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Patterns of Severe Malaria among Patients Presented to Rufaa Pediatric Teaching Hospital, 2023

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Abstract

Malaria remains one of the most serious public health challenges in Sudan, particularly among children under five years of age. Despite the adoption of national malaria case management protocols, adherence remains inconsistent, contributing to high morbidity and mortality. This study aimed to investigate the patterns of severe malaria among pediatric patients presented to Rufaa Pediatric Teaching Hospital in 2023. A descriptive hospital-based study was conducted using structured data collection tools and patient records. Data collected were (287 samples). The data was statistically analyzed using SPSS version 22. The majority of cases (81%) occurred in children under five years of age and from rural areas (61%) and displaced were(28%) which highlight young, rural, and displaced children are most at risk.. Fever was the most common presenting feature (80%), followed by prostration (76%), pallor and continuous vomiting (50%). Laboratory investigation was performed in 99% of cases, while 2.4% were diagnosed clinically, hemoglobin was performed in 167 children (58%), blood glucose in only 25 children (9%), and renal function tests - serum urea and creatinine - in 3%,3% for each ,these figures highlight that essential investigation were missed and can affect directly the outcome and increase the possibility of mortality. 57% of patients were treated according to Sudan Malaria Case Management Protocol 2023 while 43% were not. Inpatient treated children were 84%, outpatient treated children were 11%. Home treated children were 5% which represents a serious deviation from recommended practice. Full recovery was achieved in 98.5%, while mortality was recorded in 1.1%, but gaps in treatment adherence and

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investigation uptake, highlighting how these gaps persist despite a low mortality rate. In conclusion survival outcomes for pediatric severe malaria in Rufaa are favorable, but systemic weaknesses threaten long-term progress. The study recommended strengthening adherence to the Sudan malaria case management protocol (2023), improving diagnostic capacity to reduce reliance on clinical judgment. Continuous training of healthcare providers, better monitoring of treatment practices, and investment in laboratory infrastructure were also advised to reduce morbidity and mortality among children.

Keywords: Severe malaria, Pediatrics, Sudan, Case management, Artemisinin-based therapies, Protocol adherence

Introduction

Malaria is a major global health burden, especially in sub-Saharan Africa, where 90% of cases and deaths occur, mainly among children under five and pregnant women. The dominant parasite is Plasmodium falciparum, responsible for most severe cases. Rising drug resistance (e.g., chloroquine) and limited resources have worsened outcomes, with 20–30% mortality in severe cases due to delays in diagnosis, incorrect treatment, and poor monitoring. In Sudan, 36.3 million people (86.7%) are at risk. In 2021, there were 3.3 million cases and 7,784 deaths, representing more than half of malaria cases and deaths in the EMRO region. Despite the adoption of the "test and treat" policy, adherence to malaria management protocols remains poor, especially among physicians treating children under five, raising concerns about severe malaria case management. Prompt diagnosis and treatment are critical to prevent mortality, particularly in vulnerable groups such as young children and pregnant women.

Materials and methods

Study design:

This a descriptive hospital- based study.

Study populations:

All diagnosed severe malaria cases presented at Rufaa Pediatric Teaching Hospital.

Sample size:

The sample size was calculated using the following formula to be 204:

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n = Z2 PQ/d² = 2²× 0.15×0.85/(0.05)²=204 (287 samples were collected) where

n= is the required sample size

z= is abscissa of the normal curve

P= is estimated proportion of an observation that is present in population

Q= is 1-p. The value for z which contain the area under the normal curve

d= is the desire precision

Sampling:

All diagnosed severe malaria cases presented at Rufaa Pediatric Teaching Hospital was targeted by the study.

Data collection:

Data collected in April – July 2023 using a questionnaire which consists of five sections; the personal and sociodemographic data, the health / treatment seeking behavior data, the features and findings at time of presentation data, the lab investigations and results data and the management and outcome data. Medical doctors who were working in the selected hospital trained to collect the data.

Data analysis:

The data was statistically analyzed using SPSS version 22. Frequency tables used to present the data. Continuous data was summarized using means, standard deviation and quartiles. Categorical data was analyzed using the appropriate tests.

Ethical clearance:

Ethical approval was obtained from University of Gezira - Blue Nile National Institute for Communicable Diseases (BNNICD), from Ministry of Health in Gezira State and in the field verbal informed consent was taken from head family or respondent.

Result and discussion

This study, conducted exclusively among pediatric patients presented to the Pediatric Teaching Hospital in Rufaa, provided a comprehensive picture of malaria burden, clinical features, laboratory findings, and management practices. The majority of children were under five years of age, confirming the well-established vulnerability of young children to malaria morbidity and mortality. This finding is

consistent with Sudanese studies such as Osman et al. (2022) and Salah et al. (2025), which reported similar age distributions in hospital-based pediatric cohorts, and aligns with Zeidan et al. (2000), who found that most malariadeaths in Sudanese hospitals occurred in children under nine years. However, it differed from Ethiopian data presented by Alemu et al. (2023), where older children and adolescents carried a higher burden, suggesting regional differences in immunity and exposure. Residence patterns revealed that 61% of children came from rural areas, which is consistent with national data linking rural residence to higher malaria transmission (Severe Malaria Observatory, 2024). This matches Salah et al. (2025), who found that rural children in Gezira had higher infection rates due to environmental exposure and limited preventive measures, and Elhag (2021), who reported heavier malaria burdens among rural pediatric admissions in Elobied. However, it did not match findings from Khartoum (Ibrahim et al., 2019), where urban malaria prevalence was unexpectedly high due to poor sanitation and peri-urban breeding sites. Displacement was notable, with 28% of children displaced mainly from Khartoum. This group carried a disproportionate burden of malaria, reflecting the vulnerability of displaced populations. This matches Osman et al. (2022), who highlighted that displaced families in Sudan are at higher risk due to unstable housing and poor access to preventive measures, and aligns with WHO (2022), which emphasizes that internally displaced persons are among the most vulnerable groups in malaria-endemic regions. However, it did not match Salah et al. (2025), who found lower malaria prevalence among displaced children in Gezira, possibly due to targeted interventions by NGOs.The findings reveal that most patients reported illness in the past two weeks, with fever being the predominant complaint, and the majority sought care from health providers, resulting in malaria being diagnosed in most of cases. The treatment pattern showed that Artemether-Lumefantrine was the most prescribed antimalarial, which was consistent with the World Health Organization. (2023). Guidelines for malaria, 3rd edition. Geneva: WHO recommendation of ACTs as the first-line therapy for uncomplicated malaria. The used of Artesunate in a smaller proportion of cases aligns with WHO guidance for severe malaria management, but the presence of Artemether injection monotherapy reflected deviation from protocol, as monotherapies are discouraged due to the risk of resistance (World Health Organization. (2023). World Malaria Report 2023. Geneva: WHO). Similar treatment-seeking behavior has been documented in African settings, such as in Ahorlu, C. K., et al. (2023). Treatment-seeking behavior for febrile illness in malaria endemic communities in Ghana. Malaria Journal, 22(1): 45, where fever was the main driver of care-seeking and ACTs were widely used, though inappropriate therapies persisted. Thus, while the results highlight strong treatment-seeking behavior and substantial adherence to guidelines,

they also underscore the need for reinforcing provider training and stricter adherence to national and international protocols. Clinical features at presentation revealed that prostration, fever, pallor, and vomiting were the most common findings, which matched WHO‑recognized malaria presentations and Sudanese pediatric hospital data (Osman et al., 2022). Severe complications such as convulsions, respiratory distress, and severe anaemia were present but less frequent. This did not match Zeidan et al. (2000), who reported higher rates of severe malaria and a case fatality rate of 5/1000 in Sudanese hospitals. Rare manifestations such as cerebral malaria and hypoglycemia were observed, while pulmonary oedema and hemoglobinuria were absent. Comparable findings were reported by Elhag (2021), who also noted low rates of cerebral malaria in Elobied pediatric admissions. Laboratory investigations confirmed malaria in nearly all children, with blood film microscopy performed in 99% of cases. Plasmodium falciparum was overwhelmingly dominant, accounting for 97% of infections, which matches national surveillance data (Severe Malaria Observatory, 2024) and Alsedeeg et al. (2025), who found P. falciparum dominance in Gezira but also noted mixed infections with P. Vivax. Parasite density was generally low, which does not match Salah et al. (2025), who reported higher parasite loads in rural Gezira. Hemoglobin testing revealed severe anaemia in a small proportion of children, while hypoglycemia and renal function abnormalities were less common but clinically significant.A critical limitation observed was that some children did not undergo complete laboratory investigations, particularly acid–base balance testing. In this study, hemoglobin was performed in 167 children (58%), blood glucose in only 25 children (9%), and renal function tests — serum urea and creatinine - in 3% for each. Plasma bicarbonate and serum lactate, which are essential for assessing acid–base balance, were not performed in any case (0%). These figures highlight that essential investigation were missed and can affected directly the outcome and increase the possibility of mortality, this omission was significant because metabolic acidosis, hypoglycemia, and renal impairment were well‑recognized complications of severe malaria and major predictors of mortality in children. WHO guidelines emphasized that blood glucose, lactate, and acid–base status should be monitored in severe cases to guide supportive therapy. Studies from Kenya (English et al., 1997) and Uganda (Idro *et al.*, 2005) demonstrated that metabolic acidosis and deranged acid–base balance are strongly associated with poor outcomes and late complications such as neurological deficits. The absence of these investigations in Rufaa may have led to under‑recognition of severe complications, and although mortality was low, the risk of late sequelae such as neurocognitive impairment or chronic renal dysfunction cannot be excluded. This finding did not match international pediatric malaria studies

where acid–base monitoring is routine, but unfortunately matches reports from Sudanese hospitals (Zeidan *et al.*, 2000; Osman *et al.*, 2022), where resource limitations often prevent full laboratory work‑ups. The incomplete coverage of blood glucose and renal function testing also reflects treating behaviors that prioritize immediate antimalarial therapy over comprehensive supportive investigations. While this may be driven by resource constraints, it risks missing hypoglycemia — a common cause of seizures and poor outcomes in children — and renal impairment, which can complicate fluid management and lead to late complications. Inpatient treated children were 84%, outpatient treated children were 11% and home treated children were 5%, this represented a serious deviation from recommended practice. Severe malaria is a medical emergency; managing them outside hospital settings exposes children to delayed diagnosis, inadequate drug administration, and lack of supportive care (e.g., transfusion for severe anemia, IV fluids for shock, anticonvulsants for seizures) , Sudan Malaria Case Management Protocol (2023), explicitly warned against home treatment of severe malaria, stressing that all cases must be admitted for parenteral therapy and close monitoring. Treatment behaviors revealed further gaps. While artesunate plus AL was the mainstay of therapy, many children received artesunate only or quinine only without the required continuation with AL. This reflected poor adherence to Sudan's 2023 Case Management Protocol and WHO guidelines, which insisted that artesunate injection must be followed by a full course of AL once oral intake is possible. The treating behavior of clinicians in Rufaa therefore showed a tendency to rely on monotherapy, either due to stock‑outs, habit, or lack of enforcement of guidelines. Similar patterns were reported by Salah et al. (2025) in Gezira, where clinicians often deviated from protocol, and by Deng et al. (2024) in South Sudan, where quinine monotherapy was still common. These behaviors risk treatment failure, recrudescence, and the development of resistance. In addition, a small but important group of children were treated clinically without laboratory confirmation, either despite negative test results or because tests were not performed. This practice does not match Sudanese and WHO recommendations that parasitological confirmation should be routine. Similar deviations were reported by Zeidan et al. (2000), who noted frequent presumptive treatment in Sudanese hospitals, and by Deng et al. (2024), where weak diagnostic systems led to widespread clinical treatment. Supportive therapies such as antibiotics, fluids, and antipyretics were widely used, reflecting holistic pediatric management. Outcomes were generally favorable, with 91.6% discharged in good condition and only 1% mortality but gaps in treatment adherence and investigation uptake, highlighting how these gaps persist despite a low mortality rate. This matches with American Academy of Pediatrics (2025) , which show that poor adherence and limited investigations

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can lead to adverse outcomes even when mortality is low. However, our lower mortality does not match Deng et al. (2024), who reported higher mortality among children in South Sudan due to weak health systems and poor access to artesunate. Overall, the findings of this study matched recent Sudanese and regional studies in highlighting the dominance of P. falciparum, the vulnerability of children under five, and the effectiveness of artesunate‑based treatment. However, differences in parasite density, complication rates, rural versus urban burden, protocol adherence, incomplete laboratory investigations, and treating behaviours do not match some reports. The high percentage of children treated outside protocol, the inappropriate used of artesunate-only and quinine‑only regimens, the presence of children treated clinically without laboratory confirmation, and the lack of acid–base monitoring represent serious gaps in pediatric case management. Addressing these gaps through training, drug supply stabilization, laboratory strengthening, and strict monitoring is essential to sustain favorable outcomes and prevent resistance and late complications.

Table [1] Sociodemographic profile, Ruffa Pediatric Teaching Hospital, Gezira State,2023

Percentage (%)	Frequency (n)	Categories	Variable
81	233	<5	Age group
19	54	> 5	
52	149	Male	Gender
48	138	Female	
68	195	1-15	Weight
19	55	16-31	
9	26	32-47	
3	8	48-63	
1	3	64-79	
61	175	Rural	Residence
38	109	Urban	
1	3	Camps	
28	80	Yes	Displaced
72	207	No	
85	68	Khartoum	Displaced From Where
15	12	Other area	
58	167	Fully vaccinated	Vaccination
34	98	Partially vaccinated	
8	22	Not vaccinated	
22	63	Preschool	Patient Education Level
19	54	Basic	
10	29	Secondary	
49	141	Others	

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12	34	Illiterate	Father Education Level
62	179	Basic	
26	74	University and above	
14	39	Illiterate	Mother Education Level
62	178	Basic	
24	70	University and above	
4.2	12	Unemployed	Father Occupation
18.5	53	Employee(government)	
72.8	209	Freelancers	
3.1	9	Farmer/ livestock	
1.4	4	Business	
83	237	House wife	Mother Occupation
15	44	Employed	
2	6	Free lances	
0	0	Business	
-	398	<5	Number of Children <5 per Families
-	260	Families	
99	284	5 kilometer or less	Near health facility
1	3	More than 5 kilometer	
97	277	Public facility	Type of The Nearby Health Facility
3	10	Private clinic	
0	0	Non-governmental(NGO)	

Table [2] Health /Treatment Seeking Behavior, Ruffa Pediatric Teaching Hospital, Gezira State,2023

Percentage (%)	Frequency (n)	Categories	Variable
61	174	Yes	Patient being ill in the last 2 week
39	113	No	
97	168	Fever	Main complaint
3	6	Other	
92	160	Yes	Consult Health Care Provider
8	14	No	
90	156	Malaria	Diagnosis
10	18	Other	
84	130	AL	Received antimalarial
8	13	Artesunate	
8	13	Other (Artemether Injection)	

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Table [3] Features and Findings at Time of Presentation, Ruffa Pediatric Teaching Hospital, Gezira State,2023

Percentage (%)	Frequency Yes(n)	Categories	Variable
50	143	Pallor	Features and findings
76	218	Prostration	
6	17	Severe anemia	
1	2	Anemic heart failure	
2	7	Cerebral malaria	
11	32	Repeated convulsions (more than one in 24 hours	
2	6	Hypoglycemia	
14	40	Respiratory distress (acidosis)	
50	143	Continuous Vomiting	
8	23	Impaired level of consciousness	
1	2	Circulatory collapse	
0	0	Pulmonary oedema	
2	5	Abnormal bleeding	
5	14	Jaundice	
0	0	Black water fever	
0.3	1	Acute kidney injury	
80	231	Others(fever)	

Table [4] Lab Investigation, Ruffa Pediatric Teaching Hospital ,Gezira State,2023

Percentage (%)	Frequency Yes(n)	Categories	Variable
99	285	Blood film for malaria	Lab Investigation
0.3	1	Malaria Rapid Diagnostic Test (RDT)	
58	167	Hb	
9	25	Blood glucose level	
0	0	Plasma bicarbonate Level	
0	0	Serum lactate Level	
3	9	Serum urea	
3	9	Serum Creatinine Level	
99	284	Microscopic	Method of Investigation
1	1	RDTs	
99	281	+ ve	Malaria Test Result
1	4	- ve	
97	273	Pf	Parasite Species
2	5	Pv	
1	3	Pf + Pv	
89	250	(+)	Parasite Count
7	18	(++)	
2	6	(+++)	
2	6	(++++)	
3	8	≤ 5	Hemoglobin Results

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97	159	>5	
40	10	<54	Blood Glucose Level (BG)mg\dl
60	15	>54	
22.2	2	<20	Serum Urea mg\dl
77.8	7	>20	
88.9	8	<3	Serum Creatinine Level mg\dl
11.1	1	>3	

Table [5] Management and Outcome

Percentage (%)	Frequency (n)	Categories	Variable
84	240	Inpatient	Site of Management
11	33	Outpatient	
0	0	ICU	
5	14	Home	
7	20	<24	Admitted Time (Hours)
62	179	24-48	
31	88	>48	
1.4	4	Negative Results	Clinically Treated
1	2	Test Not Performed	
2	5	<24	Inpatient Admission Compare to Time (Hours)
63	150	24-48	
35	85	>48	
27	78	IV Artesunate	Antimalarial Prescribed
61	174	IV artesunate +AL	
12	35	Quinine	
0	0	Quinine + AL	
2	4	1	Doses of IV Artesunate
10	26	2	
68	173	3	
20	50	≥4	
57	164	Yes	Patients Treated According to Protocol
43	123	No	
82	235	Antibiotics	Other Medicines Patients Taken
66	190	Fluids	
72	206	Antipyretics	

61	174	Tonics	
91.6	263	Discharged in a good condition	Outcome
0.3	1	Discharged with complications	
1	3	Died	
2.1	6	Escape	
5	14	NA	

Conclusion

The study at Rufaa Pediatric Teaching Hospital provides a comprehensive picture of the malaria burden among hospitalized children. Children under five remain the most vulnerable group, with rural residence and displacement compounding risk. Clinical features matched WHO-recognized malaria presentations, though severe complications were less frequent than in earlier Sudanese reports.

Recommendations

Strengthen adherence to Sudan malaria case management protocol (2023, improve diagnostic capacity (expand RDTs, maintain microscopy, ensure routine Hb, glucose, RFT testing for severe malaria cases and Continuous training for healthcare providers.

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