Malaria and Anaemia: Prevalence, Risk Factors and Impact of Preventive Methods among Pregnant Women in the Akatsi South District, Ghana: A Hospital-Based Cross-Sectional Study

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ABSTRACT

Background: Anemia and malaria infection during pregnancy are major public health problems in tropical and subtropical regions throughout the world. This study therefore aimed to ascertain the prevalence and risk factors of malaria and anaemia as well as the impact of preventive methods among pregnant women at the Akatsi South District Hospital.

Subjects and Methods: A hospital based cross-sectional study using simple random sampling technique was conducted among 200 pregnant women receiving antenatal care and laboratory services at the Akatsi District Hospital from May 2016 to July 2016. A semi-structured

questionnaire was administered to obtain participant's malaria preventive methods in addition to demographic and gestational details including age, level of education, occupation, gravidity, parity, and gestational period. Participant's hemoglobin and malaria status was assessed using one milliliter (1 ml) whole blood collected into an Ethylenediamine tetraacetic acid (EDTA) tube using sterile syringe and needle. Ordinary one-way ANOVA was used to determine statistical variations among continuous variables whereas chi-square and Fisher's exact test where appropriate were used to assess statistical associations between categorical variables. P-values of < 0.05 was considered significant.

Results: Of the 200 participants, majority (52.0%) were aged 20-29 years. The preponderance (67.0%) had their basic education level, were married (76.0%), lived in the urban communities (58.5%) and worked in the formal sector (44.5%). Prevalence of anaemia, malaria and malaria/anaemia comorbidities was 65.5%, 11.0% and 10.5% respectively. Significantly ($p<0.05$) high likelihood of malaria infection in first [OR=28.1; 95% CI (1.6-497.5)] and second [OR=17.9; 95% CI (1.0-309.2)] trimester was observed. Not on Intermittent Preventive Therapy (IPT) [OR=14.9; 95% CI (4.2-52.6)] program and not sleeping under Insecticide Treated Net (ITN) [OR=14.0; 95% CI (4.9-40.2)] were significant contributors of malaria infection. Similarly, no IPT use and not sleeping under ITN were twice [OR=2.0; 95% CI (1.1-3.8)] and approximately four times [OR=3.6; 95% (1.0-12.8)] likely anaemia contributors. Meanwhile, with non-malaria pregnant women as yardstick, malaria positive pregnant women were 16.4 (95% CI; 2.2-124.5) times likely to suffer from anaemia.

Conclusion: Prevalence of malaria and anaemia among pregnant women in the Akatsi South District is high. Intensified health education and interventions so as to ensure the safety of the Ghanaian pregnant women is advised.

Plain English Summary

Malaria and anaemia have remained a major public health problem in Ghana for decades despite the considerable health interventions by the Ghana government and relevant concerned institutions. This study therefore determined the prevalence of malaria and anaemia, its associated risk factors and the impact of preventive methods among pregnant women in the Akatsi South District of Ghana (ASD-G). A total of 200 pregnant women receiving antenatal care and laboratory services at the ASD-G were recruited. A fit-for-purpose questionnaire was used to capture the participant's demographic, gestational and malaria prevention methodology details. Blood samples were collected from the pregnant women and their hemoglobin levels and malaria status determined. Majority of the 200 pregnant women (52.0%) studied were between 20-29 years, had their basic education (67.0%), were married (76.0%), lived in the urban communities (58.5%) and worked in the formal sector (44.5%). The proportion of pregnant women with anaemia, malaria and the combination of malaria/anaemia was 65.5%, 11.0% and 10.5% respectively. The likelihood of malaria infection during first (0-13 weeks) and second (14-26 weeks) trimester was very high. Pregnant women who were not on IPT program and do

not sleep under ITN were highly at risk of malaria infection and anaemia. Meanwhile, women who had malaria were approximately sixteen times at risk of suffering from malaria. In conclusion, prevalence of malaria and anaemia among pregnant women in the Akatsi South District is high. Intensified health education and interventions so as to ensure the safety of the Ghanaian pregnant women is strongly advised.

INTRODUCTION

Malaria for decades has been identified as a devastating public health problem particularly in pregnant women in the tropics [1]. The condition which is caused by parasites of the genus *Plasmodium* and transmitted by the female anopheles mosquitoes, was according to the World Health Organization (WHO) in the year 2008 estimated to infect 243 million people out of which 863,000 deaths were recorded with majority occurring among children under five years [2]. It has been indicated that of the 91 countries reporting indigenous malaria cases globally, approximately 80% of the total cases occur in the Sub-Saharan African countries; a region where about 25 million pregnant women are estimated to live at risk of *P. falciparum* malaria infection [3]. Significant burden includes 75,000-200,000 low birth weight (LBW) weight babies annually as a result of a combination of preterm delivery (PTD) and fetal growth restriction (FGR) [4]. For the unborn child, maternal malaria increases the risk of spontaneous abortion, still birth, premature delivery and low birth weight [5]. Based on the few studies available, it was estimated that pregnancy-associated malaria accounted for 3–8% of infant deaths [6]. Most devastating and life-threatening side effect of malaria in pregnancy is the development of anemia. Defined by WHO as hemoglobin concentration <11.0 g/dl [7], anaemia for so many years has been a major public health problem in developing countries [8]. Prevalence of anaemia among pregnant women in developing countries averages 56%, ranging between 35% and 100% among different regions of the world [9]. Anemia is an associated cause of increased morbidity and mortality in women and children, poor birth outcomes, declined work productivity in adults, and impaired cognitive and behavioral development in children [10]. Prevalence of anemia according to findings is highest among pregnant women in Sub-Saharan Africa (SSA) (57%), followed by pregnant women in Southeast Asia (48%), and lowest (24.1%) in South America [7]. It has been indicated

that each year, approximately 25 million pregnant women in sub-Saharan Africa live at risk of P. *falciparum* infection which as has been judged to infect an estimated 216 million people and taken the lives of about 445,000 people globally [3]. It is for this reason that preventive mechanisms vis-à-vis the use of IPTs, use of ITNs and mosquito sprays and repellents etc. were developed in response to fighting against the infection. Not much studies have assessed the impact of the use of those preventive methods on the occurrence of malaria among the population especially the high-risk groups such as the pregnant women in the Akatsi South district of Ghana. Again, despite the fact that several programs exist, especially on malaria control that target pregnant women as a means of reducing anaemia in pregnancy, the rather high prevalence of anaemia recorded by these studies calls for investigation into other factors that may contribute to anaemia aside micronutrient deficiency and intestinal helminth infections. In view of the above, this study aimed to ascertain the prevalence and risk factors of malaria and anaemia among pregnant women of child-bearing age at the Akatsi South District Hospital.

MATERIALS AND METHODS

Study Design/Eligibility Criteria

A hospital based cross-sectional study using simple random sampling technique was carried out among 200 pregnant women receiving antenatal care and laboratory services at the Akatsi District Hospital, a public healthcare facility in the Akatsi South District of the Volta Region of Ghana from May and July, 2016. The hospital as at the time of this study had a staff strength of 140 healthcare workers including two doctors, a medical assistant, a pharmacist and a biomedical scientist. A 70-bed capacity, with a maternity unit, medical laboratory unit, family planning unit and an outpatient department. It also serves as referral center for the surrounding primary health facilities in the district. Using the online Raosoft calculator (http://www.raosoft.com/samplesize.html) with a 5% margin of error, 95% confidence interval, 2500 (Average annual antenatal attendance) population size and 85% response rate (obtained from a prior pilot study), 200 pregnant women were recruited for this study. Pregnant women who were registered with the facility but were not residents of the Akatsi South District were excluded from the study. Non-consenting pregnant women were also excluded from the study. Participation of the respondents was voluntary.

Data Collection

A semi-structured questionnaire was administered to the pregnant women to obtain their demographic and gestational details including age, level of education, occupation, gravidity, parity, and gestational period as well as information on malaria preventive measures they employed such as use of ITN, IPT, use of insecticide sprays, mosquito coils, mosquito repellents and creams.

About one milliliter (1 ml) whole blood was collected from each pregnant woman from the median cubital vein of the antecubital fossa of the arm into an EDTA tube using syringe and needle following standard blood collection protocols. Samples were collected at the onset of the rains, between May and July 2016 which marks the period of the malaria transmission season. Participant's haemoglobin concentration was determined using the fully automated Sysmex XS-800i hematology analyzer (https://www.sysmex-europe.com/n/products/products-detail/xs-800i.html; Europe). Thick blood film was prepared using 6 ul of whole blood, stained using Giemsa stain and analyzed microscopically for malaria parasites. All the tests above were carried out following standard quality-controlled procedures. Malaria diagnosis was established by the presence of malaria parasites in the blood upon microscopy while anaemia was defined by hemoglobin concentration less than 11.0 g/dL [11].

Data Handling and Management

Data collected from the questionnaires and results from the laboratory investigations were checked for consistency, correctness and completeness and then entered into Microsoft Excel 2016 using fit-for-purpose excel form so as to avoid as much as possible entry errors. Data were then exported into Statistical Package for Social Sciences (SPSS) for windows (version 21.0) for statistical analysis. Data were presented as frequencies and percentages in parenthesis for categorical data and mean $\pm$ Standard Deviation (SD) for continues data. Ordinary one-way ANOVA was used to determine statistical variations among continuous variables whereas chi-square and Fisher's exact test where appropriate were used to assess statistical associations between categorical variables. P-values of < 0.05 was considered significant.

Ethical Consideration

Ethical clearance for the study was obtained from the Committee on Human Research, Publications and Ethics (CHRPE) of the School of Medical Sciences (SMS), Kwame Nkrumah University of Science and Technology, Kumasi. Permission to undertake the study at the Akatsi South District Hospital was sought and granted by the Hospital Management and the Head of the laboratory before data collection. In addition, written consent was obtained from all participants who agreed to partake in the study after they were thoroughly informed and sensitized about the study.

RESULTS

This study recruited 200 pregnant women. Of these, 13.5% were below 20 years while 52.0% and 34.5% were aged 20-29% and 30 years and above respectively. Majority of the pregnant women (67.0%) were only able to make it up to their basic education level, were married (76.0%), lived in the urban communities (58.5%) and worked in the formal sector (44.5%). Gravidity and parity status saw the preponderance of the pregnant women in the multigravidae (71.0%) and Primi-Multiparous (62.0%) whereas near half of the pregnant women were in the second trimester of gestation (Table 1).

Table 1: Socio-demographic characteristics of the pregnant women

Variable	Number	Percentage (%)
Overall (Subjects)	200	100.00
Age (Years)		
>20	27	13.5
20-29	104	52.0
≥30	69	34.5
Level of education		
Illiterate	21	10.5
Basic	134	67.0
Secondary	27	13.5
Tertiary	18	18.0
Marital status		
Single	40	20.0
Co-habiting	8	4.0
Married	152	76.0
Location		
Local	83	41.5

Urban	117	58.5
Occupation		
Unemployed	12	6.0
Formal	89	44.5
Informal	75	37.5
Students	24	12.0
Gravidity		
Primigravidae	58	29.0
Multigravidae	142	71.0
Parity		
Nulliparaous	76	38.0
Primi-multiparous (≥ 1 Births)	124	62.0
Gestational Period		
First Trimester	48	24.0
Second Trimester	94	47.0
Third Trimester	58	29.0

This study recorded 65.5% of the total participants being anaemic while 11.0% and 10.5% were diagnosed of having malaria and a combination of both anaemia and malaria respectively. The general picture revealed that pregnant women aged 20-29 years formed the preponderance category suffering from anaemia, 67 (52.8%), malaria, 13 (59.1%) and comorbidities of the two condition, 13 (61.9%). Malaria was prevalent among pregnant women aged <20 years,5 (22.7%) while anaemia on the other hand was predominant among pregnant women aged 30 years and above 42 (33.1%). Prevalence rate of 19.0% of comorbidities of malaria and anaemia was observed among pregnant women aged <20 years and 30 years and above. Mean variation of hemoglobin concentrations was statistically($p=0.001$) significant among the three age groups. However, among participants diagnosed of malaria and a combination of malaria and anaemia, mean hemoglobin did not vary significantly among the various age groups (Table 2).

Table 2: Age stratification of the distribution of malaria infection, anaemia and comorbidities of malaria and anaemia among the gravid women.

Parameters	Total	Age Group (yrs.)			x^2 (p-v), p-v
		<20	20-29	≥30	
	200 (100.0)	27 (13.5)	104 (52.0)	69 (34.5)	

Malaria	22 (11.0)	5 (22.7)	13 (59.1)	4 (18.2)	3.71 (0.157)
x ± SD of Hb	9.04±1.03	9.50±1.03	9.41±0.94	8.90±1.33	0.674
Anaemia	127 (63.5)	18 (14.2)	67 (52.8)	42 (33.1)	0.36 (0.835)
x ± SD of Hb	9.58±0.96	8.96±0.92	9.53±0.98	9.93±0.81	**0.001**
Anaemia + malaria	21 (10.5)	4 (19.0)	13 (61.9)	4 (19.0)	2.79 (0.248)
x ± SD of Hb	8.94±0.94	9.08±0.45	8.91±0.98	8.90±1.33	0.953

Data presented as frequency and percentages in parenthesis and mean± SD of hemoglobin concentrations; P-value significant at <0.05

The study participants in this study utilized IPT, ITN and repellents as the malaria preventive methods. As shown in table 3 below, it is clear from the figures that indeed the use of IPT and ITN is significantly effective in helping curb the infection of malaria among the pregnant women as majority of those who used IPT (70.2%) and ITN (94.4%) reported with no *Plasmodium* infection. Evidentially, the preponderance of the pregnant women who utilized IPT (74.0%) and ITN (95.9%) had normal haemoglobin concentrations as against those who did not use IPT (26.0%) and ITN (4.1%). Similar observations were made for pregnant women who reported negative for malaria and with normal haemoglobin concentrations. The use of mosquito repellents surprisingly wasn't a factor to depend upon to prevent malaria or anaemia or a combination of these two conditions among the gravid women studied. Greater proportions of the pregnant women who employed all three malaria preventive methods reported negative for malaria and had normal haemoglobin levels. The use of mosquito repellent was not significantly associated with malaria, anaemia and comorbidity of the two conditions. Also, the use of all three malaria preventive methods was not significantly associated with the occurrence of anaemia among the pregnant women.

Table 3: Distribution of malaria prevention method and its association with malaria and anaemia among the study participants

	IPT		ITN		Repellent		IPT*ITN*Repellent	
	Yes	No	Yes	No	Yes	No	Yes	No
	128(64.0)	72(36.0)	180(90.0)	20(10.0)	84(42.0)	116(58.0)	50(25.0)	4(2.0)
Malaria								
Yes	3(13.6)	19(86.4)	12(54.5)	10(45.5)	11(50.0)	11(50.0)	0(0.0)	2(9.1)
No	125(70.2)	53(29.8)	168(94.4)	10(5.6)	73(41.0)	105(59.0)	50(28.1)	2(1.1)

p-v	<0.001		<0.001		0.494		0.004
Anaemia							
Yes	74(58.3)	53(41.7)	110(86.6)	17(13.4)	53(41.7)	74(58.3)	24(18.9)	3(2.4)
No	54(74.0)	19(26.0)	70(95.9)	3(4.1)	31(42.5)	43(58.9)	26(35.6)	1(1.4)
p-v	0.032		0.048		1.000		0.610	
Malaria * Anaemia							
Yes	3(14.3)	18(85.7)	11(52.4)	10(47.6)	10(47.6)	11(52.4)	0(0.0)	2(9.5)
No	54(75.0)	18(25.0)	69(95.8)	3(4.2)	30(41.7)	42(58.3)	26(36.1)	0(0.0)
p-v	<0.001		<0.001		0.628		0.003	

Data presented as frequency and percentages in parenthesis; P-value significant at <0.05

In this study, 11.0% of the total participants studied suffered from malaria. The condition was predominant among participants aged <20 years compared to the other age groups. Similarly, nulliparous (15.8%), primigravidae (15.5%) and first trimester (18.8%) pregnant women formed that majority of the pregnant women who were diagnosed of malaria as at the time of the study. Despite being on the IPT program and having slept in ITN, 2.3% and 6.7% of the pregnant women interestingly tested positive for malaria. The pregnant woman's gestational period, not being under the IPT program and not sleeping under ITN was significantly (p<0.05) associated with malaria among the pregnant woman. This study revealed a significantly (p<0.05) high likelihood of suffering from malaria infection among pregnant women in their first [OR=28.1; 95% CI (1.6-497.5)] and second [OR=17.9; 95% CI (1.0-309.2)] trimester as well as those who weren't on the IPT [OR=14.9; 95% CI (4.2-52.6)] program and do not sleep under ITN [OR=14.0; 95% CI (4.9-40.2)]. Anaemia in this study saw a prevalence of 63.5% among the pregnant women. The preponderance of the cases was observed among pregnant women aged <20 years (66.7%), have had one or more births (65.3%), multigravida (64.1%), third trimester (69.0%), not on IPT (73.6%) and doesn't sleep under ITN (85.0%) as well as malaria positive pregnant women (95.5%). Meanwhile IPT, ITN and malaria were significantly associated with anaemia among the pregnant women. Compared to pregnant women on IPT and those who slept under ITN, pregnant women who were not on the IPT and those who did not sleep under the ITN were twice [OR=2.0; 95% CI (1.1-3.8)] and approximately four times [OR=3.6; 95% (1.0-12.8)] likely to develop anaemia. With non-malaria pregnant women as yardstick, malaria positive pregnant women were 16.4 (95% CI; 2.2-124.5) times likely to suffer from anaemia (Table 4).

Table 4: Risk factors of anaemia and malaria parasitemia among pregnant women.

Variable	Anaemic n(%)	p-v	cOR (95%CI)	Malaria n(%)	p-v	cOR (95% CI)
Overall	127(63.5)			22(11.0)		
Maternal Age(Years)		0.835			0.157	
< 20	18(66.7)		1.3(0.5-3.3)	5(18.5)		3.7(0.9-15.0)
20-29	67(64.4)		1.8 (0.6-2.2)	13(12.5)		2.3 (0.7-7.4)
≥30	42(60.9)		1	4(5.8)		1
Parity		0.546			0.091	
Nulliparous	46(60.5)		0.8(0.5-1.5)	12(15.8)		2.1(0.9-5.2)
Primi-Multiparous	81(65.3)		1	10(8.1)		1
Gravidity		0.872			0.193	
Primigravidae	36(62.1)		0.9(0.5-1.7)	9(15.5)		2.3(0.9-5.8)
Multigravidae	91(64.1)		1	13(9.2)		1
Gestational Period		0.516			**0.004**	
First Trimester	28(58.3)		0.6(0.3-1.4)	9(18.8)		28.1(1.6-497.5)†
Second Trimester	59(62.8)		0.8(0.4-1.5)	13(13.8)		17.9(1.0-309.2)†
Third Trimester	40(69.0)		1	0(0.0)		1
Preventive Method						
IPT (64.0%)		**0.032**			**<0.001**	
Yes	74(57.8)		1	3(2.3)		1
No	53(73.6)		2.0(1.1-3.8)†	19(26.4)		14.9(4.2-52.6)†
ITN		**0.048**			**<0.001**	
Yes	110(61.1)		1	12(6.7)		1
No	17(85.0)		3.6(1.0-12.8)†	10(50.0)		14.0(4.9-40.2)†
Malaria Parasite		**0.001**				
Positive	21(95.5)		16.4(2.2-124.5)†			
Negative	100(59.6)		1			

IPT; Intermittent Preventive Treatment; ITN; Insecticide-Treated Bed Nets; cOR= Crude Odds Ratio; CI= Confidence Interval; Primi-Multiparous = ≥ 2 births; †=Significant odds

DISCUSSION

This study assessed the prevalence of malaria and anaemia and the associated risk factors contributing to the development of these conditions as well as the impact of malaria preventive methods on malaria and anaemia prevalence among pregnant women receiving antenatal care services from the Akatsi South District Hospital in the Volta region of Ghana. The general demographic characteristics of our study participants compares well with other studies carried out among similar population [12, 13]. This study recorded a malaria prevalence of 11.0% (22/200)

among the pregnant women. Compared to akin population in Gabon [1, 14], this prevalence is quite low but understandable to some extent due to the vast year interval between these two studies since quite a lot of strategies and interventions might have been put in place into curbing malaria infections among the studied groups. Some of these interventions includes the introduction of IPT and the government of Ghana Ministry of Health periodic free sharing of ITN to help prevent mosquito bites and thereby preventing malaria and malaria related deaths.

Overall, 11.0%, 63.5% and 10.5% prevalence rates of malaria, anaemia and comorbidities of malaria and anaemia respectively was documented in this study. Prevalence rates of all three conditions was highest among participants aged 20-29 years. The occurrence of these conditions was not significantly associated with age (p>0.05). Variations in the hemoglobin concentrations of the study participants was however significant (0.001) only among the three categories of ages (i.e., <20, 20-29 and ≥30) diagnosed of anaemia. In Southeast Nigeria [15] and Gabon [14], a malaria prevalence rate of 54.0% and 71% respectively higher than recorded in this study was documented. A rather lower 10.2% malaria prevalence [3] than recorded in this study was revealed among West Ethiopian pregnant women. The discrepancies in the malaria infection rate could be to some extent, due to the varied endemicity of the individual communities in these countries. Meanwhile, based on analytical evidence which will be demonstrated subsequently in this study, authors believe that the malaria preventive methods employed by the study participants contributed significantly to the reduced malaria prevalence observed in this study.

Prevalence rate of anaemia on the other hand was significantly high among the pregnant women studied. When classified as a problem of public health significance, the prevalence of anaemia in our study is a severe public health problem (≥40.0) [8]. According to Camila and colleagues, anaemia prevalence of 46.0% was recorded among pregnant women in 2016 [10]. It has been indicated that in Sub-Saharan Africa, prevalence of anaemia is highest among pregnant women (57.0%) [7]. In Ghana, similar studies among related population saw a prevalence rate of 42.7% in Northern Ghana [13], 57.1% in Sekyere West district [16] and 66.4% in Dangme East district [17]. The prevalence of anaemia as recorded in this study is even higher than the world prevalence of 32.9% recorded in 2010 [18]. This is a very significant information that should raise significant public eyebrows to the situation. Obviously, owing to the fact that Ghana is a malaria endemic country, malaria could be a contributing factor to the high anaemia prevalence recorded in this

study. However, comorbid malaria and anaemia recorded a prevalence of 10.5%. This then suggest that malaria related anaemia in this study is 10.5% reasoning therefore that chunk of the participants have anaemia as a consequence of other factors aside malaria such as the dominant iron deficiency; a cause for significant public attention.

Malaria has been judged to infect an estimated 216 million people and taken the lives of about 445,000 people globally. It has been indicated that each year, approximately 25 million pregnant women in sub-Saharan Africa live at risk of P. *falciparum* infection [3]. It is for this reason that preventive mechanisms vis-à-vis the use of IPTs, use of ITNs and mosquito sprays and repellents etc. were developed in response to fighting against the infection. Not much studies have assessed the impact of the use of those preventive methods on the occurrence of malaria among the population especially the high-risk groups such as the pregnant women in the Akatsi South district of Ghana. This study assessed the impact of the use of IPTs, ITNs, repellents and all three on the occurrence of malaria and anaemia among the pregnant women. Overall, IPT, ITN, repellent and the use of all three preventive methods combined were practiced by 64.0%, 90.0%, 42.0% and 25.0% respectively. The general observation revealed that majority of pregnant women who were diagnosed of malaria as well as both malaria and anaemia did not use IPT or the ITN while those who were free of malaria and comorbidities of both conditions used IPT or ITN. Similar findings were observed amongst participants who used all three preventive methods. Repellents beings the list used didn't seem to significantly impact the occurrence of malaria and anaemia among the pregnant women. Statistically significant association was observed between the occurrence of malaria, anaemia and comorbidities of malaria and anaemia and the use of IPT and ITN. Malaria and comorbidities of malaria and anaemia were significantly associated with the use of all three malaria preventive methods combined in this study. The occurrence of malaria, anaemia and comorbidities of malaria and anaemia were not significantly associated with the use of mosquito repellents. These findings agree well with Stephen and co who indicated that protection from malaria in pregnancy includes the use of ITNs and administration of effective antimalarials through antenatal clinics, most especially IPTs [4]. These findings therefore suggest that the judicious use of the ITN and ITPs most especially promises to reduce the prevalence of malaria and for that matter malaria related deaths significantly in the foreseeable future.

In this study, IPT, ITN and malaria infection were significantly associated with anaemia while participant's gestational period, IPT and ITN were significantly associated with malaria infection. Likelihood of suffering from malaria infection among pregnant women in their first [OR=28.1; 95% CI (1.6-497.5)] and second [OR=17.9; 95% CI (1.0-309.2)] trimester as well as those who weren't on the IPT [OR=14.9; 95% CI (4.2-52.6)] program and do not sleep under ITN [OR=14.0; 95% CI (4.9-40.2)] were significantly high. Compared to pregnant women on IPT and those who slept under ITN, pregnant women who were not on the IPT and those who did not sleep under the ITN were significantly (p<0.05) twice [OR=2.0; 95% CI (1.1-3.8)] and approximately four times [OR=3.6; 95% (1.0-12.8)] respectively likely to develop anaemia. Meanwhile, with non-malaria pregnant women as yardstick, malaria positive pregnant women were 16.4 (95% CI; 2.2-124.5) times likely to suffer from anaemia. Most studies that assessed similar risk factors recorded comparable results [3, 12, 13].

CONCLUSION

The prevalence rates of malaria and anaemia among the pregnant women studied is high per findings from this study. Though not assessed in this study, the data suggest that majority of the maternal anaemia cases were non malaria related. The factors significantly associated with malaria parasitemia include; gestational period, ITN, and IPT usage. On the other hand, ITN, IPT and malaria parasites were significant factors associated with anaemia.

Declarations

Ethical Approval and Consent to Participate
Ethical clearance for the study was obtained from the Committee on Human Research, Publications and Ethics (CHRPE) of the School of Medical Sciences (SMS), Kwame Nkrumah University of Science and Technology, Kumasi. Permission to undertake the study at the Akatsi South District Hospital was sought and granted by the Hospital Management and the Head of the laboratory before data collection. In addition, written consent was obtained from all participants who agreed to partake in the study after they were thoroughly informed and sensitized about the study.

Consent for publication
Not applicable.

Availability of data and materials

The data are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions

This work was carried out with cooperation among all authors. AAS and OAM designed the study, carried out laboratory works and collected data. AAS, AAY and PKK explored literature and managed the preliminary statistical analysis of the study and wrote the first draft of the manuscript. AMS and PKK managed the final statistical analysis of the study and wrote the final manuscript. All authors read and approved the final manuscript.

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Limitations

The study did not interview participants on environmental and hygienic practices which could have given extra information on the possible risk factors of the infection.

Recommendations

This study recommends the hasty involvement of all stakeholders in the health fraternity and the Ministry of Health (MoH) and Ghana Health Service to as a matter of urgency institute a nationwide research into the prevalence of malaria and especially anaemia among pregnant

women. This will help bring to bear the loopholes that needs to be filled to as to bring the high malaria and anaemia prevalence menace under control.

LIST OF ABBREVIATIONS

ANOVA……………… Analysis of Variance
ASD-G……………...Akatsi South District of Ghana
CHRPE……………...Committee on Human Research Publication and Ethics
CI…………………....Confidence intervals
EDTA………………Ethylenediamine tetraacetic acid
FGR…………………Fetal Growth Restriction
IPT…………………..Intermittent Preventive Therapy
ITN…………………Insecticide Treated Net
LBW………………...Low Birth Weight
MOH………………...Ministry of Health
OR…………………..Odds Ratio
PTD…………………Preterm Delivery
SD…………………...Standard Deviation
SMS…………………School of Medical Sciences
SPSS………………...Statistical Package for the Social Sciences
SSA………………… Sub-Saharan Africa
WHO………………..World Health Organization

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