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PREVALENCE AND ASSOCIATED DETERMINANTS OF MALARIA INFECTION AMONG PREGNANT WOMEN IN MALARIA EPIDEMIC AREAS OF WESTERN HIGHLAND OF KENYA

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Abstract

Purpose: To determine prevalence and associated determinants of malaria infection among pregnant women in Western highland of Kenya, and specifically, Mt. Elgon Sub-County.

Methodology: Cross-sectional analytical design was adopted and mixed methods used for data collection. A total of 392 participants were randomly selected using systematic sampling in a population of 4,970 women aged between 15-49 years while qualitative approach adopted interview guides that targeted key informants working in the health facilities. Data entry and analysis was conducted using SPSS version 21.0 and presented in tables. The study used descriptive and inferential statistical analysis. To determine the association between variables bivariate logistic regression was adopted. Odds ratios were calculated and P-value of ≤ 0.05 was considered statistically significant.

Findings: Prevalence of malaria in pregnancy (MiP) was 16.2%. Prevalence was higher among women aged less than 25 (67.3%, n=262) compared to those aged $\geq$ 25 years (33.7%, n=137). Place of residence (OR: 5.7; 95% CI: 2.6 – 12.4; $p < 0.0001$); those who tested positive in the last 2 years (OR: 1.7; 95% CI: 1.0 – 2.9; $p = 0.05$); preferred shape of ITNs (OR: 3.8; 95% CI: 1.5 – 9.7; $p = 0.008$); methods used to deliver health education (OR: 4.4; 95% CI: 1.6 -12.3; $p = 0.007$) were statistically significantly associated with malaria prevalence in pregnancy. Key informants associated MiP to current policy regarding prevention on malaria among pregnant women in high epidemic malaria prone zone in Western Kenya.

Unique contribution to theory, Practice and Policy: The study results showed that patient related factors and institutional factors were significant factors that were associated with MiP. Policy regarding non-use of intermittent prophylaxis treatment as a preventive measure was reported by key informant as a determinant of MiP. To reduce MiP, the study recommends Bungoma County Government to promote use of insecticide treated nets (ITN's) and preferably rectangular ITNs by ensuring they are translated to appropriate use; support regular indoor residual spraying with insecticides and create awareness by use of print media to compliment the current malaria control measures. WHO and Kenyan Government to review IPTp-SP policy in the Western Highland of Kenya.

Keywords: *Prevalence, Determinants, Malaria Epidemic areas, Mt. Elgon, Kenya*

1.0 INTRODUCTION

Worldwide malaria is considered as an infection associated with poverty and it remains a major determinant of maternal morbidity and mortality (Moya, *et al.,* 2015; Ricci, 2016). This is in spite of the fact that efforts have been put in place by both national and international agencies in reducing malaria prevalence in pregnancy by increasing the coverage of SP and insecticide-treated nets (ITN) (Salomao *et al.,* 2017).

In Africa, malaria prevalence is 90% and accounts for 92% morbidity and 93% mortality. Among pregnant women, 50% suffer from malaria (Stephanie, *et al.,* 2016). The infection has negatively influenced the wellbeing of pregnant women and the growing foetus. Failure to intervene in time can lead to low birth weight, severe anaemia, pregnancy loss, intrauterine growth restriction, foetal hypotrophy and maternal hypoglycaemia corroborate the contribution of malaria in increased maternal and neonatal mortality rates (Stephanie *et al.,* 2016).

A study conducted in Nigeria reported prevalence of malaria in pregnancy of 52.2% with higher rate in second trimester (62.2%) compared to first trimester (5.5%) and third trimester (3.3%). *Falciparum* species is mostly responsible for the transmission of malaria in pregnancy (Idowu, *et al.,* 2017). In Ghana, malaria is the leading cause of hospital morbidity among pregnant women with 24.6% being hospitalised. However due to costs associated with malaria management, many pregnant women do not visit health facilities and prefer using herbal medicines in their home which has contributed to increased incidence of malaria mortality among this vulnerable group (Sicuri, *et al.,* 2018).

The increase in the prevalence of malaria infection has been blamed on human mobility. It is reported that there is importation of malaria from other countries and within Zambia across regions. More so, malaria prevalence in the country in expectant women is associated with seasonal patterns with higher transmission being recorded in the month of November and April (Zambia MOH, 2016).

In Kenya, malaria prevalence in pregnancy is geographically distributed and highest in lowland areas (coastal and around Lake Victoria basin) and highland areas of Great Rift Valley (Wekesa, *et al.,* 2019). It is estimated that 16% of all outpatient consultations results from malaria. In addition, the state of malaria spread is largely associated with rainfall patterns, altitude and temperature. In Mt. Elgon Sub County, malaria prevalence rate is 14% in pregnant women (Wekesa, *et al.,* 2019). *Plasmodium falciparum* is rated highly as the most common species which claims the lives of pregnant women (Yatitch, *et al.,* 2015).

Some studies carried in Mt. Elgon Sub-County, have looked at other factors such as ITN use and indoor residual spraying that determine malaria prevalence in pregnancy. Previous studies have indicated the burden of malaria to be associated with various socio-economic and demographic among others. Notably, it is not clear which predictors are related with MiP in the highland epidemic prone areas in Western Kenya (Nthiga, 2018 (Nthiga, 2018). Therefore, this study will form the foundation of information on IPTp-SP use especially in Mt. Elgon Sub-County. Furthermore, the literature data in other surveys has little information on institutional related issues, hence investigator motivated to find out more information concerning ownership of ITN's, health education and health workers understanding on SP use in pregnancy are in any way associated with malaria prevalence in pregnancy in malaria epidemic areas of western highlands of Kenya specifically Mt. Elgon Sub County.

1.2 Statement of the problem

In spite of the Kenyan government adopting WHO preventive measures, malaria in pregnancy is still high in Western highland of Kenya. In Bungoma County as compared to other areas in Africa, malaria prevalence rate in pregnant women is relatively high (32%) (Gatechelo, *et al.*, 2015). The Kenyan Government declared Western Highland area free from malaria and withdrew provision of IPTp-SP to expectant mothers in spite of there being cases of malaria in pregnancy (DHIS, 2018). The present study, therefore aimed to investigate the burden of malaria in pregnancy and its associated factors in the Mt. Elgon area.

Objectives

1.2.1 Broad Objective

To determine prevalence and associated determinants of malaria infection among pregnant women in malaria epidemic areas of western highland of Kenya.

1.2.2 Specific objectives

i. To determine patient related factors as determinants of malaria prevalence in pregnancy.

ii. To examine institutional related factors as determinants of malaria prevalence in pregnancy.

1.3 Null Hypothesis

There is no association between patient related factors, institutional related factors and malaria prevalence among pregnant women in malaria epidemic areas of western highland of Kenya.

2.0 METHODOLOGY

Study Design: A cross-sectional analytical design was adopted. Questionnaire was used to collect primary data on patient related variables and institutional related variables. Secondary data was extracted from the DHIS (2018) and the MOH 405 ANC register.

Study Setting: The study was conducted in epidemic area of Mt Elgon Sub-County which is located in the western highlands of Kenya. The study site is situated within Bungoma County which is inhabited by Sabaot, Bukusu and Teso which are Luhya sub-tribes. It neighbours Trans-Nzoia County to the north, Cheptais and Kimilili sub-counties to the south, Webuye and Tongaren sub-counties to the east and Mount Elgon forest and Mount Elgon National Game Reserve to the west. According to KNBS (2018), the estimated total population is 20,454 of which 49% (20,454) are females of the total population. Approximately, 24.3% of the women are within child-bearing age of the total population of women that is equivalent to 4,970 (KNBS, 2018). The Sub County was selected because it has been declared area free from malaria (Noor *et al.*, 2016). It has one Sub County Hospital, two health centres and two faith-based organization (FBO) health centres namely Sambocho and Kaptama and 4 dispensaries. The healthy facilities have got working laboratories and qualified laboratory technologists.

Study population: The population was pregnant women who sought ANC services in selected Mt. Elgon Sub-County health facilities. Hospital Medical Superintendent, Sub-County Malaria Control Co-ordinator, three nursing officer in-charges, laboratory in charge, and MCH/FP in-charge working in health facilities in the study area were included in the study as key informants. *Sampling method/ Sample size:* Simple random sampling method was first

used to select three healthy facilities (Mt Elgon Sub- County Hospital, Sambocho Health Centre and Kaptama Health Centre) from the nine health facilities in the study area. Systematic sampling method based on the ANC attendance list as sampling frame was adopted to select 389 study participants**.**

Inclusion criteria: All expectant women with age range of 15-49 years and who came for their ANC visits, consented and had resided in the study area for the past 2 weeks in order to avoid imported cases of malaria from somewhere else. *Exclusion criteria:* Pregnant women who were severely ill, mentally ill and who could not be able to be interviewed, non-residential and visited the area during the survey.

Data collection tools and laboratory analysis: Collection of data involved use of both questionnaire (Wekesa, *et al.,* 2019) and transcription form for laboratory test results while key informant guide was developed and administered on selected key informants. Closed-ended questionnaire was used to collect information on patient related variables, and institutional related variables. Study supervisor was responsible for coordinating the study team while three research assistants assisted in administering consent forms and collecting data. Rapid Diagnostic Test (RDT) was conducted by a qualified nurse in the ANC in order to determine presence of malaria infection among respondents. Laboratory microscopy was carried out by Laboratory Technologists with diploma qualification. Test was done after researcher referred the respondent from ANC to the laboratory for confirmatory test.

Procedure for blood sample collection: Pregnant women's blood samples were collected. Their fingers were wiped using dry small cotton wool ball. 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, a circle was created by use of a clean spreader blood. Another drop of blood was put at the centre of the same slide using a clean spreader; blood was spread at an angle of 35-45 degrees to make a thin film covering 75% of the slide. Both thick and thin films were preferred because thick blood film concentrates malaria parasites for easier viewing while thin film facilitate *Plasmodium* species identification by their morphological features. For microscopy Giemsa reagents were used while for RDT a buffer was used. The test results were positive for RDT if there was presence of both control band at the C mark and the test band at the T mark for *Plasmodium falciparum* malaria. Microscopy test was considered positive if 200 WBCs were counted and negative if no parasites was observed.

Data analysis: Data was analysed using Statistical package for Social Science (SPSS) version 21.0, (IBM and California USA). Both descriptive and inferential statistics were used to analyse the results and presented in tables. Bivariate logistic regression analysis was used to test association between independent variable that included patient related factors, institutional related factors and malaria prevalence as dependent variable. Odds ratios with 95% confidence interval were calculated. P value of less than 0.05 was used to establish statistical significance.

3.0 FINDINGS AND DISCUSSIONS

3.1 Socio-demographic characteristics of the study participants

Table 1 shows socio-demographic characteristics of respondents interviewed in the study area. A total of 389 respondents took part in the study. Two-thirds (67.3%; 262/389) of the respondents were aged 20-24 years. The overall mean age was 24.1 with a standard deviation of ±3.2 and ranged between 20.0 to 38.0 years. More than half (58.5%; 227/389) of the

respondents were single while 34.5% were married. As regards level of education, most of the respondents (64.5%) had attained secondary education compared with 32.5% who had tertiary education. Only 2.6% had reached primary education. Results on employment status show that more than two-thirds (68.6%) were engaged in some form of employment as compared to 31.5% who were unemployed. Those who were employed included business women (32.1%), teachers (12.9%) and farmers (10.5%), among others. Thirty-three percent were not employed. Further analysis revealed that, more than half (54.8%) of the respondents were Sabaot followed by (43.7%) Bukusu. Nearly 60% (59.9%; 233/389) were residents of Mt. Elgon while 20.3% were from Sambocho and 19.8% were from Kaptama. Slightly more than half (51.7%) attended their clinic at Mt. Elgon Sub County Hospital with more than a quarter (28.5%) going to Sambocho Health Centre. Less than one in five (19.8%) attended Kaptama Health Centre.

Table 1: Socio-demographic characteristics of the respondents

Variables	Categories	n	%
Age group in years	20 - 24	262	67.3
	25 - 29	99	25.5
	30 - 34	22	5.7
	≥35	6	1.5
Mean age ± SD (Range)		24.1 ± 3.2 (20.0 – 38.0)	
Marital status	Single	227	58.5
	Married	134	34.5
	Widowed	22	5.7
	Divorced	5	1.3
Level of education	Primary	10	2.6
	Secondary	251	64.5
	Tertiary	128	32.9
Employment status	Employed	267	68.6
	Unemployed	122	31.4
Occupation	Housewife	138	35.5
	Farmer	41	10.5
	Business Woman	125	32.1
	Teacher	50	12.9
	Other	35	9.0
Tribe	Sabaot	213	54.8
	Bukusu	170	43.7
	Teso	6	1.5
Location	Elgon	233	59.9
	Kaptama	77	19.8
	Sambocho	79	20.3
Name of facility	Mt. Elgon Sub-County Hospital	201	51.7
	Kaptama Health Centre	77	19.8
	Sambocho Health Centre	111	28.5

3.2 Laboratory test result

The findings revealed that 16.2% were tested for malaria in pregnancy microscopically by qualified laboratory technologists and all turned out to be positive (100%; 63) (Table 2). The choice of treatment was Artemether-Lumefantrine (AL).The positive microscopic confirmatory test is an indication of malaria infection among pregnant women in the study area.

Table 2: Laboratory test result

Variables	Categories	n	%
Tested for malaria	Yes	63	16.2
	No	326	83.8
Microscopy test results	Positive	63	100.0
	Negative	0	0.0
Treatment given	AL	63	100.0
	Other	0	0.0

3.3 Patient related factors as determinants of malaria prevalence in pregnancy

Table 3 presents logistic regression analysis results on socio-demographic factors influencing malaria prevalence in pregnancy. The study findings revealed that there was statistically significant association between place of residence and malaria infection in the study area (OR: 5.7; 95%CI: 2.6 – 12.4; $p < 0.0001$). Pregnant women who were residents of Mt. Elgon were almost three times more likely to have had malaria infection compared to their counterparts from Kaptama and Sambocho. Furthermore, the upper limit of the 95%CI OR shows that the likelihood of those from Mt. Elgon having malaria was up to 12 times in contrast to their colleagues. The findings also show that those who had had malaria in the last two years were about two times more likely to have had malaria during the current survey (OR: 1.7; 95%CI: 1.0 – 2.9; $p = 0.05$) with the results being statistically significant. Although the following results were not statistically significant, a higher proportion of participants aged less than 25 years (17.6%) had positive malaria results compared to those who were older ($p = 0.3$); participants with primary level of education were up to 9 times more likely to have had malaria ($p = 0.2$); and a smaller proportion of those who were married (13.4%) had positive malaria results ($p = 0.3$). On the other hand, employment and occupation were not statistically significantly associated with positive malaria results.

Table 3: Logistic regression analysis of socio-demographic factors and malaria prevalence in pregnancy

Variables	Categories	Total	Malaria test results		OR	95% CI	P value
			Positive	Negative			
		n	%	%			
Age group in years	< 25	262	17.6	82.4	1.4	0.7 – 2.5	0.3
	≥ 25	127	13.4	86.6			
Marital status	Married	134	13.4	86.6	0.7	0.4 – 1.3	0.3
	Single and others	255	17.6	82.4			
Level of education	Primary	10	30.0	70.0	2.3	0.6 – 9.1	0.2
	Secondary and above	379	15.8	84.2			
Employment status	Employed	267	16.5	83.5	1.1	0.6 – 1.9	0.8
	Unemployed	122	15.6	84.4			
Occupation	Housewife	138	18.1	81.9	1.2	0.7 – 2.1	0.4
	Others careers	251	15.1	84.9			
Place of residence	Mt. Elgon	233	23.6	76.4	5.7	2.6 – 12.4	**<0.0001**
	Kaptama or Sambocho	156	5.1	94.9			
Had malaria in last 2 years	Yes	161	20.5	79.5	1.7	1.0 – 2.9	**0.05**
	No	228	13.2	86.8			
History of malaria in previous pregnancy	Yes	60	15.0	85.0	0.9	0.4 – 1.9	0.8
	No	329	16.4	83.6			
Sought treatment in hospital	Yes	32	21.9	78.1	3.6	0.7 – 19.2	0.1
	No	28	7.1	92.9			
	No	38	10.5	89.5			

3.4 Ownership of ITN's and malaria prevalence in pregnancy

As shown in Table 4, the study results established that respondents who preferred any shape of ITN were almost four times and up to ten times more likely to have had positive malaria results (OR: 3.8; 95%CI: 1.5 – 9.7; p = 0.008). On the contrary, those who preferred rectangular shape of ITN were 50% less likely to have had positive malaria results, although the findings were marginally statistically significant (OR: 0.5; 95%CI: 0.3 – 1.0; p = 0.06). Likewise, respondents who felt that it is extremely important for pregnant mothers to sleep under ITN were 40% less likely to have had malaria though the significance of the results were close to borderline (p = 0.08). Notably, albeit not significant results, the proportion of those with at least three ITNs or more whose malaria results were positive, was higher (18.4%) than those with fewer number of ITNs per household (p = 0.2) suggesting that ownership of more ITNs does not translate into use of the same for malaria prevention. The number of household members who slept under ITN the night before the interview, preferred colour of ITN and confidence in hanging the net were not statistically associated with positive results of malaria test.

Table 4: Logistic regression analysis of ownership of ITN's and malaria prevalence in pregnancy

Variables	Categories	Total	Malaria test results		OR	95% CI	P value
			Positive	Negative			
		n	%	%			
Number of ITNs in the house	≥3	196	18.4	81.6	1.4	0.8 – 2.4	0.2
	<3	193	14.0	86.0			
Number of members who slept under ITN last night	One or two	257	16.3	83.7	1.0	0.6 – 1.8	0.9
	More than two	132	15.9	84.1			
Preferred colour of ITN	Blue	137	18.2	81.8	1.2	0.7 – 2.2	0.4
	Other colour	252	15.1	84.9			
Preferred shape of ITN	Rectangular	337	14.8	85.2	0.5	0.3 – 1.0	**0.06**
	Other shapes or any	52	25.0	75.0			
Preferred shape of ITN	Any shape	20	40.0	60.0	3.8	1.5 – 9.7	**0.008**
	Rectangular or conical	369	14.9	85.1			
Confident hanging mosquito net in house	Yes	302	15.2	84.8	0.7	0.4 – 1.4	0.3
	No	87	19.5	80.5			
Importance of sleeping under a treated net for pregnant mothers	Extremely important	293	14.3	85.7	0.6	0.3 – 1.1	0.08
	Very important	96	21.9	78.1			

3.5 Institutional determinants of malaria prevalence in pregnancy

Table 5 illustrates institutional determinants of malaria prevalence in pregnancy. The study findings indicated significant association between methods used to deliver health education messages and malaria infection in pregnancy (OR: 4.4; 95%CI: 1.6 -12.3; p = 0.007). Where oral method was used in delivering key messages on malaria prevention among pregnant mothers, the likelihood of respondents having positive malaria results was four-fold compared to where other methods were used suggesting ineffective medium of delivery. Further results indicate a marginally statistically significant association between having had malarial attack during the current pregnancy and positive results during the survey (OR: 0.4; 95%CI: 0.1 – 1.1; p = 0.06). Mothers who had previous malarial attack were 60% less likely to have had positive results. Probably, the negative results could be attributed to the respondents having had anti-malaria treatment. It is also worthy of noting that a smaller proportion of respondents who agreed that health workers provide free malaria preventive services (12.9%) had positive results unlike those who disagreed (19%) although the results were not significant (p = 0.1). There was no evidence of association between knowledge that

Fansidar is a method of preventing malaria in pregnancy, the number of doses for malaria prevention during pregnancy and positive malaria results among respondents.

Table 5: Logistic regression analysis of institutional factors and malaria prevalence in pregnancy

Variables	Categories	Total	Malaria test results		OR	95% CI	p value
			Positive	Negative			
		n	%	%			
Methods used to deliver health education messages	Orally	16	43.7	56.3	4.4	1.6 – 12.3	**0.007**
	Other methods used	373	15.0	85.0			
Health workers provide free malaria preventive services	Yes	178	12.9	87.1	0.6	0.4 – 1.1	0.1
	No	211	19.0	81.0			
Knows that Fansidar is a method of preventing malaria in pregnancy	Yes	163	17.8	82.2	1.2	0.7 – 2.1	0.5
	No	226	15.0	85.0			
Knows number of SP doses a pregnant mother supposed to be given	One	147	18.4	81.6	1.6	0.3 – 7.3	0.7
	Two	16	12.5	87.5			
Has had malarial attack during this pregnancy	Yes	54	7.4	92.6	0.4	0.1 – 1.1	**0.06**
	No	335	17.6	82.4			

3.6 SP policy in the study area

A medical superintendent, Sub-County Malaria Co-ordinator, three nurse in-charges of three health facilities and one nurse in-charge of MCH/FP clinic and laboratory technologist in the Sub-County Hospital were interviewed on policy.

On inquiring about their recommendations on SP policy, several key informants concurred that:

"The policy needs to be reviewed by WHO and the national government through Bungoma County Government to allow health facilities to dispense SP to pregnant women for preventive purpose even though the sub-county is considered as malaria epidemic area. Besides, nowadays regardless of rainy season, we have cases of malaria in pregnancy that seek treatment in our facilities." (Key Informant 1, 2, 6 &7, Mt. Elgon Sub-County Hospital).

3.7 Discussions

The results of the study show that prevalence of malaria among pregnant women was higher at 16.2% following confirmatory microscopic test conducted by qualified laboratory

technologists in the study area. These findings confirm the studies of (Noor, *et al;* (2016); (Larson, *et al.*, 2016); (KDHS, 2018) and (Adoke, *et al.*, 2012) who reported a prevalence of 5-20% in epidemic areas of Western Highlands of Kenya and as the leading cause of morbidity and mortality among pregnant women.

The study findings revealed that prevalence of malaria infection was higher among women aged less than 25 years old (67.3%, n=262) as compared to those aged ≥ 25 years old (33.7%, n=137). These findings were supported by the findings of Hill, *et al.*, (2014) who reported that younger pregnant women contributed significantly due to variations in malaria prevalence as confirmed also by Ebako, *et al.*, (2015) and Chuma, *et al.*, (2010). The authors attributed the higher prevalence in the younger age group due to higher activated steroids levels and depression of lymphocytic activity of which lowers down the immunity system during pregnancy period.

The study findings revealed that there was statistically significant association between place of residence and malaria infection in the study area ($p < 0.0001$). The respondents who were residents of Mt. Elgon were almost three times more likely to have had malaria infection compared to their counterparts from Kaptama and Sambocho. Furthermore, the upper limit of the 95% CI OR shows that the likelihood of those from Mt. Elgon having malaria was up to 12 times in contrast to their colleagues. Un-moderated dynamics in environment may result in increased temperature making it favourable for the survival of malaria parasites as evidenced by higher prevalence among pregnant women who are residents of Mt. Elgon area. However, there has been tremendous intensified preventive measures put in place since mid-2000's onwards which might have subjected the population in the highlands of East Africa to an increased risk of malaria in pregnancy and frequent outbreaks particularly if the current interventions are not maintained (Yousif and Eliningaya, 2016). Additionally, even in malaria low transmission areas, repeated malaria positive smears after initial intervention has been observed. Notably, participants residing in Mt. Elgon area are much closer to the forest which is a favourable habitat for mosquitoes, a possible factor that could have further contributed to increased prevalence of malaria during pregnancy.

Results also show that respondents who had had malaria in the last two years were about two times more likely to have had malaria during the current survey ($p= 0.05$) with the results being statistically significant. Repeated malaria infection could have negative effects on both individual's health and malaria transmission in the society. Further, even in malaria low transmission areas, repeated parasitaemia after initial treatment is still observed. However, this study did not investigate the causes of these recurrent episodes (Lawpoolsri, *et al.*, 2019).

The study findings established that respondents who preferred any shape of ITN were almost four times and up to ten times more likely to have had positive malaria results ($p = 0.008$). On the contrary, those who preferred rectangular shape of ITN were 50% less likely to have had positive malaria results, although the findings were marginally statistically significant ($p = 0.06$).This position was supported by other researchers (Eisele, *et al.*, 2015; Lengeler, *et al.*, 2017; New, *et al.*, 2017; WHO, 2017) who found out that ITN's that were rectangular in shape were accepted more by pregnant women than any other type of ITN because they could cover well the four corners of the bed. This was contrary to the findings of a study conducted in Ethiopia by Baume, *et al.*, (2016) where participants who were using conical shaped nets were more likely to have used the nets the previous night compared to rectangular ITNs because they are easier to hang. However, in another study conducted in Zanzibar, the preference of nets was not associated with the use of the net the former night by mothers and children below five years (Beer, *et al.*, 2015).

There was significant association between methods used to deliver health education messages and malaria infection in pregnancy (p = 0.007). Where oral method was used in delivering key messages on malaria prevention among pregnant mothers, the likelihood of respondents having positive malaria results was four-fold higher compared to where other methods were used alluding that the oral method of message delivery was ineffective. The results were in line with other studies conducted by Ankomah, *et al.*, (2014); Do, *et al.*, (2018) and Sultan, *et al.*, (2017) who found that the driving force behind health education on preventive and control measures of malaria in pregnancy was via paper (poster, billboards, newspaper) and digital (radio, television) contrary to oral health education. Report from one of the qualitative studies done in Papau New Guinea on knowledge, attitude and practice on prevention of malaria in pregnancy observed varied messages from health staff about the risks of malaria in pregnancy (MiP). Ideas on seriousness and risks of MIP greatly influenced uptake of interventions: the availability and perceived comfort of sleeping under ITN were imperative determinants of usage. This was compounded by inadequacy of health staff's message about MIP (Erin, *et al.*, 2015).

There was a marginally statistically significant association between having had malarial attack during the current pregnancy and positive results during the survey (p = 0.06). Mothers who had previous malarial attack were 60% less likely to have had positive results. Results of a study conducted by Flaxman, *et al.*, (2016) found out that treatment using SP was marginally statistically associated with pregnant women in endemic areas that led to drastic reduction of the total number of malaria cases. However, this was dependent on the number of times a mother had malaria during the current pregnancy. Probably, the negative results could be attributed to the respondents having had anti-malaria treatment.

According to WHO (2017) recommendations, pregnant women staying in moderate to high transmission endemic areas should be given SP every time they visit ANC unlike those who live in epidemic areas where they are given ITNs. Concerning SP policy use in the study area, it is not implemented because according to key informants, the area has been declared malaria free zone by WHO and the Kenyan Government. However, in the current study, women who reported previous malarial attack were affected and could not perform activities of daily living. A number of them, although comparatively small, had complications which included stillbirth and preterm labour which could be related to MiP.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

On the basis of these findings it is apparent that there is high prevalence of malaria among pregnant women in Mt. Elgon Sub-County. Patient-related factors that were associated with MiP were place of residence and having had malaria in the last two years. Participants who were residents of Mt. Elgon were more likely to have had MiP compared to their counterparts from Kaptama and Sambocho. In addition, there was statistically significant association between preferred shape of ITN and malaria prevalence in pregnancy.

The study findings established that respondents who preferred any shape of ITN were almost four times and up to ten times more likely to have had positive malaria results compared to those who preferred use of rectangular ITNs. Thus, shape determines the likelihood of malaria infection in the study area.

Further, there was significant association between methods used to deliver health education messages and malaria infection in pregnancy. Use of oral health education in the delivery of

malaria prevention messages was not effective. The study also shows a marginal association between malaria infection and the current pregnancy. IPT policy has not been implemented in the study area based on the Government recommendation regarding malaria transmission in the study area which is considered as malaria-free zone.

Recommendations

This study recommends Bungoma County Government to promote use of ITNs and preferably rectangular ITN's by ensuring they are translated to appropriate use, to support regular indoor residual spraying with insecticides. Further the County Government through Department of Health should create awareness by use of print media to compliment the current malaria control measures. Notably there is need for WHO and Kenyan Government to review SP policy in the study area due to high malaria prevalence in pregnancy. This is in line with the study results and input from key informants interviewed.

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