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Prevalence of malaria and anaemia among pregnant women attending Antenatal Care Clinic in the Hohoe Municipality of Ghana

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Abstract: Background: Malaria infection during pregnancy is a major public health problem in the tropical and sub-tropical regions. This study determined the prevalence and factors associated with malaria and anaemia among pregnant women. ***Methods:*** A cross-sectional hospital-based study carried out from January to December 2016at the Hohoe Municipal Hospital. Pregnant women of all gravidities with gestational agebetween16-37weeks, attending focused antenatal care (Focused-ANC) were interviewed using asemi-structured questionnaire to obtainsocio-demographic, obstetric and medical history data. Blood samples were examined for Hemoglobin levels and malaria parasitaemia. Chi-square test and logistic regression were used to determine the association between dependent and independent variables. Linear regression was used to determine the association between the risk factors of the covariates and the log parasite density. A P-value <0.05 was considered as statistically significant. ***Results:*** Of 1200 women, malariaparasitaemia was present in 244 (20.3%), anaemia (Hb<11.0 g⁄dl) in724 (60.3%).Ownership and usage of long-lasting insecticide treatednet(LLIN) were95.3% and 86.5% respectively. Women who were anaemic and those who visited focused-ANC 5-8 times were 1.70 and 2.08 times more likely to have malaria, (AOR=1.70, p<0.001)and (AOR=2.06, p=0.039) respectively. Women in their 3rd trimester were 41% times less likely to have malaria (AOR=0.59, p=0.033).Women aged between 30-39 years and those who took ≥ 3 doses of Sulphadoxine -pyrimethamine (SP-IPTp)were 42% and 54% times less likely to have anaemia [AOR=0.58; p=0.040] and[AOR=0.46; p=0.010] respectively. Women in their2ndtrimester were 1.39 times more likely to have anaemia [AOR=1.39; p=0.043]. Parasite density decreased with increasing age (r=-0.041, p=0.033).***Conclusion****:* One out of every 5 pregnant women had malaria and 6 out of every 10 pregnant women had anaemia. Administration of ≥ 3 doses of SP-IPTp reduces anaemia. The presence of malaria results in anaemia and makes pregnant women increase the number of Focused-ANC visits. Age is arisk factor for parasite density. With the high prevalence, targeted interventions for younger women and women in their 2ndtrimesterare needed to reduce anaemiain pregnancy within Hohoe Municipality of Ghana.

Keywords: Pregnancy, Malaria Parasitaemia, Anaemia, Focused-ANC, Hohoe Municipality, Ghana

INTRODUCTION

Malaria is a life-threatening parasitic disease transmitted by female *Anopheles*mosquitoes. More than 40% of the world population lives in malarious areas [1]. Malaria control still remains a challenge in Africa where about 45 countries are endemic for malaria and 588 million people at risk. The protection of pregnant women living in malaria-endemic countries has been of particular interest to many National Malaria Control Programs (NMCP) because of their reduced immunity [2]. According to the World Health Organization (WHO), there were 214 million cases of malaria in 2015 and 438,000 deaths. Sub-Saharan Africa (SSA)continues to carry a disproportionately high share of the global malaria burden, with 88% of malaria cases and 90% of malaria deaths [3]. Approximately 125 million pregnant women are exposed to the risk of malaria in pregnancy each year resulting in 200, 000 infant deaths [4].

According to WHO, malaria infection during pregnancy is a major public health problem in tropical and sub-tropical regions and the burden of malaria infection during pregnancy is caused mainly by *Plasmodium falciparum*, the most common malaria species in Africa. It is one of the biggest impediments to progress in Africa, with 90% of the global deaths occurring on this continent [1]. Malaria is responsible for one in four deaths below the age of 5 years and could lead to miscarriage at the early stage of pregnancy [5]. Pregnant women with relatively lower level of previously acquired immunity are particularly at high risk of the most severe complications such as cerebral malaria, severe malaria anaemia, abortions, intrauterine foetal death, premature delivery, stillbirths and both maternal and infant mortality [4].

In malaria transmission areas, pregnant women, particularly primigravidae, are known to be susceptible to malaria and to have a higher prevalence and densities of parasitaemia than non-pregnant women from the same population. The size of the excess risk varies with the age of the pregnant woman, reflecting cumulative exposure to malaria over a lifetime and with parity as a result of pregnancy-specific immunity acquired after exposure to malaria in previous pregnancies [6].

Studies in malaria in pregnancy conducted in Laos, a low transmission zone found that the prevalence of malaria among pregnant women in the community was 5.9% while malaria prevalence among women attending hospital was 3.1% [7].A study conducted in Lagos indicated that the

prevalence of malaria in pregnant women was 52% [5].It was also found that primigravidae were more susceptible to the parasite,especially *Plasmodium falciparum* than the multigravidae. Also, a study conducted in Rwanda in six districts revealed the prevalence of malaria to be 6.2% [8]. In the Nchelenge District of Zambia, it was found that the prevalence of malaria among pregnant women by microscopy was 31.8% and by PCR, 57.8% [9].

Among pregnant women in Ghana, malaria accounts for 28.1% of Outpatient Department (OPD) attendance, 13.7% of ward admissions and 9.0% of maternal deaths [10]. A study conducted among pregnant women who presented to an antenatal care (ANC) clinic in the Kassena-Nankana district of Ghana revealed that the overall prevalence of malaria parasitaemia during pregnancy was 47%. Among women with parasitaemia, older women were less likely to have a high parasite density infection than younger women [11]. Another comparative cross-sectional study carried out at the University Hospital, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana reported that the prevalence of malaria in pregnant women was 12.6%. Also, parasite density was higher in the younger than the older women [12].

In Ghana, the National Malaria Control Programme (NMCP) is the body championing the national effortsat reducing the malaria burden. Ghana adopted the WHO's current recommendation package of interventions for controlling malaria during pregnancy in high transmission zones. This package includes using Intermitted Preventive Treatment of malaria in pregnancy (IPTp) with Sulphadoxine-Pyrimethamine (SP) (SP-IPTp), the use of long lasting insecticide treated Net (LLIN) for malaria prevention and the Artemisinin-based combination therapy for case management of malaria illness in 2004 [10].

According to the Volta Regional Health Directorate (VRHD), the total number of malaria cases among pregnant women dropped from 34,452 in 2013 to 25,790 in 2014 constituting 25.1% reduction [13]. This indicates the effectiveness of the existing preventive strategies such as the use of LLIN, SP-IPTp, rapid testing for malaria and treatment with artemisinin-based medications in the region. However, in spite of the increased coverage and usage of LLIN, reports still indicate that malaria tops most OPD in Ghana [14]. Similarly, in the HohoeMunicipality, malaria is still the leading cause of OPD attendance (28%) and the leading cause of deaths (19.4%) [15].This study determined the prevalence and factors associated with malaria andanaemiaamong pregnant women in the Hohoe Municipality of Ghana.

Study site:

The study was undertaken in the Hohoe Municipality of Ghana, which is one of the twenty-five administrative districts of the Volta Region. The Municipality is located in the central part of the region with a total land surface area of 1,172 km squareconsisting of 102 communities with a total population of 167,016 people (projected from 2010 population census). It is located at longitude 0 degrees 15 East and 0 degrees 45 East and latitude 6 degrees 45 North and 7 degrees 15 North and lies almost in the heart of the Volta Region. It is bounded by Jasikan District to the North, Northwest by BiakoyeDistrict, South by Afadjato South District, West and South West by Kpando Municipality and East by the Republic of Togo. There are two main seasons, the wet and dry seasons. The major wet season lasts from April to July and the minor one from September to November. The rest of the year is relatively dry. The average annual rainfall recorded by the Hohoe Municipal Meteorological Department (HMMD) in the district is 1,592 mm with approximately 1,296 mm rain falling between April and October. Malaria is hyper-endemicand transmission is throughout the years but with seasonal peaks. The Municipality has been divided into seven (7) Health Sub-Municipalities namely: Akpafu/Santrokofi, Alavanyo, Agumatsa, Lolobi, Gbi-Rural, Hohoe-sub and Likpe. Hohoe Municipality has a total of Twenty-one (21) health facilities including Municipal Hospital (1) Health centres (14) and CHPS compounds (6). Fifty-seven (57) outreach Child Welfare Clinics (CWCs) clinics are carried out every month in the Municipality.

The Municipal Hospitalissituated at Hohoe. Typical of the health system in Ghana, the Municipal Hospital is the only referral facility that provides secondary and tertiary care. The Municipal Hospital and the health centresprovide ANC and PNC services. Approximately 3500 babies are delivered at the health facilities per year in the municipality. The hospital for the past three years 2012 to 2015 recorded an average of 2800 deliveries per year [15].All pregnant women within the Municipality are referred to the Municipal Hospital for laboratory services. The Municipal hospital and health centres provide daily focused ANC and delivery services. The Midwives also promote the use of LLINs during pregnancy.

Study population:

The study population was primigravidae and secundigravidae women (paucigravid women) with gestation between 16 and 37 weeks, residing within the Hohoe Municipality and attending Focused-ANC clinic at the HohoeMunicipal Hospital during the study period.

Study Design:

The design was a cross-sectional hospital-based study carried out from January to December 2016 at the Hohoe Municipal Hospital ANC. Data were collected in the form of interviews usingaquestionnaire to obtained information on socio-demographic characteristics, obstetrics and medical history and collection of biological samples. Finger-prick/venous blood was collected for blood film for malaria parasites and haemoglobin level.The blood film was examined immediately after collection. Those with malaria parasitaemia were treated with Artesunate plus Amodiaquine (AS+AQ), the standard treatment for malaria during pregnancy in Ghana.

Inclusion criteria:

The inclusion criteria were apaucigravid woman attending ANC with gestation 16-37 weeks at the Hohoe Municipal Hospital within the period of the study, not seriously ill (pulmonary tuberculosis and HIV) and consented to participate.

Main exclusion criteria:

The exclusion criteria werea paucigravid woman seriously ill (pulmonary tuberculosis and HIV) and no consent by the pregnant woman.

Sampling and sample size determination:

The sample size was estimated on the basis of the following: 95% confidence level (Z),thepower of 80% and the prevalence (P) of malaria in pregnant women as 19.7% [16]. The least acceptable prevalence of malaria was 5.0%. Using Open Epi software version 3,the sample size calculated for the cross-sectional surveys was 1050 women with gestation 16-37 weeks[17]. However, all women who were illegible and consented to participate were included. Therefore, a total 1200 were included in the survey.

Enrolment and consent:

Eligible women were approached for consent to participate in the study. This process was carried out by trained midwives using the local language (Ewe) in the Municipality. All women who gave consent to participate appended their signatures or right thumbprints to the consent form. The midwife also signed to indicate that she has adequately informed the participant about the study and answered all the questions posed by the participants for clarification.

Data Collection:

Data collection involved asking pregnant women questions using pre-tested semi-structured questionnaire and collecting finger-prick/venous blood for laboratory investigations.Information was also obtained on socio-demographic characteristics, LLIN ownership and usage,the number of ANC visits and the doses of SP-IPTp received.Blood pressure measurements were extracted from the ANC book. Finger prick/venous blood sample was collected for the determination of malaria parasitaemia and haemoglobin (Hb) levels.

LABORATORY METHODS

Malaria blood films for microscopy:

Thick blood films were prepared on a glass slide using 10 µL of blood, evenly spread to cover an area of 15 x 15mm of the slide. The smear was stained with 10% Giemsa for 10 minutes and then examined under oil immersion with a light microscope (magnification x 100). The slides were double read by trained Microscopists. Asexual parasite densities were estimated by counting the number of parasites per 200 white blood cells (WBCs) in the thick film. Parasite counts were converted to parasites per microliter (µl), using a relative WBC of 8000 leukocytes per µl of blood [18]. A sample was considered negative if no parasite was counted after 200 high power fields had been read. If there occurred discrepancies in the findings in a slide between the two initial technicians (positive or negative or a 50% or more difference in parasite density) a third, more senior Microscopist's reading was deemed necessary and then adopted. Two senior Microscopists from the Noguchi Memorial Institute of Medical Research (NMIMR) and University of Health and Allied Sciences (UHAS), examined all the positive blood films including a 20% random sample of negative blood slides for quality control.

Haemoglobin measurement:

Haemoglobin was measured using URIT-12 Haemoglobin Meter (URIT Medical Electronic Co., Ltd. UK). The Classification of haemoglobin(Hb)levelwas done according to the WHO standards and guidelines [19]:

Normal: Hb≥ 11.0 g/dl
Anaemia: Hb<11.0 g/dl
Mild anaemia: Hb10-10.9 g/dl
Moderate anaemia:7-9.9 g/dl
Severe anaemia: < 7 g/dl

Data analysis:

Data were entered using Epi DATA 3.1 software and then exported to STATA 14 (STATA Corporation, Texas, USA) for analysis. After data were entered, cleaning and validation were done to ensure data quality before analysis was carried out. Descriptive statistics such as proportions and frequency distribution were performed to describe categorical variables and the results were presented in bar chart and tables. Inferential statistics such as Chi-square test and logistic regression were used to assess the associations between the categorical dependent and independent variables. Linear regression was used to determine the association between the risk factors of the covariates and the log parasite density. AP-value <0.05 was considered as statistically significant.

Ethical considerations:

The current study was approved by the Ethical Review Committee (ERC) of the Ministry of Health/Ghana Health Service(MoH/GHS), with approval numberGHS-ERC: 13/07/2014. Before the commencement of the study, permission was sought from the Hospital Management Team (HMT). A written informed consent was obtained from the participants. All the information collected was treated confidentiallyand used for research purposes only.

RESULTS

Demographic,obstetric and clinical characteristics of the respondents:

Table 1 shows that a total of 1200 women were screened with a mean age of 27.6 ±6.2 years. Most of the participants attained Junior High School (JHS) level of education, 539 (44.9%). The Majority 450 (37.5%) of the participants were traders, and most, 1022 (85.2%) were Christians. Of the 1200 participants, the majority, 921 (76.7%) were multigravidae. Nulliparous participants were 709 (59.1%).

Table 1: Demographic, obstetric and clinical characteristics of the respondents

Characteristic	Total [N=1200]	Percent (%)
Number recruited	1200	
Mean age(in years)(SD)	27.58	6.19
Age(years)		
<20	122	10.2
20-29	625	52.1
30-39	417	34.7
40-49	36	3.0
Education level		
None	117	9.8
Primary	156	13.0
JHS	539	44.9
SHS	245	20.4
Tertiary	143	11.9
Occupation		
Unemployed	228	19.0
Artisan	326	27.2
Trading	450	37.5
Farming	56	4.6
Civil servant	140	11.7
Religion		
Christians	1022	85.2
Muslims	178	14.8
Gravidity		
Primigravida	279	23.3
Multigravida	921	76.7
Parity		
Nulliparous	709	59.1
Primiparous	239	19.9
Multiparous	252	21.0
Gravidity		
Primigravida	279	23.3
Multigravida	921	76.7
Parity		
Nulliparous	709	59.1
Primiparous	239	19.9
Multiparous	252	21.0
Malaria parasites		
Absent	956	79.7
Present	244	20.3
Anaemia status		
Normal	476	39.7
Anaemia	724	60.3
Own LLIN		
No	57	4.7
Yes	1143	95.3
Use LLIN		
No	154	13.5
Yes	989	86.5
Number of visits		
First visits	433	36.1
2-4 visits	461	38.4
5-8 visits	293	24.4
9-12 visits	13	1.1
Number of SP doses		
No dose	509	42.4
1-2 doses	456	38.0
≥ 3 doses	235	19.6
Gestation (in weeks)		
1st trimester	427	35.6
2nd trimester	406	33.8
3rd trimester	367	30.6
Previous delivery outcomes		
No deliveries	403	33.6
Live births	756	63.0
Still births/neonatal deaths	41	3.4
Hypertension		
Normal	1136	94.7
Hypertensive	64	5.3

Prevalence of malaria:

Table 1 and figure 1 show that of the 1200 pregnant women, 244 (20.3%) had malaria parasites in their blood as determined by microscopy. Of the 279 women who were primigravidae 53 (19.0%) had malaria and 191(20.7%) of the 921multigravidae had malaria (Figure 1).Of the 437 women in their first trimesters, 85 (19.9%) had malaria, while 96 (23.6%) of the 406 women in their 2nd trimesters and 63 (17.2%) of the 367 women in their 3rd trimesters had malariaparasitaemia(Figure 2).

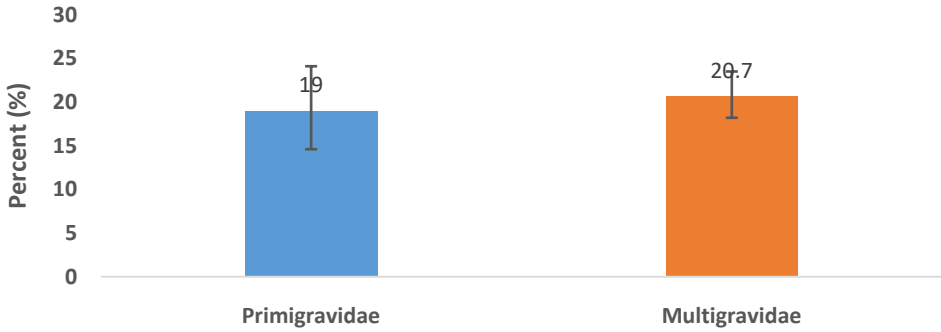

Figure 1: Malaria prevalence among primigravidae and Multigravidae (p=0.294)

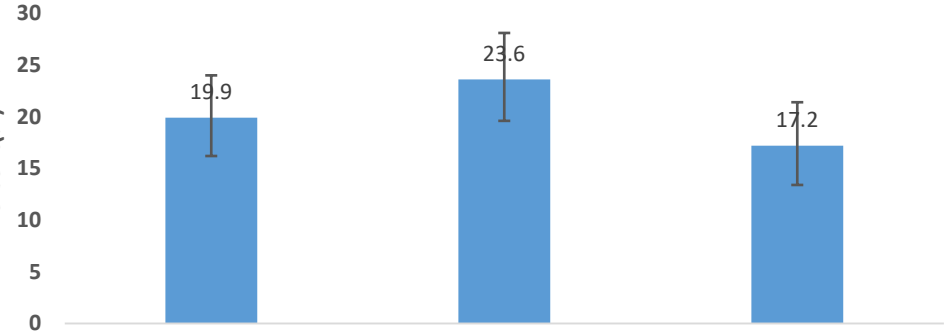

Figure 2: Malaria prevalence among pregnant women in each trimester

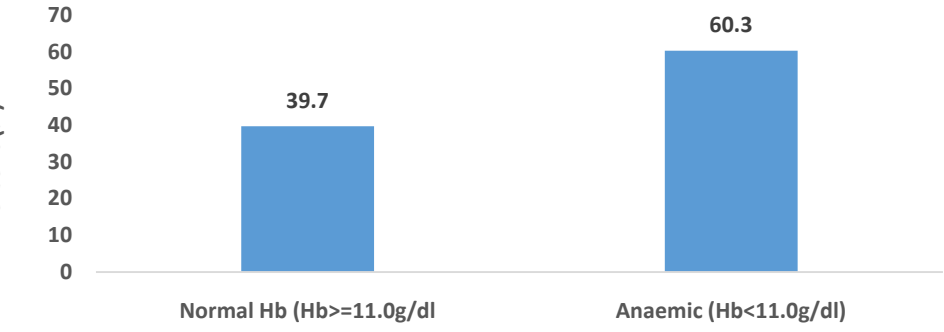

Figure 3: Prevalence of anaemia among pregnant women at ANC

Prevalence of anaemia:

Table 2 shows that, of the 1200 pregnant women,the majority, 724 (60.3%) were anaemic (Hb<11.0g/dl) (Figure 3). The majority of participants, 1143 (95.2%) own an LLIN. Most 989 (86.5%) of the participants claimed they slept inside an LLIN the night before the survey.Of the 1200 participants, 433 (36.1%) were visiting ANC for the first time with that pregnancy. During the survey, most, 509 (42.4%) of the participants had not taken any SP doses. The majority, 427 (35.6%) of the participants had their gestation less than 24 weeks.Of the 1200 participants, the majority, 797 (66.4%) had ever delivered before,most, 756 (94.9%) of whom had live births. Of the 1200 participants,themajority, 1136 (94.7%) had normal blood pressure.

Association between socio-demographic characteristics,haemoglobin levels and Odds of malaria infection:

Table 2 shows that there was a statistically significant association between anaemia, LLIN usage and malaria infection (χ^2=14.84, p<0.001) and (χ^2=10.18, p<0.001).Participants who were anaemic (Hb<11.0g/dl) were 1.70 times more likely to have malaria as compared to

those with a normal Hb [AOR=1.70 (95% CI: 1.25, 2.32); p<0.001].Participants with gestation 32 weeks or more were 0.58 times less likely to have malaria as compared to those with agestation less than 24 weeks [AOR=0.58 (95% CI: 0.36, 0.94); p=0.027] (Table 2).

Table 2: Associationbetween background characteristics and the Odds of malaria

	Malaria Parasite					
Characteristics	**Negative [N=956] n(%)**	**Positive [N=244] n(%)**	**Total [N=1200] N(%)**	**χ^2 (p-value)**	**COR(95% CI) p-value**	**AOR(95% CI) p-value**
Age(years)						
<20	96(10.0)	26(10.7)	122(10.2)			
20-29	502(52.6)	123(50.4)	625(52.1)		0.90(0.56, 1.46) 0.680	0.85(0.50, 1.44) 0545
30-39	331(34.6)	86(35.2)	417(34.7)		0.96(0.58,1.57) 0.869	0.90(0.50,1.62) 0.731
40-49	27(2.8)	9(3.7)	36(3.0)	0.74(0.863)	1.23(0.51, 2.94) 0.640	1.10(0.43, 2.80) 0.838
Education level						
None	89(9.3)	28(11.5)	117(9.8)			
Primary	121(12.7)	35(14.3)	156(13.0)		0.92(0.52, 1.62) 0.772	0.85(0.48, 1.51) 0.574
JHS	433(45.3)	106(43.4)	539(44.9)		0.77(0.48, 1.25) 0.300	0.74(0.45, 1.20) 0.217
SHS	197(20.6	48(19.7)	245(20.4)		0.77(0.46, 1.31) 0.344	0.71(0.45, 1.22) 0.215
Tertiary	116(12.1)	27(11.1)	143(11.9)	1.78(0.776)	0.74(0.41, 1.34) 0.322	0.65(0.35, 1.21) 0.172
Occupation						
Unemployed	178(18.6)	50(20.5)	228(19.0)			
Artisan	248(25.9)	78(32.0)	326(27.2)		1.12(0.75, 1.68) 0.583	
Trading	370(38.7)	80(32.8)	450(37.5)		0.77(0.52, 1.14) 0.195	
Farming	47(4.9)	9(3.7)	56(4.6)		0.68(0.31, 1.48) 0.335	
Civil servant	113(11.8)	27(11.0)	140(11.7)	5.49(0.240)	0.85(0.50, 1.43) 0.545	
Religion						
Christianity	814(85.2)	208(85.3)	1022(85.2)			
Islam	142(14.8)	36(14.7)	178(14.8)	0.0015(0.969)	0.99(0.67, 1.47) 0.969	1.17(0.79, 1.75) 0.432
Gravida						
Primigravida	226(23.6)	53(21.7)	279(23.3)			
Multigravida	730(76.4)	191(78.3)	921(76.7)	0.40(0.527)	1.11(0.79, 1.56) 0.527	
Parity						
Nulliparous	567(59.3)	142(58.2)	709(59.1)			
Primiparous	192(20.1)	47(19.3)	239(19.9)		0.98(0.68, 1.41) 0.903	
Multiparous	197(20.6)	55(22.5)	252(21.0)	0.45(0.797)	1.11(0.78, 1.58) 0.544	
Anaemia status						
Normal(Hb ≥11.0gm/dl)	402(45.1)	74(30.3)	476(39.7)			
Anaemic(Hb<11.0gm/dl)	554(57.9)	170(69.7)	724(60.3)	11.16(<0.001)	1.67(1.23, 2.25)<0.001	1.70(1.25, 2.32)<0.001
Own LLIN						
No	50(5.2)	7(2.9)	57(4.8)			
Yes	906(94.8)	237(97.1)	1143(95.2)	2.39(0.122)	1.87(0.84, 4.17) 0.127	
Use LLIN						
No	137(15.1)	17(7.2)	154(13.5)			
Yes	769(84.9)	220(92.8)	989(86.5)	10.18(<0.001)	2.30(1.36, 3.90) 0.002	
Number of visits						
First visits	353(36.9)	80(32.8)	433(36.1)			
2-4 visits	365(38.2)	96(39.3)	461(38.4)		1.16(0.83, 1.61) 0.378	1.42(0.78, 2.62) 0.253
5-8 visits	227(23.7)	66(27.1)	293(24.4)		1.28(0.89, 1.61) 0.182	2.06(1.04, 4.11) 0.039
9-12 visits	11(1.2)	2(0.8)	13(1.1)	2.06(0.561)	0.80(0.17, 3.69) 0.777	1.62(0.30, 8.89) 0.575
Number of SP doses						
No dose	411(43.0)	98(40.2)	509(42.4)			
1-2 doses	356(37.2)	100(41.0)	456(38.0)		1.17(0.86, 1.61) 0.304	0.89(0.49,1.60) 0.701
≥ 3 doses	189(19.8)	46(18.8)	235(19.6)	1.17(0.558)	1.02(0.69, 1.51) 0.918	0.95(0.48, 1.87) 0.886
Gestation (in weeks)						

1st trimester	342(35.8)	85(34.8)	427(35.6)			
2nd trimester	310(32.4)	96(39.3)	406(33.8)		1.24(0.89, 1.73) 0.191	1.03(0.71, 1.49) 0.862
3rd trimester	304(31.8)	63(25.8)	367(30.6)	5.07(0.079)	0.833(0.58, 1.73) 0.323	0.59(0.37, 0.96) 0.033
Delivery Outcomes						
No deliveries yet	323(33.8)	80(32.8)	403(33.6)			
Live births	597(62.4)	159(65.2)	756(63.0)		1.07(0.79, 1.45) 0.636	
Still births/neonatal deaths	36(3.8)	5(2.0)	41(3.42)	1.96(0.375)	0.56(0.21, 1.47) 0.241	
Hypertension						
Normal	907(94.9)	229(93.9)	1136(94.7)			
Hypertensive	49(5.1)	15(6.1)	64(5.3)	0.40(0.526)	1.21(0.67, 2.20) 0.527	

Association between socio-demographic characteristics and odds of anaemia:

Table 3 shows that there was a statistically significant association between age, malaria parasitaemia,utilisation of LLIN and anaemia (χ^2=10.78, p=0.013), (χ^2=11.16, p<0.001) and (χ^2=7.17, p=0.007) respectively. There was also a statistically significant association betweenthenumber of ANC visits, the number of SP doses received, gestation, previous delivery outcomes and anaemia (χ^2=14.67, p=0.002), (χ^2=24.52, p<0.001), (χ^2=9.88, p=0.007) and (χ^2=7.09, p=0.029) respectively.Participants who were aged 30-39 years were 0.58 times less likely to have anaemia as compared to those aged less than 20 years [AOR=0.58 (95% CI: 0.35, 0.98); p=0.040]. Participants with malaria parasites present in their blood were 1.70 times more likely to have anaemia as compared to those who did not have any malaria parasitaemia [AOR=1.70 (95% CI: 1.24, 2.31); p<0.001].Participants who received 3 doses of SP or more were 0.46 times less likely to have anaemia as compared to those who did not receive any dose of SP [AOR=0.46 (95% CI: 0.26, 0.83); p=0.010]. Participants in their 2nd trimesterswere 1.39 times more likely to have anaemia as compared to those in their 1st trimesters [AOR=1.39 (95% CI: 1.01, 1.90);p=0.043].

Table 3: Association between background characteristic and the Odds of anaemia

Characteristics	Normal [N=476] n(%)	Anaemia [N=724] n(%)	Total [N=1200] N(%)	χ^2 (p-value)	COR(95% CI) p-value	AOR(95% CI) p-value
Age(years)						
<20	34(7.1)	88(12.1)	122(10.2)			
20-29	243(5.1)	382(52.8)	625(52.1)		0.61(0.40, 0.93) 0.022	0.72(0.45, 1.15) 0.171
30-39	184(38.7)	233(32.2)	417(34.7)		0.49(0.31, 0.76)<0.001	0.58(0.35, 0.98) 0.040
40-49	15(3.1)	21(2.9)	36(3.0)	10.78(0.013)	0.54(0.24, 1.17) 0.119	0.61(0.27, 1.39) 0.238
Education level						
None	46(9.7)	71(9.8)	117(9.7)			
Primary	60(12.6)	96(13.6)	156(13.0)		1.04(0.63, 1.69) 0.886	
JHS	227(47.7)	312(43.1)	539(44.9)		0.89(0.59, 1.34) 0.578	
SHS	84(17.6)	161(22.2)	245(20.4)		1.24(0.79, 1.96) 0.351	
Tertiary	59(12.4)	84(11.6)	143(11.9)	4.57(0.335)	0.92(0.56, 1.51) 0.751	
Occupation						
Unemployed	88(18.5)	140(19.3)	228(19.0)			
Artisan	123(25.8)	203(28.0)	326(27.2)		1.04(0.73, 1.46) 0..836	
Trading	172(36.1)	278(38.4)	450(37.5)		1.01(0.73, 1.41) 0.925	
Farming	30(63)	26(3.6)	56(4.7)		0.54(0.30, 0.98) 0.043	
Civil servant	63(13.2)	77(10.6)	140(11.7)	7.20(0.126)	0.77(0.50, 1.18) 0.226	
Religion						
Christianity	408(85.7)	614(84.8)	1022(85.2)			
Islam	68(14.3)	110(15.2)	178(14.8)	0.19(0.665)	1.07(0.77, 1.49) 0.665	
Gravidity						
Primigravida	94(19.7)	185(25.5)	279(23.2)			
Multigravida	382(80.3)	539(74.5)	921(76.8)	5.42(0.020)	0.72(0.54, 0.95) 0.020	0.81(0.59, 1.13) 0.215
Parity						
Nulliparous	267(56.1)	442(61.0)	709(59.1)			
Primiparous	108(22.7)	131(18.1)	239(19.9)		0.73(0.54, 0.98) 0.040	
Multiparous	101(21.2)	151(20.9)	252(21.0)	4.26(0.119)	0.90(0.67, 1.12) 0.497	
Malaria parasites						

Negative	402(84.4)	554(76.5)	956(79.7)			
Positive	74(15.6)	170(23.5)	244(2.3)	11.16(<0.001)	1.67(1.23, 2.25) <0.001	1.70(1.24, 2.31) <0.001
Own LLIN						
No	17(3.6)	40(5.5)	57(4.7)			
Yes	459(96.4)	684(94.5)	1143(95.3)	2.42(0.120)	0.63(0.35, 1.13) 0.122	
Use LLIN						
No	77(16.8)	77(11.3)	154(13.5)			
Yes	382(83.2)	607(88.7)	989(86.5)	7.17(0.007)	1.58(1.13, 2.23) 0.008	
Number of visits						
First visits	153(32.1)	280(38.7)	433(36.1)			
2-4 visits	174(36.5)	287(39.6)	461(38.4)		0.90(0.68, 1.18) 0.455	1.08(0.63, 1.85) 0.769
5-8 visits	142(29.8)	151(20.9)	293(24.4)		0.58(0.42, 0.79) <0.001	0.82(0.45, 1.50) 0.522
9-12 visits	7(1.5)	6(0.8)	13(1.1)	14.67(0.002)	0.46(0.15, 1.41) 0.180	0.87(0.24, 3.08) 0.824
Number of SP doses						
No dose	178(37.4)	331(45.7)	509(42.4)			
1-2 doses	172(36.1)	284(39.2)	456(38.0)		0.89(0.68, 1.15) 0.375	0.80(0.47, 1.34) 0.395
≥ 3 doses	126(26.5)	109(15.1)	235(19.6)	24.52(<0.001)	0.46(0.34, 0.63) <0.001	0.46(0.26, 0.83) 0.010
Gestation (in weeks)						
1st trimester	164(34.4)	263(36.3)	427(35.6)			
2nd trimester	143(30.0)	263(36.3)	406(33.8)		1.14(0.86, 1.52) 0.341	1.39(1.01, 1.90) 0.043
3rd trimester	169(35.6)	198(27.4)	367(30.6)	9.88(0.007)	0.73(0.55, 0.97) 0.030	1.25(0.86, 1.84) 0.238
Delivery Outcomes						
No deliveries yet	139(29.2)	264(36.5)	403(33.6)			
Live births	318(66.8)	438(60.5)	756(63.0)		0.72(0.56, 0.93) 0.012	
Still births/neonatal deaths	19(4.0)	22(3.0)	41(3.4)	7.09(0.029)	0.61(0.32, 1.16) 0.134	
Hypertension						
Normal	447(93.9)	689(95.2)	1136(94.7)			
Hypertensive	29(6.1)	35(4.8)	64(5.3)	0.90(0.343)	0.78(0.47,1.30) 0.344	

Correlation analysis of log parasite density of the risk factors of the covariates:

Table 4showsthe results of the linear regression of log of malaria parasite density on the actual age of the woman, the gestational age, the gravidity, the parity or the SP doses. Among these, the actual age, gravidity and SP doses werenegativelyassociatedwith log parasite density, implying that for any unit increase in any of them, there is a corresponding decrease in log parasite density. However, only the actual age was statistically significantly associated with the log parasite density. It implies that for any unit increase in the actual age there is a corresponding decrease in the parasite density-0.041, 95% CI (-0.0003, -0.079), over the constant5.842, all other things being equal.

Table 4: Linear Regression of Log of Malaria parasite density

Variable	Coefficient (r)	95% CI	P-value
Age	-0.041	(-0.079, -0.003)	0.033
Gestation	0.014	(-0.025, 0.054)	0.472
Gravidity	-0.033	(-0.263, 0.197)	0.779
Parity	0.054	(-0.179, 0.287)	0.647
SP doses	-0.100	(-0.316, 0.116)	0.363
Constant	5.842	(4.518, 7.166)	<0.001

DISCUSSION

This study assessed the prevalence of malaria parasitaemia and anaemia among pregnant women attending ANC. The prevalence of malaria in this study was found to be 20.3% by microscopy. This is in agreement with what was found in Dodowa, Ghana (19.7%)[16], inthe Central Region of Ghana (20.9%) [20] and in Ouagadougou, Burkina Faso (24.0%) [21].On the contrary, another study in KasenaNankanadistrict in the Northern part of Ghana reported 47% prevalence [11], whilst a study in Kumasi, Ghana,reported a lower prevalence of malaria (12.6%) [12].The difference in prevalence could be due to the differencesingeographical locations and endemicity of malaria. These findings indicate that malaria parasitaemia prevalence among pregnant women has not changed since 2009.

Our findings also indicate that pregnant women with 5-8 ANC visits were more likely to be infected with malaria parasites. This is in agreement with a study conducted in Burkina-Faso where pregnant women with more than 3 ANC visits were found to be 1.3 times more likely to have malaria [22]. The frequent visits by the pregnant women in the current study might be due to ill health, which required thatthey returned to the ANC for review. Results from this

study also indicated thatpregnant women in their third trimester were 41% times less likely to be infected with malaria (AOR=0.59, p=0.033). This is in agreement with what was reported from a studyin northern Ghana pregnant women in their third trimester were associated with decreased risk of malaria parasitaemia [11]. It is possible that malaria parasites reduced among women in their 3rd trimester because they might have received treatment during the early part of the pregnancy; therefore the parasites might have been cleared. Also in the 3rdtrimester, pregnant women are less mobile and inactive. They are therefore less likely to stay outside late in the evening to be exposed to mosquito bites.

With respect to the prevalence of anaemia, this study found a prevalence of 60.3%. The prevalence of anaemia found in this study was higherthan the 53.9% prevalence reported in Ethiopia[23].The currentstudy revealed pregnant women who were 30-39 years were 42% times less likely to have anaemia (AOR=0.58, p=0.040),whichisin contrast with the high risk of anaemia with respect to the same age group in Turkey [24]. This study also revealed that pregnant women in their second trimester were 1.39 times more likely to have anaemia (AOR-1.39, p=0.043),which is consistent with a study conducted where pregnant women in their second trimester were 2.87 times more likely to be anaemic [25]. However, this is contrary to what was found in Malaysia where pregnant women in their second trimester were 0.30 times less likely to be anaemic [26].It ispossible that some measures have been put in place in Malasia to address the problem of high anaemia prevalence among women in their 2nd trimester.

We also found that pregnant women with malaria parasitaemia were1.68 times more likely to be anaemic. This is in line with findings from a study conducted in Ethiopiamalariaparasitaemia increases the risk of anaemia in pregnant women by 11.2 times [23].Similarly, other studies have reported that being positive for malaria parasitaemia increases the risk of anaemia [25,27].

This current study revealed that for any increase in age, parasite density decreases, which is similar to other findings [11, 12.]This explains why younger pregnant women are more likely to have anaemia in this study. It is possible that older women might have developed some immunity from the previous pregnancies, therefore, were partially protected against malaria. The current study also found that3 or more doses of SP-IPTpis significantly associated with a decrease in risk of anaemia (AOR=0.46, p=0.010). This could be as a result of the protective nature of the drug against malaria infection, which in turn reduces the risk of anaemia.

CONCLUSION AND RECOMMENDATIONS

Anaemia prevalence in pregnancy is high with higher prevalence among pregnant women in their 2nd trimester. This is as aresult ofthehighprevalenceof malaria among pregnant women. Malaria parasite density reduces with age probably due to partial immunity acquired in the previous pregnancies. Uptake of more SP-IPTp doses reduces anaemia and older women are less likely to have anaemia. Targeted health promotion programmes are required for younger pregnant women and women in their 2nd trimester to reduce malaria and anaemia in pregnancy in the Hohoe municipality.

List of abbreviations:

ANC: Antenatal Care, WHO: World Health Organization, NMCP: National Malaria Control Programme, MoH: Ministry of Health, KNUST: Kwame Nkrumah University of Science and Technology, LLIN: Long Lasting Insecticide Treated Net, SP: Sulphadoxine-pyrimethamine, IPTp: Intermitted Preventive Treatment of malaria in pregnancy, VRHD: Volta Regional Health Directorate,HMHD: Hohoe Municipal Health Directorate, PNC: Postnatal Care, AS+AQ: Artesunate plus Amodiaquine, NMIMR: Noguchi Memorial Institute of Medical Research, UHAS: University of Health and Allied Science, WBCs: White Blood Cells, OPD: Outpatient Department,Hb: Haemoglobin, GHS: Ghana Health Service, ERC: Ethical Review Committee, GHS- ERC: Ghana Health Service Ethical Review Committee.

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MK and MOconceived the study, MK, MA, WT, RO, PP and WA did the data analysis and wrote the methods section. MK, MO, MA, WT, and ET and were responsible for the initial draft of the manuscript. All authors reviewed and approved the final version of the manuscript.

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