Malaria prevalence and risk analysis among pregnant women in Bungoma county, Kenya

Article *in* Medicine Science | International Medical Journal · June 2019

DOI: 10.5455/medscience.2018.07.8947

4 authors, including:

Wekesa Antony
Masinde Muliro University of Science and Technology
3 PUBLICATIONS **4** CITATIONS
SEE PROFILE

Chrispinus Mulambalah
Moi University
31 PUBLICATIONS **132** CITATIONS
SEE PROFILE

Elizabeth Omukunda
Masinde Muliro University of Science and Technology
19 PUBLICATIONS **249** CITATIONS
SEE PROFILE

Available online at www.medicinescience.org

ORIGINAL RESEARCH

Medicine Science International Medical Journal

Medicine Science 2019; ( ):

Malaria prevalence and risk analysis among pregnant women in Bungoma county, Kenya

[1]**Wekesa Antony Wanyonyi** ORCID: 0000-0002-3800-4184
[2]**Chrispinus Siteti Mulambalah** ORCID: 0000-0002-5760-3000
[1]**David H. Mulama** ORCID: 0000-0003-2198-2798
[1]**Elizabeth Omukunda** ORCID: 0000-0001-7516-7962

[1] *Masinde Muliro University of Science and Technology, Department of Biological Sciences, Kakamega, Kenya.*
[2] *Moi University, School of Medicine, Department of Medical Microbiology & Parasitology, Eldoret, Kenya*

Received 07 August 2018; Accepted 26 October 2018
Available online 11.01.2019 with doi:10.5455/medscience.2018.07.8947

Abstract

Malaria during pregnancy has adverse consequences on the mother and fetus. Information describing the prevalence, *Plasmodium* species types and the influence of socio-economic risk factors of malaria in pregnancy is scarce. In order to determine the distribution of malaria parasite species and risk factors among pregnant women in Bungoma County, a cross sectional hospital based study was carried out between March 2016 and January 2017 among 750 consented expectant mothers seeking antenatal services at the Bungoma County hospital. Malaria positivity and species identification were determined microscopically using Giemsa stain technique. Socio economic risk factors were collected using a structured pre-tested questionnaire. Data was analysed using STATA version 12. Descriptive analysis was used to determine malaria prevalence. Chi-square (X^2) and regression analyses were used to determine the association between malaria and risk factors with P-<0.05 and 95 % CI. A total of 162/750 (21.6%) of expectant mothers had malaria parasites. *Plasmodium falciparum* being the most prevalent species 83.3%, *Plasmodium malariae*, 10.5%, *Plasmodium ovale,* 1.2%, and mixed infection of *Plasmodium falciparum* and *plasmodium malariae* 4.9%. Risk factors were unemployment OR 2.134 (1.228-3.371) *P*-value 0.006; lack of malaria treatment OR 3.615(1.285-10.167) *P*-value 0.015; lack of mosquito net use 3.220 (2.019-5.138) *P*-value 0.0001. Participants in first and second trimesters of pregnancy were at higher risk of infection by malaria OR 2.126 (1.238-6.651), *P*-value 0.006. Routine screening of pregnant women for malaria parasites and treatment is essential during all trimesters. Provision of treated mosquito nets and continuous health education are important in preventing malaria in pregnancy.

Keywords: Prevalence, malaria, pregnant women, socio economic risk factors

Introduction

Malaria is still a major global health burden in tropical and subtropical countries, despite the intensive control measures that are carried out worldwide. Annually, approximately 350 to 500 million cases of malaria are reported globally [1]. The disease kills more than one million people worldwide with most deaths occurring in Sub-Saharan Africa. It is the leading cause of deaths in children under five years, pregnant women and those in low socioeconomic status [2]. Human malaria is caused by five known parasite species in the genus *Plasmodium: Plasmodium falciparum, P.vivax, P.ovale. P.malariae and P.knowlesi.* Most infections are caused by *P. falciparum* [1].

Malaria in pregnancy is a major cause of maternal and fetal morbidity and mortality. Compared to other malaria parasites, *Plasmodium falciparum* is known to be a major contributor to pregnancy anemia especially in nulliparous women [3]. The species has been consistently and widely associated with pathologies including maternal anemia, low birth weight (LBW) infants, intrauterine growth retardation, premature deliveries and infant mortality during gestation [4]. However, the impact of the other malaria parasites (*P.vivax, P. malariae* and *P.ovale*) particularly in pregnancy is not clear although it is estimated that up to 200,000 infants die annually worldwide as a result of maternal malaria infection during pregnancy [5,6]. Therefore, there is an urgent need to understand the prevalence and risk factors that predispose to malaria in pregnancy.

Previously it has been reported that malaria prevalence in the general population is influenced by a number of factors such as maternal age parity, use of prophylaxis, nutritional status, host genetics, parasite genetics and transmission rate [7]. It remains however unclear which factors are significantly associated with malaria in pregnancy. Pregnant women are particularly vulnerable to infections due to suppression of their immune system during

***Coresponding Author:** Chrispinus Siteti Mulambalah, Moi University, School of Medicine, Department of Medical Microbiology & Parasitology, Eldoret, Kenya
E-mail: csmulambalah@gmail.com

pregnancy [8]. A clear understanding of the epidemiology and risk factors of malaria parasites in human population is inadequate specifically in respect to expectant mothers [9].

Malaria transmission in Kenya can be described as stable, unstable depending on location and altitude with children and expectant mothers being the most vulnerable [10]. In western Kenya, malaria is prevalent and a persistent public health problem. A recent study by Jekins and colleagues in the Lake Victoria region reported *Plasmodium falciparum* malaria prevalence of 28% in adult females with concomitant anemia [10]. The high prevalence of malaria associated anemia in pregnancy compared with low anemia in non-pregnant women in western Kenya has been a major concern to health personnel [11]. Although efforts aimed at preventing malaria in pregnancy have been ongoing, the disease is still prevalent in counties in Western Kenya more so in Bungoma County. No study has looked at the distribution of malaria parasite species among pregnant women in Bungoma County. Thus, this study sought to determine the distribution and risk factors of malaria parasites among pregnant women in Bungoma County. The findings from this study provide useful information for designing strategies for effective control and management of malaria in expectant mothers.

Materials and Methods

Study Design

A cross sectional hospital based study was adopted. Consecutive sampling was used to recruit participants who met inclusion criteria from March 2016 to January 2017.

Study Setting

The study was conducted at Bungoma Country referral hospital. The hospital is located in Kanduyi Sub County; Bungoma County in Western Kenya. The study area lies between latitude 0° 34′0”N and Longitude 34° 34′ 0”E. Bungoma County has an area of 3,032.2sq km with an estimated human population of 1,375,063 according to Kenya 2009 national census [12]. It has 9 sub counties, Kanduyi, Bumula, Sirisia, Kabuchai, Kimilili, Webuye East, Webuye West, Tongaren and Mount Elgon. It has a tropical climate characterized by hot and humid conditions with two rainy seasons, long rains season (April and August) and the short rains (October to December). Dry season is experienced from January to March of every year. The predominant ethnic groups are Luhyas (Bukusu),Teso and Sabaot, who practise subsistence farming.

Sampling Frame and Inclusion Criteria

A total of 750 pregnant women were recruited in the study as they sought antenatal services at the Bungoma County referral hospital. The recruited expectant mothers were grouped into three age groups 18-27 years, 28-37 years and 38-49 years. Inclusion criteria were based on age range 18 -49 years, being residents of Bungoma County for at least six months and willing to participate in the study.

Collection of Demographic Data

Pre-tested, semi-structured questionnaire was developed and administered to participants’ prior to blood sample collection. The questionnaire was used to collect data on age, use of malaria preventive measures, housing conditions, residence, stage (trimester) of pregnancy, marital status, level of education and employment. Quality control was performed by daily review of each questionnaire.

Blood Sample Collection and Processing

Blood samples were aseptically collected from all the 750 participants. A finger was cleaned with cotton swap moistened in 70% alcohol. The swabbed area was dried using a piece of dry cotton wool. A prick was done using a sterile disposable blood lancet. The first drop of blood was wiped off. Thick and thin films were made on the same slide. A drop of blood was put at one end of the glass slide, using a clean spreader blood was spread to make a circle. Another drop of blood was put at the middle of the same slide, using a clean spreader; blood was spread at an angle of 35-45 degrees to make a thin film covering approximately ¾ of the slide. Slides were air-dried in a horizontal position. Thin blood films were fixed by dipping in a jar of 70% methanol for 30 seconds then air-dried. Both thin and thick films were stained using 10% Giemsa for 10 minutes. Thick and thin blood films were preferred because thick blood film concentrates malaria parasites for easier viewing while thin blood film facilitates *Plasmodium* species identification by their morphological features.

Detection and Quantification of Malaria Parasites

The slides were examined microscopically using 100 magnification by a qualified medical laboratory technologist. All asexual forms of malaria parasites (trophozoites and schizonts) in each preparation were identified by their morphological features and recorded. Malaria parasites density per microliter of blood was calculated by counting the number of malaria parasites against 200 white blood cells (WBCs) and multiplying by 8,000 to obtain malaria parasites/µl of blood. At least 100 high-power fields were examined before a film was declared negative [13]. For quality control 10% buffered (pH 7.2) Giemsa stain was prepared for use after every 6 hours. Further, known malaria positive controls with low parasitemia were stained and examined daily to check the quality of the stain. At least 10% of the read blood smears were re-examined by the second qualified laboratory technologist for quality control. Relevant procedures for waste segregation and disposal were followed.

Data Analysis

Data was analysed using STATA version 12 (STATA Corporation college station TX USA). Both descriptive and inferential statistical tools were used to analyse data. Prevalence of malaria and parasite quantification per microliter of blood was calculated based on blood sample results. Chi-squire (X^2) was used to determine the relationship between malaria and risk factors. Multivariate logistic regressions were employed for those variables that had significant association at bivariate analysis to determine the main socio economic risk factors of infection. P-value ≤ 0.05 was considered significant. Odds ratios (OR) with a 95% confidence interval were computed to compare the strength of association between explanatory variables.

Ethical Considerations

The study was approved by Masinde Muliro University of Science and Technology Institutional Review Board (approval number MMU/COR403OO9 (57). Further approval was obtained from Bungoma County Referral Hospital. Oral and written informed consent was obtained from all study participants in either English, Kiswahili. Pregnant women were given explanations pertaining to the study objectives and procedures before signing written

individual consent forms. Study participants were given the option to withdraw from the study at any time they wished. Data obtained was coded and kept strictly confidential. The results were shared with individual study participants and those confirmed positive for malaria were treated in accordance with clinical guidelines of WHO and Ministry of Health, Kenya.

Results

Malaria Prevalence and Density

The overall malaria prevalence was 21.6% (n=162) with *Plasmodium falciparum* being the most prevalent species 83.3% (n=135), *Plasmodium malariae* 10.5 % (n=17), *Plasmodium ovale* 1.2 % (n=2), and mixed infection of *Plamodium falciparum* and *Plasmodium malariae* 4.9 % (n=8). The mean malaria parasite density in pregnant women was as follows *Plasmodium falciparum* 528, CI (405-751), *Plasmodium malariae* 312, CI (254-370) and *Plasmodium ovale* 132, CI (48-74) parasites per micro litter of blood (Parasites/µl) (Table1).

Social Economic Risk Factors

Expectant mothers of age group 18-27 years were more likely to be infected with malaria parasites 79% (n=128), χ22.151 p=0.341 compared to higher age groups for instance 28-37years 19.8% (n=32) χ25.086 p=0.079, 38-49 years 1.2% (n=2), χ20.341 p=0.184.

Malaria prevalence was higher in expectant mothers residing in rural areas 129 (79.6%), χ22.709 p=0.001 compared to those in urban areas 33 (20.4%), χ2 0.330 p=0.467. Similarly, study participants who lived in semi-permanent houses (houses build of mud walls, earthen floors and iron -roofed) were more infected with malaria 110 (67.9%), χ28.174 p=0.002 compared to those residing in permanent houses (houses build of cement walls, cement floors and iron sheet roofs) 52(32.1%), χ20.871 p=0.201.

Expectant mothers with primary level of education were more likely to be infected with malaria 79 (48.8%), χ222.786 p=0.001 compared to those who had attained tertiary and higher education 22 (13.6%), χ24.366 p=0.359. Unemployed study participants were more likely to be infected with malaria 87 (53.7%), χ2 11.999 p=0.007 compared to those employed 23 (14.2%), χ28.738 p= 0.033. Expectant mothers in their 2nd trimester were more likely to be infected with malaria 107(66.1%), χ2 3.478 p=0.176 than those in 1st trimester 31(19.1%), χ2 8.327 p= 0.16 and 3rd trimester 24 (14.8%), χ2 4.309 p=0.116.

Multivariate Analysis of Risk Factors for Malaria in Pregnancy

The risk factors for malaria infection among expectant mothers considered in the study included unemployment P=0.002 OR 9.588 (2.281-40.304), lack of malaria treatment P=0.015 OR 3.615(1.285-10.167), not sleeping under treated mosquito net P=0.001 OR 3.220 (2.019-8.138) and 2nd trimester of pregnancy P=0.006 OR 2.126 (1.238-3.651). The analyzed variables are presented in Table 2.

Table 1. Prevalence and density of malaria parasites

No. +ve for malaria parasites	*P. falciparum*	*P. malariae*	*P. ovale*	*P. falciparum* and *P. malariae*
21.6% (n=162)	83.3% (n=135)	10.5%(n=17)	1.2%(n=2)	4.9%(n=8)
Mean malaria parasites/µl of blood				
P.f 528 CI (405-751)	*P.m* 312 CI (254-570)		*P.o* 132 CI (48-74)	

Key: *P.f- Plasmodium falciparum, P.m- Plasmodium malariae, P.o- Plasmodium ovale,* CI-95% confidence interval

Table 2. Risk factors for malaria in pregnancy

Variable	Malaria		
	p-value	OR	95% CI
Malaria Treatment			
No treatment	0.015	3.615	1.285-10.167
More than 6 months	0.078	0.520	.251-1.075
Mosquito net use			
Does not use	0.001	3.220	2.019-5.138
Not always	0.001	0.035	0.004-0.276
Employment			
Unemployed	0.006	2.034	1.228-3.371
Employed	0.149	1.333	0.92-1.970
Trimester			
1st	0.040	0.708	0.509-0.984
2nd	0.006	2.126	1.238-3.651
3rd	0.013	2.235	1.186-4.211

Key: 95% CI=Confidence interval, OR= Odds ratio, P<0.05 was considered significant

Discussion

Malaria is one of the most serious public health problems in Kenya. The disease epidemiology varies depending and locality and may be influenced by several factors relating to parasite species, host and environmental. Our study has shown that socio-economic factors, age, stage of pregnancy and parity status of the mother are important determining factors in malaria infection in pregnancy. In this study, malaria prevalence was 21.6% with *Plasmodium falciparum* being the most prevalent species. *Plasmodium malariae* and *Plasmodium ovale* were recorded as common. These results are comparable to a study in Ghana where the prevalence was 25.7% which lie in the same tropical region as Kenya [3]. The two countries lie within tropical belt of Africa with comparable climatic conditions. Locally, these observation suggest high transmission of malaria in Bungoma county. This could be attributed to favorable tropical environmental conditions suitable for the development of *Anopheles* mosquitoes and consequently to the development and propagation of *Plasmodium* parasite.

Our study reported a prevalence rate that was lower than what was obtained in similar studies elsewhere due to differences in ecosystems. For instance a similar study in Cameroon where the prevalence rate of 77.2 % was reported [14] while another similar study along the coastal region of Kenya a prevalence rate of 32% was reported [15]. However, malaria prevalence rate in this study was higher than11.6% reported in Ethiopia [16] and 16.5% in Ghana [11]. The observed differences could be linked to dissimilarities in the geo-ecological and climatic conditions that influence the number and distribution of malaria vector breeding in different study sites. Further, population and demographic dynamics in the study sites are not identical and this can impact on the disease epidemiology.

Malaria parasite intensity in this study was quantified as moderate and varied considerably depending on malaria parasite species. These findings could be attributed to the infection rate which may vary depending on the *Plasmodium* species in study sites and the preventive measures operational in the study sites for instance chemoprophylaxis. These and other factors such as host immunity are known to influence malaria infection intensity [17]. Malaria intensity was classified as described by Trape [18] and our study findings were comparable with a study by Yatich and others in Ghana [3] which showed that mean intensity of malaria species specific infections vary considerably in individuals.

The study was undertaken during the long rains season characterized by flooding and with several stagnant pools of water favorable for *Anopheles* mosquito vector breeding. Therefore, relatively high malaria prevalence and intensity was anticipated but this was not the case. This unexpected observation could be due to widespread use of insecticide treated mosquito nets, a policy that has been enforced by the Kenyan government for expectant mothers and which protect them from mosquito bites and consequently reduction in malaria transmission. Mothers in second trimester of pregnancy had the highest malaria parasite prevalence rate (66.1%). This could be explained by the observation that expectant mothers miss out on first trimester antenatal care and later seek antenatal services during the second trimester of pregnancy when the malaria diagnosis was done.

Malaria risk factors were unemployment, lack of mosquito net use, staying in rural area and age group 18-25 year. Unemployment leads to poverty which results in low standard of living. Majority of malaria positive expectant mothers were from rural set ups and lived in semi-permanent structures a reflection of poor and deprived communities. Similar findings were also observed in a recent study in Nigeria [19]. Explanation for these findings could be attributed to poor sanitation in rural communities living in environmental conditions favoring breeding of vector mosquitoes and thus increased risk of being bitten and acquiring malaria. These findings support the idea that it is essential to scale up malaria prevention efforts in more isolated and deprived communities as highlighted in a meta-analysis of data from 25 African countries [20].

Although one of the first line prevention of malaria in Kenya among pregnant women relies on nationwide distribution of treated mosquito nets at antenatal clinic visits, we found out that close to half of expectant mothers do not sleep under mosquito nets. These findings demonstrate the need for public health awareness campaigns. It is important for expectant mothers to know how to use bet nets when provided, otherwise they will not have desired impact. Therefore integrated effort for controlling malaria transmission especially in rural areas, particularly in deprived communities is essential.

Conclusion

A multipronged strategy should be employed in the control of malaria in expectant women. The strategy should incorporate aspects relating to the age of the mothers, parity, socio-economic status as well as stage in pregnancy.

Apart from *Plasmodium falciparum* being prevalent, the study findings revealed that *Plasmodium malariae* and *Plasmodium ovale* were also common in the study area. Principal risk factors were primary education, unemployment, lack of malaria treatment, lack of mosquito nets and second trimester pregnancy. Exposure to malaria in pregnancy was associated mainly with the failure to use treated mosquito nets and unemployment. These findings are useful in designing control and management strategies for malaria among pregnant women in Bungoma County

The study recommends routine diagnosis and prompt treatment of malaria; provision of treated mosquito nets together with health awareness to expectant mothers during their visit to antenatal clinics.

Acknowledgement
We thank Dr Isaac Omeri, medical superintendent, Bungoma County referral hospital who granted us permission to carry out the study in the hospital. We also thank hospital staff for their assistance. Special thanks go to pregnant women who participated in the study.

Competing interests
The authors declare that they have no competing interest.

Financial Disclosure
The authors declared that this study has received no financial support.

Ethical approval
The study protocol was approved by the University ethics committee with reference numbers MMU/COR403009(57).

References

1. World Malaria Report. http://www.who.int/malaria/publications/world-malaria -report 2015 access date 5.5.2018
2. World Malaria Report. http://www.who.int/malaria/publications/world_malaria_report_2013 access date 5.5.2018
3. Yatich NJ, Pauline EJ, Ellen F, et al. The Effect of Malaria and Intestinal Helminth Coinfection on Birth Outcomes in Kumasi, Ghana. Am J Trop Med Hyg. 2010;82:28-34.
4. Yatich NJ, Yi J, Agbenyega T, et al. Malaria and intestinal co-infection among pregnant women in Ghana: prevalence and risk factors. Am J Trop Med Hyg. 2009;80:896-901.
5. Steketee RM, Nahlen BL, Praise ME, et al. The burden of malaria in pregnancy in malaria endemic areas, Am J Trop Med Hyg. 2001;64:28-35.
6. Bhattacharyya PC. Malaria in pregnancy. Medicine Update. 2011:477.
7. Tako EA, Zhou A, Lohoue J, et al. Risk factors for placenta malaria and its effect on pregnancy outcome in Yaounde, Cameroon. Am J Trop Med Hyg. 2005;72:236-42.
8. Meeusen EN, Bishof RJ, Lee CS. Comparative T-cell response during pregnancy in large animals and humans Am J Repro Immunol. 2001;46:169-79.
9. Telfer S, Lambin X, Birtles R. Species interactions in a parasite community drive infection risk in a wildlife population. Science. 2010;330:243-6.
10. Rachel J, Raymond O, Michael O, et al. Prevalence of malaria parasites in adults and its determinants in malaria endemic area of Kisumu County, Kenya. Malaria Journal. 2015;14:263.
11. Samuel C, Kofi T, Emmanuel A, et al. Parasitic infections and maternal anaemia among expectant mothers in the Dangme East District of Ghana. BMC Research Notes. 2017;10:1.
12. Government of Kenya National Bureau of Statistics. The 2009 population and housing census: Ministry of State for Planning, National Development and Vision 2030, counting our people for implementation of Vision 2030 Vol 1. Government printer, 2010.
13. Cheesbrough M. District Laboratory Practice in Tropical Countries. Part I. Cambridge University Press. 1998:242-53.
14. Francis Z, Viviane H, Matong T, et al. Co-infections of Malaria and Geohelminthiasis in two rural Communities of Nkassomo and Vian in the Mfou District, Cameroon, PLoS Negl Trop Dis. 2014 Oct 16;8:e3236.
15. Fairley JK, Bisanzio D, King CH. Birth weight in offspring of mothers with high prevalence of helminth and malaria infection in coastal Kenya. J Trop Med Hyg. 2013;88:48-53.
16. Getachew M, Tafess K, Zeynudin A, et al. Prevalence soil transmitted helminthiasis and malaria co-infection among pregnant women and risk factors in Gilgel Gibe Dam area, southwest Ethiopia. BMC Res Notes. 2013;6:263.
17. Bigoga JD, Nanfack MF, Awono-Ambene HP, et al. Seasonal prevalence of malaria vectors and entomological inoculation rates in the rubber cultivate area of Niete, South Region of Cameroon. Parasites Vectors. 2012;5:197.
18. Trape FJ. Rapid evaluation of malaria parasite density and standardization of thick smear examination for epidemiological investigations. Trans R Soc Trop Med Hyg. 1985;78:181-4.
19. Fredrick OA, Taiwo AO, Christopher EO, et al. Co-infection of malaria and intestinal parasites among pregnant women in Edo state, Nigeria. J Med Trop. 2017;1:43-8.
20. Eisele TP, Larsen DA, Anglewicz PA, et al. Malaria prevention in pregnancy, birth weight, and neonatal mortality: a meta-analysis of 32 national cross-sectional datasets in Africa. Lancet Infect Dis. 2012;12:942-9.