

*Life Research***Social and physical factors influencing malaria incidence among farmers in Bugesera District, Rwanda**

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Abstract

Background: In Rwanda, farmers experience health problems due to the consistency increase in mosquitoes which bring about malaria incidence. We researched to realize if there is malaria occurrence among farmers and to assess the factors associated with malaria occurrence among farmers. **Methods:** In 2019, data collected was done through a descriptive cross-sectional study design among farmers, health center workers and community health workers in rural. A sample of 384 respondents was used to respond the structured questionnaires. We used an interview guide to key informant respondents to support other information related to malaria occurrence. **Results:** Within 3 months before data collection, 342 (89.1%) of respondents have had malaria. Multivariate analysis shows that males were highly infected (AoR = 19.60; 95% CI: 9.049–42.452). Those with no formal education (AoR = 11.10; 95% CI: 3.128–39.433) demonstrated high incidence. Farmers aged 15 to 25 years (AoR = 13.44; 95% CI: 5.257–34.358) were highly infected compared to those aged 37 to 47 years. Concerning the household size, 4–6 members (AoR = 5.97; 95% CI: 1.919–18.574) showed higher incidence than those above eight members. Public servants (AoR = 7.00; 95% CI: 2.669–18.394) were highly infected compared with traders. Farmers with a monthly income of 0–50,000 rwf (AoR = 6.65; 95% CI: 2.079–21.324) were significantly associated with malaria occurrence. **Conclusion:** Higher prevalence of malaria was observed among farmers in Bugesera District. Three hundred and forty-two respondents (89.1%) have had malaria within 3 months before data collection. The use of mosquito nets was highlighted by 119 (31%) of respondents. Encouraging farming direction can help to reduce malaria as indicated by 81 (21.1%) of respondents while using insecticide-spray was helpful as indicated by 172 (44.8%) of respondents.

Key words: Malaria, Occurrence, Farmers, Factors associated

Author contributions:

Mfashwanayo Cyriaque, Nicholas Ngomi, Mochama Monica and Rutayisire Erigene participated in the conception and design of the study. Mfashwanayo Cyriaque collected and analyzed the data. Mfashwanayo Cyriaque, Nicholas Ngomi, Mochama Monica and Rutayisire Erigene interpreted the data. Mfashwanayo Cyriaque drafted the initial manuscript. All the authors read, contributed and approved the manuscript.

Abbreviations:

AoR, adjusted odd ratio; CI, confidence interval.

Competing interests:

The authors declare that they have no conflict of interest.

Citation:

Mfashwanayo Cyriaque, Nicholas Ngomi, Mochama Monica, et al. Social and physical factors influencing malaria incidence among farmers in Bugesera District, Rwanda. *Life Research* 2020, 3 (3): 125–130.

Executive Editor: Yu-Ping Shi.

Submitted: 07 May 2020, **Accepted:** 11 July 2020, **Online:** 24 July 2020

Background

Malaria is an infectious disease in both pathogenic agents and vectors observed mostly at the health of the world's population lives. It was seen that malaria affects more than 300,000,000 individuals every year and African countries are likely to be affected compared with developed countries [1].

The occurrence of malaria and death has had a decreased worldwide from 262,000,000 to 839,000 since 2000. It has reached 214 to 438,000 million since 2015 with most 88% of the cases in 2015 which occurred in the Africa continent. Due to this fact, policies against malaria have had improvement which led to health improvement in developing countries [2].

In sub-Saharan countries, malaria contributes to health problems which lead to an enormous global incidence estimated at 300 million cases occurring each year followed with an increased death rate. Malaria threatens human life and is the leading cause of mortality in low-income countries. Pregnant women are more likely to be affected by malaria and demographic factors have been reported as the main factors contributing to malaria prevalence [3].

Cattle sheds are also the leading cause of malaria and sometimes connected by shared wall to human houses but nowadays more efforts are taken to control it. With cattle shed, refuge for mosquitoes focusing on humans with regard to malaria control is the bit like treating the tip of iceberg [1].

The dynamic of humans, cattle and mosquitoes has pushed policy makers to control it with more practices not only in developing countries but also in developed countries [4]. In India, policies are applied where malaria transmission is sustained by zoophilic vectors. The country engaged in using tools in achieving its ambition in 2030 of the malaria elimination target to achieve the world health program. These policies led to 90% of achievement in 2015 and the overall elimination intends to reach 35 additional countries by 2030 [4].

In Rwanda, more than 80 percent of the population which is principally comprised of the rural poor is exposed to dangerous mosquitoes from livestock sheds and farming activities. Over 85% of Rwandans depend on rearing livestock associated with farming at home for income generation because alternative sources of income are often unreliable and unaffordable for the majority of the population [5].

The health impact of malaria worldwide is considerable and primarily results from insufficient control measures. House dwellings associated with farming activities increase malaria risk as this attracts more mosquitoes to nearby houses [1]. In addition, most of farmers do not have sheds and they live in the same house which shows that the level of knowledge and practice about linkage between farming and malaria

prevention is still low in Bugesera District and particular in Rwanda [6].

There are effects of increased farming activities which result into human biting rate of the vectors. This means that farming associated with cattle need to be separate from human dwellings to decrease the biting rate [7]. Farming activity near to human dwelling leads to probable malaria occurrence if not controlled. Rwanda is one of the developing countries facing the major public health problem which may be caused by farming and livestock [5]. The majority of farmers in Rwanda are near their living houses and this increases risks of malaria. An increase in mosquito is a great problem for malaria incidence. Inadequate farmers' knowledge and skills, poor control and farming not oriented are other factors leading to malaria occurrence.

Methods

Study design

We adopted a descriptive cross-sectional study design.

Study setting

The study was conducted in rural sectors of Bugesera District, Rwanda. These rural sectors have a high incidence of malaria [6]. The total number of households in these sectors is 38,180. This area is composed of 221 health center workers and 234 community health workers to make a total of 38, 635.

Study duration

The duration of this study was about 6 months including three months of data collection from August to December 2019.

Data collection

For quantitative information, a pretested semi-structured questionnaire was developed in English translated into Kinyarwanda ([Supplementary material 1](#)). The questionnaire was designed by Mfashwanayo Cyriaque of Mount Kenya University. The questions were given to study participants with the help of trained research assistants to assess the factors associated with malaria occurrence among farmers. A simple random sampling technique proportional to the sector was used.

For qualitative data, the cell phones were used to record the information during an interview guided to key informant participants. Purposive sampling technic was used to select key informant participants for the interview guide, five key respondents were used for malaria occurrence knowledge in farmers. The study targeted a total population of 38,635 respondents from which a sample of 384 was selected to determine the factors associated with malaria occurrence.

The protocol of the present study was conducted in approval of the Public Health Department and by the Institute of Postgraduate Studies and Research of Mount

Kenya University, Rwanda with the permission of the Bugesera District. All participants provided have signed informed consent. The institutional review board statements for this study is in [Supplementary material 2](#).

Inclusion criteria

The study has considered the one household farmer in a family regardless of the types of farming activities. These include men, women and youth practitioners above 18 years old. In this study, farmers who have had various animals and farms the ones engaged in for a longer period of time were selected.

Exclusion criteria

Farmers who were no longer in the activity of farming were excluded; the exclusive criterion also reflected new coming farmers in the process of farming activities as they were not experienced with malaria brought about by farming.

Statistical analysis

Information from the tools returned was subjected to data processing by coding, editing and tabulation. Therefore, after entering into computer-based software known as SPSS 17 (statistical package for social science); the data was put in order to present in terms of percentages, frequencies, tables and histogram chart. The data presented in tables were interpreted, analyzed and generalized and the researcher presented and reported findings. A descriptive analysis was performed through proportions, mean and frequency. Data from key informant participants were transcribed and analyzed thematically. Kinyarwanda language was used at field level to ease communication between respondents.

Results

Socio-demographic characteristics of respondents

The results showed that the majority 304 (79.2%) of respondents were male. Regarding the education of a farmer, research findings showed that 124 (32.3%) had no formal education while 22 (5.7%) of respondents had a university degree. Regarding the marital status, research findings showed that 282 (73.4%). Based on the age group of respondents, research findings showed that 150 (39.1%) of respondents had ages between 15–25 years, while 78 (20.3%) had the age group between 37–47 years old.

In terms of household size, research findings showed, 131 (34.1%) had family members between 6–8 members while 24 (6.2%) had 8 members and above. When assessing income earned, research findings showed that 154 (40.1%) earn an income between 51,000–100,000 rwf, 102 (26.6%) earn income more than 101,000–200,000 rwf, while 25(6.5%) earn an income between 201,000–300,000 rwf.

Malaria related prevention measures used by farmers

Research findings showed that 290 (75.5%) sleep in mosquito nets. When assessing the causes of malaria, research findings showed that 119 (31%) argued that malaria was caused by mosquito bite, 162 (42.2%) malaria was caused by flies, 85 (22.1%) of respondents pointed out change in season. When assessing influences that increased mosquito bites, research findings showed that 83 (21.6%) of respondents indicated farming activity, 155 (40.4%) of respondents argued that lack of bed nets increased mosquito bites, 41 (10.7%) of respondents indicated improper insecticide.

The information collected related to the associated factors of malaria in 6 sectors showed that physical factors were among malaria occurrence from which 75 (19.5%) of respondents indicated farming areas, 61 (15.9%) of respondents take into consideration size of farm, 164 (42.7%) considers nature of habitation, 84 (21.9%) of respondents highlighted geographical location.

Research findings also showed that environmental factors such as season as reported by 164 (42.7%) of respondents and also the size of family as reported by 141 (36.7%) of the surveyed respondents.

Research findings showed that farmers of selected sectors of the Bugesera District face some challenges while preventing malaria. These include near home farming as reported by 17 (4.4%) of respondents. The lack of insecticide nets was indicated by 119 (31%). Lack of medicines as indicated by 164 (42.7%) and also climate change and reported by 84 (21.9%).

The use of mosquito nets was highlighted by 119 (31%) of respondents. The research findings also showed that encouraging farming direction can help to reduce malaria in 6 sectors of Bugesera District as indicated by 81 (21.1%) of respondents while the use of insecticide spray was considered as helpful as indicated by 172 (44.8%) of respondents.

The researcher was interested in knowing the distance of farmer from the farming activity and research findings showed that some farmers farm inside the home in the same area of compound as reported by 57 (14.8%) of respondents. 162 (42.2%) also indicated that they are affected by malaria due to the fact that their farming activity is operated nearest their habitation. A total 92 (24.0%) of respondents indicated that they travel the distance of between 150–300 m to reach farming area, while 73 (19.0%) argued that they travel the distance between 300–450 m to reach farming area.

Malaria occurrence and influencing factors among farmers

Research findings showed that 342 cases of malaria equivalent to 89.1% have occurred in the last three

months before data collection. The finding revealed that 89.1% of farmers have been diagnosed with malaria in the last 3 months and this is similar to what was reported by three health center staffs during the interview by saying “We diagnose almost 33 cases of malaria per day in this health center, this number is too high due to the exchange of seasons and the rainy seasons we observe many cases compared to dry season. Also, the citizens are at high risk of having malaria because most of time they went in bush for farming and expose to mosquito.” (laboratory technicians)

One nurse reported as this: “There is a farmer who told me that he cannot go to the health center because he already knows the disease as it is common, he said he usually goes to the shops to buy coartem when he suffers from headache (Health Center staff).” Another staff reported: “When I go to visit my farm, I hear people saying that they have severe headache and body pains (Health Center worker).”

The quote from the clinic says: “Malaria is a common disease in this area and most of them are farmers. Many farmers when are back from their activities come here in the afternoon complain about the headache and most of them are diagnosed with malaria (Health Center representative).” Bivariate analysis of factors associated with malaria occurrence among farmers was performed, after these analysis variables with *P*-value, less than

0.05 were taken to multivariate analysis to assess factors associated with malaria among farmers.

Bivariate analysis of factors associated with malaria occurrence among farmers

The results show that 86.0% of respondents who had malaria in the last three months were male, gender was statistically related to malaria occurrence among farmers ($P < 0.001$, Table 1). Education level of farmers was statistically associated with malaria occurrence among farmers ($P < 0.001$), the findings show that 34.8% of farmers who had malaria in the last 3 months had no formal education, while few of them 4.4% had university degree. Marital status was not statistically associated with malaria occurrence ($P = 0.056$), however majority 71.9% of farmers who diagnosed with malaria in the last 3 months were married. Age group of farmers was significantly associated with malaria occurrence ($P < 0.001$), a total of 148 (43.3%) who had malaria were aged 26–36 years old, few of them 14.6% were aged 37–47 years old.

The farmers who have had malaria in the last 3 months, 116 (33.9%) had household size of 4–6 persons while 5% had family size of eight or more persons. Household size was statistically associated with malaria occurrence ($P < 0.001$). Regarding the occupation other than farming, 164 (48.0%) do other artisan activities,

Table 1 Multivariate analysis of factors associated with malaria occurrence among farmers

	AoR	95% CI	<i>P</i> -value
Gender of farmer			
Male	19.60	9.049–42.452	< 0.001
Female	Reference		
Education of farmer			
No formal	11.10	3.128–39.433	< 0.001
Primary	27.30	5.186–143.702	< 0.001
Secondary	1.51	0.562–4.090	0.411
Bachelor	Reference		
Age group			
15–25	13.44	5.257–34.358	< 0.001
26–36	10.36	4.434–24.205	< 0.001
37–47	Reference		
Households size			
2–4	6.79	2.035–22.687	0.002
4–6	5.97	1.919–18.574	0.002
6–8	2.15	0.796–5.841	0.130
8 +	Reference		
Occupation other than farming			
Artisan	3.55	1.666–7.581	0.001
Public servant	7.00	2.669–18.394	< 0.001
Trader	Reference		
Monthly income			
0–50, 000 rwf	6.65	2.079–21.324	0.001
51,000–100,000 rwf	5.76	1.994–16.692	0.001
> 101,000	4.53	1.503–13.665	0.007
	Reference		

AoR, adjusted odd ratio; CI, confidence interval.

36.5% of farmers had also public work, other occupation was statistically associated with malaria occurrence ($P < 0.001$). Monthly income was statistically associated with malaria occurrence in the last three months ($P = 0.005$). A total of 139 (40.6%) who have had malaria had the monthly income of 51,000–100,000 Rwandan francs, 27.8% had a monthly income of 0–50,000 Rwandan francs. Monthly income was significantly associated with malaria occurrence ($P = 0.005$). Sleeping in mosquitoes net and distance to farming areas were not associated with malaria occurrence among farmers in the last 3 months. Among farmers who have had malaria 258 (75.4%) slept in mosquitoes net last night preceding the research, 146 (42.7%) have the farming area nearest of the place of living but this contradictory to what four health center representatives reported by saying “We all agree that high loads of mosquitoes are caused by their sheds and other agricultural activities at home which results to malaria cases among farmers due to the fact that malaria occurs during wet and drought season (Health Center representative).”

Multivariate analysis of factors associated with malaria occurrence among

Findings from the multivariate analysis detailed in [Table 1](#), show that males were more likely to have malaria (AoR = 19.60; 95% CI: 9.049–42.452; $P < 0.001$) compared to females. Farmers with no formal education (AoR = 11.10; 95% CI: 3.128–39.433; $P < 0.001$), primary education (AoR = 27.30; 95% CI: 5.186–143.702; $P < 0.001$) were at risk of having malaria compared to farmers with bachelor’s degree.

Farmers aged 15 to 25 years (AoR = 13.44; 95% CI: 5.257–34.358; $P < 0.001$) and 26 to 36 years old (AoR = 10.36; 95% CI: 4.434–24.205; $P < 0.001$) were more likely to have malaria compared to those aged 37 to 47 years old. Concerning the household, farmers with 2–4 family members (AoR = 6.79; 95% CI: 2.035–22.687; $P = 0.002$), 4–6 family members (AoR = 5.97; 95% CI: 1.919–18.574; $P = 0.002$) compared to those with 8 or more family members. Artisan (AoR = 3.55; 95% CI: 1.666–7.587; $P < 0.001$), public servant (AoR = 7.00; 95% CI: 2.669–18.394; $P < 0.001$) had higher risk of having malaria.

Farmers with a monthly income of 0–50,000 rwf (AoR = 6.65; 95% CI: 2.079–21.324; $P = 0.001$), of 51,000–100,000 rwf (AoR = 5.76; 95% CI: 1.994–16.692; $P = 0.001$) and 101,000 < (AoR = 4.53; 95% CI: 1.503–13.665; $P = 0.007$) were significantly associated with malaria occurrence among farmers in Bugesera District and this is supported by the discussion conducted with health center workers showed that farming contributes to the economic income not only to farmers but also to the whole population but also they reinforced the farmers' challenges by saying “The farmers are facing the challenges related to the fact that

they don’t want to put far from home their farming activities fearing the thieves. We are facing the positive effect of farming that is to generate income but also the negative effect is improper hygiene, mosquitoes increase and diarrhea due to wrong sanitation.” (health officer)

Discussion

Factors such as education level and understanding among farmers are a cause of malaria occurrence. This is emphasized by the following quotation from a health community worker: “People do not want to go to the health center, they say because they are farmers, they will lose the time when they go there, they choose to treat themselves by shopping some drug or using herbs (Health Community worker).”

Malaria remains the most important cause of morbidity and mortality among farmers in Rwanda. The results from this study show that 89.1% of farmers have had malaria in the last 3 months prior to the survey. These results highlighted the high prevalence of malaria among farmers in selected sectors of Bugesera District. Similarly, in rice farming communities in Rwanda and elsewhere, where malaria has been noted as a serious public health problem, *P. falciparum* parasites have been repeatedly observed to be the leading cause of symptomatic and asymptomatic malaria infections and disease [8].

Generally in Bugesera District, there are more male farmers compared to females, therefore these results are in agreement with existing data on the relationship between malaria and gender. Mosquito nets have been demonstrated to reduce the risk of acquiring malaria infection among individuals who report using mosquito nets. In contrast, other community studies have not observed a difference relating to gender in terms of malaria prevalence [8]. This research revealed that farming activities done near the houses of living encourage mosquito increase and bites, similar to study done in Indonesia where a high percentage of families farming had a high prevalence of clinical malaria (East Nusa Tenggara, 12.0%; Papua, 18.4%) [9]. The results from this study showed that education level was a factor that is associated with malaria occurrence among farmers. The farmers who completed at least secondary school were low diagnosed with malaria and some with no or low education attributed malaria to overworking in their daily activities. The findings support the previous study done in Kenya where they reported that people with low education were significantly associated with malaria occurrence [10].

Acknowledgement

I thank Mount Kenya University Rwanda learning experience, my supervisors Dr. Nicholas Ngomi and Dr.

Monica Mochama for their valuable contribution to prepare and present the work, family Muhawenimana Gaspard, Bugesera district, my family and beloved Mukundwa Laurence and lecturers including Dr. Erigene Rutayisire for their support.

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Reviewer information *Life Research* thanks Ke-Wu Zeng and the other anonymous reviewer(s) for the contribution to the peer review of this paper.