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# Prevalence and risk factors of asymptomatic malaria among under-five children in Huye District, Southern Rwanda

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**Abstract**

**Background:** Enhanced malaria control has resulted in its reduction in some areas of Sub Saharan Africa including Rwanda. However, asymptomatic hosts serve as a reservoir for the malaria parasite for communities. The objective of this study was to determine the prevalence of malaria parasites and risk factors associated with malaria infection among children under-five years in Huye district, Rwanda.

**Methods:** This community-based cross sectional study was conducted from May to June 2016 among under-five years children. Asymptomatic children under-five years of age were randomly selected from 13 villages. Thick and thin blood smears were prepared from each child for malaria parasite diagnosis. Interviews with parents or guardians were conducted to collect data on malaria associated risk factors. Observations were made of the presence of mosquito breeding sites near and around the homestead.

**Results:** A total of 222 children were included in the study. Nearly a third (28.8%) of the children were within the age of 25-36 months. The majority (54%) of the children were females. Most of the parents/guardians were married (95.9%), nearly all (99.5%) had attended primary school and most (97.3%) were peasants. The overall *Plasmodium falciparum* prevalence in children was 12.2%. Children aged 1 to 12 months were 3.5 times more likely to have malaria parasites than children aged 13 to 59 months [AOR=3.56; 95%CI=1.18-10.71; *p*=0.024]. Children who were not sleeping under insecticide treated nets were 15 times more likely to be infected with malaria parasites compared to those who were sleeping under nets [AOR=15.27; 95%CI=4.42-52.82; p<0.001].

**Conclusion:** Malaria parasite prevalence in under-five year children in Huye District, Rwanda is moderate. The asymptomatic infections in the community forms a reservoir for transmission in the area. Young age of the child and not sleeping under mosquito net were associated with malaria parasite infection. The continuing use of mosquito nets needs to be emphasized.

**Keywords:** malaria, children, prevalence, risk factors, Rwanda

## Introduction

Rwanda is heavily affected by malaria which is one of the major human health threats globally. In the tropics and sub-tropics, the disease is rampant and has received much attention over the years due to its impact on public health (Autino *et al.* 2012). In 2013, malaria cases were estimated at 198 million and 584,000 deaths worldwide, 90% of which occurred in Africa (WHO 2014). In Rwanda, the whole population is at risk of malaria with children and pregnant women having the highest morbidity (PMI, 2014).

Increased malaria control interventions such as use of long lasting insecticide-treated mosquito nets, indoor residual house spraying with insecticides and effective case management have resulted in significant decline of malaria incidence between 2006 and 2008 in Rwanda (Bizimana *et al.,* 2015). The mortality rate in children under-five years old also decreased by 61% between 2000 and 2010. The prevalence of malaria in this age group declined from 2.6% in 2007 to 1.4% in 2010 (PMI, 2014) . However since 2012 Rwanda has been experiencing an increase in malaria

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cases reaching about 1,597,143 from 962,000 in 2013. The malaria morbidity rate in the country was 5.8% in 2012 but increased to 18.3% in 2015 (NISR, 2014). This increase is blamed on climatic change, environmental modification, human behaviour and insecticide resistance (MOH, 2014). Although malaria cases has been increasing, malaria mortality trends remained constant with 5% in 2015 due to efficacy antimalarial drug in use in the (NISR 2014).

Transmission of malaria in the country is related to altitude and microclimate and occurs in May-June and November-December. Malaria is more prevalent in lowlands than in highlands (PMI, 2014). In addition to the favourable climate, other factors such as proximity to marshlands, irrigation schemes and cross border movement of people influence the transmission especially in the Southern and the Eastern parts of the country (PMI 2014).

While efforts are being made in Rwanda through sentinel sites to capture key indicators, there are a number of areas which would benefit from a survey to determine the community prevalence of malaria infection from asymptomatic hosts which serve as reservoirs (Winskill *et al.*, 2011; MoH, 2012). Identification of the specific risk factors in a locality may provide support for existing preventative measures or the introduction of new ones. The objective of the present study was to determine the current prevalence of malaria parasites in under-five children and the associated risk factors in Huye district, Rwanda.

## Materials and Methods

### *Study area*

This was a cross sectional study conducted from May to June 2016 in malaria endemic rural villages of Rukira Cell located in Huye district, Southern Province of Rwanda. Rukira Cell is made up of 13 villages and covers 10 km$^2$, with a population of 6,529 persons living in 1,600 households. It is situated in the central plateau with hills of an average altitude of 1,700m and an average temperature of about 20°C and rainfall of 1,160 mm annually. The selection of Rukira cell was based on the fact that it is close to marshland and irrigated areas making it highly likely to have malaria vector breeding hence increased malaria transmission. The villages involved were Agahenerezo, Agakombe, Agacyamu, Gitwa, Kanazi, Kaseramba, Kubutare, Magonde, Nyanza, Nyagasambu and Sabaderi.

### *Study population*

The study population was children under-five years of age whose parents or guardians were residents of Rukira cell. A simple random sampling method was applied to select the appropriate sample of children. The list of all children under-five year was obtained from the community health workers. The list of all children was entered into SPSS Version 22 and 222 children out of 705 were selected randomly. The selected participants were visited at their homes and were informed about the study and invited to participate. If the participant was not at home the research team had to visit the house for a minimum 3 times before replacing her/him with another one. Children whose parents or guardians declined to give assent were excluded and replaced with those parents/guardians who gave assent.

### *Data collection*

Data on independent predictors were collected using both questionnaire and observation methods. The family members were interviewed to obtain demographic information and risk factors for malaria infection such as utilization of malaria control measures. Information sought included ownership of insecticide treated mosquito nets, use of nets and having a child under-five with malaria fever in the household in the last two weeks. Any mosquito breeding sites near the house or nearby swamps were identified by observation.

Both thick and thin blood smears were prepared from each selected child following standard operating procedures. Two drops of blood (about 20µl each) were collected on a clean microscopic slide. One drop was used to prepare a thick smear and the other was used to prepare

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a thin smear (Cheesbrough, 1998). Finally, the slides were labelled with participant code and packed into slide porter after being air dried (Warhurst & Williams, 1996). All slides were transported at Sovu Health Centre located in the study area. The thin smear on each slide was fixed with absolute methanol and both thick and thin smears were stained with 10% Giemsa for 10 minutes and examined microscopically under a light microscope for malaria parasites. Parasite results were reported based on screening of 100 microscopic fields at x100 magnification. Malaria parasites positive results were based on the finding of the malaria trophozoite, gametocyte or schizont on thick smear. For quality assurance, 10% of positive slides were sent at Butare University Teaching Hospital for species confirmation.

***Data analysis***
Data were analysed using Statistical Package for Social Sciences version 22. Descriptive analysis using frequencies, proportions, means and standard deviation were computed. Pearson's chi-square test was used to establish the association between presence of malaria parasite and independent variables. Odds ratio (OR) and 95% Confidence interval (CI) were used to estimate the strength of association between the independent variables and malaria. All the independent variables found to be significantly associated with malaria at bivariate analysis were considered together in multivariable analysis. This was performed using binary logistic regression by specifying '*backward conditional*' method with removal at $p < 0.05$. Asymptomatic malaria was defined as being free of fever (body temperature ≤37.5 °C) and presence of malaria parasite infection and absence of any malaria related symptom at the time of data collection (Laishram *et al*., 2012).

***Ethical consideration***
The study received ethical approval from the Institution Review Board of University of Rwanda. Permission to conduct research in the area was sought from the administration of the study area. The researchers explained the purpose of the study to the parents or guardians of each selected child and those who agreed to participate, gave a written consent. Children with malaria parasites were treated with artemether-lumefantrine at Sovu health centre.

## Results

***Socio-demographic characteristics***
A total of 222 children participated in the study. The mean age of the children was 32.2 months. The highest percentage (28.8%, 64/222) of the children were within the age group of 25-36 months followed by those aged between 13-24 months (23.4%). Female children were slightly more (54.1%) than male children (45.9%). Most of the parents/guardians were married (95.9%, 213.222) while only (4.1%, 7/222) were widowed. Nearly all the parents/guardians (99.5%, 221/221) attended primary school and most (97.3%, 216/222) were peasants (Table 1).

**Table 1: Socio-demographic characteristics of parents/guardians and children**

| Variable | Response | n=222 | % |
|---|---|---|---|
| Age (months) | 1-12 | 23 | 10.4 |
| | 13-24 | 52 | 23.4 |
| | 25-36 | 64 | 28.8 |
| | 37-48 | 47 | 21.2 |
| | 49-59 | 36 | 16.2 |
| Sex of the child | Male | 102 | 45.9 |
| | Female | 120 | 54.1 |
| Marital status of parent/guardian | Married | 213 | 95.9 |
| | Widowed | 9 | 4.1 |

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| | | | |
|---|---|---|---|
| Education level of parent/guardian | Primary | 221 | 99.5 |
| | Tertiary | 1 | 0.5 |
| Occupation of parent/guardian | Farmer | 216 | 97.3 |
| | Trader | 2 | 0.9 |
| | Nurse | 2 | 0.9 |
| | Teacher | 2 | 0.9 |

***Prevalence of malaria***

Microscopic examination of thin smear detected the presence *Plasmodium falciparum* in all blood smears. The prevalence of *P. falciparum* infection among the children was 12.2% (95% CI of 7.89% to 16.51%). Children aged 1 to 12 months were more likely to have malaria infection than children aged 13 to 59 months; 7/23 (30.4%) and 20/199 (10.1%), respectively [OR=3.92; 95%CI=1.44-10.66; p=0.005]. The proportion of malaria infection was higher among male children than their female counterparts; 18/102 (17.6%) and 9/120 (7.5%), respectively [OR=2.64; 95%CI=1.13-6.17; p=0.021]. There was no statistical significant geographical variation of malaria between villages (Table 2).

**Table 2: Association between socio-demographic characteristics and malaria parasite infection**

| Variable | Status of Malaria Infection | | OR (95%CI) | Chi square |
|---|---|---|---|---|
| | Positive, n (%) | Negative, n (%) | | *P value |
| **Age of child** | | | | |
| 1-12 months | 7(30.4%) | 16(69.6%) | 3.92 (1.44-10.66) | **0.005** |
| 13-59 months | 20(10.1%) | 179(89.9%) | Reference | |
| **Sex of the child** | | | | |
| Male | 18(17.6%) | 84(82.4%) | **2.64 (1.13-6.17)** | **0.021** |
| Female | 9(7.5%) | 111(92.5%) | Reference | |
| **Marital status of child's parent/guardian** | | | | |
| Married | 26(12.2%) | 187(87.8%) | 1.11 (0.13-9.26) | 0.922 |
| Widowed | 1(11.1%) | 8(88.9%) | Reference | |
| **Villages** | | | | |
| Agasharu | 4(19.0%) | 17(81.0%) | 4.47 (0.45-44.01) | 0.199 |
| Magonde | 2(18.2%) | 9(81.8%) | 4.22 (0.33-52.90) | 0.264 |
| Rugarama | 2(18.2%) | 9(81.8%) | 4.22 (0.33-52.90) | 0.264 |
| Agakombe | 2(16.7%) | 10(83.3%) | 3.80 (0.31-47.21) | 0.299 |
| Kubutare | 4(16.0%) | 21(84.0%) | 3.62 (0.37-47.21) | 0.268 |
| Agacyamu | 2(13. %) | 13(86.7%) | 2.92 (0.24-35.29) | 0.401 |
| Kaseramba | 2(12.5%) | 14(87.5%) | 2.71 (0.23-35.68) | 0.433 |
| Nyagasambu | 2(12.5%) | 14(87.5%) | 2.71 (0.22-32.99) | 0.433 |
| Nyanza | 2(11.1%) | 16(88.9%) | 2.36 (0.19-28.67) | 0.496 |
| Sabaderi | 1(9.1%) | 10(90.9%) | 1.90 (0.11-33.7) | 0.662 |
| Agahenerezo | 2(6.7%) | 28(93.3%) | 1.35 (0.11-16.05) | 0.809 |
| Gitwa | 1(6.2%) | 15(93.85) | 1.26 (0.07-21.97) | 0.871 |
| Kanazi | 1(5.0%) | 19(95.0%) | Reference | |

Key: OR= odds ratio; CI= confidence interval; *=significant p-value

***Malaria infection risk factors***

Children who were not sleeping under insecticide-treated net were more likely to have malaria infection 8/13 (61.5%) (OR=16.0; 95%CI = 4.76-53.80; p < 0.001) compared to those who were sleeping

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under insecticide-treated net 19/209 (9.1%) (Table 3). However, there was no significant association between malaria infection and possession of insecticide treated net, window screen, presence of mosquito breeding sites near the house and whether suffered from malaria in the last month.

**Table 3: Relationship of malaria vector control interventions /breeding sites of mosquitoes with malaria parasite infection**

| | **Status of Malaria infection** | | **OR (95%CI)** | **Chi square** |
|---|---|---|---|---|
| **Variable** | **Positive, n (%)** | **Negative, n (%)** | | ***p value** |
| **Possession of insecticide treated net** | | | | |
| Yes | 26 (12.0%) | 190 (88.0%) | Reference | |
| No | 1 (16.7%) | 5 (83.3%) | 1.46 (0.16-13.0) | 0.734 |
| **Sleeping under insecticide treated net** | | | | |
| Yes | 19 (9.1%) | 190 (90.9%) | Reference | |
| No | 8 (61.5%) | 5 (38.55) | **16.0 (4.76-53.80)** | **<0.001** |
| **Window screen** | | | | |
| Yes | 1 (25.0%) | 3(75.0%) | 2.46 (0.25-24.55) | 0.428 |
| No | 26 (11.95) | 192(88.1%) | Reference | |
| **Presence of mosquito breeding sites near the house** | | | | |
| Yes | 27 (12.6%) | 187 (87.4%) | - | 0.284 |
| No | 0 (0.0%) | 8 (100.0%) | UD | |
| **Whether suffered from malaria in the last month** | | | | |
| Yes | 26 (12.3%) | 185 (87.7%) | 1.41 (0.17-11.43) | 0.749 |
| No | 1 (9.1%) | 10 (90.9%) | | |

Key: OR= Odds ratio; CI= Confidence Interval; UD= Undefined; * Significant p value

Children who were not sleeping under insecticide treated net were 15 times more likely to be infected with malaria parasites [AOR=15.27; 95%CI=4.42-52.82; *p*<0.001] compared to those who were sleeping under insecticide treated net. Children aged 1 to 12 months were 3.5 times more likely to have malaria parasites than children aged 13 to 59 months [AOR=3.56; 95%CI=1.18-10.71; *p*=0.024] (Table 4).

**Table 4: Logistic regression for factors associated with malaria parasite infection among children**

| **Predictor** | | **AOR** | **95% CI** | **P-value** |
|---|---|---|---|---|
| ***Full model*** | | | | |
| Age (in months) | 1-12 | 2.93 | 0.98-8.80 | 0.55 |
| | 13-59 | Reference | | |
| Sex | Male | 2.24 | | |
| | Female | Reference | 0.88-5.70 | 0.091 |
| Sleeping under ITN | Yes | Reference | | |
| | No | 14.33 | 4.13-49.77 | <0.001 |
| ***Reduced model*** | | | | |
| Age | 1-12 | 3.56 | 1.18-10.71 | 0.024 |
| | 13-59 | Reference | | |
| Sleeping under ITN | Yes | Reference | | |
| | No | 15.27 | 4.42-52.82 | <0.001 |

AOR= Adjusted odds ratio; CI= Confidence Interval

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## Discussion

Malaria transmission in Rwanda varies widely with two seasonal peaks in May to June and November to December. Although the participants in the present study were apparently healthy, infection prevalence of 12.2% was observed. The prevalence was high as compared to the previous reports (Gahutu *et al*., 2011; PMI, 2014). This difference may be related to the coverage of this study which was conducted in one malaria-endemic cell of Huye district whereas other studies were conducted on a larger scale. *P. falciparum* which is known to cause severe malaria was the only observed malaria parasite species in this study. These findings are in agreement with previous studies elsewhere in sub-Saharan Africa (Cheesbrough, 1998).

According to the findings of this study, use ITNs was considered as one of the protective factors against mosquito bites and malaria acquisition. In the current study, children who were not sleeping under ITNs were 15 times more likely to be infected with malaria compared to those who were sleeping under ITNs. Similar findings were reported elsewhere (Lengeler, 2004; Wiinskill *et al.*, 2011).

Children aged 1 to 12 months were more likely to have malaria infection than children aged 13 to 59 months. This could be due to the relative slow build-up of anti-*Plasmodium spp*. immunity which is bolstered by repeated exposure. The prevalence of malaria infection was significantly more among male children compared to their female counterparts in bivariate analysis. However, this observation was not sustained in multivariable analysis. The reason for this may be due to the high number of male children who were between 1-12 months. Upon considering both age and sex, the analysis revealed that sex was no longer significant implying that sex was confounded by age.

Some of the limitations of the study included the fact that with cross sectional nature of the study, it is difficult to determine the temporal nature of observed associations. Participants could also have had recall problem on some issues explored. Moreover, the information on malaria infection prevalence and associated risk factors was collected from a rural setting of one Cell and may not be generalizable the whole district or country. The restriction of microscopy for the detection of low parasitaemia is also acknowledged. We conclude that the prevalence of *P. falciparum* infection is high among children less than five years of age in the study area. Male gender and sleeping under treated bed nets are independently associated with malaria infection.

## Competing interests

There was no competition of interests.

## Acknowledgements

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## Authors’ contribution

CN, MM, DM, KJN designed the study. RC, MH analysed the data. CN wrote the manuscript with contributions of the other authors. All the authors read and approved the final version of the manuscript.

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