

Short-Term Outcome and Associations of Mortality in Children Admitted with Severe Malaria in a Tertiary Health Facility, in South East, Nigeria

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Abstract

Background

Severe malaria remains a leading cause of childhood morbidity and mortality in sub-Saharan Africa. Despite global efforts to reduce the malaria burden, Nigeria continues to bear the highest burden of cases and deaths, particularly among children under five years. This study aimed to determine the short-term outcomes and identify the sociodemographic and clinical risk factors associated with mortality among children admitted with severe malaria at a tertiary hospital in South-East Nigeria.

Methods

A hospital-based retrospective cross sectional study was conducted, at the Imo State University Teaching Hospital from August 2019 to August 2024. Medical records of children aged 2 months to 12 years admitted with severe malaria were reviewed. Diagnosis was based on the 2015 WHO criteria for severe malaria. Data on sociodemographic characteristics, clinical presentations and outcomes were extracted and analyzed using SPSS version 23. Bivariate and multivariate analyses were performed to identify factors associated with mortality, with $p < 0.05$ considered statistically significant.

Results

Of 2,384 pediatric admissions, 434 (18.2%) met the inclusion criteria for severe malaria. The majority were under five years (63.4%), and the male-to-female ratio was 1.8:1. The overall mortality rate was 53 (12.2%). Mortality was significantly higher among children under five years 44 (83.0%), those residing in urban areas 41 (77.4%) and those presenting after more than five days of illness 43 (81.1%). The highest case fatality rates were observed in children presenting with shock 3 of 7 (42.9%), multiple convulsions 20 of 97 (20.6%), impaired consciousness 40 of 204 (19.6%) and respiratory distress 27 of 152 (17.8%). Independent predictors of mortality were, age < 5 years (OR = 3.17, 95%CI: 1.51–6.69), urban residence (OR = 2.60, 95%CI: 1.33–5.11), shock (OR = 2577.66, 95%CI: 11.78–424.00), impaired consciousness (OR = 4.07, 95%CI: 2.11–7.86), multiple convulsions (OR = 2.81, 95%CI: 1.30–4.40) and respiratory distress (OR = 2.13, 95%CI: 1.19–3.80).

Conclusion

Severe malaria remains a critical condition with high mortality burden in South-East Nigeria, particularly among young children and those presenting with neurological or respiratory complications. Delayed presentation and residence in urban areas were significant contributing factors. Strengthening emergency triage, intensive care capacity and community health seeking behavior is crucial to reducing

mortality. Prospective studies are recommended to explore the temporal relationships and implementation strategies for early diagnosis and effective management in resource-limited settings.

Introduction

Severe malaria is a life-threatening medical emergency and a major public health burden in developing tropical countries, particularly in sub-Saharan Africa.¹ In the post-neonatal period, it is a leading cause of death among children under five years of age.² The condition is defined by the presence of asexual forms of *Plasmodium falciparum* in a patient with one or more life-threatening complications, after excluding other etiologies.³ These complications include impaired consciousness, metabolic acidosis, hypoglycemia, hyperparasitemia, severe anemia, acute kidney injury, jaundice, pulmonary edema, significant bleeding, and shock.³ The pathophysiology is primarily driven by the sequestration of parasitized erythrocytes in the microvasculature of vital organs, leading to end-organ dysfunction and if left untreated, rapid clinical deterioration and death.³

Globally, an estimated 249 million malaria cases and 608,000 deaths occurred in 2022 with the African region accounting for 94% of cases and 95% of deaths.⁴ Children under five years bear approximately 80% of this mortality.⁴ Nigeria carries the highest burden, reflecting their heightened vulnerability due to immature immunity and lack of acquired protective antibodies.⁴ Nigeria carries the highest burden globally, with an estimated 68 million cases and 194,000 deaths in 2022, representing approximately 27% of global and 40% of African malaria deaths.² Despite a 26% reduction in incidence since 2000, transmission remains perennial in most parts of the country and mortality remains alarmingly high.¹ Malaria is caused by five species of *Plasmodium* (*P. falciparum*, *P. vivax*, *P. ovale*, *P. malaria* and *P. knowlesi*), with *P. falciparum* and *P. vivax* being the most prevalent in Africa and outside Africa respectively.⁵ While malaria is both preventable and curable, control efforts in Nigeria have focused on vector control measures such as long-lasting insecticidal nets, indoor residual spraying, as well as chemoprevention strategies including intermittent preventive therapy in pregnancy, seasonal malaria chemoprevention.⁶

Despite these interventions, the progress in reducing malaria mortality has been uneven across regions and the factors contributing to death among children with severe malaria remain incompletely understood. A substantial body of research has focused on preventing and treating malaria, but relatively few studies have examined the sociodemographic and clinical factors associated with mortality among children hospitalized with severe malaria, particularly in the South-East geopolitical zone of Nigeria. Understanding these factors is critical for clinicians to identify high-risk patients early and for health systems to allocate resources effectively. Furthermore, the contribution of sociodemographic factors to under-five mortality has been highlighted by several researchers, with Issa et al⁷ noting the impact of these factors on survival in northern Nigeria and Azuh et al⁸ demonstrating their significance in determining the pattern and prevalence of under-five mortalities in rural South-West Nigeria.

Given the paucity of data from South-East Nigeria, this study aimed to evaluate the short-term outcomes and identify the sociodemographic and clinical risk factors associated with mortality in children admitted with severe malaria at a tertiary health facility in Imo State, South-East Nigeria.

We hypothesized that specific clinical features, particularly neurological and respiratory complications, along with sociodemographic factors such as age and place of residence, would be significantly associated with mortality. The findings of this study are expected to help clinicians recognize common predictors of mortality and guide targeted interventions to reduce deaths from severe malaria in this region. .

Methods

Study design and settings

This was a hospital-based retrospective cross-sectional study conducted at the Children's Ward and Emergency Room of Imo State University Teaching Hospital (IMSUTH), Orlu, Nigeria. IMSUTH is a 300-bed public tertiary facility located in Orlu, a semi-urban town in the tropical rainforest belt of South-East Nigeria. The hospital serves as a referral centre for Orlu and surrounding towns in the Imo state as well as adjoining South East states. The Paediatric department is staffed by Consultant paediatricians, resident doctors and nurses providing 24 hour emergency services and inpatient care for children with acute medical conditions. The study period covered five years, from August 2019 to August 2024.

Study population

All medical records of children aged 2 months to 12 years admitted with a clinical diagnosis of severe malaria during the study period were reviewed for potential inclusion and medical data extracted. All records meeting the inclusion criteria during the study period were included in the analysis. This approach was chosen to maximize the sample size and ensure comprehensive capture of all eligible cases over the five year period.

Inclusion Criteria

Inclusion required meeting one or more of the 2015 WHO clinical criteria for severe malaria,⁷ which include: Severe malarial anemia: Hemoglobin < 5 g/dL or hematocrit < 15% with parasite count > 10,000/ μ L. Impaired consciousness: Blantyre coma score < 3. Hypoglycemia: Blood glucose < 2.2 mmol/L (< 40 mg/dL). Acidosis: Plasma bicarbonate < 15 mmol/L or clinical respiratory distress. Hyperparasitemia: Parasitemia > 20%. Jaundice: Serum bilirubin > 50 μ mol/L (> 3 mg/dL) with parasite count > 100,000/ μ L. Renal impairment: Serum creatinine > 265 μ mol/L (> 3 mg/dL) or blood urea > 20 mmol/L. Pulmonary edema: Clinical respiratory distress with oxygen saturation < 92%. Significant bleeding: Recurrent or prolonged bleeding from gums, nose, or venipuncture sites; hematemesis; or melena. Shock:

Compensated (prolonged capillary refill) or decompensated (systolic blood pressure < 70 mmHg with signs of impaired perfusion).

Malaria diagnosis confirmation: Malaria diagnosis was confirmed by light microscopy of Giemsa-stained thick and thin blood films which is the gold standard for malaria diagnosis in resource poor settings. Three negative smears were required to rule out the diagnosis, per WHO recommendations.⁹ only patients with confirmed *P falciparum* infection (asexual forms on blood smear) were included.

Exclusion Criteria

Records were excluded if they had unclear or inconclusive diagnosis or final diagnoses other than severe malaria were excluded. Records that were incomplete medical with insufficient data for analysis or with evidence of co-infections that could confound the presentation (meningitis).

Data Collection and Analysis

Data were extracted from patient medical records using a standardized data collection proforma developed for the study. Data collected included sociodemographic characteristics, clinical features presence of prostration, severe anaemia, impaired consciousness, respiratory distress, multiple convulsions (more than 2 seizures in 24 hours), jaundice, hyperpyrexia, hypoglycaemia, abnormal bleeding, haemoglobinuria, acute renal failure and shock. Treatment outcomes-discharge (recovered and discharged home), death during hospitalization, or discharge against medical advice (DAMA).

Data were entered into Microsoft excel sheet and analyzed using SPSS version 23. Categorical variables were summarized as frequencies and percentages. Chi-square test was used to assess associations between categorical sociodemographic variables and mortality. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to identify risk factors for mortality. A p-value < 0.05 was considered statistically significant.

Case fatality rate for each clinical feature was calculated as the number of deaths among children with that feature expressed as a percentage.

Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of Imo State University Teaching Hospital. Individual informed consent was waived due to the retrospective nature of the study.

Results

A total of 2,384 children were admitted to the paediatrics wards during the five year study period. Of these, 434 (18.2%) met the WHO criteria for severe malaria and were included in the analysis. The mean

age of study participants was 4.5 years (SD 2 months to 12 years) with a significant proportion, 275 (63.4%) being under 5 years of age. There was a male preponderance with 281 (64.7%) males and 153(35.3%) females, giving a male female ratio of 1.8:1. Most children 259 (59.7%) resided in urban areas, while 175(40.3%) were from rural communities. A majority, 258 (58.8%) of the children presented to the hospital after more than five days of illness (delayed presentation) while 176 (41.2%) presented within two days of symptom onset. These sociodemographic characteristics are summarized in Table 1.

Table I: Sociodemographic characteristics children admitted with severe malaria (N = 434)

Sociodemographic characteristics	No [frequency]	%
Age		
< 5	275	63.4
> 5	159	36.6
Sex		
Male	281	64.7
Female	153	35.3
Place of Residence		
Rural	175	40.3
Urban	259	59.7
Duration of illness before presentation		
< 5days	179	41.2
> 5 days	255	58.8
Total	434	100

Clinical features

Fever was documented in all children 434 (100%) on admission. The most common clinical features of severe malaria were prostration observed in 264 (60.8%) children, severe anaemia (haemoglobin<5g/dL) present in 225(51.8%), impaired consciousness present in 204 (47.0%) and respiratory distress present in 152 (35.0%). Less common features included hyperpyrexia in 52(12%), hypoglycaemia in 52(12%) abnormal bleeding in 45(10.4%) shock in 7(1.6%) and acute renal failure in 9 (2.1%). Many children presented with multiple severe malaria features concurrently. This is shown in Table II below. When stratified by age group, the distribution of clinical features showed some notable differences. Prostration, severe anaemia and impaired consciousness were more common among children under five years, whereas respiratory distress and hyperpyrexia were more frequent in older children. Multiple

convulsions were predominantly seen in the under five age group affecting 76(83.5%) of those with the feature.

Table II: Clinical features of children presenting with severe malaria.(N = 434)

Clinical features	No(%)	< 5years [No%]	> 5 years[N ₀ %]
Prostration	264(60.8)	174[65.9]	90 [34.1%]
Severe Anaemia	225(51.8)	155[60.9]	70 [31.1]
Impaired consciousness	204(47.0)	130[63.7]	74 [36.3]
Respiratory distress	152(35.0)	49[32.2]	103 [67.8]
Multiple convulsion	97(22.4)	76[83.5]	15 [16.5]
Jaundice	74(17.1)	42 [56.8]	32 [43.2]
Hyperpyrexia	52(12.0)	23 [44.2]	29 [55.8]
Hypoglycemia	52(12.0)	21 [40.4]	31 [59.6]
Abnormal bleeding	45(10.4)	28[62.2]	17 [37.8]
Haemoglobinuria	30(6.9)	15 [50.0]	15 [50.0]
Acute Renal failure	9(2.1)	6 [66.7]	3 [33.3]
Shock	7(1.6)	5 [71.4]	2[28.6]

*Some patients had more than one clinical feature of severity, so percentages do not sum to 100%.

Treatment Outcomes

Of the 434 children admitted with severe malaria, 369 (85.0%) recovered and were discharged home following treatment. Fifty three (12.2%) died during hospitalization while the parents of 12 children (2.8%) discharged them against medical advice (DAMA). The overall mortality rate among children with severe malaria was 12.2%. This is summarized in Table III below.

Table III: Treatment outcomes for children with severe malaria (N = 434)

Outcome	No	%
Dead	53	12.2
Discharge home	369	85.0
DAMA*	12	2.8
Total	434	100

*DAMA: Discharged Against Medical Advice, were excluded from further analysis to avoid miscalculation of outcomes.

Factors Associated with Mortality.

Table IV shows that mortality was significantly higher among children under 5 years of age who accounted for 44 (83.0%) of all deaths ($\chi^2 = 10.3152$, $p = 0.016$). Children under five years were 3.2 times more likely to die compared to older children. Urban residence was significantly associated with mortality with 41 (77.4%) of deaths among urban residents ($\chi^2 = 7.843$, $p = 0.005$). Urban children had 2.6 times higher odds of death compared to rural children. Delayed presentation (more than five days of illness) was also significantly associated with mortality as 43 (81.1%) of deaths occurred in children who presented after more than five days of illness ($\chi^2 = 11.548$, $p = 0.007$). Although mortality was higher among males (58.5%) of deaths the difference was not statistically significant ($\chi^2 = 1.035$, $p = 0.309$).

Table IV: Association between sociodemographic factors and mortality (N = 53)

Sociodemographic characteristics	No	%	χ^2	df	Pvalue
Age					
< 5	44	83.0	10.315	1	0.016*
> 5	9	17.0			
Sex					
Male	31	58.5			
Female	22	41.5	1.035	1	0.309
Place of Residence					
Rural	12	22.6			
Urban	41	77.4	7.843	1	0.005*
Duration of illness					
< 5 days	10	18.9			
> 5 days	43	81.1	11.548	1	0.0007*
Total	53	100			
*Statistically significant					

Case fatality rates by clinical features

The highest case fatality rates (CFR) were observed among children with shock where 3 of 7 affected children died (CFR: 42.9%). This was followed by multiple convulsions with 20 of 97 affected children dying (CFR: 20.6%), impaired consciousness with 40 of 204 affected children dying (CFR: 19.6%) and respiratory distress with 27 of 152 affected children dying (CFR: 17.8%). Other notable CFR were acute renal failure (CFR: 11.1%), hyperpyrexia (CFR:9.6%), severe anaemia (CFR:5.7%), prostration (CFR : 3.4%).No deaths were recorded among children presenting with jaundice or haemoglobinuria alone. This is depicted in Table 5.

Table V: Case fatality rates by clinical feature

Clinical manifestation	No.	Mortality	CFR %
Prostration	264	9	3.42
Severe Anemia	225	13	5.7
Impaired consciousness	204	40	19.6
Respiratory distress	152	27	17.8
Multiple convulsion	97	20	20.6
Jaundice	74	-	-
Hyperpyrexia	52	5	9.6
Hypoglycemia	52	1	1.9
Abnormal bleeding	45	2	4.4
Haemoglobinuria	30	-	-
Acute Renal failure	9	1	11.1
Shock	7	3	42.9

Some children presented with more than one clinical features of severity.

Independent Predictors of Mortality

Multivariate logistics analysis identified independent risk factors for mortality among children admitted for severe malaria shown in Table VI. After adjusting for potential confounders, age,<5 years remained a significant predictor of mortality (aOR = 3.17, 95%CI: 1.51–6.69; p = 0;002) with children under 5 being 3.2 times more likely to die as older children. Urban residents was independently associated with mortality (aOR = 2.60, 95%CI: 1.33–5.11; P = 0.005) with urban children having 2.6 times higher odds of death compared to rural children. Delayed presentation > 5 days was also independently associated with mortality (aOR = 0.30, 95%CI : 0.30–0.62; P = 0.001). The odds ratio of 0.30 indicates that delayed presentation was associated with increased mortality risk. Clinical features with the strongest association were shock, impaired consciousness, multiple convulsions, and respiratory distress.

Table VI: Risk factor associated with mortality in children admitted with severe malaria

Risk factor [variable]	No	90% CI	Odd Ratio	Pvalue
Age				
< 5years	44	1.5057-	3.1746	0.0024
> 5 years	9	6.6933	1	1
Place of Residence				
Urban	41	1.3257–5.1059	2.6017	0.0054
Rural	12			
Duration of illness				
< 5years	10	0.3044–0.6238	0.3044	0.0012
> 5 years	43			
Severe Anemia	14	0.1520–0.5503	0.2892	0.0002
Impaired consciousness	40	2.1089–7.8596	4.0713	< 0.0001
Respiratory distress	27	1.1914–3.7964	2.1268	0.0107
Hyperpyrexia	6	0.3765–2.2955	0.9297	0.8741
Acute Renal Failure	1	0.1099–7.3131	0.8966	0.0918
Shock	3	11.7776-424	2577.6.6570	< 0.0001
Multiple convulsion	20	1.3013–43998	2.807	0.0050

Discussion

This retrospective cross-sectional study provides critical data on the prevalence, clinical profiles and factors associated with mortality in children with severe malaria in South-East Nigeria, a region with perennial malaria transmission. The prevalence of severe malaria among paediatric admissions was 18.2%, which is lower than the 43.7% reported in North-Central⁸ Nigeria and 79.1% in North-East⁹ Nigeria, but higher than the 11.3% reported in Ibadan South-West Nigeria.¹⁰ These regional differences likely reflect variations in transmission intensity, climate, vector ecology, socioeconomic conditions, and the effectiveness of malaria control interventions. The relatively moderate prevalence observed in our study compared to other regions may be attributable to the semi-urban nature of Orlu, which experiences lower transmission intensity than the more rural and hyperendemic areas of northern Nigeria. Nonetheless, the finding that nearly one in five pediatric admissions had severe malaria underscores the continued public health significance of this condition in South-East Nigeria and highlights the need for regionally tailored malaria control strategies and resource allocation.

The overall mortality rate of 12.2% observed in this study is alarmingly high and consistent with findings from other Nigerian studies, which report rates ranging from 9% to 12.4% in the South^{11,12,13} and 12.3% in the North-East.¹⁴ Our rate is comparable to the 10% mortality reported in a large multi-country African study,¹⁵ reaffirming that severe malaria remains a lethal condition despite progress in control efforts.¹⁶ This persistently high mortality rate is concerning and suggests that current management strategies may be inadequate, particularly in the face of delays in presentation and limited intensive care capacity. The fact that 12.2% of children admitted with severe malaria died in a tertiary facility, where specialized care should be available, highlights the urgency of strengthening emergency triage protocols and critical care services. It also underscores the need to address pre-hospital factors, as many deaths may be preventable with earlier recognition of danger signs and prompt referral.

A key finding is the disproportionate mortality among children under five years, who accounted for 83% of all deaths, with an odds ratio of 3.17 (95%CI: 1.51–6.69). This finding is consistent with the well-established vulnerability of this age group due to their immature immunity^{11,17,18} and aligns with the national and regional burden where under-five children bear the brunt of malaria mortality.² This age-dependent mortality pattern has been extensively documented in sub-Saharan Africa, with younger children being at highest risk of severe disease and death.¹⁶ The biological basis for this vulnerability includes the waning of maternal antibodies, the delayed development of acquired immunity and the higher prevalence of severe anemia and cerebral malaria in younger children. Our finding reinforces the need for targeted interventions for this high-risk age group, including intensified case management, prompt treatment of febrile illnesses, and chemoprevention strategies.

Furthermore, health education programs should emphasize the importance of seeking care promptly for febrile children less than five years, as early treatment can prevent progression to severe disease and death.

Although the mortality in this study was higher in the males 58.5% of deaths, the difference was not statistically significant ($p = 0.309$). This finding is consistent with reports from other workers¹⁹ and contrasts with some previous studies that suggested male preponderance.²⁰ However, our results align with others studies that have found gender not to be strongly associated with mortality in children with severe malaria.²¹ The lack of a significant gender difference may reflect the fact that both male and female children in this age group have similar levels of exposure and susceptibility to malaria infection; and that gender-related differences in health-seeking behavior or access to care may not be as pronounced in this setting as in other regions. It is also possible that the retrospective nature of our study, with incomplete documentation, may have obscured small but clinically meaningful differences. Nonetheless, our findings suggest that malaria control interventions should target both male and female children equally, rather than focusing disproportionately on one gender.

However, the finding that urban residence was strongly associated with mortality (OR = 2.6, 95CI: 1.33–5.11) is noteworthy and contrasts with the common narrative of higher rural risk.^{22,23} This finding

challenges the conventional assumption that rural populations are uniformly at greater risk of malaria mortality and suggests that urban malaria may be an underappreciated problem in South-East Nigeria. Several factors may explain this unexpected finding. First, Orlu is a semi-urban town with significant urban slums characterized by poor drainage, stagnant water and unkempt bushes, all conducive to mosquito breeding and increased malaria transmission. Urban slums often have higher population densities, which can facilitate transmission and poorer housing conditions that offer less protection against mosquito bites. Furthermore, access to care in these urban slums may be hindered by poor road networks and importantly, security challenges (banditry and kidnapping) during the study period, which likely delayed presentation and access to timely care. Third, the higher cost of living and healthcare in urban areas may create financial barriers to seeking prompt care, as families may attempt home management or visit patent medicine vendors before presenting to the hospital. Our findings highlight the need for targeted malaria interventions in urban slums, including improved environmental sanitation, vector control and community health education. Additionally, healthcare facilities in urban areas should be equipped to manage severe malaria cases, as patients may present with more advanced disease due to delays in seeking care.

Delayed presentation defined as more than five days of illness before hospital admission was strongly associated with mortality (OR = 0.30, 95%CI: 0.30–0.62), a finding consistently reported across cross sectional and other study designs.^{14,19,24,25} In our study, 81.1% of children who died had presented after more than five days of illness, highlighting the critical importance of early diagnosis and prompt treatment. However, because of the cross-sectional design, we cannot definitely determine whether delayed presentation preceded death in all cases, although clinical reasoning strongly supports that direction. The strong association between delayed presentation and mortality has several potential explanations. First, children who present late are more likely to have developed severe complications such as cerebral malaria, severe anemia, or shock, which are more difficult to manage and carry higher case fatality rates. Second, delays in seeking care may reflect poor health-seeking behavior, financial constraints, or reliance on traditional medicine, which are key modifiable factors in reducing mortality. Thirdly, delayed presentation may be associated with a greater burden of disease, including higher parasitemia levels and more severe metabolic derangements, which may not be fully reversible even with appropriate treatment. Our findings underscore the importance of community-based interventions to promote early health-seeking behavior and reduce delays in presentation. Health education programs should emphasize the danger signs of severe malaria and the importance of seeking care within 24–48 hours of symptom onset. Additionally, interventions to reduce financial barriers to care, such as the removal of user fees for children under five years, may help ensure that families seek care early rather than delaying due to cost concerns.

Clinically, shock, impaired consciousness, multiple convulsions and respiratory distress emerged as the strongest independent predictors of mortality, consistent with findings from cross sectional studies from the North-East Nigeria and the Democratic Republic of Congo.^{25,26} Shock, although uncommon in our study (affecting only seven children), was associated with a case fatality rate of 42.9% and an

extraordinarily high odds ratio for mortality (OR = 2577.66, 95%CI: 11.78–424.00). This finding is consistent with the well-known association between shock and poor outcomes in severe malaria, as shock reflects severe hypovolemia, metabolic acidosis, and impaired tissue perfusion, which are difficult to reverse even with aggressive fluid resuscitation and intensive care. The high case fatality rate associated with shock highlights the need for rapid recognition and aggressive management, including prompt fluid resuscitation and inotropic support. However, the small number of children with shock in our study limits the precision of our estimates and underscores the need for larger studies to confirm these findings. Impaired consciousness was present in 47.0% of children and was independently associated with mortality (OR = 4.07, 95%CI: 2.11–7.86), with a case fatality rate of 19.6%. This finding aligns with the established understanding that cerebral malaria is one of the most severe manifestations of *P. falciparum* infection, with mortality rates ranging from 15–25% even with appropriate treatment. The pathophysiology of cerebral malaria involves sequestration of parasitized erythrocytes in the cerebral microvasculature, leading to endothelial activation, blood-brain barrier disruption, and neuronal injury, which can result in permanent neurological sequelae or death. Our findings underscore the need for early recognition of impaired consciousness and prompt initiation of antimalarial therapy, along with supportive care to prevent complications such as aspiration pneumonia and seizures. In resource-limited settings where intensive care is unavailable, the management of children with impaired consciousness should focus on maintaining airway patency, preventing hypoglycemia, and controlling seizures.

Multiple convulsions were also strongly associated with mortality (OR = 2.81, 95%CI: 1.30–4.40), with a case fatality rate of 20.6%. Seizures in severe malaria are associated with increased intracranial pressure, metabolic acidosis and neuronal injury, which may contribute to poor outcomes.

The association between multiple convulsions and mortality, highlights the importance of prompt seizure control and the need for anticonvulsant therapy in children with severe malaria. Similarly, respiratory distress was independently associated with mortality (OR = 2.13, 95%CI: 1.19–3.80), with a case fatality rate of 17.8%.

Respiratory distress in severe malaria may reflect metabolic acidosis, pulmonary edema, or pneumonia and is a marker of severe disease. The presence of respiratory distress should prompt immediate evaluation for acidosis and hypoxia with aggressive management initiated; including oxygen therapy and where available, ventilatory support. These complications often require intensive care management; however, a recent survey in Nigeria highlighted severe deficits in intensive care infrastructure, including bed space, functional equipment, and trained critical care staff, which likely contributes to the high mortality observed.²⁷ The absence of a pediatric intensive care unit at our study site may have significantly influenced outcomes, as children with shock, impaired consciousness, respiratory distress, or multiple convulsions would have been managed on the general pediatric ward, where the level of monitoring and care may be suboptimal.

In contrast, severe anemia, despite being a common complication, affecting 51.8% of children, was not strongly associated with mortality in this study. This is likely due to the availability of a functional blood

bank and timely transfusion services at the study center, a factor that a retrospective cross-sectional review can capture effectively. The relatively lower case fatality rate among children with severe anemia 5.7% compared to those with neurological or respiratory complications suggests that anemia is a more readily treatable complication, provided that blood products are available and transfusion is administered promptly. This finding highlights the importance of maintaining functional blood transfusion services and ensuring that children with severe anemia have access to timely blood transfusions. However, it should be noted that severe anemia may still contribute to mortality through mechanisms such as hypoxia and heart failure, particularly in resource-limited settings where safe blood products may be scarce.

The overall finding of this study highlights the importance of considering sociodemographic characteristics in understanding the mortality patterns among children with severe malaria. The contribution of sociodemographic factors to under-five mortality has been highlighted by several researchers. Issa et al⁷ working in northern Nigeria, noted the impact of sociodemographic factors on the survival of under-five children, while Azuh et al⁸ demonstrated the significance of sociodemographic and environmental determinants of child mortality in rural South-West Nigeria. Our findings complement these studies by demonstrating that even in urban and semi-urban settings; sociodemographic factors such as age, place of residence and duration of illness before presentation significantly influence mortality. This suggests that interventions targeting these factors, such as improving access to care in urban slums, promoting early health-seeking behavior and strengthening health systems, may have a substantial impact on reducing malaria mortality.

Limitations

This study's retrospective design is subject to limitations, including incomplete documentation (which may introduce information bias), the inability to establish causality and survival bias (the study includes only children admitted to hospital, excluding those that died on the way to the hospital, potentially underestimating mortality associations). The cross-sectional design does not allow us to determine whether the observed associations are causal or merely correlated. Data were from a single tertiary center, which may not apply to primary or secondary healthcare settings where case mix and resources differ limiting generalizability. Additionally, the absence of a pediatric intensive care unit at the study site may have influenced outcomes and the findings may not be applicable to settings with better intensive care capacity. Our study did not assess socioeconomic status, nutritional status, HIV status, or prior antimalarial treatment, which may influence outcomes.

Conclusion

Severe malaria is associated with a high mortality rate of 12.2% in children admitted to a tertiary hospital in South-East Nigeria. Young age (< 5 years), urban residence, delayed presentation and the presence of shock, impaired consciousness, multiple convulsions, or respiratory distress only measured at admission are significantly associated with death in this patient population. Given the retrospective

cross-sectional design, these associations should not be interpreted as causal; prospective studies are needed to confirm temporal relationships and to explore the underlying mechanisms. These findings highlight the urgent need to strengthen emergency triage and treatment protocols; enhance critical care capacity and promote community awareness for early health-seeking behavior. Specifically, interventions should focus on reducing delays in presentation, improving the recognition and management of neurological and respiratory complications and ensuring the availability of functional intensive care services. Future research should focus on implementation strategies for early diagnosis and effective management of severe malaria complications, particularly in resource-limited settings. Additionally, prospective studies are needed to confirm these findings and to explore other potentially modifiable risk factors, such as socioeconomic status, nutritional status and HIV co-infection. Ultimately, reducing mortality from severe malaria will require a multi-pronged approach that addresses both health system factors and community-level barriers to care, with a particular focus on the most vulnerable populations.

Declarations

Ethics approval

Ethical approval was obtained from the Research Ethics Committee of Imo State University Teaching Hospital, with approval number IMSUTH/CS/250.

Consent to participate

Individual informed consent was waived due to the retrospective nature of the study.

Consent for publication

Not applicable

Conflict of interest:

Authors declare no conflict of interest.

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Author Contribution

CJO and JE conceptualized the study, CJO collected the data. Manuscript writing was by JE and CJO. All authors reviewed the manuscript.

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Data availability:

The data for this work can be made available upon reasonable request.

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