposed to malaria infection as they are immuno-suppressed especially at early stage and as a primigravida and as teenage mothers than multigravida and older mothers. The problem of P. falciparum in pregnant women can be prevented by the preventive package of intermittent preventive treatment (IPT) with sulfadoxine pyrimethamine (SP) at 2 doses given to the pregnant women during their antenatal clinical visits. During this study, the prevalence of malaria infection among pregnant women attending Muhammad Abdullahi Wase Teaching Hospital was notably higher. P. falciparum is the most common Plasmodium parasite in this region therefore, more special attention should be directed towards pregnant women who exhibit identified risk factors for malaria infection.

Keywords: Pregnancy, Prevalence, Primigravida *P. falciparum* and, Kano.

**Author for Correspondence*

INTRODUCTION

Malaria stands out as the most widespread tropical disease, causing substantial illness and death while also having significant economic and social repercussions (WHO, 2010). Nigeria carries the heaviest malaria burden globally, recording approximately 51 million cases and 207,000 annual deaths, which account for roughly 30% of Africa total malaria cases (WHO,2010). However, about 97% of Nigeria population, approximately 173 million people face the risk of malaria infection (WHO, 2010).). Over 90% of all deaths caused by malaria occur in sub- Saharan Africa and about 85% of deaths globally were in children under 5 years of age and pregnant women (WHO, 2010). In addition, pregnant women are at immense risk of malaria due to natural immune depression in pregnancy (Borgella *et al.,* 2013). About 25% of all estimated malaria cases in the African region occur in Nigeria (WHO, 2010).

Malaria infection in pregnancy presents a significant public health challenge in the tropical and subtropical region the world (WHO, 2010).The primary plasmodium parasite responsible for the burden of malaria in pregnancy is *Plasmodium falciparum,* which is the predominant malaria species in Africa (WHO, 2010).

Annually, there are a minimum of 3 million pregnancies among women living in malaria endemic regions of Africa with the majority residing in areas characterized by consistently prevalent malaria transmission (Brabin, 2000).The symptoms and complications associated with malaria during pregnancy vary based on the intensity of malaria transmission, and consequently, the level of immunity acquired by the expectant mother (Perlmann and Troye-Blomberg, 2000).Pregnant women and their unborn children face exceptional vulnerability to malaria, which constitutes a significant contributor to prenatal mortality, low birth weight, and maternal anemia (Greenwood *et al.,*2007).

In Nigeria, malaria is responsible for 50% of outpatient visits to hospitals, 40% of inpatient admissions and 11% of maternal deaths. (Salihu and Sanni, 2013). Malaria accounts for over 40% of public health expenditure in sub-Saharan Africa (Sohantz and Noir, 2009). Malaria cost Nigeria 13.3% of its gross domestic product (GDP) in 2007 and 7.3% in 2011(FMOH, 2007).

Malaria infection in pregnant women poses a significant threat to both the mother and the developing fetus as well as to newborns (Gajida *et al.,* 2010).Although pregnant women in high transmission areas may not exhibit symptoms of malaria due to acquired immunity, they still face an increased risk of maternal anemia, spontaneous abortion, stillbirth, premature, and low birth weight (Steketee and Parise, 2001; WHO, 2010). Moreover, severe maternal anemia increases the mother's risk of death (WHO, 2010). Malaria related anemia is estimated to cause as many as 10,000 maternal deaths each year in Africa (WHO, 2004).

Kano state is highly endemic for malaria and the potential immunosuppression that occurs during pregnancy, it become imperative to assess the prevalence of malaria among expectant mothers. This evaluation has dual objective, firstly, to enable the tracking of the intermittent preventive treatment policy for pregnant women, and secondly, to assess the overall efficacy of distributing treated mosquito nets during antenatal clinic visits. These measures play a critical role in averting or alleviating the severe complications that may arise from malaria infections during pregnancy, affecting both the mother and the unborn child. This study aimed to ascertain the prevalence of malaria among pregnant women attending Muhammad Abdullahi Wase teaching hospital Kano, Kano State, Nigeria.

MATERIAL AND METHODS

Study Area

This study was carried out at general out-patient department (GOPD) of Muhammad Abdullahi Wase teaching hospital, Nassarawa, which is located in Kano metropolis, Kano State, Nigeria. The hospital is usually attended by low and moderate socio-economic groups and therefore, is affordable and accessible to most dwellers of Kano city and neighboring Local Governments Areas. Kano State is located at the north-western region of Nigeria laid between latitude10^{o}33'N and 12^{o}23'E and longitude 7^{o}45'N and 9^{o}29'E with total land area of 21,276.872 kilometers with 1,754,200 hectares for agricultural activities and 75,000 hectares forest vegetation and grazing land (Abaje, 2014).

Ethical Clearance

Ethical approval for the study was obtained from Ministry of Health Kano, Kano State, based on the recommendation of Muhammad Abdullahi Wase teaching hospital ethical committee. Verbal informed consent from all the participating pregnant women was also obtained prior to sample collection.

Blood Sample Collection

A total of one hundred and forty samples were collected from pregnant women through venous puncture of blood by medical laboratory scientists. Collected blood sample were subsequently stored in bottle containing Ethylene-diamine-tetra acetic acid (EDTA) to prevent coagulation.

Preparation of Blood Films and Microscopy

Thick Blood Films

Thick blood films were prepared according to the procedure of Cheesbrough (2005). A large drop of well-mixed blood sample of each patient was placed at the center of a clean microscope slide. Disposable stirrer was used to spread the blood in a circular motion over an area of about 15mm in diameter. The slide was allowed to air dry at room temperature. The dried unfixed thick blood films were arranged on a staining rack and flooded with 10% Giemsa stain in phosphate buffer (pH 7.2). The slide was allowed to stand for 10 minutes after which they were washed using tap water gently and kept in an upright position in a draining rack to air dry. Two drops of oil immersion were placed on each of the stained thick blood film. The slide was then mounted on the microscope and examined using x100 objectives lens to determine the parasitaemia level of *P. falciparum*.

Thin Blood Films

A thin blood film was prepared according to the procedure of Cheesbrough (2005). A drop of blood sample was placed at 1cm away from the edge of the slide. A spreader was placed at an angle of 45^{o}C to the blood and touches the blood to run along the slide drawing the blood behind it until the drop was smeared. The dried thin blood films were arranged on a staining rack and fixed using absolute methanol for 1 minute, 10% Giemsa solution in phosphate buffer (pH 7.2) was poured on the slide and left to stain for 20 minutes. The slides were rinsed carefully and thoroughly using tap water and left in an upright position to air dry. Two drops of oil immersion was placed on each of the stained thin blood film. The slide was the mounted on the microscope and examined using x100 objectives lens to check for mono infection with *P. falciparum*.

Statistical Analysis
Categorical variables (gestation and gravidity) were presented as frequency and percentages study and Chi- square ($\chi 2$) analysis was used at 95% confidence interval. P- Values was less than 0.05 were considered significant during the study.

RESULTS

Results obtained indicate that out of the collected blood samples 80(57.1%) were negative while 60(42.9%) were positive. Malaria species identification was done microscopically using thin and thick smears and all identified parasite were *plasmodium falciparum* species. In this study, women between the ages of 18 and 22 years had the highest prevalence of 17.9% (Table 1).

Table 2 shows the percentage distribution of malaria parasite in pregnancy according to gravida. In this Table premigravida mother (23.6%) were more infected with *Plasmodium falciparum* malaria than Secundigravida (14.3%) and Multigravida (5%).The prevalence distribution of malaria parasite in pregnant women by gestation reveal highest percentage of (25%) observed among pregnant woman in their first trimester of their pregnancy followed by second trimester (13.57%) and (4.28%) in their third trimester as shown in Table 3.

Table 1: Prevalence of malaria parasite among pregnant women based on age group

Age group	Number Examined	Positive Cases %
18-22	43	25(17.9)
23-27	32	15(10.71)
28-32	30	10(7.14)
33-37	23	8(5.71)
38-42	12	2(1.42)
43-47	0	0
Total	140	60(42.9)

P-Value = 0.3002

Table 2: Prevalence of malaria infection in relation to number of pregnancies (gravida)

Types Gravida	Number examine	Number positive (%)
Primigravida	46	33(23.6)
Secundigravida	51	20(14.3)
Multigravida	43	7(5)
Total	140	60(42.9)

P-Value = 0.009

Table 3: Frequency of malaria infection in pregnancy with respect to gestation

Gestation period	Number Examined	Number Positive (%)
First trimester	65	35(25)
Second trimester	39	19(13.57)
Third trimester	36	6(4.28)
Total	140	60(42.9)

P-Value = 0.002

DISCUSSION

Malaria during pregnancy poses a significant public health concern, but there has been notable worldwide advancement in reducing both incidence of malaria and related facilities (WHO, 2016). Pregnant women and infants are particularly vulnerable to malaria infection (WHO, 2016).To ensure continued and enhanced progress, emphasis is needed in the prevention of malaria during pregnancy. The current study at Muhammad Abdullahi Wase teaching hospital in Kano state revealed a 42.8% prevalence of *Plasmodium falciparum* caused

malaria infection in pregnant women attending antenatal care clinic. This finding surpassing the 22.1% prevalence rate reported in a previous study conducted among pregnant women in Maiduguri (Kagu *et al.,* 2007). Also, the prevalence rate reported in our study is higher than some previous studies carried out in Felege Hiwot referral hospital and Addis Zemen health center, Ethiopia (2.83%) (Asmama *et al.,* 2013), rural district surrounding Arbaminch town, Ethiopia (9.1%) (Nega *et al.,* 2015), coastal Ghana (5%) (Steffen *et al*., 2003), South-West Nigeria (7.7%) (Agomo *et al.,* 2009). North-west Nigeria (Audu *et al.,* 2020). Southern Laos (8.3%) (Briand *et al.,* 2016) and India (5.4%) (Sohail *et al*., 2015).

The differences detected in the prevalence rates might be attributed to the difference in geographical location among the study areas. For example, our study was conducted in a malaria-endemic area with a high rate of transmission. Therefore, individuals living in malaria-endemic areas have a greater chance of developing asymptomatic malaria while those living in low transmission areas have a low chance of being infected, which can lead to a low prevalence of the diseases in such areas (Audu and Abdulsalam, 2015). On the other hand, the prevalence rate observed in this study was lower compared to various studies conducted in different regions of Nigeria, include those by Frank *et al.(*2016); Ukiebe *et al.*(2016);Adebayo *et al.(*2015); Ifeani *et al*.(2009);Ogbodo *et al.(*2009)and FMH(2000), which reported prevalence rates of 66.7, 73.1,57.7,58,59.9 and 70.5% respectively in their respective study areas across the country.

However, These findings are consistent with the results reported by Jombo *et al*.(2010) in Otukpo Benue state ,Fala *et al.(*2015) in Northern Nigeria and Olever *et al*.(2014) in Abakaliki, Southern Nigeria, these study reported a total prevalence rate of 42.3%,41.6% and 42% respectively.

Although, this study was conducted in the dry season, the observed malaria prevalence rate might be attributed to sanitation problem, including the absence of proper drainage and sewage disposal system, as well as the presence of stagnant water bodies that provided favorable breeding habitats for malaria vectors. The temporal and spatial fluctuations in malaria prevalence across various regions of Nigeria cloud be attributed to variety of factors, including environmental and climatic conditions that encourage mosquito vector, the competence of these vectors in transmitting the disease, and the lack of effective preventive measures (Audu and Abdulsalam, 2015).

The age distribution had a substantial impact on the malaria prevalence among pregnant women, as indicated by the study findings. Younger pregnant women exhibited the highest rate of malaria infection, possibly owing to their immunity status. These results are consistence with previous studies by Ogbu *et al.*(2015), Ukiebe *et al.*(2017), and Audu *et al.*(2020).These findings may be attributed to the development of immunity against malaria parasites as the individuals grow older, consistent with the established knowledge that higher prevalence in younger individuals and lower prevalence in older individuals is a result of natural immunity to infectious diseases, including malaria, which pregnant women acquire as they age increase (Fala *et al.*(2015) and Kweku *et al*.(2019).

In terms of pregnancy history, it was noted that premigravida and secundigravida had a higher rate of infection compared to multigravida. This is often because parasitaemia is more frequently and more severe in first time pregnant mothers (Fala *et al.,* 2016). The malaria prevalence rate among Primigravida (23.60%) in this study, is greater than what was observed in previous studies conducted by Ukiebe *et al*.(2016) and Ejike *et al*.(2017).An analysis of

malaria during pregnancy in Africa also revealed that parasitaemia is notably more common and more severe in premigarvida compared to secundigravida and multigravida as reported by (Van Eiik *et al*.,2015).

The results indicate that premigravida women are at a higher risk of malaria infection compared to secundigravida and multigravida, with the latter group having the lowest risk. Additionally, this study has revealed that the gestational period plays a significant role, with women in their first trimester having the highest prevalence of malaria, this findings is in line with the findings of Ejike *et al.* (2017). The higher prevalence rate of malaria in the first trimester could be attributed to a potential loss of immunity during the early stages of pregnancy. It might also be influenced by the regular administration of intermittent preventive treatments in Pregnancy (IPTP) during antenatal care visits, typically commencing in the second trimester. However, it is worth noting that Idowu *et al*. (2006) and Frank *et al.* (2016) reported different results, with higher prevalence rates in the third and second trimesters.

CONCLUSION

During the conduct of this study, the prevalence rate of malaria infection among pregnant women in Kano State, Nigeria, particularly in Muhammad Abdullahi Wase teaching hospital, is notably higher. *P. falciparum* stands was the most common *Plasmodium* species in this region and is a significant contributor to anemia during pregnancy. In many developing regions, it is crucial to provide extensive support for maternal and child health services at all levels to effectively prevent and manage malaria in pregnant women. Healthcare professionals should prioritize offering comprehensive health education on malaria prevention methods during antenatal care (ANC) visits. Additionally, special attention should be directed towards pregnant women who exhibit identified risk factors for malaria infection.

Furthermore, there is a need for further research in this area, with a recommendation to employ more sensitive diagnostic methods such as polymerase chain reaction and blood film microscopy for the accurate diagnosis of malaria. This will help in gaining a deeper understanding of the extent of the issue and developing more effective strategies for combating malaria in pregnant women.

ACKNOWLEDGEMENT

The authors wish to appreciate all those who in one way or another facilitated the successful completion of this research.

CONFLICT OF INTEREST

The authors wish to state categorically that they do not hold any conflict of interest in whatever shape or form.

REFERENCES

Abaje, I.B., Ndabula, C. and Garba, A.H. (2014). Is the Changing Rainfall Patterns of Kano State and Its Adverse Impacts an Indication of Climate Change? *European Scientific Journal*, **10**:192-206.

Adebayo, A.M., Akinyemi, O.O., and Cadmus, O.E. (2015). Knowledge of malaria prevention among pregnant women and female caregivers of under-five children in rural southwest Nigeria, *Peer Journal*, 10:4.

Agomo, C.O., and Oyibo, W.A. (2013). Factors associated with risk of malaria infection among pregnant women in Lagos Nigeria. *Infectious Disease Poverty*, **2**(1):19.DOI: 10.1186/2049-9957-2-19.

Asmamaw, T., Alemu, A., Alemu, A., and Unakal, C.(2013). Prevalence of malaria and HIV among pregnant women attending antenatal clinics at felege hiwot referral hospital and Addis zemen health center. *International Journal of Life Science Biotechnology Pharmacy Research*, **2:**1–13.

Audu and Abdulsalam, U. (2015). Detection of malaria parasites by microscopy and rapid diagnostic test kit (pLDH) in pregnant women and children, Lagos, Nigeria. *Nigerian Journal of Parasitology,* **36**(2):137-140.

Audu-Ohida, H., Babable, S. K. and Ajakaiye, A.(2020).Prevalence of malaria infection among pregnant woman attending clinal at Kogi State specialist hospital, Lokoja, Kogi State. *Biosciences Journal FUDMA*.**1** (1):47 - 55 ISSN: 9876-5432.

Borgella, S., Fievet, N., Huynh, B-T., Ibitokou, S., Hounguevou, G.,et al.(2013). Impact of Pregnancy-Associated Malaria on Infant Malaria Infection in Southern Benin. *PLoS ONE* 8(11): e80624. doi:10.1371/journal.pone.0080624.

Brabin, B. J. (2000). The risks and severity of malaria in pregnant women in Africa. Report no 1. 2000. Geneva: WHO: 1-43.

Briand,V., Le, H., Jean,Y., Mayxay, M., Newton, P. N., et al. (2016).Prevalence of malaria in pregnancy in southern Laos: a cross-sectional survey. *Malaria Journal*, **15**(1):436.

Cheesbrough, M. (2005). *District Laboratory Practice in Tropical Countries*, Cambridge University Press, Cambridge, UK, 2nd edition.

Ejike, B., Ohaeri, C., Amaechi, E., Ejike, E., Okike-Osisiogu, F., et al. (2017). Prevalence of falciparum malaria amongst pregnant women in Aba South Local Government Area, Abia State, Nigeria. *Nigerian Journal of Parasitology,* **38**(1), 48-52.

Fala, S. A., Bunza, M. D., .Abubakar; A. S., Aliyu, I.,, Asiya, U. et al. (2015). Prevalence and risk factors associated with malaria infection among pregnant women in a semi-urban community of north-western Nigeria. *Infectious Diseases of Poverty,* **4**(1):24–32.

Federal Ministry of Health (2000). Situational Analysis of Malaria Control in Nigeria, Abuja. Federal Ministry of Health Report.

Federal Ministry of Health.(2007).National Framework for Monitoring and Evaluation of Malaria Control in Nigeria. FMOH, Abuja.

Frank, M.D., Robinson–Bassey, G.C. and Akaeze, G.O. (2016). Prevalence of malaria parasitaemia among pregnant women attending three selected health centers in ideato south local government area, imo state. *Obstetrics & Gynecology International Journal*. **4**(3):103–106.

Gajida, A.U., Iliyasu Z., and Zoakah, A.I.(2010). Malaria among antenatal clients attending primary health care facilities in Kano state, Nigeria. *Annals of African medicine*. **9**: 188-193.

Greenwood, B.M., Bojang, K., Whitty, C., and Targett, G. (2007). Malaria in pregnancy. *Lancet*, **365**(9469): 1474-1480.

Idowu, O.A., Mafiana, C.F., and Dapo,S. (2006).Malaria among pregnant women in Abeokuta, Nigeria,*Tanzania Health Research Bulletin*, **8**(1):28-31.

Ifeanyi, U., Onyebuchi, V., Ukamaka, T, and Ugochukwu, B. (2009). Asymptomatic Plasmodium parasitaemia in pregnant Nigerian women: almost a decade after roll Back malaria. *Malarial Journal*. **24**:16–20.

Jombo, G.T.A., Mbaawuaga, E.M., Ayegba, A.S., Enenebeaku, M.N.O., Okwori, E.E., et al. (2010). How far we rolled back malaria on the African continent nine years down? The burden of malaria among pregnant women in a semi-urban community of northern Nigeria. *Journal Medicine Medicine Science*.**1**:235–41.

Kagu, M.B., Kawuwa, M.B., and Gadzama, G.B. (2007). Anaemia in Pregnancy: A cross-sectional study of pregnant women in a Sahelian tertiary hospital in Northeastern Nigeria. *Journal Obstet Gynaeco*l.**27:**676–9.

Kweku, M., Parbey, P. A.,. Takramah, W., Owusu, R., Axame, K. W., and Tarkang, E.,(2019). Assessment of the prevalence of anaemia and associated risk factors among children under five years in rural communities of Hohoe municipality, Ghana," International *Journal of Nursing Didactics*, **7**(7):10-20.

Nega, D., Dana, D., Tefera, T., and Eshetu, T.(2015). Prevalence and predictors of asymptomatic malaria parasitemia among pregnant women in the rural surroundings of Arbaminch town, South Ethiopia. *PLoS One*. 10(4): e0123630.

Ogbodo, S., Nwagha, U., Okaka, A., Ogenyi, S., Okoko, R., & Nwagha, T.(2009). Malaria parasitaemia among pregnant women in a rural community of eastern Nigeria; need for combined measures. *Nigerian Journal of Physiological Science*, **24** (2):95-100.

Ogbu, G.I, Aimakhu, C.O., Ajen Anzaku, S., Ngwan ,S and Ogbu, D.A.(2015). Prevalence of malaria parasitaemia among asymptomatic women at booking visit in a tertiary hospital, North central Nigeria. *Journal of Reproductive Biology and Health*, 3:1. http://dx.doi.org/10.7243/2054-0841-3-1.

Oliver, O., Angela, I., Nneka, L.O., and ngozi., O. (2014). Prevalence of malaria among pregnant mothers and possible relationship to parity in Abakaliki, Southeast Nigeria. *European Journal of Experimental Biology*, **4**(4):15-19.

Perlmann,p., and Traye-Blomberg,M.,(2000). Malaria blood-stage infection and its control by the immune system, *Pub.medi*; **46**(6):210-218.

Salihu, O.M., and Sanni, N.A.(2013). Malaria burden and the effectiveness of malaria control measures in Nigeria: A case study of Asa Local Government Area of Kwara State. *Journal of Economics and Sustainable Development* ISSN-2222-1700 (Paper) ISSN-2222-2855 (Online); **4**(3).

Sohail, M., Shakeel, S., Kumari, S, Bharti, A., Zahid, F., et al.(2015). Prevalence of malaria infection and risk factors associated with Anaemia among pregnant women in Semi urban Community of Hazaribag, Jharkhand, India. *Biomed Research International*,16. http://dx.doi.org/10.1155/2015/740512.

Sohantz-Dunn, J., and Noir, N.M. (2009). Malaria in Pregnancy: A Global Health Perspective. *Rev Obstet Gynaecol* **2**(3):186-192.

Steffen, R., debernardis, C., and Bano, A.(2003) Travel epidemiology—a global perspective. *International Journal Antimicrobian Agents*., **21** (2):89–95.

Steketee ,R.W.N.B., and Parise, M.E.M.C.(2001). The burden of malaria in pregnancy in malaria-endemic areas. *American Journal Tropical Medicine Hygiene*; **64**:28–35.

Ukibe, S., Ukibe, N., Mbanugo, J., and Ikeakor, L. (2016). Prevalence of malaria among pregnant women attending antenatal clinics in hospitals in Anambra State, South-East Nigeria. *Nigerian Journal of Parasitology,* **37**(2):240-248.

Van Eijk, A.M., Hill, J., Noor, A.M., Snow, R. W., Ter Kuile, F. O. (2015). Prevalence of malaria infection in pregnant women compared with children for tracking malaria transmission in sub-Saharan Africa: a systematic review and meta-analysis. *The Lancet Global Health*, **3**(10):17–28.

W.H.O. A Strategic Framework for Malaria Prevention and Control during Pregnancy in the African Region, In World Health Organization RegionalOffice for Africa. AFR/MAL/04/01. 2004.

W.H.O. World Malaria Report 2016. http://apps.who.int/iris/bitstream/handle/10665/252038/9789241511711-eng. Pdf; jsessionid =7E1CFE7AA71BA4CF0466B2BB370096F5? Sequence =1 (accessed 29, November 2021).

W.H.O.AFRG. African Region 2010 malaria report. 2010.