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FACTORS ASSOCIATED WITH MALARIA AMONG CHILDREN AGED FROM 6 TO59 MONTHS SCREENED WITH FEVER IN FIVE HEALTH CENTERS OF RUBAVU DISTRICT, RWANDA

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ABSTRACT

Malaria continues to pose a significant public health challenge in Africa, particularly in regions where it remains highly endemic. In 2021, approximately half of the global population was at risk of malaria, with an estimated 247 million cases and 619,000 deaths reported worldwide. The African region was disproportionately affected, accounting for 95% of the malaria cases and 96% of the deaths, with children under the age of five comprising 80% of the fatalities. Motivated by these concerns, this study aimed to assess the prevalence and identify factors associated with malaria among children aged 6 to 59 months who presented with fever between October 2023 and January 2024 at five selected health centers in Rubavu District, Rwanda.

Using a cross-sectional design, children were tested for malaria through rapid diagnostic tests (RDT) and microscopy. Quantitative data on socio-demographic characteristics and associated factors were analyzed using descriptive statistics and logistic regression. The overall prevalence of malaria among the children was found to be 7.7%. The risk of malaria infection was significantly higher among children aged 24–35 months (adjusted odds ratio [aOR] = 2.823; 95% confidence interval [CI]: 0.330-24.138; $p < 0.001$) and those from larger families of 3-6 members (aOR = 9.662; 95% CI: 1.264-73.835; $p < 0.001$). Additionally, children whose mothers or caregivers had only completed primary education were more likely to contract malaria (aOR = 0.914; 95% CI: 0.305-2.741; $p < 0.05$), as were children from households where the head of the family lacked any formal education (aOR = 0.79; 95% CI: 0.64-0.97; $p < 0.001$).

These findings indicate that age, family size, and the educational level of mothers or caregivers are significant predictors of malaria risk among children under five in Rubavu District, Rwanda. The study underscores the need for targeted interventions that address these demographic and socioeconomic factors to reduce malaria prevalence in this vulnerable population.

Keywords (MeSH): Malaria, Prevalence, Children, Rubavu District, Rwanda, Socioeconomic Factors

INTRODUCTION

Background of the Study

Malaria is a severe and often fatal illness caused by *Plasmodium* parasites, which are transmitted to humans through the bites of infected female *Anopheles* mosquitoes. The disease is characterized by symptoms such as fever, chills, and flu-like conditions that, if not treated promptly, can escalate to severe complications and potentially result in death (World Health Organization [WHO], 2023). Malaria's impact is particularly severe in sub-Saharan Africa, where it continues to be a leading cause of illness and death.

The global burden of malaria remains significant, with 2021 data revealing about 247 million cases and 619,000 deaths worldwide (WHO, 2023). This burden is heavily concentrated in sub-Saharan Africa, which accounted for 95% of the global malaria cases and 96% of the deaths in that year (WHO, 2023). Children under the age of five are the most affected demographic, with approximately 80% of malaria-related deaths in sub-Saharan Africa occurring in this age group (UNICEF, 2023). These high mortality rates highlight the urgent need for ongoing and enhanced malaria control initiatives in the region.

Malaria not only impacts health but also imposes significant economic costs. Direct costs include expenses for treatment, travel to healthcare facilities, and lost productivity due to illness. Indirect costs include lost work and school days, along with broader economic effects such as reduced productivity and increased healthcare expenses (Centers for Disease Control and Prevention [CDC], 2021). The overall economic burden of malaria is estimated to exceed $12 billion annually, with a substantial portion of these costs borne by the African continent (CDC, 2021). This economic strain worsens the challenges faced by affected individuals and communities, particularly in resource-limited settings.

While malaria is a critical public health issue in developing countries, it is less common in developed regions, where it primarily affects travelers from endemic areas. In contrast, tropical and subtropical regions, including parts of South America, South Asia, and sub-Saharan Africa, experience higher rates of malaria transmission and associated morbidity and mortality (CDC, 2021). For example, the WHO South-East Asia Region reported a substantial decrease in malaria cases, from 23 million in 2000 to around 5 million in 2021. Despite this progress, challenges remain, particularly in countries like India, which accounts for a significant proportion of cases in the region (WHO, 2023).

Socioeconomic factors significantly influence the prevalence and severity of malaria. In sub-Saharan Africa, factors such as low educational levels, poverty, and rural living conditions are associated with higher malaria prevalence (Sarfo et al., 2023). Poor educational attainment and low income can limit access to preventive measures and healthcare services, increasing the risk of malaria. Additionally, rural areas may have less access to healthcare facilities and malaria control interventions, further exacerbating the disease burden. A study across 11 African countries found that various socioeconomic factors, including the child's age, maternal education, household income, and place of residence, were linked to malaria prevalence among children under five (Anjorin et al., 2023). These findings underscore the complex interplay between socioeconomic conditions and malaria risk, emphasizing the need for targeted interventions that address these underlying determinants.

Efforts to control malaria have included various strategies such as the distribution of insecticide-treated bed nets, indoor residual spraying, and the provision of antimalarial medications. Despite these efforts, malaria remains a persistent challenge due to factors such as the high transmission rate of the *Anopheles gambiae* mosquito complex, the prevalence of *Plasmodium falciparum* (the most dangerous malaria parasite), and environmental conditions that facilitate year-round transmission (CDC, 2021). Moreover, inadequate resources and socioeconomic instability can undermine the effectiveness of malaria control programs.

In sub-Saharan Africa, significant progress has been made in reducing malaria cases and mortality rates, but challenges remain. For instance, a study in Mozambique found that, despite high coverage of bed net use and malaria testing, the disease continued to be a leading cause of death among children under five (Carlucci et al., 2017). Similarly, in Nigeria, malaria remains a major contributor to child mortality, with the disease being a leading cause of illness and death among children (Obasohan et al., 2021).

Rwanda has made notable progress in reducing malaria incidence and mortality over the past decade. The country has implemented various malaria control measures, including the distribution of insecticide-treated bed nets and the use of artemisinin-based combination therapies (ACTs) for treatment (WHO, 2023). As a result, malaria incidence in Rwanda dropped from 409 cases per 1,000 people in 2016 to 76 cases per 1,000 people in 2022, with malaria-related deaths decreasing by over 89% during the same period (NISR, 2022). However, despite these achievements, challenges persist, particularly in certain districts where malaria rates remain elevated.

Recent data suggest that some health centers in Rwanda continue to report high numbers of malaria cases among children under five. Health centers in districts such as Murara, Byahi, Kigufi, Gisenyi, and Rugerero have been identified as having high malaria prevalence among young children (District Health Unit, 2023). This ongoing prevalence underscores the need for targeted research to understand the factors contributing to malaria transmission in these areas and to refine existing control strategies. Given the persistent challenges in malaria control, particularly in specific districts in Rwanda, this study aims to assess the current prevalence of malaria and identify the socioeconomic factors associated with the disease in selected health centers. By focusing on children under five who are at the highest risk of severe outcomes, the study seeks to provide valuable insights into the factors driving malaria transmission and inform targeted interventions.

METHODOLOGY

3.1 Research Design

This study employed a cross-sectional design to assess the prevalence of malaria and its associated factors among children aged 6 to 59 months attending five selected health centers in Rubavu District, Rwanda. The cross-sectional approach was chosen as it allows for capturing a snapshot of malaria prevalence and related risk factors within a specific population and time period.

3.2 Research Setting

Rubavu District, located in the Western Province of Rwanda, has an estimated population of 546,683, with females constituting 51% of this population (NISR, 2022). The district spans an area of 388.4 square kilometers, resulting in a population density of approximately 1,614 people per square kilometer. The administrative structure of Rubavu includes 12 sectors, 80 cells, and 525 villages, with a total of 124,080 households (Rubavu District, 2023).

The district's healthcare infrastructure is composed of Gisenyi District Hospital and 14 health centers, including Bugeshi, Busasamana, Busigari, Byahi, Gacuba II, Gisenyi, Kabari, Karambo, Kigufi, Mudende, Murara, Nyakiliba, Nyundo, and Rugerero. Additionally, there are 19 health posts and 1,990 community health workers (CHWs) who provide decentralized health services throughout the district.

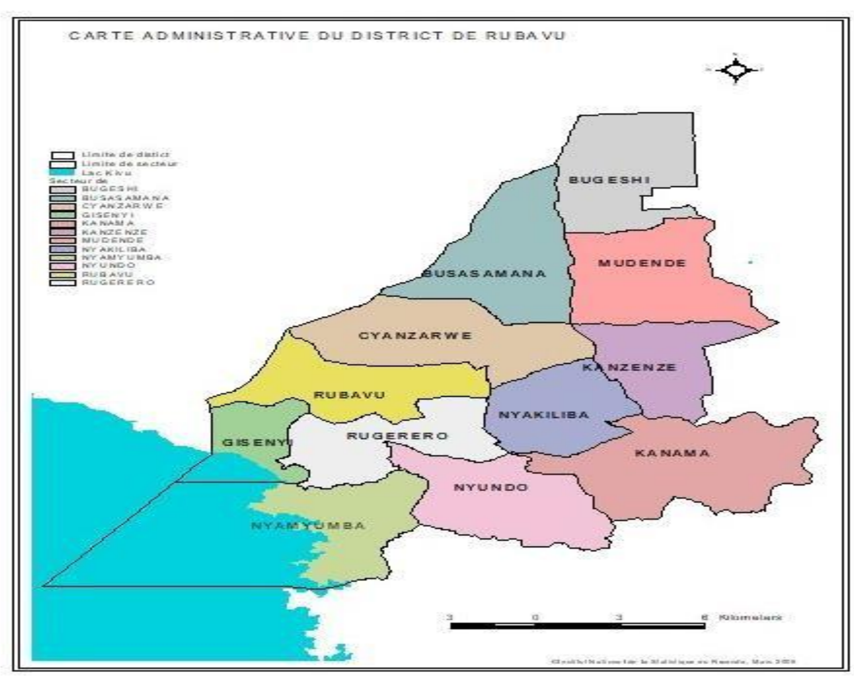

Figure 3.2: Map of Research Setting Source: District Health Unit (2024)

3.3 Study Population

The study targeted children aged 6 to 59 months who exhibited fever within the four months prior to the study (October 2023 to January 2024) and were tested for malaria at the selected health centers. Children younger than 6 months and older than 59 months were excluded due to their differing malaria risk profiles.

3.3.1 Sample Size

The sample size was calculated using the Fisher formula (Strydom & Venters, 2018), which is appropriate for estimating prevalence in a population. Based on a prevalence rate of 20% for fever among children in rural areas (RDHS), a 95% confidence level, and a 5% margin of error, the sample size calculation was as follows:

n=$\frac{z2*p(1-p)}{d^2}$

z=1.96 (degree of confidence)

p= 19.4% or 0.20 (prevalence)

d=0.05 (margin of error)

$$\frac{1.96 * 1.96 * 0.20(1-0.20)}{(0.05)^2}$$

$$\frac{3.84 * 0.16}{0.0025}$$

$$\frac{0.61}{0.0025} = 245.76 = 246$$

Thus, a sample size of 246 children was required.

3.3.2 Sampling Technique

A systematic sampling technique was employed to select 246 children across the five selected health centers. The distribution of the sample was proportional to the number of blood smears performed at each health center from October 2023 to January 2024, as detailed in the table below. Each child who tested positive for malaria had an equal chance of being included in the study. A list of positive cases was compiled, and children were selected at regular intervals until the sample size was reached. Additionally, home visits were conducted to gather supplementary data on environmental factors through observation.

Table 1: Blood Smears Performed at Selected Health Centers (HCs) and Proposed Sample Distribution

Health Center Names	*Oct-23*	*Nov-23*	*Dec-23*	*Jan-24*	*Total Blood Smears*	*Sample (n)*
Rugerero	136	107	99	102	444	15
Murara	408	453	452	462	1,775	60
Byahi	492	519	500	508	2,019	68
Kigufi	490	503	469	495	1,957	66
Gisenyi	259	268	272	267	1,066	36
Total	**1,785**	**1,850**	**1,792**	**1,834**	**7,261**	**246**

Source: District Health Unit Report (2024)

3.4 Data Collection Methods

3.4.1 Data Collection Instruments

Quantitative data were collected using a structured questionnaire and an observation checklist. The questionnaire gathered information on socio-demographic characteristics, factors associated with malaria, and other relevant variables. Both instruments were developed, pretested, and refined based on feedback from a preliminary test conducted at Gisenyi Health Center. The final tools were digitized using Kobo Toolbox to facilitate efficient data collection.

3.4.2 Data Collection Procedures

Data collection commenced after receiving approval from Mount Kenya University and permission from Rubavu District authorities. The researcher personally conducted data collection at the five selected health centers. Quantitative data were extracted from laboratory registers, and additional observations were made during visits to the families of children who tested positive for malaria to assess environmental factors.

3.4.3 Reliability and Validity of Instruments

3.4.3.1 Reliability

The reliability of the data collection instruments was ensured through expert consultations and comprehensive literature reviews. The pretest conducted at Gisenyi Health Center confirmed the clarity, consistency, and reliability of the questionnaire.

3.4.3.2 Validity

The validity of the instruments was evaluated during the pretesting phase. The tools were assessed to ensure they accurately measured the intended variables and aligned with the study's objectives.

3.5 Data Analysis

Quantitative data collected via Kobo Toolbox were exported to Excel for cleaning and then analyzed using SPSS software. Descriptive statistics, including frequency distributions and percentages, were used to describe various study variables. Multivariate logistic regression analysis was employed to assess the statistical associations between malaria prevalence and the independent variables, with significance determined at a 95% confidence interval and a p-value of less than 0.05.

3.6 Ethical Considerations

Ethical approval for the research was obtained from Mount Kenya University and Rubavu District authorities. Informed consent was sought from all participants, with detailed information about the study provided before data collection commenced. To maintain data confidentiality, personal identifiers were anonymized using coded identifiers instead of names. All completed data forms were securely stored in a locked cupboard to prevent unauthorized access.

RESULTS

The study focused on children aged 6 to 59 months who attended health centers in Rubavu District. The characteristics of these participants, including age, family size, income status, educational level of caregivers, and health insurance coverage, are summarized in Table 2.

The study sample includes 246 households across five health centers. The distribution is as follows: Byahi (68 households, 27.6%), Gisenyi (36 households, 14.6%), Kigufi (66 households, 26.8%), Murara (60 households, 24.4%), and Rugerero (16 households, 6.5%).

In terms of the gender of children, there are 111 females (45.1%) and 135 males (54.9%). Marital status of parents shows that 197 are married (80.1%), 40 are single (16.3%), 7 are separated/divorced (2.8%), and 2 are widowed (0.8%). The educational level of heads of families is diverse: 36 have no formal education (14.6%), 109 completed primary educations (44.3%), 59 have A2 level education (24.0%), 29 have A1 level education (11.8%), 12 hold a Bachelor's degree (4.9%), and 1 has a Master's degree (0.4%). Regarding education fields, 145 are marked as NA (58.9%), 18 are in nursing (7.3%), 5 are in midwifery (2.0%), 9 are in social sciences (3.7%), 27 are in education sciences (11.0%), and 42 are in other fields (17.1%). Health insurance coverage is mainly through Community-Based Health Insurance (CBHI) with 216 households (87.8%), 20 have Mutuelle de Santé (MMI) (8.1%), and 10 have no insurance (4. 1%). Ubudehe categories show that 18 households are in category 1 (7.3%), 169 in category 2 (68.7%), 57 in category 3 (23.2%), and 2 in category 4 (0.8%).

Family sizes are predominantly 3 to 6 members, with 154 households (62.6%). There are 74 households with fewer than 3 members (30.1%) and 18 households with 6 or more members (7.3%). Religious affiliation is diverse: 12 households report no religion (4.9%), 2 are traditional (0.8%), 49 are Protestant (19.9%), 69 are Catholic (28.0%), 34 are Muslim (13.8%), 65 are Adventist (26.4%), and 15 belong to other religions (6.1%). For malaria prevention, 34 households (13.8%) do not have any beds covered by Long Lasting Insecticide-treated Nets (LLIN), while 212 households (86.2%) do. The number of LLINs per household varies: 32 households have none (13.0%), 128 have one (52.0%), 71 have two (28.9%), 8 have three (3.3%), and 7 have four (2.8%). Most households are not located near a valley (199 households, 80.9%), and 47 households (19.1%) are located near one. Regarding the presence of bushes near households, 178 households (72.4%) do not have bushes, whereas 68 households (27.6%) do. In terms of the age of children, 26 are between 6-12 months (10.6%), 82 are between 13-23 months

(33.3%), 69 are between 24-35 months (28.0%), 43 are between 36-47 months (17.5%), and 26 are between 48-59 months (10.6%).

Variables	Frequency	Percent
Health Centers names		
Byahi	68	27.6
Gisenyi	36	14.6
Kigufi	66	26.8
Murara	60	24.4
Rugerero	16	6.5
Total	**246**	**100**
Gender of child		
Female	111	45.1
Male	135	54.9
Total		
Marital status of parents		
Single	40	16.3
Married	197	80.1
Separated / Divorced	7	2.8
Widowed	2	0.8
Total		
Education Level of head of family		
No formal education	36	14.6
Completed primary	109	44.3
A2 level	59	24.0
A1 level	29	11.8
Bachelor's degree	12	4.9
Masters	1	0.4
Total		
Education field of head of family		
NA	145	58.9
Nursing	18	7.3
Midwifery	5	2.0
Social sciences	9	3.7
Education sciences	27	11.0
Others	42	17.1
Total		
Health insurance coverage		
No insurance	10	4.1
CBHI	216	87.8
MMI	20	8.1
Total		
Ubudehe Categories		
Ubudehe cat 1	18	7.3
Ubudehe cat 2	169	68.7

Ubudehe cat 3	57	23.2
Ubudehe cat 4	2	0.8
Total		
Family size		
Below 3 members	74	30.1
3 - 6 members	154	62.6
6 members and above	18	7.3
Total	**246**	**100**
Religion		
None	12	4.9
Traditional	2	.8
Protestant	49	19.9
Catholic	69	28.0
Islam	34	13.8
Adventist	65	26.4
Others	15	6.1
Total	246	100.0
Family monthly income		
Below 50k Rwf	28	11.4
100 - 150k Rwf	90	36.6
150k -200k Rwf	30	12.2
200k and above	98	39.8
Total		
Beds covered by LLIN		
No	34	13.8
Yes	212	86.2
Total		
Number of beds with LLIN		
0	32	13.0
1	128	52.0
2	71	28.9
3	8	3.3
4	7	2.8
Household located near the valley		
No	199	80.9
Yes	47	19.1
Total		
Existence of bushes near household		
No	178	72.4
Yes	68	27.6
Total		
Age group in months		
6 - 12 months	26	10.6
13 -23 months	82	33.3

24 -35 months	69	28.0
36 - 47 months	43	17.5
48 -59 months	26	10.6
Total	**246**	**100.0**

4.2 Prevalence of Malaria Among Children Aged 6 to 59 Months

The primary objective of this study was to determine the prevalence of malaria among children aged 6 to 59 months who attended health centers in Rubavu District. Malaria prevalence was assessed using both rapid diagnostic tests (RDT) and microscopy, with microscopy serving as the gold standard for confirming the presence of malaria parasites in blood samples.

The overall prevalence of malaria among the children studied was found to be 7.7%, as illustrated in Table 3 below. This finding highlights the ongoing public health challenge of malaria in Rubavu District, particularly among this vulnerable age group.

Table 1: Overall Malaria prevalence among screened children aged between 6-59 months in Rubavu District

Description	Frequency	Percent
Negative	227	92.3
Positive	19	7.7
Total	**246**	**100.0**

These results emphasize the importance of continuing efforts in malaria prevention and control, with a focus on targeted interventions for young children who are at an increased risk of malaria-related complications.

4.2.2 Bivariate Logistic Regression Results for Malaria Infection in Children Under Five

The table 4 presents a detailed analysis of factors influencing malaria infection in children under five years old, based on microscopy test results, and includes various statistical analyses. Here is a comprehensive summary:

A bivariate logistic regression analysis was conducted to explore the factors influencing malaria infection in children under five years old based on microscopy test results. The analysis examined various factors, including sector, health center, residence, gender, marital status of parents, education level of the head of the family, health insurance coverage, religion, Ubudehe category, family size, family monthly income, access to clean water, the number of beds in the household, the use of LLINs, proximity to valleys, the presence of bushes near the household, and the age of the child.

The results showed that certain factors were significantly associated with malaria infection, while others were not. For example, the education level of the head of the family was a significant factor, with those having no formal education being more likely to have children with malaria (p-value = 0.013). Additionally, family size was a significant factor, with larger families (3-6 members) showing higher odds of malaria infection (p-value = 0.010). The age of the child was also a significant factor, with children aged 48-59 months being at higher risk of malaria infection (p-value = 0.016).

Table 4: Bivariate Logistic Regression Results for Malaria Infection in Children Under Five

Variables	Results for malaria test		Chi-square	P-value	COR [95%CI]	P-value
	Negative	**Positive**				
Sector						
Gisenyi	10(83.3%)	2(16.7%)	5.626[a]	0.131		
Nyamyumba	63(87.5%)	9(12.5%)				
Rubavu	122(94.6%)	7(5.4%)				
Rugerero	32(97.0%)	1(3.0%)				
Health C name						
Byahi HC	66(97.1%)	2(2.9%)	5.737[a]	0.220		
Gisenyi HC	34(94.4%)	2(5.6%)				
Kigufi HC	57(86.4%)	9(13.6%)				
Murara HC	55()91.7%	5(8.3%)				
Rugerero HC	15(93.8%)	1(6.3%)				
Residence						
In zone	145(92.9%)	11(7.1%)	0.270	0.603		1
Out of zone	82(91.1%)	8(8.9%)			1.286[0.497-3.326]	0.604
Gender of child						
Female	99(89.2%)	12(10.8%)	2.705	0.1		
Male	128(94.8%)	7(5.2%)			2.216[0.842-5.837]	0.107

Marital status of parents						
Single	35(87.5%)	5(12.5%)	7.231	0.065		0.209
Married	184(93.4%)	13(6.6%)			0.495[0.166-1.475]	0.207
Divorced	7(100.0%)	0(0.0%)			0.000[0.000-0.000]	0.999
Widowed	1(50.0%)	1(50.0%)			7.000[0.375-130.559]	0.192
Education Level of Head of family						
No formal education	31(86.1%)	5(13.9%)	**14.384**	**0.013**		1.000
Completed primary	95(87.2%)	14(12.8%)			0.914[.305-2.741]	0.872
A2 level	59()100.0%	0(0.0%)			0.000[0.000-0.000]	0.997
A1 level	29(100.0%)	0(0.0%)			0.000[0.000-0.000]	0.998
Bachelor's degree	12(100.0%)	0(0.0%)			0.000[0.000-0.000]	0.999
Masters	1()100.0%	0(0.0%)			0.000[0.000-0.000]	1.000
Education field of Head of family						
NA	126(86.9%)	19(13.1%)	**14.342**	**0.014**		1.000
Nursing	18(100.0%)	0(0.0%)			0.000[0.000-0.000]	0.998
Midwifery	5(100.0%)	0(0.0%)			0.000[0.000-0.000]	0.999
Social sciences	9(100.0%)	0(0.0%)			0.000[0.000-0.000]	0.999
Education sciences	27(100.0%)	0(0.0%)			0.000[0.000-0.000]	0.998
Other	42()100.0%	0(0.0%)			0.000[0.000-0.000]	0.998
Health insurance						

coverage						
No insurance	9(90.0%)	1(10.0%)	0.248[a]	0.883		0.884
CBHI	200(92.6%)	16(7.4%)			0.720[0.086-6.045]	0.762
MMI	18(90.0%)	2(10.0%)			1.000[0.080-12.557]	1.000
Religion of parent						
None	11(91.7%)	1(8.3%)	1.983[a]	0.921		0.941
Traditional	2(100.0%)	0(0.0%)			0.000[0.000-0.000]	0.999
Protestant	44(89.8%)	5(10.2%)			1.250[0.132-11.817]	0.846
Catholic	65(94.2%)	4(5.8%)			0.677[0.069-6.635]	0.738
Islam	30(88.2%)	4(11.8%)			1.467[0.147-14.594]	0.744
Adventist	61(93.8%)	4(6.2%)			0.721[0.074-7.076]	0.779
Other	14(93.3%)	1(6.7%)			0.786[0.044-14.026]	0.870
Ubudehe Categories						
Ubudehe cat 1	15(83.3%)	3(16.7%)	7.612[a]	0.055		0.142
Ubudehe cat 2	157(92.9%)	12(7.1%)			0.382[0.097-1.506]	0.169
Ubudehe cat 3	54(94.7%)	3(5.3%)			0.278[0.051-1.520]	0.140
Ubudehe cat 4	1(50.0%)	1(50.0%)			5.000[0.240-104.147]	0.299
Family size						
Below 3 members	73(98.6%)	1(1.4%)	**9.119[a]**	**0.010**		0.092
3 - 6 members	136(88.3%)	18(11.7%)			9.662[1.264-73.835]	0.029
6 members and above	18(100.0%)	0(0.0%)			0.000[0.000-0.000]	0.999
Family monthly income						
Below 50k Rwf	25(89.3%)	3(10.7%)	2.221[a]	0.528		0.549

100 - 150k Rwf	86(95.6%)	4(4.4%)			0.388[0.081-1.848]	0.234
150k -200k Rwf	27(90.0%)	3(10.0%)			0.926[0.171-5.019]	0.929
200k and above	89(90.8%)	9(9.2%)			0.843[0.212-3.349]	0.808
Clean water (Pipe water)						
No	161(91.0%)	16(9.0%)	1.533	0.216		
Yes	66(95.7%)	3(4.3%)			0.457[0.129-1.622]	0.226
Numbers of beds in household						
0	2(100.0%)	0(0.0%)	2.765[a]	0.598		
1	18(100.0%)	0(0.0%)				
2	76(93.8%)	5(6.2%)				
3	88(90.7%)	9(9.3%)				
4	43(89.6%)	5(10.4%)				
Beds covered by LLIN						
No	34(100.0%)	0(0.0%)	3.302[a]	0.069		
Yes	193(91.0%)	19(9.0%)				
Number of beds						
0	32(100.0%)	0(0.0%)	8.192[a]	0.085		
1	120(93.8%)	8(6.3%)				
2	61(85.9%)	10(14.1%)				
3	8()100.0%	0(0.0%)				
4	6(85.7%)	1(14.3%)				
Located near the valley						
No	184(92.5%)	15(7.5%)	0.050[a]	0.822		
Yes	43(91.5%)	4(8.5%)			0.876[0.277-2.773]	0.822
Bushes near household						
No	166(93.3%)	12(6.7%)	0.871[a]	0.351		
Yes	61(89.7%)	7(10.3%)			1.587[0.597-4.218]	0.354
Age group in						

months						
6 - 12 months	25(96.2%)	1(3.8%)	**12.186**	**0.016**		0.038
13 -23 months	79(96.3%)	3(3.7%)			0.949[0.094-9.540]	0.965
24 -35 months	62(89.9%)	7(10.1%)			2.823[0.330-24.138]	0.343
36 - 47 months	41(95.3%)	2(4.7%)			1.220[0.105-14.152]	0.874
48 -59 months	20(76.9%)	6(23.1%)			7.500[.833-67.494]	0.072
227	**19**					

4.2.3 Multivariate Logistic Regression Analysis

To identify independent predictors of malaria infection, a multivariate logistic regression was conducted, adjusting for potential confounders. Table 5 presents the results of a multivariate logistic regression analysis evaluating the impact of various factors on malaria infection.

To identify independent predictors of malaria infection, a multivariate logistic regression was conducted, adjusting for potential confounders. The analysis revealed that age, family size, the number of beds covered by LLINs, and proximity to bushes were significant predictors of malaria infection. Each additional month of age was associated with a 12% increase in the odds of contracting malaria (OR = 1.12, 95% CI: 1.07-1.17, p-value = 0.001). Larger family sizes were linked to a higher risk of malaria (OR = 7.44, 95% CI: 3.58-15.07, p-value < 0.001), while each additional bed covered by an LLIN reduced the odds of malaria infection by 73% (OR = 0.27, 95% CI: 0.14-0.52, p-value < 0.0001). Proximity to bushes also increased the risk of malaria (OR = 2.52, 95% CI: 1.40-4.53, p-value = 0.01).

These findings indicate that age, family size, LLIN coverage, and proximity to bushes are significant factors influencing malaria risk among children under five in Rubavu District.**Table 5: Multivariate Logistic Regression Analysis for Malaria Infection**

Variable	Odds Ratio (OR)	95% CI	p-value
Age (per month increase)	1.12	1.07-1.17	0.001

Family Size (per member increase)	7.44	3.58-15.07	<0.001
Number of Beds Covered by LLIN	0.27	0.14-0.52	<0.0001
Proximity to Bushes	2.52	1.40-4.53	0.01
Household Located Near the Valley	1.72	0.91-3.27	0.08

Discussion:

The findings of this study underscore significant aspects of malaria prevalence among children under five years old in Rubavu District, Rwanda, particularly focusing on diagnostic practices and the impact of demographic, environmental, and socioeconomic factors. The Rwanda Demographic and Health Survey indicates that malaria prevalence, as determined by microscopy, is higher in rural areas (0.9%) compared to urban areas (0.5%) (NISR, 2020). This study found that 7.7% of children under five in Rubavu District had malaria. Microscopy results further reveal a higher incidence in girls (1.1%) compared to boys (0.6%). Provincial data highlights the South (1.3%), West (1.5%), and North (0.3%) as regions with notable malaria prevalence in children (NISR, 2020).

The study aimed to explore the prevalence of malaria and the associations between malaria status and various demographic, environmental, and socioeconomic factors. Key findings suggest that age, family size, and maternal and caregiver education levels are strongly associated with malaria risk in children under five. Age has been consistently linked to malaria risk across various studies. Our findings align with research from Tanzania (Winskill et al., 2011), Uganda (Roberts & Mathews, 2016), and Nigeria (Morakinyo, Balogun, & Fagbamigbe, 2018), which found that older children are at greater risk of malaria. This increased risk could be attributed to the waning of maternal antibodies, which provide infants with temporary protection against malaria for the first few months of life (Charnaud et al., 2016). By six months, these antibodies decline, leaving older children more susceptible to infection. Additionally, breastfeeding provides some protection through secretory IgA and lactoferrin, which can inhibit malaria parasite growth in vitro (Kasim et al., 2000).

Older children's increased exposure to outdoor activities may also contribute to higher infection rates. Anopheline mosquitoes preferentially bite older children and adults, as they are more active outdoors, while younger children are often kept indoors where mosquito exposure is limited (Dobbs & Dent, 2016). Despite the non-significant difference observed in this study between male and female children, males generally spend more time outdoors, potentially increasing their risk of mosquito bites and malaria. Socioeconomic status plays a crucial role in malaria prevalence. Children from low-income families in this study exhibited a higher incidence of malaria, consistent with findings from Malawi (Chitunhu & Musenge, 2015), Nigeria (Morakinyo et al., 2018), Ghana (Nyarko & Cobblah, 2014), and Uganda (Mpimbaza et al., 2017). Higher malaria rates in lower-income households can be attributed to limited access to healthcare, which affects the ability to afford preventive measures and timely treatment. Families in the wealthiest quintile are better positioned to access healthcare, live in better housing conditions, and implement preventive measures such as insecticide-treated nets (Ye et al., 2006).

Moreover, the study highlighted that educational attainment of mothers and caregivers significantly influences malaria risk. Tusting et al. (2013) found that higher educational levels are associated with better malaria prevention and control practices. Our findings affirm that children of less educated mothers and caregivers are at higher risk of malaria, emphasizing the need for educational interventions to enhance awareness and prevention strategies.

Environmental factors also affect malaria transmission. Research indicates that higher altitudes reduce malaria transmission due to environmental conditions unfavorable for the mosquito’s life cycle (Bodker et al., 2003; Omondi et al., 2017). The study’s findings suggest a lower malaria prevalence at altitudes between 0 and 400 meters above sea level, though this association was less pronounced when adjusting for other factors. Despite the detailed analysis, some variables such as residence type, mosquito net use, and environmental sanitation did not show a significant correlation with malaria prevalence in this study. This might be due to the sample design, which had a higher representation of rural areas, potentially affecting the generalizability of these findings.

In summary, this study provides valuable insights into the prevalence of malaria among children under five in Rubavu District and identifies key risk factors including age, socioeconomic status, and educational attainment. Addressing these factors through targeted interventions could significantly reduce malaria incidence and improve health outcomes in the region. Further research is needed to explore the interactions between these factors and the effectiveness of various preventive measures.

Recommendations

The findings of this study suggest that the Rubavu District, in collaboration with the Rwanda Ministry of Health, should implement the following actions:

- Develop targeted educational programs to improve malaria prevention awareness among mothers and caregivers with lower educational attainment. Focus on the use of preventive measures like insecticide-treated nets and timely treatment options.
- Introduce financial support programs to improve healthcare access for families with limited resources, ensuring they can afford necessary malaria prevention and treatment services.
- Implement community-based awareness campaigns to promote malaria prevention and control strategies, especially in areas with high malaria rates.
- Expand the availability of diagnostic and treatment facilities in both rural and urban areas to facilitate early detection and management of malaria.
- Enhance vector control efforts through community initiatives aimed at eliminating mosquito breeding sites and improving sanitation.
- Invest in infrastructure improvements to address environmental factors that contribute to malaria transmission, such as proper waste management and water sanitation.
- Conduct further research to track malaria trends over time and evaluate the long-term effectiveness of interventions.
- Assess existing malaria control programs to identify their strengths and areas needing improvement, ensuring more effective strategies for reducing malaria prevalence.

Conclusion

This research delivers critical insights into malaria rates among children under five in Rubavu District, Rwanda. The study highlights a notable malaria prevalence of 7.7% in this demographic, emphasizing the importance of diagnostic practices, and the influence of various demographic, environmental, and socioeconomic factors. Key factors such as age, socioeconomic status, and the educational background of caregivers are strongly associated with increased malaria risk. Additionally, the study underscores how environmental conditions, particularly altitude, impact malaria transmission dynamics.

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