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Factors Associated with the Vital Prognosis of Severe Malaria in Children Aged 0-59 Months Admitted to the M'pedere Medical Clinic in Farakala, Sikasso Health District, from January 2022 to December 2023

Yacouba Sidibe[1]*, Moussa Keita[2], Fatoumata B. Traore[1], Fanta Niare[1], Nana Kadidja Diallo[1]

[1]Bamako Dermatology Hospital
[2]Baraoueli Reference Health Center

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***Corresponding author:** Yacouba Sidibe
Bamako Dermatology Hospital

Abstract **Original Research Article**

Malaria remains a major public health problem worldwide, particularly in sub-Saharan countries such as Mali. The severe form is responsible for high mortality among vulnerable targets such as children under 5 years of age. Several factors that may be associated with this excess mortality need to be known and controlled. For this reason, we initiated the present study, the general objective of which was to study the factors associated with the vital prognosis of severe malaria in children aged 0 to 59 months admitted for consultation at the MPEDERE medical clinic, Farakala commune, Sikasso health district, from January 2022 to December 2023. We conducted a cross-sectional and analytical study with prospective recruitment which was conducted in the said clinic. The results of the study showed us a hospital frequency of severe malaria of 52.47%, with a sex ratio of 1.01 in favor of boys, a mean age of 32.47 ± 16.26 months and a modal age of 36 months. An epidemiological model of factors associated with mortality related to severe malaria in children aged 0 to 59 months revealed that a delay in seeking care beyond 24 hours as well as respiratory distress were factors significantly associated with excess mortality related to severe malaria in children aged 0-59 months (OR = 285.857; 95%CI. OR: 48.931 – 1669.991 and OR = 0.008; 95%CI. OR: 0.001 – 0.069).

Keywords: Severe Malaria, associated factors, M'PEDERE Medical Clinic, Rural Commune of Farakala, 2022-2023.

I. INTRODUCTION

According to the WHO 2020 report, out of 241 million reported malaria cases, 627,000 deaths were recorded. These figures, compared to 2019, represented an increase of 14 million cases and 47,000 additional deaths [1]. A similar trend was already observed in 2019 compared to 2018 with an increase of 1 million cases and 4,000 additional deaths [2] (WHO, 2019).

The WHO 2021 report notes that malaria remains a major public health problem worldwide, particularly in low-income developing countries south of the Sahara [3]. (WHO, 2021). While a child under 5 years of age dies every minute from malaria worldwide, sub-Saharan Africa recorded 95% of cases and 96% of deaths in 2020 and pregnant women and children under 5 years of age accounted for 80% of deaths [3]. (WHO, 2021).

In Mali in 2020, malaria was the leading cause of morbidity with 34% of reasons for consultation compared to 40.4% in 2022 [4, 5]. (SLIS 2020, SNIS 2022). Children under 5 years of age constitute one of the groups most vulnerable to malaria infection (26% morbidity and 22% mortality) in 2022 among children under 5 years of age [4, 5].

Of the 1,197,864 cases of severe malaria in Mali in 2022, 29.8% concerned children aged 0-59 months. On the other hand, of the 285,279 suspected cases of malaria in pregnant women, 273,869 were tested by RDT and GE with a confirmation rate of 56% (152,273 cases). The national case fatality rate is 1.25‰ [4-6]. (SLIS 2020, SNIS 2022, SNIS 2023).

The factors associated with excess mortality linked to this parasitosis are multiple and varied. Identifying and monitoring these factors are not always easy in rural areas, particularly in the private sector where qualified personnel are rather rare and the population is mostly illiterate and less aware. This is why we were interested in studying these factors in the M'PENDERE medical clinic in Farakala in the Sikasso health district from January 2022 to December 2023. The objective was to determine the main factors associated with the deaths of children under 5 years of age, to

describe the socio-demographic characteristics of the cases, to determine the hospital frequency of cases of severe malaria among the targets in the said clinic as well as the mortality rate.

II. METHODOLOGY

2.1 Framework of the Study

The M'PEDERE Medical Clinic is located in the village of Farakala, in the Rural Commune of the same name, on the Bamako-Sikasso axis and 35 km from the city of Sikasso. The Commune of Farakala was created according to Law No. 096/056/ of 1996 [7]. It is one of the 25 Communes of the circle of Sikasso, in the 3rd administrative region of Mali. The village was created by the SANOGO who are currently the customary chiefs.

According to civil status sources of the commune of Farakala and the health map of the region, the population is estimated at 18,204 inhabitants in 2022 with an annual demographic growth of 0.036 [8]. (Digital Health Map of Mali, 2022).

On the health and educational level, the municipality has a medical clinic which served as a place of study; a Protestant Centre for Disease Assistance; a Community Health Centre not yet operational; a rural maternity; five nursing offices all functional; five Community Health Agent sites all functional; a private High School; a Vocational Training Centre; a Second Cycle and two basic schools.

It is important to note that the village of Farakala is crossed by a pond which retains a significant quantity of water throughout the winter and a good part of the dry season (from November to January), constituting an important breeding ground for mosquitoes.

2.2. Method of the Study

2.2.1 Type, Location and Study Population

This study, carried out in the M'PEDERE Medical Clinic in the Rural Commune of Farakala, was cross-sectional and analytical with prospective recruitment including all children aged 0 to 59 months hospitalized for severe malaria in the said clinic.

The study site was chosen voluntarily because it was the only health structure in the municipality authorized to provide appropriate treatment for severe and complicated malaria (Technical Platform).

The target population consisted of children aged 0 to 59 months and the elderly people caring for them.

2.2.2 Inclusion and Exclusion Criteria

Included in this study were children aged 0 to 59 months who had a severe form of malaria (biologically confirmed) and were treated at the M'PEDERE Medical Clinic in Farakala;

Excluded from this study were children aged 0 to 59 months who had an episode of severe malaria but died on arrival or who had had an episode of malaria or whose parents' consent was not obtained by the investigators, and cases of escape or exit required by the parents against medical advice before recovery.

2.2.3 Data Collection

The survey form, patient follow-up form, curative consultation registers, laboratory registers were used for data collection.

Data collection was carried out from January 2022 to December 2023 using consultation and hospitalization records and operational monitoring sheets for children aged 0 to 59 months. Targets meeting the inclusion criteria were recruited exhaustively.

The technique used consisted of conducting interviews with the parents of sick children, administering questionnaires face-to-face, analyzing patient follow-up records to calculate lengths of stay, condition at discharge, and using curative and laboratory consultation records for concordance.

For methodical recording and proper processing of data, the survey forms were completed regularly and correctly by all service providers depending on their availability, which demonstrates their involvement and commitment to the success of the study and were processed weekly to detect any missing or aberrant data.

2.2.4 Data Collection Tools

The collection tools consisted of:

a) A questionnaire addressed to parents or carers of sick children
b) A questionnaire addressed to service providers
c) A tracking sheet for sick children

2.2.5 Data Analysis

Quantitative data were entered through Epi info software version 7.1.3.3 and analyzed using SPSS software version 26.0 IBM and Microsoft office Excel software version 2016. We used the Chi-square test with a significance level of 0.05. Crude and adjusted odds ratios with their 95% confidence intervals were estimated to measure the strength of the association between the dependent variable and the explanatory variables.

The dependent variable, which is vital prognosis, was dichotomized into two modalities: 1= death, 2= alive. A stepwise downward logistic regression analysis was performed to obtain a final model of associations between dependent and explanatory variables. This model identified factors associated with severe malaria mortality in children aged 0 to 59 months;

The description of the data made it possible to determine the socio-demographic characteristics, the hospital frequency of malaria in children aged 0 to 59 months as well as the mortality rate.

2.2.6 Use of Results

The results obtained in this study were the subject of a final dissertation which was presented and defended publicly in the EHESP defense room.

The results will be returned to the EHESP, at the M'PEDERE Medical Clinic in Farakala in the presence of the municipal authorities.

The final document will be shared with all stakeholders with the aim of strengthening the health system in general and improving the quality of care in particular.

The final report will be the subject of written or oral communication and scientific publication.

2.2.7 Limits

Our work had limitations inherent in all prospective cross-sectional studies carried out in private structures:

- ✓ Low level of technical support and the absence of certain specialties, often forcing providers to make referrals/evacuations to other better equipped structures for better care (CSRéf and local hospitals).
- ✓ The private nature of the structure, according to the health pyramid in Mali, although private structures are counted among the first level of reference, they are often less frequented compared to other health structures such as ASCs, faith-based centers, CSCOm, and CSRéf. This under-attendance could have an influence on the sample size during studies.
- ✓ The sometimes-high cost of services, which could be one of the factors of under-attendance, could also have a negative effect on the sample size during studies.

However, we have taken into account these biases in the data analysis which deserve to be commented on.

2.2.8 Ethical Considerations

The participation of the target children was obtained with the free and informed consent of their parents and caregivers. Informed consent was obtained from the parents (see consent form in the appendix) before proceeding with a detailed explanation of the protocol during which we emphasized the voluntary nature of their participation.

The survey forms were anonymous and the data were kept confidential.
All survey subjects voluntarily and without coercion agreed to participate in the study.

Participants were informed that they could withdraw from the study at any time without this having any impact on the quality of care or the caregiver-patient relationship.

The survey forms were anonymous and the data were kept confidential.
Approval from the EHESP ethics committee and the dissertation director has been obtained.

Permission from the municipal authorities was requested and obtained, the objectives of the study and the data collection methodology were explicitly detailed to all stakeholders involved in the study.

The agreement of the promoter of the M'PEDERE Medical Clinic was obtained before data collection.

III. RESULTS

We present this section according to the descriptive results and the analytical results. Thus, we obtained the following results:

3.1 DESCRIPTIVE RESULTS

❖ **Children Sociodemographic Characteristics :**

Table 1: Sample distribution according to explanatory variables

Variable	n	%
Sex		
Boy	343	50.3
Girl	339	49.7
Age		
0 to 11 months	79	11.6
12 to 59 months	603	88.4
Origin		
Out of town	554	81.2
In the municipality	128	18.8
Mode of Admission		
Self-reference	581	85.2
Referred by a structure	71	10.4
Evacuated by a structure	30	4.4

Variable	n	%
Reason for consultation		
Fever + vomiting	42	6.2
Fever + pallor	211	30.9
Fever + Convulsion + Pallor	152	22.3
Fever + Convulsion	127	18.6
Dizziness + anorexia	108	15.8
Respiratory distress + Fever	27	4.0
Coma + pallor	15	2.2
Clinical forms		
Severe malaria complicated by anemia	384	56.3
Severe malaria complicated by neurological involvement	142	20.8
Severe malaria with anemia and neurological involvement	152	22.3
Severe malaria complicated by hypoglycemia	4	0.6
Length of hospital stay		
1 to 2 days	377	55.3
3 to 4 days	281	41.2
5 days and more	24	3.5

Of the total 682 children included in the study, the distribution was almost equal between girls and boys, with a female predominance of 50.3%.

The age group of 12 to 59 months was the most represented, at 88.4%, with a mean age of 32.47 ± 16.26 months and a modal age of 36 months.

Paradoxically, children from outside the municipality were the most represented, at 81.2%. Four forms of severe malaria with various complications were described in this study. Cases with anemia were the most represented with 56.3%.

The most frequent hospitalization delay was 1 to 2 days, or 55.3%, with an average of 1.48 ± 0.57 days.

Table 2: Distribution of clinical forms in the sample according to the sex of the patients

Sex	Severe malaria complicated by anemia n (%)	Severe malaria complicated by neurological involvement n (%)	Severe malaria with anemia and neurological involvement n (%)	Severe malaria complicated by hypoglycemia n (%)
Boy	195(56.9)	69(20.1)	78(22.7)	1(0.3)
Girl	189(55.8)	73(21.5)	74(21.8)	3(0.9)
Total	**384(56.3)**	**142(20.8)**	**152(22.3)**	**4(0.6)**

Severe malaria complicated by anemia was the most represented clinical form in the sample with a proportion of 56.3%, but this difference is not statistically significant (Khi-2=1.288; P=0.732).

Table 3: Distribution of clinical forms in the sample according to age group

Age Group	Severe malaria complicated by anemia n (%)	Severe malaria complicated by neurological involvement n (%)	Severe malaria with anemia and neurological involvement n (%)	Severe malaria complicated by hypoglycemia n (%)
0 to 11 months	42 (53.2)	15 (19.0)	22 (27.8)	0
12 to 59 months	342 (56.7)	127 (21.1)	130 (21.6)	4 (0.7)
Total	**384 (56.3)**	**142 (20.8)**	**152 (22.3)**	**4 (0.6)**

The majority of severe malaria cases, regardless of clinical form, were in the 12-59 month age group, but the difference was not statistically significant according to age group (Chi-2=2.064; p=0.559).

❖ **Infant and Child Mortality Related to Malaria**

Table 4: Disease outcome in the sample by patient sex

Variables	Alive	Deceased
Sex		
Boy	337 (98.3%)	6 (1.7%)
Girl	337 (99.4%)	2 (0.6%)
Age group		
0 to 11 months	76 (96.2%)	3 (3.8%)
12 to 59 months	598 (99.2%)	5 (0.8%)
Communal origin		
Out of town	536 (98.6%)	8 (1.4%)
In the municipality	126 (100%)	0 (0%)
Clinical forms of severe malaria		
Severe malaria complicated by anemia	378 (98.4%)	6 (1.6%)
Severe malaria complicated by neurological involvement	142 (100%)	0 (0%)
Severe mixed malaria	150 (98.7%)	2 (1.3%)
Severe malaria complicated by hypoglycemia	4 (100%)	0 (0%)
Respiratory distress		
Yes	37 (84.1%)	7 (15.9%)
No	637 (99.8%)	1 (0.2%)

The mortality rate appears higher in boys than girls, but this difference is not statistically significant (P = 0.180; OR = 0.333; 95% CI OR: 0.67-1.663).

Children aged 0-11 months were 99.8 times more likely to die from severe malaria compared to those aged 12-59 months (P = 0.036; OR = 0.212; 95% CI OR: 0.05-0.904).

There is no statistically significant difference in mortality according to the clinical forms of severe malaria in children aged 0 to 59 months (P = 0.563; OR = 0.762; 95% CI OR: 0.304 – 1.913).

3.2 Analytical Results

3.2.1 Bivariate Analysis

❖ **Factors Associated with Malaria-Related Deaths**

Table 5: Severe malaria in children aged 0-59 months according to the presence or absence of different explanatory variables

Variables	Alive	Deceased
Time to seek care		
Access to care within 24 hours	667 (99.7%)	2 (0.3%)
24 Hour Care and more	7 (53.8%)	6 (46.2%)
Blantyre Score		
General condition altered	12 (60%)	8 (40%)
General condition: Fair	278 (100%)	0 (0%)
General condition good	384 (100%)	0 (0%)
Presence of generalized convulsions		
Yes	14 (100%)	0 (0%)
No	660 (98.8%)	8 (1.2%)
Malnutrition		
Yes	10 (100%)	0 (0%)
No	664 (98.8)	8 (1.2%)
Generalized edema		
Yes	5 (100%)	0 (0%)
No	669 (98.2%)	8 (1.2%)
Hypoglycemic coma		
Yes	15 (93.8%)	1 (6.3%)
No	659 (98.9%)	7 (1.1%)
Prostration		
Yes	292 (97.3%)	8 (2.7%)
No	382 (100%)	0 (0%)

Mortality due to severe malaria is 0.008 times higher in children suffering from acute respiratory distress compared to those not suffering from this symptomatology: (P < 0.05; OR = 0.008; 95% CI OR: 0.001 – 0.069) and 285.86 higher in children who sought care beyond 24 hours, compared to those with a delay of less than 24 hours: (P < 0.05; OR = 285.857; 95% CI OR: 48.931 – 1669.991).

3.2.2 Multivariate Analysis

Table 6: Final model of factors associated with the outcome of severe malaria in children aged 0-59 months admitted to the M'PEDERE clinic in the rural commune of FARAKALA in the Sikasso Health District from January 2022 to December 2023

Variables	n	ORa	95% confidence interval for ORa		P-Value
			Lower bound	Upper bound	
Constant					,000
12-59 months	603				1
0-11 months	79	0.158	0.010	2,548	0.194
Girl	339				1
Boy	343	1,783	0.142	22,378	0.654
Appeal deadline: 24 hours	669				1
Appeal deadline less than 24 hours	13	285,973	14,268	5731,833	0.000
No acute respiratory distress	638				1
Acute respiratory distress	44	0.010	0.001	0.181	0.002
No Hypoglycemic Coma	666				1
Hypoglycemic coma	16	3,861	0.052	288,890	0.539

Adjusted for age, sex, respiratory distress, hypoglycemic coma and clinical presentation, children with severe malaria and delayed access to care of more than 24 hours were 286 times more likely to die during their hospitalization, compared to those who were treated in a conventional health facility in less than 24 hours (P<0.001; OR=0.010; 95% CI OR: 14.268-5731.833).

Similarly, adjusted for age, sex, time to care, hypoglycemic coma and clinical presentation, children affected by severe malaria with acute respiratory distress have 0.010 times more likely to die, compared to those not suffering from this symptomatology (p=0.002; ORa=0.008; 95%CI OR: 0.001-0.181).

V. COMMENTS AND DISCUSSIONS

❖ **Sociodemographic Characteristics of Hospitalized Children**

- **Sex**

In our study of 682 participants, 50.3% were male and 49.7% female, a sex ratio of 100 girls to 98 boys. This near gender equality shows us that malaria transmission is not gender-related.

Results comparable to ours were observed by AL SANOGO in 2021 at Sikasso hospital in its study on the morbidity and mortality of severe malaria in children aged 6 to 59 months (52.17%) and by CO SOW in 2023 at the CSRéf of commune VI of Bamako (54.3%) [7-9], who found a male predominance. Similarly AA Oumar *et al*., [10], in their study on the impact of malaria chemoprevention on the mortality of children aged 3 to 59 months in the Diré health district in Mali, carried out in 2021 in the Diré health district in Mali, found a sex ratio of 1.02 in favor of boys.

However, our results are different from those of Traore AM who reported a clear female predominance with 54.7%. A study carried out in Niger by A SAMANA and Al also found a female predominance with 57.1%.

These findings seem all the more likely since no study has yet proven an association between severe malaria and sex according to current data in the literature.

- **Age**

The age group of 12 to 59 months was predominantly affected (88.4%) by malaria with a mean age of 33 months, a modal age of 36 months and extremes of 2 to 59 months.

This result is comparable to those of AL SANOGO in 2021 at Sikasso hospital [7]. (47.72%) among 25 to 59 months and CO SOW in 2023 at the CSRéf of commune VI of Bamako (49.30%) [9].

The 0-11 month age group was the most affected by this mortality related to severe malaria (3.79%). It should be noted that in this study, age was a determining factor for death due to severe malaria (P = 0.036; OR = 0.212; 95% CI OR: 0.05-0.904) in bivariate analysis. However, age was not retained as a factor associated with severe malaria in multivariate analysis (P < 0.001; OR = 3.721; 95% CI OR: 0-0.999).

The 3 cases of death occurring in the age group 0 to 11 months respectively (6 months, 10 months and 7 months), could be explained by the fact that after the age of 06 months, infants lose the immunity conferred by maternal antibodies and become very vulnerable to infections due to the immaturity of the immune system according to the literature.

- **Hospital Frequency**

During our study period, we identified 682 patients meeting our inclusion criteria out of 1,311 hospitalized, representing a hospital frequency of 52.47%. This frequency is similar to that of AL SANOGO [7], which found 58.54% in 2021 at Sikasso hospital [7].

On the other hand, it is different from those reported by CO SOW in 2023 (13%) to the CSRef of commune VI of Bamako and by R. Dembélé in 2018 (15.75%) to the pediatrics department of the Mali hospital [6-9].

Our result can be explained by the study area (Sikasso), which is a region of high rainfall in Mali and which is cited as an area of hyper malaria endemicity in Mali. Better still, the duration of the study, which included two periods of high transmission (July to December 2022 and 2023), could have impacted the high hospital frequency observed in this study.

- **Reason for Consultation, Method of Admission and Clinical Forms of Severe Malaria**

The predominant symptomatological variety was represented by (fever, conjunctival pallor, convulsions and anorexia represented (93.8%). This result is consistent with those of CO SOW in 2023 at the CSRéf of commune VI of Bamako which had fever as the first reason for consultation (89.4%), followed by pallor (73.5), of AL SANOGO in 2021 from the Sikasso hospital which had found fever as the first reason for consultation (82.23%) [7-9], followed by pallor (56.25%) and convulsions (21.68%) and A SAIDOU in 2022 in his study on the Prognostic Factors of Severe Malaria at the Diffa Mother-Child Health Center [11], who found fever as the primary reason for consultation (90.36%). Also SANGHO *et al*., [12], at the DEMBA NYUMAN mutual insurance company in Bamako in 2020 found diarrhea associated with vomiting as the main reason for consultation (22.10%), fever (52.3%), followed by convulsions (33.2%) and pallor (14.5%).

All these results are consistent with the literature which gives fever as the main reason for consultation. Self-referral was the most frequent mode of admission (85.2%), which is consistent with those of N TELLY in 2020 in the intensive care unit at the pediatric center of Yaoundé in Cameroon and of A SAIDOU [11], in Niger who had respectively found (57%) and (51.27%).

According to the forms of severe malaria, severe malaria complicated by anemia was the most frequent form (56.6%) followed by the neurological + anemic form (22.3%). This result observed in this study is similar to those of KEITA et al in 2022 in their study on the epidemiological, clinical, paraclinical and therapeutic aspects of severe malaria in children hospitalized in the pediatric department of the CSRéf CIV in the district of Bamako in Mali.

who had found (42.7%), B MAIGA who had found (42%) and A SAIDOU *et al*., had found (28.85%) [11-14].

Moreover, these results are different from those of AL SANOGO and M DIAKITE in 2021 in his study onthe morbidity and mortality of severe malaria in children aged 6-59 months hospitalized in the Pediatrics department of the Ouélésseboungou Reference Health Center, which found a clear predominance of severe malaria complicated by neurological involvement (50.43%) and (39%) respectively [5-7].

It is important to note that in this study, we noticed a relatively high frequency of blood transfusion history (1, 2, 3 and 4) in some children depending on their municipal origin (27.3%) of the 682 children included in the study. Children coming from other municipalities were mostly represented (82.25%) compared to those residing in the municipality.

The reasons for this history of transfusion could be an interesting research topic.

- **Evolution**

During our study, 98.82% of patients were cured without sequelae and 2.16% with sequelae. We recorded 8 cases of death, representing a mortality rate of 1.16%.

This result in terms of cure rate and after-effects is close to those of AL SANOGO, M DIAKITE, and who had respectively found (90.03%) without after-effects, (2.02%) with after-effects, (82.3%) without after-effects, (1.8%) with after-effects [5-7].

This mortality rate (1.16%) linked to malaria in our study is close to that found by AL SANOGO of the Sikasso hospital who found a cure rate of and a mortality rate of (3.76%) [7].

Furthermore, this result is lower than those of CO SOW, M KEITA *et al*., N TELLY, A SAIDOU, who respectively found a mortality rate of (11.1%), (5.5%), (16.7%) and finally (6.62) [9-13].

The relatively low mortality rate (1.16%) in our series could be explained by the proximity of our structure to the hospital and the CSRef to which complicated cases are referred and/or evacuated for better management.

The six deaths occurring in children aged 12 to 59 months could be explained by the fact that parents reduce their control over children at this age, unlike in the 0 to 11 month age group. They are more or less left to their own devices, which would explain the vulnerability of this group.

The average length of hospitalization was 2.74, roughly equal to 3 days in 43.00%. This result is similar to those of AL SANOGO who found a length of hospitalization of 3 days (86.13)%, M KEITA *et al*., [13], had found 4.8 days serious, darkens the child's vital prognosis.

IV. CONCLUSION

Malaria, in its severe forms as defined by the WHO, remains a major cause of death among children aged 0 to 59 months in the M'PEDERE medical clinic in Farakala. This excess mortality is associated with two key factors: delays in seeking conventional medical care and acute respiratory distress in children. Health authorities, political and administrative actors, populations, as well as local partners and non-governmental organizations, must be made aware of the importance of taking these key factors into account in the management of malaria and the overall fight against the disease.

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