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INTRIGUING PREDICTORS ASSOCIATED WITH MALARIA INFECTION AMONG PREGNANT WOMEN IN MT. ELGON SUB COUNTY, KENYA

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Abstract

Introduction: Universally, malaria continues to ravage the lives of innocent expectant women. In Kenya malaria prevalence among adult females is 28% while in Mt. Elgon Sub County, which is categorised under highland epidemic prone malaria area, prevalence of malaria in pregnancy (MiP) is uncertain. Therefore, this study sought to determine intriguing predictors associated with malaria infection among pregnant women in Mt. Elgon Sub-County.

Methods: Cross-sectional analytical design was employed and mixed methods used for data collection. For quantitative data collection, semi-structured questionnaire was used to collect primary data from pregnant women who attended ANC in selected health facilities in the study area. Further, qualitative approach adopted interview guides that targeted key informants in the health facilities. Systematic random sampling method was used to select 392 participants for the study. Data was analysed by SPSS version 25.0. Bivariate logistic regression analysis was used to test the association between independent variable and dependent variable.

Findings: Study results revealed that, the prevalence of 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). The following five factors were statistically significantly associated with malaria prevalence in pregnancy: 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 ITN's (OR: 3.8; 95%CI: 1.5 – 9.7; $p = 0.008$);earth floor (OR: 1.8; 95%CI: 1.0 – 3.1; $p = 0.03$); mud wall (OR: 1.8; 95%CI: 1.0 – 3.1; $p = 0.03$). In conclusion, age group, place of residence, testing positive in the last 2 years, preferred shape of ITN, earth floor and mud wall were significant factors associated with MiP.

Recommendations: To curb MiP, the study recommends Bungoma County government to promote use of ITNs and preferable rectangular ITN's by ensuring they are translated to appropriate use; support regular indoor residual spraying with insecticides and educate the residents on the role of improved housing on malaria protection and empowerment of the community to adopt improved housing.

Keywords: *Intriguing, Predictors, Malaria, Epidemic, Mt. Elgon Kenya.*

INTRODUCTION

Worldwide, malaria is considered as an infection associated with many havoc as far as health sector is concern. Currently malaria infection remains a major determinant of maternal sickness and death. (Moya, *et al.*, 2015; Ricci, 2016). Nevertheless, efforts have been put in place by the governments in reducing malaria prevalence in pregnancy by increasing the coverage of SP and insecticide-treated nets (ITN) (Salomoao, *et al.*, 2017).

Malaria prevalence in Africa is 90% accounting for 92% morbidity and 93% mortality thus prevalence of malaria in pregnant women is 50% (Stephanie, *et al.*, 2016). This infection has negatively influenced the wellbeing of the pregnant women and the growing foetus in the uterus. Failure to intervene in time can led to low birth weight, severe anaemia, pregnancy loss, intrauterine growth restriction, foetal hypotrophy, maternal hypoglycaemia, which substantiate the influence of malaria infection on the mother and the baby in relation to number of cases and death (Stephanie *et al.*, 2016).

Prevalence of malaria pregnancy in Sokoto in Nigeria is 52.2%. It is much higher in second trimester with 62.2% as compared to first trimester 5.5% and third trimester 3.3%. The falciparum species is mostly responsible for the transmission of malaria in pregnancy. (Idowu, *et al.*, 2017). Prevalence of malaria in northern Western Nigeria is 51%, in Calabar south Nigeria 70.1%, in Gombe state 92%, 57% in Abeokota and 67% in Enugu all in Nigeria (Franket, *et al.*, 2016; Yoriyo, *et al.*, 2014; Idowu, *et al.*, 2017). Malaria is the leading cause of hospital morbidity among pregnant women with 24.6% in Ghana. Total number of bed days 20%, 29.4% of total mortality and total costs of patient user fees in the hospitals (Sicuri, *et al.*, 2018). However due to costs associated with malaria management, many women do not visit health facilities but prefer using herbal medicines in their home and this has really contributed to increased incidence of malaria cases (Sicuri, *et al.*, 2018).

Statistics in Zambia shows that 4 million people are confirmed cases of malaria with 2389 deaths every year (WHO, 2015), Therefore malaria continues to be a disease of a great significance in Zambia in spite of current scaling up implementation and recorded decline in malaria challenges among pregnant women and children (Zambia MOH, 2016). Furthermore, the high malaria prevalence in Zambia is due to human mobility. It is reported that there is importation of malaria from other countries and within Zambia across regions. More so, in Zambia, malaria prevalence in expectant women is associated with seasonal patterns of higher transmission recorded in the month of November and April. The peak incidence of this disease in Zambia it is in Northern, Luapula and Eastern provinces and the lowest is in Lusaka province (Zambia MOH 2016).

In Kenya, malaria prevalence in pregnancy is based on geographical two regions that is lowland areas (coastal and around Lake Victoria basin) and highland areas of Great Rift Valley. 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). Observation made in Kenya is that plasmodium falciparum is rated highly as the most species which claims the lives of pregnant women by causing anaemia particularly in primigravidas women (Yatitch, *et al.*, 2015). Other associated bad outcomes with this species is low birth weight, intrauterine growth restriction, pre-term labour and infant mortality (Bhattacharyya, 2015).

Jekins studies in Lake Victoria Nyanza regions demonstrate that plasmodium falciparum malaria in pregnancy stands at 28% and is associated with anaemia (Atieli, *et al.,* 2015). Nonetheless regardless of Kenyan government adopting WHO preventive measures, the pathology is on upsurge in western highland of Kenya. In Bungoma County as compared to other studies carried out in Africa, malaria prevalence rate in pregnant women is 32% than 11.6% in Ethiopia, 16.5% in Ghana. This variability is due to differed climatic and geo-ecological weather that determines plasmodium species in varied survey areas (Gatechelo, *et al.,* 2015). Moreover, due to different population characteristics and demographic changes in the study area this could significantly influence malaria prevalence (Wekesa, *et al.,* 2019). Accordingly, even though this study was conducted during rainy season, but malaria prevalence was centre of concern. However, this could be due to provision of ITNs as a policy by the Kenyan government. The survey noted that there was higher malaria prevalence rate of 66.1% in 2nd trimester as compared to other trimesters. This was due to delays of pregnant women to seek first ANC services in time but later go for ANC services in their 2nd trimester of pregnancy when diagnosis of the infection was carried out (Choonora, *et al.,* 2015).

Furthermore, Kenya as one of the low-income countries in the world, nonetheless is not left out, progress towards improving malaria preventive services coverage in pregnancy remains a challenge with widespread regional and socio-economic differences in terms of accessibility and utilization of this highly cost-effective services (Atieli, *et al.,* 2015). Additionally, in Kenya malaria prevalence among adult females is 28% while in Mt. Elgon Sub County, which is categorised under highland epidemic prone malaria area, prevalence of malaria in pregnancy MiP is 14%. (DHIS, 2018). Previous studies have indicated the burden of malaria to be associated with various socio-economic and demographic factors among others. Notably, it is not clear which intriguing predictors are related with MiP in Mt. Elgon (Nthiga, 2018). Therefore this information is a pointer to the Kenyan government that despite of declaring this area free from malaria and withdrawing provision of IPTp-SP to expectant mothers, there are still cases of malaria in pregnancy (DHIS, 2018). Thus, warranted the need to carry out an investigation to unravel malaria burden and associated influencers of malaria infection in pregnancy.

MATERIALS AND METHODS

Study Design: A cross-sectional analytical design was adopted. Secondary data was extracted from the DHIS (2018) and the MOH 405 ANC register.

Study area: The study area was conducted in epidemic area of western highlands of Kenya specifically Mt Elgon Sub County. This sub county is situated within Bungoma County and it is inhabited with Sabaot, Bukusu and Teso's. It neighbours Trans-nzoia County to the north, Cheptais and Kimilili sub counties to the southern, to the east it borders Webuye and Tongaren sub counties, borders Mount Elgon forest and Mount Elgon National game reserve to the western. Furthermore, it has got one Sub County Hospital, two health centres and two faith-based organization (FBO) health centres namely Sambocho and Kaptama and 4 dispensaries. These healthy facilities have got working laboratories and well equipped with instruments, reagents for testing samples and qualified laboratory technologists. Additionally, according to KNBS (2018), the estimated total population is 20,454. The total females comprise of 49% (20,454) of the total population. Finally, mothers who are of fertile age include 24.3% of the total population and that is equivalent to 4,970 (KNBS, 2018). This sub county was selected because it has cases of malaria among pregnant women and yet it has been declared area free from malaria (Noor *et al.,* 2016).

Target population: A total of 4,970 women of reproductive age were recruited as they sought ANC services at Mt. Elgon Sub County. Hospital medical superintendent, Sub County malaria control co-ordinator, three nursing officer in charges, laboratory in charge, and MCH/FP in charge, in this study area were included as key informants. Inclusion criteria was based on age range 15-49 years, being pregnant women who came for their ANC visits, consented and resided in the study area for the past 2 weeks.

Sampling method/size: Simple random method was first used to select three healthy facilities (Mt Elgon Sub County Hospital, Sambocho health centre and Kaptama health centre) from the entire nine health facility in the study area. Systematic sampling method was adopted to select 389 study participants in antenatal clinic in Mt. Elgon Sub-county from the chosen health facility.

Data collection methods: Collection of data involved use of both Questionnaire and laboratory test while key informant guide for key informant. Adopted from; Wekesa, *et al.*, 2019).

Questionnaire: were used to collect information on patient related variables, trends and environmental factors. This study had a researcher who was responsible for coordinating the study team, three research assistant who assisted in collecting data and interpretation of the questionnaire to pregnant women who were unable to read and write. The existing ANC nurse staff issued mothers with informed consent to sign.

Laboratory test: Particularly microscopy was carried out by a qualified Laboratory Technologist with a diploma were by it was conducted in the laboratory after referring pregnant women from ANC clinic. Rapid Diagnostic Test (RDT) were conducted by a qualified nurse in the ANC clinic order to determine accurately malaria prevalence in pregnant women. Although microscopy was somewhat a gold standard at the health facility level since the RDT were fairly simple to use, it was used as a good comparison test to microscopy.

Data analysis: Data was analysed using Software Programme for Social Science (SPSS) version 25.0, (IBM and California USA). Both descriptive and inferential statistical tools were used to analyse the data. Bivariate logistic regression analysis was used to test association between independent variable that included patient related factors, environmental factors and malaria prevalence as dependent variable. *P*-value $\leq$ 0.05 was considered statistically significant associated determinants of malaria infection among pregnant women. Odds ratios (OR) with a 95% CI were computed to compare the strength of association between independent variables and dependent variables.

RESULTS

Socio-demographic characteristics of the study participants

A total of 389 respondents took part in the study. Two-thirds (67.3%; 262/389) of the respondents were between ages of 20-24 years distantly followed by age group of 25-29 years (25.5%). 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) 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. Regarding where respondents sought ANC services, 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
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

Laboratory test result

The findings revealed that 16.2% tested for malaria in pregnancy microscopically by qualified laboratory technologists and all turned out to be positive. The choice of treatment was AL. These clearly indicated that malaria in pregnancy was a real threat to pregnant women in the study area. AL.

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

Patient related factors as determinants of 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). This implies that 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. The findings also reveal 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 significantly associated with positive malaria results.

Table 3: Bivariate logistic regression analysis of socio-demographic determinants 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			
Place of residence	Mt. Elgon	233	23.6	76.4	5.7	2.6 – 2.4	**<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 – 9.2	0.1
	No	28	7.1	92.9			
	No	38	10.5	89.5			

Ownership of ITN's and malaria prevalence in pregnancy

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 less 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: Bivariate 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			

Housing type and malaria prevalence in pregnancy

The study results indicated that three factors were correlated with malaria positive results among the respondents were type of floor, type of wall and type of roof, though the latter result was marginally statistically significant. Respondents who had earth floor were about twice as likely to have had positive malaria results compared to those with other type of floors (OR: 1.8; 95%CI: 1.0 – 3.1; p = 0.03). Similarly, those with wall made of stone and mud were two time more likely to have had malaria (OR: 1.8; 95%CI: 1.0 – 3.1; p = 0.03). The same respondents who had earth floors also had houses with walls made of stone and mud. Respondents with roofs made of sticks and mud were 70% less likely to have had malaria (OR: 0.3; 95%CI: 0.1 – 1.1; p = 0.06). Normally, the sticks used to make roofs are tightly interwoven together which prevent any leakage when it rains and also preventing mosquitoes from entering the house through the roof. It is also important to mention that a higher proportion of respondents with semi-permanent houses (17.1%) had malaria compared to those with permanent houses (14.5%), the results not being statistically significant (p = 0.5). Also noted are the results of those with wire mesh to prevent entry of mosquitoes into the house where a smaller proportion of such respondents (12.3%) in comparison to 17.7% without such protective materials had malaria, again the results being not statistically significant (p = 0.2). Number of sleeping rooms was not statistically associated with malaria test results being positive (p = 0.6).

Table 5: Bivariate logistic regression analysis of housing type and malaria prevalence in pregnancy

Variables	Categories	Total	Malaria test results		OR	95% CI	p value
			Positive	Negative			
		n	%	%			
Type of house living in	Semi-permanent	251	17.1	82.9	1.2	0.7 – 2.2	0.5
	Permanent	138	14.5	85.5			
Type of floor	Earth	134	21.6	78.4	1.8	1.0 – 3.1	**0.03**
	Other types	255	13.3	86.7			
Type of roof	Sticks and mud	38	5.3	94.7	0.3	0.1 – 1.1	**0.06**
	Other types	351	17.4	82.6			
Type of wall	Stone with mud	134	21.6	78.4	1.8	1.0 – 3.1	**0.03**
	Other types	255	13.3	86.7			
Number of sleeping rooms	Three or more	47	19.1	80.8	1.2	0.6 – 2.8	0.6
	Less than three	342	15.8	84.2			
Presence of wire mesh on windows to protect house from mosquitoes	Yes	283	12.3	87.7	0.9	0.8 – 2.9	0.2
	No	106	17.7	82.3			

DISCUSSION

The results of the study show that prevalence of malaria among pregnant women was higher at 16.2% after confirming microscopically 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 results 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. However, there is tremendous reduced malaria via intensified measures sine mid 2000's onwards, these dynamics in environment might put population in the highlands of east Africa to an increased risk of malaria in pregnancy and its outbreaks particularly if the current interventions are not maintained (Yousif and Eliningaya 2016). Further, even in malaria low transmission areas, repeated malaria positive smears after initial intervention is observed. Albeit this survey did not contradict the aetiology of this occurence (Lawpoolsri, *et al.*, 2019).Besides, participants residing in Mt. Elgon area are much closer to the forest which is a favourable habitat for mosquitoes.

Further, findings showed 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. Albeit this study did not contrast 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 studies conducted in Myanmar by (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. 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, the results being statistically significant [OR = 2.27 (95% CI 1.10–4.68) p < 0.05]. 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).

Concerning the type of housing, respondents who had earth floor were about twice as likely to have had positive malaria results compared to those with other type of floors (p = 0.03). These results were supported by another study done by Wekesa *et al.,* (2019) who found out that majority of pregnant women who tested positive smear, were from rural areas. They lived in semi-permanent houses build of mud walls, earthen floors and iron-roofed. This clearly indicated poverty hence greatly influence malaria prevalence in rural areas unlike urban areas where pregnant women lived in permanent houses with cemented floor, walls and iron sheets roof. Traditional earthen floors provide an odorous and moist environment, attracting mosquitoes to the residence.

Similarly, those with house wall made of stone and mud were two times more likely to have had malaria (p = 0.03). The same respondents who had earth floors also had houses with walls made of stone and mud. These findings agree with the findings of WHO, (2015) which established that in Sub Saharan in rural areas, people are very poor whereby they stay in mud walled and roof made of sticks houses thus housing mosquito parasites. Further water that is used at home is not covered with lids but left open providing breeding points for mosquitoes that infect pregnant women.

Respondents with roofs made of sticks and mud were 70% less likely to have had malaria (p = 0.06). Notably, in the study area, residents use split-bamboo sticks to construct the roofs. The sticks used to make roofs are tightly interwoven together which prevents mosquitoes from entering the house through the roof. Study findings suggest that this type of roofing may help protect against malaria in the study area. As regards Uganda survey, it showed that human biting rate was greater in homes with mud walls, thatched roofs and open eaves (Njie, *et al.*, 2016).

CONCLUSION

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.

As regards housing type, respondents who had earthen floor were about twice more likely to have had positive malaria results compared to those with other type of floors. Similarly, those with wall made of stone and mud were two times more likely to have had malaria. Further, respondents with roofs made of sticks were less likely to have had malaria.

RECOMMENDATION

This study recommends that, Bungoma county government to promote use of ITNs and preferable rectangular ITN's by ensuring they are translated to appropriate use; support regular indoor residual spraying with insecticides. Further, Bungoma County government should

educate the residents on the role of improved housing on malaria protection and empowerment of the community to adopt improved housing.

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