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Prevalence and Factors Linked to Severe Malaria in Under 5 Children at Fort Portal Regional Referral Hospital, Western Uganda

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ABSTRACT

Malaria remains a significant global public health concern, particularly among children under the age of five, with a high prevalence in sub-Saharan Africa. This study was conducted at Fort Portal Regional Referral Hospital, Western Uganda, to assess the prevalence and factors associated with severe malaria in under five children. The research included socio-demographic, household, and health facility factors. The study found a prevalence of 65.3% for severe malaria in the pediatric ward. Notably, a child's age, distance from home to the health facility, and waiting time before seeking medical care were significantly associated with severe malaria. The odds of severe malaria were higher among older children, those living farther from the hospital, and those with longer waiting times for medical care. These findings underscore the importance of timely access to healthcare services and targeted interventions to reduce severe malaria among children in the region.

Keywords: Malaria, Anopheles mosquito, Plasmodium, Pediatric ward.

INTRODUCTION

Malaria is one of the world's most common and life-threatening tropical diseases. It is caused by Plasmodium parasites, transmitted through a bite of an infected female Anopheles mosquito, especially between evening and morning [1, 2]. Among humans, malaria is caused mainly by four species of Plasmodium: Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae, and Plasmodium ovale. Plasmodium falciparum and Plasmodium vivax are the most common [3–5]. The majority of malaria cases are concentrated in sub-Saharan Africa, and nearly all of these malaria cases are caused by Plasmodium falciparum. It is the most important threat to public health worldwide and is mostly deadly, responsible for more than 90% of malaria deaths worldwide [6]. Malaria is widespread in most tropical places, with around 3.4 billion people worldwide exposed to malaria each year, and 1.2 billion at high risk [7]. Despite being preventable and curable, malaria causes significant morbidity and mortality, particularly in areas with limited resources [8]. It was estimated that 300-500 million people suffer from malaria, and 1.5-2.7 million deaths occur annually, with Sub-Saharan Africa being the most affected region, contributing over 80% of global malaria deaths[2, 9]. Therefore, half of the world's population is at risk of malaria, including people living or visiting malaria-endemic areas. The most vulnerable people are pregnant women and children[10, 11]. Malaria is a leading cause of death in children less than 5 years old, contributing to 77% of all global malaria deaths [12]. In Africa, a child dies from malaria every minute[13]. Severe malaria is due to delayed treatment and poor management of uncomplicated malaria; hence, severe malaria is defined as the presence of clinical and laboratory evidence of vital organ dysfunction[14, 15]. However,

almost all deaths from malaria result from infection with Plasmodium falciparum [2, 16]. Malaria is still a significant health threat, although there are interventions in terms of new drugs and vaccines, eradication has not yet been achieved, and many health strategies now focus on malaria prevention and control [17].

Uganda has the third-highest number of Plasmodium falciparum infections in sub-Saharan Africa and some of the highest reported malaria transmission rates in the world [18]. There is stable, perennial malaria transmission in 90–95% of the country. Based on 2015 data from Uganda's Health Management Information System (HMIS), malaria accounts for 34% of outpatient visits and 28% of hospital admissions for all reported malaria cases in 2015[19]. An average of 55% of cases was laboratory-confirmed, although this average increased to 64% between July and December compared to 2014 HMIS data[19]. Hospital admissions decreased by two percentage points (from 30%) in 2015, while laboratory-confirmed cases increased by 16 percentage points (from 39%), showing a positive trend in malaria case management [20]. Efforts to minimize the malaria burden have recently increased due to the deployment of efficient malaria tools such as intermittent preventive treatment for pregnant mothers, distribution of Long Lasting Insecticide Treated Mosquito Nets to communities, and early diagnosis and treatment [21].

Malaria is an old disease whose name is derived from the Italian "mal-aria," meaning "bad air." It was also known as Roman fever, ague, marsh fever, or periodic fever [6, 22, 23]. There were numerous, sometimes bizarre theories on how malaria was transmitted until 1898 when Dr. Ronald Ross discovered that the female Anopheles mosquito was actually responsible for transmitting the malaria parasite.

Malaria is a serious public health concern around the world, particularly among children. Two-thirds of malaria cases occur in children under the age of five, and the majority of deaths due to malaria happen in Sub-Saharan Africa [24]. Since 2010, death rates among children under the age of five have decreased by 34% [25, 26]. Malaria is prevalent in more than 95% of Uganda, according to Ministry of Health statistics [27]. Malaria remains the biggest cause of death in Uganda, accounting for more than 27% of all deaths. According to statistics, Uganda has the world's highest malaria incidence, with a rate of 478 cases per 1,000 populations per year [27]. It was estimated that 216 million cases of malaria occurred worldwide in 2016, with 445,000 deaths globally. The WHO African region had the most cases at 90%, followed by the WHO Southeast Asia region at 7%, and the WHO Eastern Mediterranean region at 2%. In 2016, most deaths (91%) were in the WHO African region [10]. Two-thirds of malaria cases in 2016 occurred in children under the age of five, and most of these deaths occurred in sub-Saharan Africa. Since 2010, mortality rates among children under 5 years have fallen by 34% [28]. Malaria is endemic in over 95% of Uganda. Statistics from the Ministry of Health show that malaria is still the leading cause of death in Uganda, accounting for over 27% of deaths. The statistics also show that Uganda has the world's highest malaria incidence, with a rate of 478 cases per 1,000 populations per year. According to the Parliamentary Committee on Health report from [29], Uganda was ranked as one of the leading countries in Africa with high malaria-related mortality rates in children under the age of five, accounting for 50% of malaria deaths in Uganda. Malaria remains the most serious disease in Uganda, causing significant morbidity, mortality, and a negative socioeconomic impact. Children under the age of five are particularly vulnerable due to a lack of immunity to the disease. Malaria is estimated to account for 30-50% of outpatient visits, 15-20% of admissions, and 19-14% of inpatient mortality, according to hospital records [30]. Malaria-related mortality in children under the age of five typically exceeds 10% and rises with age. Coma, anemia, convulsions, acidosis, respiratory distress, hypoglycemia, hyperpyrexia, increased concentrations of lactate in

blood and cerebrospinal fluid, and increased concentrations of tumor necrosis factor have all been identified as risk factors for death in severe childhood malaria [31, 32]. Many interventions have been made by the international community. However, this study focuses on the Prevalence and Factors Associated with Severe Malaria in Children under 5 Years of Age at Fort Portal Regional Referral Hospital, Western Uganda.

METHODOLOGY

Study Design

This is a cross-sectional, descriptive, and analytical study conducted at Fort Portal Regional Referral Hospital to assess the prevalence, socio-demographic, and risk factors associated with severe malaria in children under the age of five years.

Area of Study

The study was conducted at the Pediatric ward of Fort Portal Regional Referral Hospital, located about 180 km northwest of Mbarara, the largest city in the western region. This is approximately 297 km by road west of Kampala, Uganda's largest and capital city, on a tarmac two-lane highway. Fort Portal is the main town of the Tooro kingdom in the Kabarole district. The district is bordered by the Ntoroko district to the north, Kibaale district to the northeast, Kyenjojo district to the east, Kamwenge district to the southeast, Bunyangabo district to the south, and the Democratic Republic of Congo to the southwest. FRRH is a public hospital funded by the Uganda Ministry of Health, and general care in the hospital is provided free of charge.

Study Population

The study population was children less than five years old who were admitted to the pediatric ward of Fort Portal Regional Referral Hospital.

Inclusion Criteria

- A child below 5 years of age admitted at the pediatric ward of Fort Portal Regional Referral Hospital.
- A caregiver who consented to participate in the study.

Exclusion Criteria

i. A child below 5 years of age was admitted at the pediatric ward but died on admission.
ii. A child admitted with severe malaria but above 5 years of age.

Sample Size Determination

The sample size was determined using the Kish-Leslie (1965) formula[33]:

$n = z^2p\ (1-p) / E^2$;

Where;

n = Estimated minimum sample size required

P = Proportion of 75% prevalence of severe malaria in children less than five years in sub-Sahara according to WHO (2015).

Z = 1.96 (for 95% Confidence Interval)

E = Margin of error set at 5%

n = 1.962 x 0.75(1 – 0.75) / 0.052

n = 288

Sampling Procedure

All children under the age of five who matched the inclusion criteria were enrolled until the target sample size is reached.

Data Collection Method

In this study, I utilized caregivers of children who had severe malaria. Structured questionnaires were used to interview caregivers of children with severe malaria. The majority of the questions were open-ended and closed-ended. Data on caregivers as well as children with severe malaria were collected. The questionnaire offered a wide range of responses from which respondents chose. The questionnaire was designed to capture demographic information on caregivers and their children, including other healthcare system and household factors. Caregivers of children with severe malaria were interviewed on the day of admission or the next day when the child's health had stabilized. Trained research assistants administered the questionnaires.

Data Analysis

Following the completion of data gathering, the data was input into SPSS version 20 for analysis. Each independent variable was evaluated in a univariate form in a tabular form, then the independent variables were compared with the dependent variable in a bivariate form, then multivariate, and this served as the basis for making a conclusion in this research.

Quality Control Measures

The study protocol, questionnaire, informed consent process, and other study procedures were taught to select Research Assistants. The accuracy, consistency, and completeness of completed questionnaires were evaluated on a daily basis.

Ethical Consideration

Ethical approval was obtained from KIU IREC and FRRH. The study proposal was forwarded to the FRRH Department of Pediatrics for review and approval, to seek permission before beginning the study. Participants were asked to provide written informed consent. They were also able to ask the investigator any questions they had about the study, and the investigator responded. Participants had the option to decline participation or withdraw consent at any point during the study. Therefore, participation in the study was completely voluntary.

RESULTS

Socio-Demographic Findings

Table 1: Socio-demographic factors of the study participants

Variable	Frequency (n)	Percentage (%)
Age of the child		
Below 2 years	112	38.9
Above 2 years	176	61.1
Sex of a child		
Male	135	46.9
Female	153	53.1
Occupation of the caregiver		
Peasant farmer	201	69.8
Not a farmer	87	30.2
Education level of the caregiver		
None	127	44.1
Primary	107	37.2
Secondary	36	12.5
Tertiary	18	6.2

Table 1 above shows that the majority of the children were females and aged above 2 years. As most of the caregivers were, farmers and many of them were uneducated.

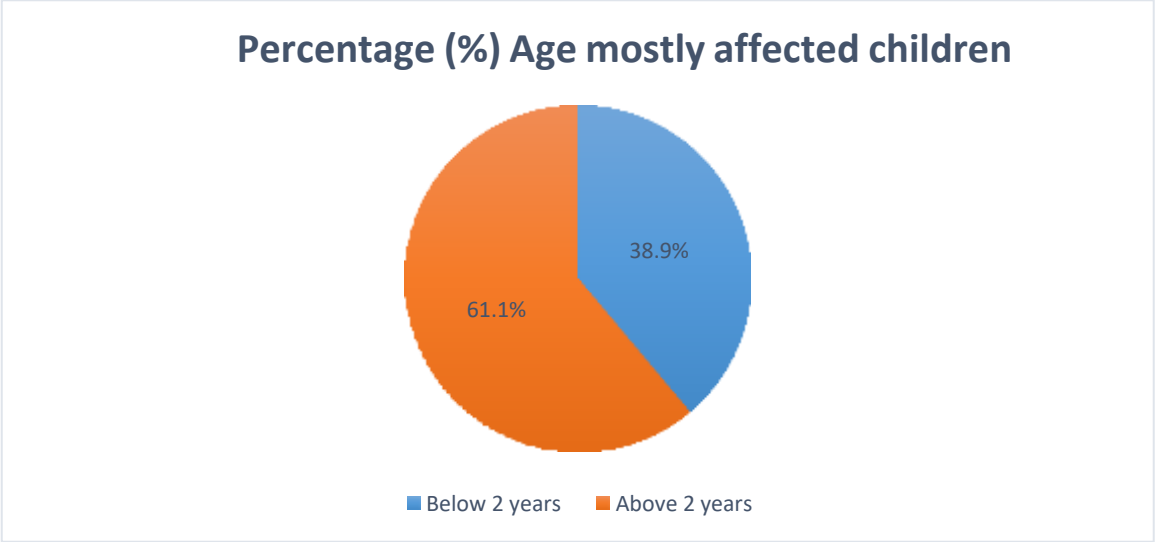

Figure 1: Percentage age mostly affected cheildren

Prevalence of Severe Malaria among Children Under FiveYears at FRRH

Table 2: Malaria status of children admitted at FRRH

Results of malaria bloodsmear	Frequency (n)	Percentage (%)
Severe malaria	188	65.3
Not severe malaria	100	34.7

Table 2 above shows that out of the 288 children admitted to the pediatric ward at FRRH in the study, 188 (65.3%) had severe malaria.

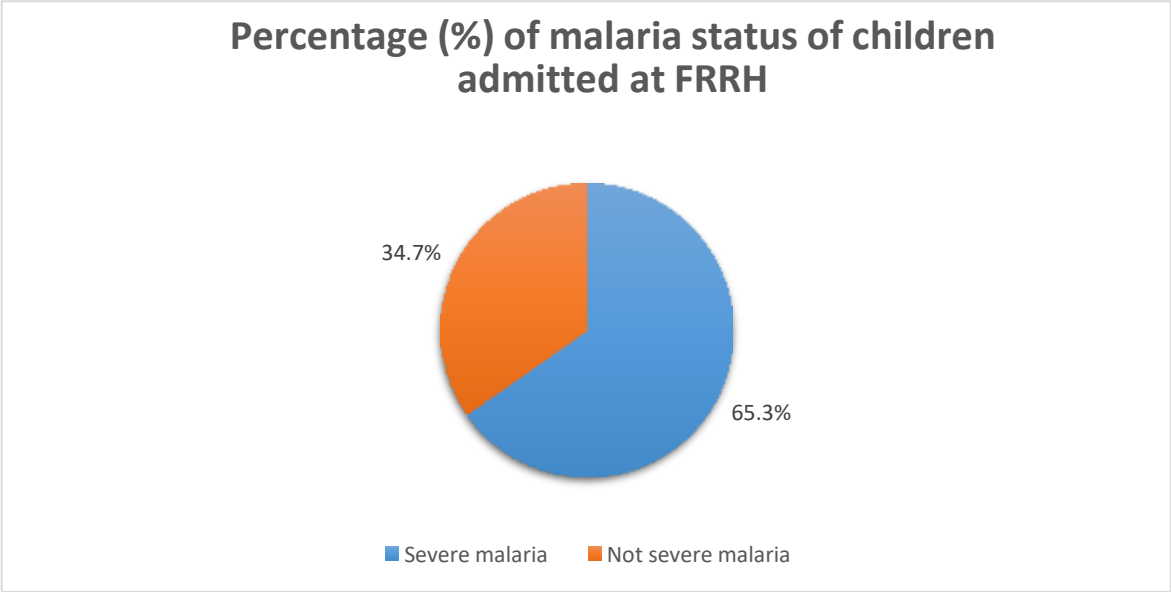

Figure 2: Showing percentage of malaria status of children admitted at FRRH

Socio-Demographic Factors Associated with Severe Malaria inChildren Under Five Years Admitted on Pediatric Ward at FRRH.

Bivariate analysis using the Chi-square

Table 3: Results of Bivariate Analysis for Socio-demographic factors.

Variable	Severe n (%)	Not severe n (%)	Un adjusted OR (95% CI)	P-value
Age of the child				
Above 2 years	79(70.5)	33(29.5)	2.1 (1.15-3.93)	**0.015**
Below 2 years	111 (63.1)	67 (26.9)	1.0	
Sex of a child				
Male	115 (85.2)	20(14.8)	1.0	
Female	73 (47.7)	80 (52.3)	3.8(0.82-17.54)	0.087
Occupation of the caregiver				
Peasant farmer	116 (57.7)	84 (42.3)	1.0	
Not a farmer	71 (81.6)	16 (18.4)	1.0 (0.49-2.08)	0.976
The education level of the caregiver				
No	81(63.8)	46(36.2)		
primary	61(57.0)	46(43.0)	3.00(0.62-14.45)	0.172
Secondary	31(86.1)	5(13.9)	2.67(0.57-12.47)	0.214
Tertiary	15(83.3)	3(16.7)	2.68(0.53-13.54)	0.232

From Table 3 above only the child's age and sex, age had P-values <0.2 thus taken for themultivariate analysis.

Multivariate Binary Logistic Regression of Socio-Demographic Factors Associated with Severe Malaria Among the Study Participants.

Table 4: Multivariate binary logistic regression of socio-demographic factors associated withsevere malaria among the study participants.

Variable	Adjusted OR (95% CI)	P-value
Age of the child		
Above 2 years	2.0 (1.07-3.74)	**0.030**
Below 2 years	1.0	
Sex of a child		
Female	1.84(0.97-3.50)	0.063
Male	1.0	

Following multivariate analysis, being a child above 2 years was significantly associated with severe malaria (P-value ≤ 0.05). The odds of having severe malaria were two-fold higher among children aged above 2 years as compared to those below 2years.

Household Factors Associated with Severe Malaria in Children Less than Five Years Admitted On Pediatric Ward at FRRH.

Table 5: Results of Bivariate analysis for household factors using the Chi-square test (Bivariate analysis).

Variable	severe	Not	Un adjusted OR	P-value	n (%) severe (95% CI)	n (%)
Household size						
Below 5 in number	80(80.0)	20(20.0)	3.4 (0.67-17.09)	0.142		
Above 5 in number	108(57.4)	80(42.6)	1.0			
Do you have mosquito nets at home?						
Yes	37 (32.5)	77(67.5)	1.0			
No	121 (78.6)	33 (22.2)	1.5 (0.78-2.78)	0.233		
Number of under-five children at home						
One child	87 (56.1)	55 (43.9)	1.0			
2 or more children	101 (69.2)	45 (30.1)	1.7 (0.72-4.05)		0.219	
Type of family						
Polygamous	143 (88.6)	21 (14.4)	1.00			
Monogamous	45 (36.3)	79 (63.7)	3.6 (0.82-15.89)		0.091	
Materials used on walls of your house						
Wattle and mud	97 (68.8)	44 (31.2)	1.00			
Wood	43 (70.5)	18(29.5)	1.1 (0.39-3.25)		0.814	
Sand and bricks	48 (55.8)	38 (44.2)	1.5 (0.47-4.91)		0.490	

In the Bivariate analysis in Table 5 above household size and type of family had P-values <0.2 thus takenfor the multivariate analysis.

Multivariate Binary Logistic Regression: Household Factors Associated with Severe Malaria Among the Study Participants.

Table 6: Model one of multivariate binary logistic regression: Household factors associated withsevere malaria among the study participants.

Variable	Adjusted OR (95% CI)	P-value
Household size		
Below 5 in number	1.80(0.56-5.76)	0.320
Above 5 in number	1.00	
Type of family		
Polygamous	1.00	0.172
Monogamous	3.00(0.62-14.45)	

From Table 6 above, both household size and type of family were not statistically significant inrelation to severe malaria since both P-values > 0.05.

Health-Related Factors Associated with Severe Malaria in Children Under Five Years Admitted On Pediatric Ward at FRHH.

Table 7: Results of Bivariate Analysis for Health-related factors using the Chi-square test (Bivariate analysis).

Variable	Severen (%)	Not severen (%)	Unadjusted OR(95% CI)	P-value
Community Health facility				
yes	103 (79.2)	27 (20.8)	1.0	
no	85(53.4)	73 (46.6)	1.0 (0.36-2.85)	0.973
Distance from home to the health facility				
2-5 kilometers	60 (49.8)	63 (51.2)	4.0 (1.64-9.83) 1.0	**0.002**
1 kilometer	93 (76.9)	28 (23.1)	2.0 (1.02-3.93)	
> 5 kilometers	35 (91.3)	9 (8.7)		**0.043**
Means of transport to hospital				
Foot	66 (54.1)	56 (45.9)	1.0	
Bicycle	11 (40.7)	16 (59.3)	1.4 (0.29-6.88)	0.664
Boda Boda	90(81.8)	20(18.2)	2.2(0.201-1.170)	0.207
Motor car	21(72.4)	8(27.6)	0.8 (0.278-2.409)	0.715
Medication is given to a child whenidentifies sickness				
no medication given	101(65.2)	54(34.8)	1.00	
local herbs	37(52.1)	34(47.9)	0.86 (0.32-2.34)	0.755
medication from drug shops/pharmacy	50(80.6)	12(19.4)	0.84 (0.29-2.42)	0.743
Waiting time before taking achild to hospital				
Within one day				
After one day	79 (81.4)	18 (18.6)	1.6(0.126-1.00)	**0.150**
	109 (57.1)	82 (42.9)	1.0	
Time is taken to see a health worker at the hospital				
with1 hour	53(71.3)	27(29.7)	0.63 (0.18-2.24)	0.472
with 2 hours	77(67.0)	38(33.0)	0.74 (0.45-1.24)	0.261
> 3 hours	58(62.4)	35(37.6)	1.00	
Getting all medication when at the health facility				
Within one day				
After one day	60(84.5)	11(15.5)	0.93 (0.53-1.62)	0.790
	128(59.0)	89(31.0)	1.00	

From Table 7 above distance from home to the health facility and waiting time before taking achild to the hospital had P-values <0.2 and thus taken for the multivariate analysis.

Multivariate binary logistic regression: Health-related factors associated with severe malaria among the study participants.

Table 8: Final model of multivariate binary logistic regression: Health-related factors associatedwith severe malaria among the study participants.

Variable	Adjusted OR (95% CI)	P-value
Distance from home to thehealth facility		
2-5 kilometers	3.8 (1.51-9.56)	**0.005**
1 kilometer	1.0	**0.033**
> 5 kilometers	2.1 (1.06-4.27)	
Waiting time before taking achild to hospital		
Within one day	1.1 (0.37-2.98)	0.924
After one day	1.00	

According to Table 8 above, distance of 2-5 kilometres from home to the hospital and distance of greater than 5 kilometres from home to the hospital were significantly associated with severe malaria. The odds of having severe malaria were two-fold higher among children within 5 kilometres or greater from home to the hospital as compared to the distance of 1 kilometre from home to the hospital. In addition, the odds of having severe malaria were four-fold higher among children taking a distance of 2-5 kilometres from home to the hospital as compared to those taking a distance of 1 kilometre from home to the hospital.

DISCUSSION

Prevalence of Severe Malaria in Children Under Five Years of Age

In this study, the prevalence of severe malaria in children admitted to the pediatric ward at FRRH was 65.3%. Although the results of a study by Gaston et al. [34] and Zgambo et al. [35] showed that in Malawi, the prevalence of severe malaria among children under five had increased from 28% in 2012 to 33% in 2014, this study's prevalence of severe malaria among children under five is higher. Therefore, Mpimbaza et al. [36] shows that malaria continues to contribute to 20-30% of all pediatric admissions to hospitals across the country, and this study shows that 65.3% of these cases are severe. The national under-five malaria deaths might rise, threatening the achievement of SDGs in Uganda.

Association between Socio-Demographic Factors and Severe Malaria in Children Under Five Years of Age

In this study, a child's age was significantly associated with severe malaria, and the odds of having severe malaria were two-fold higher among children aged above 2 years compared to those below 2 years. A study done in Malawi by Zgambo et al. [35], and finally, a study conducted in Ghana by Mensah et al. [37], since in all these studies, older children were associated with a higher risk of malaria compared to younger ones. This could be a result of all these studies being done in developing countries in Africa. In addition, Mensah et al. [36] indicates that older children were associated with a higher risk of developing severe malaria due to the fact that older children move freely and can go outside more often at night, hence getting exposed to mosquito bites. In a study done by Zgambo et al. [35], mothers always sharing a bed with younger children and covering them well under mosquito nets was a reason for higher

risk of severe malaria in older children. However, the study's finding is inconsistent with a study done in Rwanda by Nyirakanani et al. [38], which showed that children who were 1 to 12 months were more associated with suffering from malaria compared to those aged 13 to 59 months. Therefore, the inconsistency could be a result of differences in the age groups used.

Household Factors Associated with Severe Malaria in Children under the Age of Five

Various studies have shown a significant association of household factors with severe malaria in children under five years of age, such as household size, the number of children less than five years old, type of family, availability of electricity, and availability of treated mosquito nets. However, this study found no household factors significantly associated with severe malaria.

Association between Health Facility Factors and Severe Malaria in Children Under Five Years of Age

According to this study, distance was significantly associated with severe malaria. The odds of having severe malaria were two-fold higher among children living within 5 kilometers or more from home to the hospital compared to a distance of 1 kilometer from home to the hospital. Also, the odds of having severe malaria were four-fold higher among children taking a distance of 2-5 kilometers from home to the hospital as compared to those taking a distance of 1 kilometer from home to the hospital [37, 38, 39, 40]. This is in line with a study done in Ghana, by Mensah et al. [37], which acknowledged that longer distances promote a preference for indigenous medicine, allowing mild forms of malaria to progress to severe forms of malaria [41,42,43]. Also, a study done in Sudan by Mensah et al. [37] showed similar findings. This could be because the choice of treatment for sick children among caregivers is highly dependent on the accessibility and availability of health facilities. Thus, longer distances to the nearest health facility are a risk factor for severemalaria.

CONCLUSION

Malaria remains a substantial burden on child health, particularly in sub-Saharan Africa. This study conducted at Fort Portal Regional Referral Hospital in Western Uganda revealed a high prevalence of severe malaria among under five children. The results indicate that age, distance to the health facility, and waiting time before seeking medical care play crucial roles in determining the severity of malaria cases. Older children are at higher risk, as are those living farther from healthcare facilities and those experiencing delays in receiving medical attention. To mitigate the impact of severe malaria in this region, efforts should focus on improving access to healthcare services, particularly for children in remote areas. Promoting early diagnosis and prompt treatment is essential to reduce the severity of malaria cases. Additionally, public health interventions targeting these risk factors, such as the distribution of mosquito nets, health education, and improved transportation infrastructure, are vital to combat severe malaria and reduce its devastating impact on the most vulnerable population—children under five.

Recommendations

Mothers and caregivers should be extremely careful with their children's health, especially children above 2 years (older children).

The government and potential health workers should consider availing health centers near people.

Academicians, researchers, and organizations should carry out more studies related to severe malaria in children under five years.

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