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# Prevalence, Factors Associated and Outcomes of Severe Malaria Anaemia Among Under Five Children Admitted With Severe Malaria at Kayunga Regional Referral Hospital

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**Research Article**

**Keywords:** Severe malarial anemia (SMA), Hemoglobin, Complete Blood Count, Giemsa Stain, Uganda

**Posted Date:** June 3rd, 2025

**DOI:** https://doi.org/10.21203/rs.3.rs-6710452/v1

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**Additional Declarations:** No competing interests reported.

## Abstract

# Background

Severe malarial anemia (SMA) is a major contributor to morbidity and mortality among children under five in malaria-endemic regions. This study aimed to determine the prevalence, associated factors, and Outcomes of SMA among children with severe malaria at Kayunga Regional Referral Hospital.

# Methods

A hospital-based mixed study design was conducted, enrolling 321 children aged 0–5 years with severe malaria. Data were collected through structured questionnaires, clinical evaluations, and laboratory tests. Prevalence and outcomes were calculated as percentages with 95% confidence intervals (CI), while logistic regression was used to identify factors associated with SMA.

# Results

The prevalence of SMA was 27.41% (95% CI: 22.79–32.58%). Significant predictors of SMA included age below two years (AOR = 2.57, p = 0.008), history of convulsions (AOR = 4.84, p < 0.001), splenomegaly (AOR = 2.58, p = 0.008), severe acute malnutrition (AOR = 4.40, p = 0.011), high parasitemia (+++; AOR = 8.91, p < 0.001), and delayed healthcare-seeking (AOR = 3.52, p < 0.001). Mortality was significantly higher in children with SMA (19.32%) compared to those without (0.45%, p < 0.001). Prolonged hospitalization (≥ 5 days) was more frequent in children with SMA (72.73%) than those without (19.73%, p < 0.001). Shock, hyperparasitemia (+++), and hypoglycemia were also significantly linked to increased mortality and extended hospital stays.

# Conclusions

SMA remains a significant burden among children with severe malaria, with younger age, clinical complications, and delayed healthcare-seeking as key risk factors. Early diagnosis, timely treatment, and integrated anemia management are essential to improving survival and reducing hospital stays.

## Background

Severe malarial anemia (SMA) is a major cause of morbidity and mortality in children under five, particularly in malaria-endemic regions like sub-Saharan Africa( India. & Jokhi, 2018). The World Health Organization's 2020 Malaria Report highlighted an increase in global malaria cases from 227 million in 2019 to 241 million in 2020, with further growth to 247 million cases in 2022(2). Of the 85 malaria-endemic countries, 26 accounted for 96% of the global malaria burden. The WHO African Region,

particularly six high-burden countries—Nigeria, the Democratic Republic of Congo, Uganda, Mozambique, Angola, and Burkina Faso—was responsible for approximately 55% of malaria-related deaths in 2020 (3).

It results from Plasmodium falciparum infection, with contributing factors such as delayed healthcare-seeking behavior, self-medication, malnutrition, and coexisting infections (4). Delays in seeking timely medical care increase the severity of malaria and are associated with poorer outcomes, including complications like pulmonary edema and metabolic acidosis. Self-medication is common in resource-limited settings, where misdiagnosis and misuse of anti-malarial drugs can lead to Severe Malarial Anemia and complications, further exacerbating the condition (5). Malnutrition, particularly iron deficiency, impairs immunity and worsens malaria outcomes (6).

SMA is characterized by dangerously low hemoglobin levels due to red blood cell destruction caused by the malaria parasite and it is often associated with high mortality rates and long-term health consequences, including cognitive and developmental impairments (7). In endemic regions, up to 20% of children with severe malaria present with SMA (WHO, 2023). Studies in East Africa, such as those in Kenya and Uganda, highlight the significant impact of SMA, driven by high malaria transmission, nutritional deficiencies, and inadequate healthcare access (8), (9). The prevalence of SMA remains alarmingly high, with studies showing correlations between parasitemia and anemia in hospitalized children (10).

The SMA outcomes, particularly in children under five, face increased risks of mortality and long-term developmental challenges (11). In Uganda, a high percentage of children under five are affected by anemia, with SMA carrying a higher mortality risk compared to other forms of severe pediatric anemia (12) (13). Given the severe burden of SMA (14), this study aims to explore the prevalence, associated factors, and outcomes of severe malaria anemia in children.

# Materials and Methods

### Study design and setting

This study utilized a hospital-based mixed study design was conducted at the pediatric ward of Kayunga Regional Referral Hospital, located in Kayunga District, Uganda. The hospital serves as a referral center for the district and surrounding areas, which experience a high malaria burden. The hospital is equipped with a laboratory capable of performing necessary investigations, such as complete blood counts and malaria diagnostics. On average, the pediatric ward admits approximately 100 children with severe malaria per month, providing a suitable setting for this research. Participants were enrolled at the time of admission and followed through hospitalization until discharge or death, enabling longitudinal tracking of severe malaria anemia and outcomes. Concurrently, cross-sectional data collection at enrollment captured sociodemographic and clinical characteristics, providing a comprehensive snapshot of the prevalence and associated factors of severe malaria anemia.

# Participants

Children aged 0 to 59 months with a positive blood smear for P. falciparum with clinico-laboratory finding of severe malaria were included, provided parental consent was obtained. Children with known hematological disorders, such as sickle cell disease, were excluded from the study.

## Study duration

This study was conducted from November 2024 to February 2025

## Variables and data sources

Data was collected using an interviewer-administered questionnaire. As a principal investigator, i met with the targeted respondents who took part in the study after obtaining permission for data collection from them. Each participant was required to give informed consent before enrolling in the study. The researcher assisted the respondents in filling out the questionnaires by explaining to them for clarification. The properly filled questionnaires were then collected, and data was taken for analysis. The researcher used a structured questionnaire, and participants were asked similar questions, and from the options, they picked the best alternative

Laboratory investigations were conducted to assess malaria parasitemia through thick and thin blood films prepared from a finger prick. Slides were Giemsa-stained and examined under oil immersion at 1000x magnification. Asexual malaria parasites were counted in a thick blood smear stained with Giemsa under a light microscope at 1000x as follows: 0 = no parasites; 1 + = 1–10 parasites per 100 microscopic fields; 2 + = 11–100 parasites per 100 fields; 3 + = 1–10 parasites per field; (World Health Organization 1991). A complete blood count (CBC) was performed using the Sysmex Hematology Analyzer (XN-1000, Sysmex, Kobe, Japan) to evaluate anemia, thrombocytopenia, and abnormal leucocyte counts. severe anaemia was taken to be a haemoglobin concentration of < 5.0 g/dl. Severe malarial anaemia was defined as a haemoglobin concentration of this level in a patient who had a positive malaria smear.. Thrombocytopenia was classified as a platelet count of < 150,000/μL. The WHO severe malaria criteria define renal impairment or AKI was defined as as creatinine > 3 mg/dL for both adults and children.2 Normal ranges for creatinine in adults range from 0.5–1.0 mg/dL in women and 0.7–1.2 mg/dL in men.

**Sample size calculation**: the sample size was calculated using Daniel's formula: $\varvec{n} = \frac{\varvec{z}^2\varvec{p}\varvec{q}}{\varvec{d}^2}$ Using findings from a prospective study in eastern Uganda, where 25.5% of patients had severe malaria anemia (Cate Namayanja et al., 2023), P = 0.255, q = 1-0.255, d = 0.05 and Z = 1.96 for 95% level of significance. Substituting, n=**292**. Adding 10% to account for potential loss to follow-up: $Final\ Sample\ Size = 292 + 29 = 321$

**Data analysis**

Data analysis for this study was performed using STATA software version 14.2, structured to address three primary objectives. The prevalence of children diagnosed with Severe Malarial Anemia was calculated as fraction of participants with Severe Malarial Anemia against all participants enrolled in the study and expressed as percentage. Binary logistic regression was utilized to document the odds ratios, p-values, and corresponding confidence intervals for factors associated with severe anemia. Variables with a p-value < 0.2 in bivariate analysis were included in the multivariable model. A p-value ≤ 0.05 was considered statistically significant at the multivariable level. The proportion of participants experiencing Outcomes (e.g., mortality or prolonged hospital stay) was calculated and expressed as percentages. The statistical uncertainty of these estimates was quantified using 95% Confidence Intervals (CIs). Tables summarizing the fractions and their CIs were generated, complemented by bar charts or pie charts for clear visualization of findings.

## RESULTS

# Characteristics of study Participants

A total of 344 children under five years of age presenting with severe malarial anaemia were assessed for eligibility at Kayunga Regional Referral Hospital. Among these, eight children with sickle cell disease (SCD) were excluded and received routine care. Of the remaining 336 eligible participants, caregivers of 15 children did not provide informed consent, leaving 321 children enrolled in the study. Comprehensive assessments were conducted to identify factors associated with severe malarial anaemia. During hospitalization, follow-up was completed for 311 children, while 10 participants were lost to follow-up—two were referred to other facilities, and eight were discharged by their caregivers against medical advice. Clinical outcomes, including vitality status at discharge, were documented for the 311 children who completed the follow-up.

# Prevalence of Severe Malarial Anemia Among Children with Severe Malaria

Among the 321 participants, 88 (27.41%) were diagnosed with severe anemia. The 95% confidence interval (CI) for this proportion was calculated as 22.79–32.58%, indicating that there is a 95% probability that the true prevalence of Severe Malarial Anemia in the population lies within these boundaries (Fig. 1).

## Descriptive Statistics

# Sociodemographic Characteristics of the Study Participants

This study analysed 321 children admitted with severe malaria, focusing on their sociodemographic characteristics.

Most participants were children above 2 years (58.88%), with a nearly equal distribution between male (47.66%) and female (52.34%) participants. The majority of caregivers were 25–34 years old (47.35%), with primary education (42.37%), and engaged in informal employment (44.86%). Most families resided in rural areas (59.50%), and 43.61% had a low monthly income of less than 250,000 UGX. The details are summarized in Table 1.

# Medical and clinical Characteristics of the Study Participants

A significant proportion of participants (35.20%) reported delayed healthcare-seeking, while 26.79% practiced self-medication before hospital admission. Difficulty in breathing (11.84%), convulsions (18.38%), and colored urine (37.69%) were commonly reported clinical features. Malnutrition was present in 28.04% of participants, with 19.63% having moderate acute malnutrition (MAM) and 8.41% classified as severe acute malnutrition (SAM). Dehydration was observed in 53.27%, while shock was rare (0.93%). splenomegaly were noted in 28.97% of participants, respectively. Parasitemia levels varied, with 66.04% having low parasitemia (+), 22.43% moderate (++), and 11.53% high parasitemia (+++) (Table 2).

# Factors Associated with Severe Malarial Anemia (Sociodemographic Variables)

The bivariate analysis of sociodemographic factors associated with severe anaemia are represented. Crude odds ratios (cOR) with 95% confidence intervals (CI) were calculated to assess these associations. Children under 2 years (37.12%) with a cOR of 2.27 ($p = 0.001$). Male children (34.64%) than females (20.83%), with a cOR of 1.99 ($p = 0.009$). Children in rural (32.46%), with a cOR of 1.92 ($p = 0.014$) ( Table 3).

# Factors Associated with Severe Malarial Anemia (Clinical Variables)

The bivariate analysis of clinical factors associated with Severe Malarial Anemia among study participants were illustrated. Crude odds ratios (OR) with 95% confidence intervals (CI) were calculated to evaluate the strength of associations.

Delay in seeking healthcare (43.36%), with an cOR of 3.32 ($p < 0.001$). Self-medication (44.19%), with an OR of 2.93 ($p < 0.001$). A history of convulsions (49.15%)), with an cOR of 3.33 ($p < 0.001$). Difficulty in breathing (DIB (), with an cOR of ($p = 0.165$). Dark-colored (33.88%) cOR of 1.67 ($p = 0.045$). Hepatomegaly (37.18%), with an cOR of 1.85 ($p = 0.027$). Splenomegaly (48.39%), with an OR of 4.03 ($p < 0.001$). Nutritional status (59.26%), with an OR of 5.27 ($p < 0.001$). Moderate Acute Malnutrition (MAM) , (34.92%), with an OR of 1.94 ($p = 0.032$). Higher parasitemia levels (+++) (52.78%), with an OR of 5.85 ($p < 0.001$), and those with parasitemia (++) ,(43.24%) with an OR of 3.99 ($p < 0.001$). Shock (), with a p-

value of < 0.001. Reduced urine output (43.90%), with an OR of 2.35 (p = 0.013). Dehydration (32.75%), with an OR of 1.80 (p = 0.023) ( Table 4).

# Multivariate Analysis of Factors Associated with Severe Anemia

In this analysis, several factors were examined for their association with the outcome, with adjusted odds ratios (aOR) presented along with corresponding p-values.

The age of the child (aOR = 2.57, p = 0.008). The caregiver's level of education those with no formal education (aOR = 3.20, p = 0.039). Delay in seeking healthcare (aOR = 3.52, p < 0.001). Self-medication (aOR = 2.76, p = 0.006). History of convulsions (aOR = 4.84, p < 0.001). Dark-colored urine (aOR = 1.10, p = 0.792). Splenomegaly (aOR = 2.58, p = 0.008).

Nutritional status For MAM, (aOR = 2.57, p = 0.027), and for SAM, aOR = 4.40, p = 0.011). Dehydration (aOR = 2.87, p = 0.005). Parasitemia levels for those with parasitemia (+++) (aOR = 8.91, p < 0.001). Similarly, (++), aOR4.74 (1.77–12.68), **p = 0.002 (Table 6)**.

# Outcomes of Severe Malaria and Associated Complications

# Frequency Distribution of Mortality and Length of Stay

After losing to follow up 10 participants from the original cohort (n = 321), the outcomes were assessed in 311 participants. 293 children (94.21%) were discharged alive, whereas 18 (5.79%) died during hospitalization. Regarding hospital stay duration, 203 children (65.27%) were hospitalized for less than 5 days, and 108 children (34.73%) remained hospitalized for 5 or more days.

The mortality rate (5.79%) highlights the severity of malaria among hospitalized children. Similarly, approximately one-third of the patients required prolonged hospitalization, emphasizing the extended burden on healthcare resources

Table 1
Sociodemographic Characteristics of Study Participants (N = 321)

| Characteristic | Frequency (n) | Percentage (%) |
|---|---|---|
| **Age of Child** | | |
| Below 2 years | 132 | 41.12 |
| 2 years and above | 189 | 58.88 |
| **Age of Caregiver** | | |
| Below 25 years | 87 | 27.10 |
| 25–34 years | 152 | 47.35 |
| 35 years and above | 82 | 25.55 |
| **Sex of Child** | | |
| Male | 153 | 47.66 |
| Female | 168 | 52.34 |
| **Residential Area** | | |
| Urban | 130 | 40.50 |
| Rural | 191 | 59.50 |
| **Level of Education of Caregiver** | | |
| No formal education | 70 | 21.81 |
| Primary | 136 | 42.37 |
| Secondary | 62 | 19.31 |
| Tertiary | 53 | 16.51 |
| **Occupation of Caregiver** | | |
| Unemployed | 114 | 35.51 |
| Informal employment | 144 | 44.86 |
| Formal employment | 63 | 19.63 |
| **Monthly Family Income** | | |
| Low income (< 250,000 UGX) | 140 | 43.61 |
| Middle income (250,000–450,000 UGX) | 119 | 37.07 |
| High income (> 450,000 UGX) | 62 | 19.31 |

Table 2
Clinical Characteristics of Study Participants (N = 321)

| Characteristic | Frequency (n) | Percentage (%) |
|---|---|---|
| **Delay in Seeking Healthcare** | | |
| Yes | 113 | 35.20 |
| No | 208 | 64.80 |
| **Self-Medication Use** | | |
| Yes | 86 | 26.79 |
| No | 235 | 73.21 |
| **History of Convulsions** | | |
| Yes | 59 | 18.38 |
| No | 262 | 81.62 |
| **Difficulty in Breathing (DIB)** | | |
| Yes | 38 | 11.84 |
| No | 283 | 88.16 |
| **Colored Urine** | | |
| Yes | 121 | 37.69 |
| No | 200 | 62.31 |
| **Presence of Fever** | | |
| Yes | 200 | 62.31 |
| No | 121 | 37.69 |
| **Nutritional Status** | | |
| Normal | 231 | 71.96 |
| Moderate Acute Malnutrition (MAM) | 63 | 19.63 |
| Severe Acute Malnutrition (SAM) | 27 | 8.41 |
| **Presence of Shock** | | |
| Yes | 3 | 0.93 |
| No | 318 | 99.07 |
| **Level of Consciousness** | | |
| Impaired | 19 | 5.92 |

| Characteristic | Frequency (n) | Percentage (%) |
|---|---|---|
| Normal | 302 | 94.08 |
| **Prostration** | | |
| Yes | 229 | 71.34 |
| No | 92 | 28.66 |
| **Hepatomegaly** | | |
| Yes | 78 | 24.30 |
| No | 243 | 75.70 |
| **Splenomegaly** | | |
| Yes | 93 | 28.97 |
| No | 228 | 71.03 |
| **Parasitemia Levels** | | |
| + | 212 | 66.04 |
| +++ | 72 | 22.43 |
| ++ | 37 | 11.53 |

Table 3
Bivariate Analysis of Sociodemographic Factors Associated with Severe Malarial Anemia (N = 321)

| Characteristic | No Severe Malarial Anemia n (%) | Severe Malarial Anemia n (%) | cOR (95% CI) | p-value |
|---|---|---|---|---|
| **Age of Child** | | | | |
| < 2 years | 83 (62.88) | 49 (37.12) | 2.27 (1.38–3.74) | **0.001** |
| ≥ 2 years | 150 (79.37) | 39 (20.63) | Ref | |
| **Sex of Child** | | | | |
| Male | 100 (65.36) | 53 (34.64) | 1.99 (1.19–3.31) | **0.009** |
| Female | 133 (79.17) | 35 (20.83) | Ref | |
| **Residential Area** | | | | |
| Urban | 104 (80.00) | 26 (20.00) | Ref | |
| Rural | 129 (67.54) | 62 (32.46) | 1.92 (1.14–3.25) | **0.014** |
| **Age of Caregiver** | | | | |
| < 25 years | 60 (68.97) | 27 (31.03) | 1.67 (0.69–3.50) | 0.204 |
| 25–34 years | 109 (71.71) | 43 (28.29) | 1.49 (0.75–2.96) | 0.252 |
| ≥ 35 years | 64 (78.05) | 18 (21.95) | Ref | |
| **Education Level of Caregiver** | | | | |
| No formal education | 46 (65.71) | 24 (34.29) | 2.24 (0.96–5.23) | **0.061** |
| Primary | 98 (72.06) | 38 (27.94) | 1.67 (0.76–3.65) | 0.201 |
| Secondary | 46 (74.19) | 16 (25.81) | 1.50 (0.61–3.65) | 0.377 |
| Tertiary | 43 (81.13) | 10 (18.87) | Ref | |
| **Occupation Type** | | | | |
| Unemployed | 79 (69.30) | 35 (30.70) | 1.13 (0.64–2.00) | 0.674 |
| Informal employment | 110 (76.39) | 34 (23.61) | 0.81 (0.47–1.41) | 0.450 |

| Characteristic | No Severe Malarial Anemia n (%) | Severe Malarial Anemia n (%) | cOR (95% CI) | p-value |
|---|---|---|---|---|
| Formal employment | 44 (69.84) | 19 (30.16) | Ref | |
| **Monthly Family Income** | | | | |
| < 250,000 UGX | 102 (72.86) | 38 (27.14) | 1.03 (0.58–1.81) | 0.911 |
| 250,000–450,000 UGX | 86 (72.27) | 33 (27.73) | 1.06 (0.58–1.95) | 0.850 |
| > 450,000 UGX | 45 (72.58) | 17 (27.42) | Ref | |

Table 4
Bivariate Analysis of Clinical Factors Associated with Severe Malarial Anemia (N = 321)

| Characteristic | Frequency (n) | Percentage (%) |
|---|---|---|
| **Delay in Seeking Healthcare** | | |
| Yes | 113 | 35.20 |
| No | 208 | 64.80 |
| **Self-Medication Use** | | |
| Yes | 86 | 26.79 |
| No | 235 | 73.21 |
| **History of Convulsions** | | |
| Yes | 59 | 18.38 |
| No | 262 | 81.62 |
| **Difficulty in Breathing (DIB)** | | |
| Yes | 38 | 11.84 |
| No | 283 | 88.16 |
| **Colored Urine** | | |
| Yes | 121 | 37.69 |
| No | 200 | 62.31 |
| **Presence of Fever** | | |
| Yes | 200 | 62.31 |
| No | 121 | 37.69 |
| **Nutritional Status** | | |
| Normal | 231 | 71.96 |
| Moderate Acute Malnutrition (MAM) | 63 | 19.63 |
| Severe Acute Malnutrition (SAM) | 27 | 8.41 |
| **Presence of Shock** | | |
| Yes | 3 | 0.93 |
| No | 318 | 99.07 |
| **Level of Consciousness** | | |

| Characteristic | Frequency (n) | Percentage (%) |
|---|---|---|
| Impaired | 19 | 5.92 |
| Normal | 302 | 94.08 |
| **Prostration** | | |
| Yes | 229 | 71.34 |
| No | 92 | 28.66 |
| **Reduced urine output** | | |
| Yes | 41 | 12.7 |
| No | 280 | 87.2 |
| **Renal Impairment** | | |
| Yes | 15 | 36.5 |
| No | 26 | 63.5 |
| **Hepatomegaly** | | |
| Yes | 78 | 24.30 |
| No | 243 | 75.70 |
| **Splenomegaly** | | |
| Yes | 93 | 28.97 |
| No | 228 | 71.03 |
| **Parasitemia Levels** | | |
| + | 212 | 66.04 |
| +++ | 72 | 22.43 |
| ++ | 37 | 11.53 |

# *p < 0.2, Ref: Reference category, OR: Odds Ratio, CI: Confidence Interval

Table 5
Bivariate Analysis of Clinical Factors Associated with Severe Malarial Anemia (N = 321)

| Characteristic | No Severe Malarial Anemia n (%) | Severe Malarial Anemia n (%) | OR (95% CI) | p-value |
|---|---|---|---|---|
| **Delay in Seeking Healthcare** | | | | |
| Yes | 64 (56.64) | 49 (43.36) | 3.32 (1.99–5.52) | **< 0.001*** |
| No | 169 (81.25) | 39 (18.75) | Ref | |
| **Self-Medication** | | | | |
| Yes | 48 (55.81) | 38 (44.19) | 2.93 (1.73–4.97) | **< 0.001*** |
| No | 185 (78.72) | 50 (21.28) | Ref | |
| **History of Convulsions** | | | | |
| Yes | 30 (50.85) | 29 (49.15) | 3.33 (1.85–5.98) | **< 0.001*** |
| No | 203 (77.48) | 59 (22.52) | Ref | |
| **Difficulty in Breathing (DIB)** | | | | |
| Yes | 24 (63.16) | 14 (36.84) | 1.65 (0.81–3.35) | **0.165*** |
| No | 209 (73.85) | 74 (26.15) | Ref | |
| **Dark Colored Urine** | | | | |
| Yes | 80 (66.12) | 41 (33.88) | 1.67 (1.01–2.75) | **0.045*** |
| No | 153 (76.50) | 47 (23.50) | Ref | |
| **Fever** | | | | |
| Yes | 143 (71.50) | 57 (28.50) | 1.15 (0.69–1.93) | 0.575 |
| No | 90 (74.38) | 31 (25.62) | Ref | |
| **Hepatomegaly** | | | | |
| Yes | 49 (62.82) | 29 (37.18) | 1.85 (1.07–3.18) | **0.027*** |
| No | 184 (75.72) | 59 (24.28) | Ref | |
| **Splenomegaly** | | | | |

| Characteristic | No Severe Malarial Anemia n (%) | Severe Malarial Anemia n (%) | OR (95% CI) | p-value |
|---|---|---|---|---|
| Yes | 48 (51.61) | 45 (48.39) | 4.03 (2.39–6.82) | **0.000*** |
| No | 185 (81.14) | 43 (18.86) | Ref | |
| **Nutritional Status** | | | | |
| Normal | 181 (78.35) | 50 (21.65) | Ref | |
| Moderate Acute Malnutrition (MAM) | 41 (65.08) | 22 (34.92) | 1.94 (1.06–3.56) | **0.032*** |
| Severe Acute Malnutrition (SAM) | 11 (40.74) | 16 (59.26) | 5.27 (2.30–12.06) | **< 0.001*** |
| **Parasitemia Levels** | | | | |
| + | 178 (83.96) | 34 (16.04) | Ref | |
| +++ | 34 (47.22) | 38 (52.78) | 5.85 (3.24–10.56) | **< 0.001*** |
| ++ | 21 (56.76) | 16 (43.24) | 3.99 (1.89–8.42) | **< 0.001*** |
| **Shock** | | | | |
| Yes | 0 (0.00) | 3 (100.00) | Perfect Prediction | < 0.001 |
| No | 233 (73.27) | 85 (26.73) | Ref | |
| **Reduced Urine Output** | | | | |
| Yes | 23 (56.10) | 18 (43.90) | 2.35 (1.20–4.60) | **0.013*** |
| No | 210 (75.00) | 70 (25.00) | Ref | |
| **Renal impairment** | | | | |
| Yes | 10(66.7%) | 5(33.3%) | 2.6(1.10–3.10) | **0.270** |
| No | 13(50%) | 13(50%) | Ref | |
| **Loss of Consciousness (LOC)** | | | | |
| Yes | 11 (57.89) | 8 (42.11) | 2.02 (0.63–6.55) | 0.238 |
| No | 222 (73.51) | 80 (26.49) | Ref | |
| **Prostration** | | | | |

| Characteristic | No Severe Malarial Anemia n (%) | Severe Malarial Anemia n (%) | OR (95% CI) | p-value |
|---|---|---|---|---|
| Yes | 167 (72.93) | 62 (27.07) | 0.94 (0.55–1.62) | 0.829 |
| No | 66 (71.74) | 26 (28.26) | Ref | |

*p < 0.2, Ref: Reference category, OR: Odds Ratio, CI: Confidence Interval

## Discussion

# Prevalence of Severe Malarial Anemia Among Children with Severe Malaria

The prevalence of Severe Malarial Anemia in this study was 27.41%, higher than other studies in Uganda and malaria-endemic regions. For instance, a study in Rakai, Uganda, reported 11%, attributed to intense malaria transmission and limited healthcare access (15). A study in Burkina Faso found 24.4%, linking delayed healthcare and nutritional deficiencies to malaria-related anemia(16) (Zeba et al., 2022). In contrast, a study in Mbale, Uganda, reported 52.7%, likely due to increased hemolysis, higher parasite loads, and a malaria epidemic (Namayanja et al., 2023). Regions with better malaria control measures, like northwestern Uganda, showed lower prevalence (6.7%) due to interventions like ITNs, early diagnosis, and community health initiatives (17). Variability in prevalence rates is influenced by diagnostic criteria, healthcare access, and malaria transmission intensity. This study highlights the need for early diagnosis, malaria prevention, anemia management, and standardized diagnostic criteria to improve outcomes and guide future research.

# Factors Associated with Severe Anemia

This study identified multiple factors associated with Severe Malarial Anemia in children with severe malaria, highlighting the interplay of sociodemographic, clinical, and health-seeking behaviors. Children under 2 years old had a 2.57 times higher risk of Severe Malarial Anemia due to immature immune systems and higher nutritional demands (15). Children with caregivers who had no formal education were three times more likely to develop severe anemia, emphasizing the role of delayed healthcare-seeking (18). Delayed healthcare-seeking increased the risk by 3.52 times, underlining the importance of early malaria diagnosis and treatment (16). Clinical factors like convulsions, hemoglobinuria, splenomegaly, and high parasitemia were significant predictors of Severe Malarial Anemia (19). Malnutrition, especially moderate-to-severe acute malnutrition, significantly increased the risk, as did dehydration and renal failure (16). The study emphasizes the need for early diagnosis, improved healthcare access, community education, and integrated malaria and anemia management. Interventions like insecticide-treated nets, seasonal malaria chemoprevention, and iron supplementation,

along with better early referral systems, are critical (16). Future research should explore long-term outcomes and genetic factors that influence susceptibility (2)

# Outcomes Associated with Severe Malaria

This study examined mortality and prolonged hospitalization among children with severe malaria, emphasizing the impact of malaria-related complications on these outcomes. The overall mortality rate was 5.79%, with 293 children (94.21%) discharged alive and 18 (5.79%) dying during hospitalization. Regarding the duration of hospitalization, 203 children (65.27%) were admitted for less than 5 days, while 108 (34.73%) remained hospitalized for 5 or more days. This aligns with studies in Burkina Faso and Zambia, where Severe Malarial Anemia was a major contributor to malaria-related deaths due to its role in exacerbating hypoxia, metabolic acidosis, and multi-organ dysfunction (16)(20). Severe Malarial Anemia compromises oxygen transport, increasing the risk of fatal outcomes, especially in critically ill children.

Prolonged hospitalization (≥ 5 days) was observed in 34.73% of the cohort. Among children with severe anemia, 72.73% required extended hospital stays compared to 19.73% of children without severe anemia. This finding aligns with previous research, which demonstrated that Severe Malarial Anemia significantly prolongs hospital stays due to the need for blood transfusions, nutritional rehabilitation, and close monitoring for malaria complications (20).

These findings underscore the systemic impact of severe anemia, hemolysis, and metabolic disturbances in prolonging recovery and increasing mortality risk. Strengthening early diagnostic and treatment strategies is critical for improving outcomes in children with severe malaria. Timely blood transfusions, fluid resuscitation, and nutritional support should be prioritized in hospital settings to minimize complications and shorten recovery times (17). Additionally, integrating routine anemia screening into malaria case management can help identify high-risk children early, allowing for proactive interventions to prevent Severe Malarial Anemia progression and reduce hospital stays (18)

Community-based interventions, such as insecticide-treated net (ITN) distribution, seasonal malaria chemoprevention (SMC), and education programs promoting early healthcare-seeking behaviors, are essential in preventing severe malaria and its complications (20) ). Future research should explore cost-effective strategies for integrating malaria and anemia management, ensuring better clinical outcomes for children in high-burden regions (16); (19); (2)

# Study Limitations

Data collection was conducted over a specific period, which may not account for seasonal variations in malaria transmission and associated anemia. Data on healthcare-seeking behavior and other variables were self-reported by caregivers, introducing the possibility of recall bias or social desirability bias, which may have affected the accuracy of the findings. The study did not account for severe malarial comorbidities that might influence LOS and Mortality.

## Conclusion

Severe Malarial Anemia was prevalent among children with severe malaria, highlighting its significant burden in endemic regions.

Key predictors included younger age, convulsions, splenomegaly, hemoglobinuria, delayed healthcare-seeking, dehydration, malnutrition, and high parasitemia, underscoring its multifactorial nature.

Severe Malarial Anemia was also linked to higher mortality and prolonged hospitalization, reinforcing the need for early diagnosis, timely transfusions, and integrated management strategies to improve outcomes and reduce malaria-related complications.

# Recommendations

To Strengthen malaria diagnostics, routine hemoglobin screening, and timely transfusions.

To Prioritize high-risk children and provide nutritional support

To Monitor trends, assess long-term outcomes, and evaluate adherence to treatment guidelines interventions.

To Enhance vector control (ITNs, IRS)

## Abbreviations

**ANC**: Antenatal Care

**AOR**: Adjusted Odds Ratio

**BS**: Blood Smear

**CBC**: Complete Blood Count

**CI**: Confidence Interval

**DIB**: Difficulty in Breathing

**DVD**: Digital Versatile Disc

**GS**: Giemsa Stain

**Hb**: Hemoglobin

**HIV**: Human Immunodeficiency Virus

**ITNs**: Insecticide-Treated Nets

**KRRH**: Kayunga Regional Referral Hospital

**LMICs**: Low and Middle-Income Countries

**LOS**: Length of Stay

**MAM**: Moderate Acute Malnutrition

**MUAC**: Mid-Upper Arm Circumference

**PI**: Principal Investigator

**REC**: Research Ethical Committee

**RDT**: Rapid Diagnostic Test

**RR**: Respiratory Rate

**SAM**: Severe Acute Malnutrition

**SMA**: Severe Malarial Anemia

**SOPs**: Standard Operating Procedures

**STATA**

**UNCST**: Uganda National Council for Science and Technology

**UGX**: Ugandan Shillings

**WHO**: World Health Organization

**WBC**: White Blood Cell

# Declarations

### Ethical Approval and Consent to participate

Ethics approval and consent to participate of the study was approved by Kampala International University - Research ethics committee (Ref no: KIU-2024-518)

### Consent for publication

Written informed consent was obtained from the patients for publication of this study.

### Availability of supporting data

Data can be obtained upon request from authors.

### Competing interests

The authors declare no competing interests.

### Funding

This research was not funded by any specific grant from public or non-Profit organizations but get some laboratory support from the Hospital of Kayunga and staff.

### Authors' contributions

**Abbas Hussein Musse** is the principal investigator, formulated and designed the study, collected data and wrote the draft of the manuscript. **Prof Ndeezi Grace, Dr. Kumbowi Kumbakulu Patrick, Elakey Walyeldin, And Dr. Kayina Vincent** supervised the study and approved the manuscript.

### Conflicts of interest

The authors declare that they have no conflicts of interest**.**

### Acknowledgment

The author extends sincere gratitude to the study participants, data collectors, supervisors, and the staff of the Kayunga RRH for their invaluable support in making this study a reality.

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## Figures

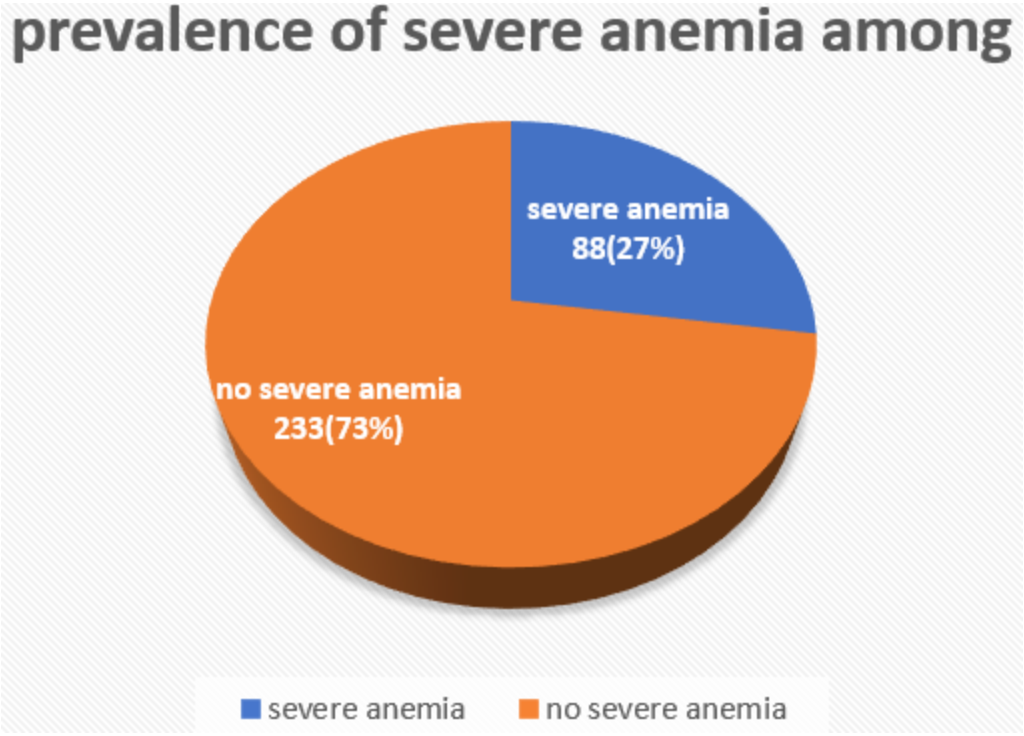



**Figure 1**

A pie chart showing the prevalence of Severe Malarial Anemia among study participants

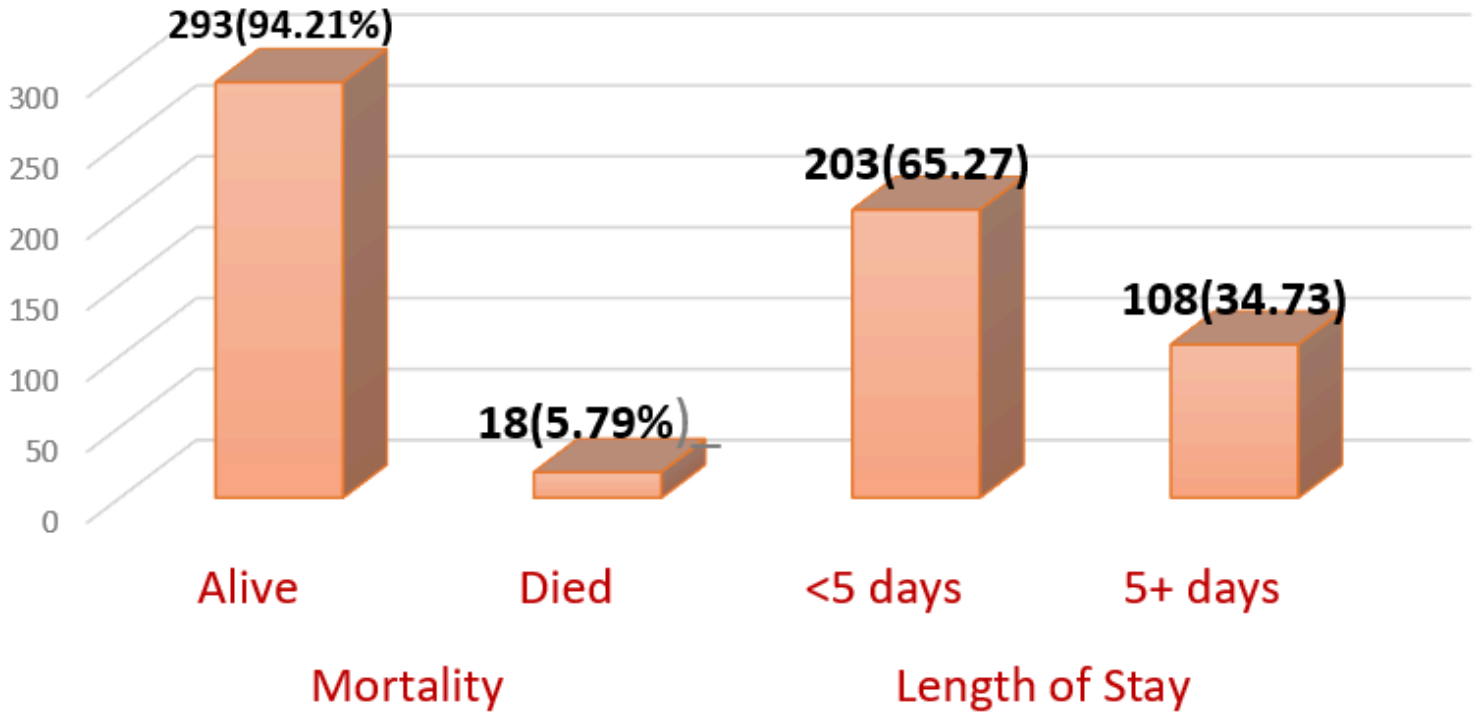



**Figure 2**

Figure 4: Outcomes of Severe Malaria Among Study Participants