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Factors Associated with in-Hospital Mortality Related to Severe Malaria in Children Aged 0-59 Months at the National Hospital of Niamey: A Retrospective Study

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Abstract: Severe malaria is a global public health problem and remains a major cause of death among children in sub-Saharan Africa. The aim of the study is to investigate the factors associated with severe malaria mortality in children aged 0-59 months. A cross-sectional study was conducted among children aged 0-59 months admitted for severe malaria to the paediatric service of the national hospital of Niamey. This study concerned the records of children hospitalised from 1st January 2016 to 31st December 2020. The selection was made by non-probability sampling for convenience. A total of 3300 cases were selected on the basis of the selection criteria, of which 131 deaths were recorded, i.e. a case-fatality rate of 4%. The frequency of hospitalisation for severe malaria was 24.84% The factors associated with death were patient age over 48 months (OR=8.14 p=0.034), lethargy (OR=7.34 p=0.012), convulsion (OR=3.26, p=0,032), maternal age over 30 years (OR=1.61, p=0.014), not fully vaccinated (OR=1.99, p=0.021), severe pallor (OR=1.82, p=0.002), hyperglycaemia over 7 mmol (OR=6.87 p< 0.0001), severe malaria anaemia (OR=2.79 p<0,0001). Other clinical manifestations were significantly associated with death: respiratory distress (p<0.0001), altered general condition (p<0.0001), coma (p<0.0001) frequency of seizures ≥ 3 (p<0.0001), coma (p<0.0001), malnutrition (p<0.0001), dehydration (p<0.0001), hyperthermia ≥ 39°C (p<0.0001), hyperparasitemia ≥1000 p/ul (p<0.0001) and hyperleukocytosis >12000/mm^3 (p<0.0001). Severe malaria remains the leading cause of hospitalisation in paediatric wards with a frequency of 24.84%. The fatality (lethality) rate was 4.00%. The factors associated with death thus defined (age over 48 months, convulsion, lethargy), a reinforcement of the technical platform as well as a good malaria prevention policy (use of impregnated mosquito nets, chemoprevention, hygiene rules, etc.) is necessary for a reduction intra-hospital mortality of this pathology.

Keywords: Severe Malaria, Children, Associated Factors, Niamey

1. Introduction

Malaria remains a worrying disease in the world. It is a major public health problem with mortality remaining high in severe forms, especially in children [1]. In 2019, the World Health Organization (WHO) estimated the number of malaria cases worldwide at 229 million with 409,000 deaths, 67% of which (i.e. 274,000 cases) were among children under 5

years of age. The WHO African Region alone accounted for 93% of these deaths [2]. According to the same report, almost 90% of cases and deaths worldwide were concentrated in the African region. In 2016, according to the Niger Health Statistical Yearbook, malaria was diagnosed in 1.5 million children under the age of 0-59 months, of which 90,000 were severe malaria cases (5.81%) [3]. Of the 1561 deaths recorded in the same year, 77.19% were children in this age group. The lethality of malaria is mainly related to severe forms exclusively secondary to Plasmodium falciparum infestation. [1, 4-5]. Despite Niger's efforts to reduce malaria morbidity by 75% and to eliminate it as a public health problem by 2030, malaria still represents more than 35% of the causes of paediatric consultations [6]. In a study on factors associated with death in children aged 1 month to 15 years with severe malaria at the National Hospital of Niamey in 2016, the case fatality of severe malaria was 14.50%. The main factors associated with death that were identified were maternal age, maternal education level, maternal socioeconomic level, coma, hypoglycaemia and renal failure [7]. However, few studies have been conducted specifically on in-hospital mortality of severe malaria in children aged 0-59 months and the identification of associated factors; hence the interest of this study. The objective of our study was to investigate the factors associated with severe malaria mortality in children aged 0-59 months.

2. Materiel and Method

2.1. Study Sitting and Place Study

The study took place in the national hospital of Niamey, specifically in the paediatric wards A and B where malaria was endemic with a seasonal recrudescence during the rainy season which runs from July to October. It is one of the largest hospitals in the country. These services receive small children (0-24 months) and older children (>24 months) respectively. All children under five years of age are treated free of charge in accordance with the state health policy in place since 2006. Niamey is the capital of Niger and is located on the Niger River in the far west of the country with an estimated population of 1.8 million in 2018. It is located at 13°31 North latitude and 2°6 East longitude. With an area of 239.3 km^2, it is built on two plateaus overlooking the Niger River, at an altitude of 218 m. The climate is Sahelian with a temperature ranging from 17° to 45°C depending on the period and a rainfall varying from 500 to 700 mm per year (July-October).

2.2. Type of Study

A retrospective study was conducted among children aged 0-59 months admitted with severe malaria from January 1st 2016 to December 31st 2020.

2.3. Population and Sampling

The study included all children aged 0-59 months who were referred or admitted to and managed in the paediatric A and paediatric B wards of the NNH during the study period.

Our study included all medical records of children aged 0-59 months admitted for severe malaria during the study period (2016-2020) in the paediatric A and B wards of the NNH. The sampling method was non-probability and for convenience with selection of all records of children aged 0-5 years in the two paediatric wards during the study period. Cases of uncomplicated malaria and all other pathologies that prompted a paediatric consultation were excluded from our sample.

2.4. Technique and Method of Data Collection

Data collectors were selected and trained to fill in the questionnaire. The data was entered manually. Data entry was done with the KoBoCollect software version V1.2.3 installed on the smartphones of the collection team.

2.5. Data Analysis Technique

The sampling technique was non-probability for convenience, with exhaustive selection of all child records meeting the selection criteria. Data were collected on the socio-demographic (mothers and children), clinical and biological characteristics of the children. The data were collected using a questionnaire and then entered using the KoboCollect version 1.29.3 software. The data were then analysed using SPSS-Win version 22.0. The quantitative variables were presented as proportions and the quantitative variables as mean (Mean) and standard deviation (SD). Bivariate and multivariate logistic regression was performed to identify associated factors for in-hospital mortality in children aged 0-59 months. The significance level of 5% was considered to retain significant variables and the strength of the association was measured using Odds ratios. The 5% significance level is the maximum threshold retained for accepting a variable as a predictor in the logistic regression model.

3. Results

3.1. Descriptively

We collected 19901 patients hospitalised in the 2 paediatric wards. Of these patients, 4943 were hospitalised for severe malaria. This gives a prevalence of 24.84%. Thus 3300 files were selected on the basis of the selection criteria: 1673 files in paediatrics A and 1627 in paediatrics B, i.e. 50.70% and 49.30% respectively.

In terms of the socio-demographics of the children, the average age of the children was: Mean (SD) = 32.30 (17.22) months with extremes ranging from 1 to 59 months. 54% of severe malaria cases were observed in children aged 24-48 months, 55% of the cases were male, 64.4% of the cases were from urban areas and 68% of the cases were from parents with low socio-economic status.

In terms of mode and reason for admission, 81% were referred to the national hospital by another health facility.

The most predominant reasons for consultation were fever (93.60%), pallor (35.70%), digestive disorders (38.40%) and convulsion (28.40%).

On clinical examination on admission, 22.90% of patients had hyperthermia ≥ 39°C, altered general condition and consciousness in 23.50% and 19.30% of cases respectively. A proportion of 5.30% of patients presented with respiratory distress.

The most frequent clinical forms were the anaemic form, 1697 cases out of 3300, i.e. 51.43%, the neurological form, 990 cases out of 3300, i.e. 30%, and the mixed form (at least two forms combined), 377 cases out of 3300, i.e. 11.40%.

Biologically, severe anaemia < 5g/dl was observed in 1073 cases out of 3288 or 32.50%, severe hypoglycaemia < 2.2mmol in 580 cases out of 2373 or 17.60% and hyperparasitemia ≥ 10000p/ul in 458 cases out of 3300 or 13.50%.

Therapeutically, injectable artesunate was the most commonly administered drug in 2131 cases out of 3300 (64.60%), followed by injectable artemether in 1123 cases out of 3300 (34%). More than half of the patients were transfused (54.52%) mainly whole blood. Antibiotic therapy based on Ceftriaxone or ampicillin was performed in 83.21% of patients often combined with gentamycin. The evolution was favourable in 3169 cases out of 3300 or 96% with a case fatality of 4%.

The majority of patients who died were affected by the neurological form in 54 cases or 41.22%, followed by the anaemic form in 37 cases or 28.25% and hypoglycaemic form in 22 cases or 16.79% (Figure 1).

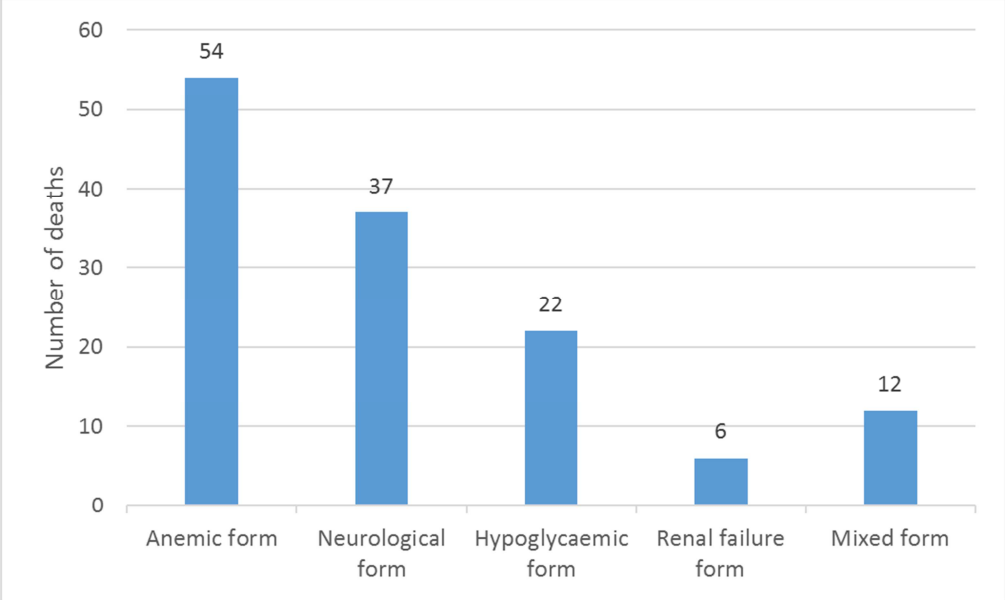

Figure 1 *Dispatching of patient deaths according to severe forms of malaria at Niamey National Hospital 2016-2022.*

3.2. Factors Associated with Severe Malaria Cases in Univariate Analysis

3.2.1. Socio-demographic Factors of Children

Among the socio-demographic variables studied in the patients, the risk of intra-hospital mortality was 2.34 times higher in children over 48 months of age than in those under 24 months of age 2.34 [1.21-4.53], (p=0.011). Rural origin was also significantly associated with intra-hospital mortality p (< 0.0001), (Table 1).

Table 1. *Relationship between children's socio-demographic factors and in-hospital mortality of severe malaria cases at the National Hospital of Niamey, 2016-2020, univariate analysis.*

	Intra-hospital mortality					
	Yes		**No**		**Univariate analysis**	
	n	**%**	**n**	**%**	**OR [IC]**	**p-value**
Age group						0.017
<24 Months	977	29.61	53	1.61	1	
24 à 48 Months	1716	52.00	67	2.03	1.38[0.96-2.00]	0.080
>48 Months	476	14.42	11	0.33	2.34[1.21-4.53]	0.011
Gender						0.307
Mal	1744	52.85	78	2.36	1	
Female	1425	43.18	53	1.61	1.20[0.64-1.71]	0.310
Source						<0.0001
No	2064	62.55	62	1.88	1	
Yes	1105	33.48	69	2.09	0.48[0.33-0.68]	<0.0001

3.2.2. Factors Associated with the Socio-demographic Characteristics of the Mother

Children of mothers aged 30 years or older had a 1.6-fold higher risk of intra-hospital mortality compared to children whose mothers were younger than 30 years 1.564 [1.08-2.39], (p=0.014) (Table 2).

Table 2. *Relationship between socio-demographic characteristics of mothers and intra-hospital mortality of severe malaria cases at Niamey National Hospital, 2016-2020, univariate analysis.*

	Intra-hospital mortality					
	Yes		**No**		**Univariate analysis**	
	n	**%**	**n**	**%**	**OR [IC]**	**p-value**
Age Group (years)						0.014
<30	1975	59.85	96	2.91	1	
≥30	1161	35.18	35	1.06	1.61[1.08-2.39]	0.014
Level education						0.275
No	878	26.61	32	0.97	1	
Primary	1853	56.15	85	2.58	0.79[0.52-1.20]	0.227
Secondary	276	8.36	11	0.33	0,91[0.45-1,83]	0.802
Superior	162	4.91	3	0.09	1,96[0.59-6.50]	0.267
Mothers' occupation						0.314
Trader	115	3.48	2	0.06	1	
Pupil/student	137	4.15	7	0.21	1.15[0.19-7.04]	0.874
Housewife	2739	83.00	117	3.55	0.47[0.14-1.50]	0.203
Civil servant	149	4.52	3	0.09	0.39[0,09-1.55]	0.183
Other	29	0,88	2	0.06	0.29[0.04-1.82]	0.188
Parents' socio-economic level						0.449
Low	2150	65.15	94	2.85	1	
Medium	828	25.09	32	0.97	1.13[0.75-1.70]	0.555
High	191	5.79	5	0.15	1.67[0.67-4.15]	0.270

3.2.3. Factors Related to Patient History

Among the antecedents, unvaccinated children (p=0.007) had a 1.99 higher risk of death than those who were vaccinated. Stunting (p=0.022) and malnutrition (p<0.0001) were significantly associated with intra-hospital mortality, (p=<0.0001) (Table 3).

Table 3. *Relationship between background factors and intra-hospital mortality of severe malaria cases at the National Hospital of Niamey, 2016-2020, univariate analysis.*

	Intra-hospital mortality					
	Yes		**No**		**Univariate analysis**	
	n	**%**	**n**	**%**	**OR [IC]**	**p-value**
Psychomotor Development						0.022
Good/Satisfactory	3108	94.18	124	3.76	1	
Delay	61	1.85	7	0.21	0.34 [0.15-0.77]	0.022
Vaccinations						<0.0001
To date	1480	44.85	64	1.94	1	
Doubtful	725	21.97	46	1.39	0.68[0.46-1.01]	0.053
Not up to date	964	29.21	21	0.64	1.99[1,20-3.27]	0.007
History of sickle disease						0.556
No	3056	92.61	125	3.79	1	
Yes	113	3.42	6	0.18	0.77[0.33-1.78]	0.556
History of Malnutrition						<0.0001
No	2803	84.94	42	1.27	1	
Yes	366	11.09	89	2.70	0.06[0.42-0.09]	<0.0001

3.2.4. Factors Related to the Mode of Admission and Reason for Consultation

Children who were admitted with severe pallor had a 1.82-fold increased risk of intra-hospital mortality compared with those who were not pallid 1.82 [1.21-2.75], p=0.002. Being referred from another health facility (p=0.014), lethargy (p<0.0001), number of convulsions ≥3 (p<0.0001), coma (p<0.0001) were identified as factors significantly associated with patient death (Table 4).

Table 4. *Relationship between factors related to mode of admission, reason for consultation and intra-hospital mortality of severe malaria cases at the National Hospital of Niamey, 2016-2020, univariate analysis.*

	Intra-hospital mortality					
	Yes		**No**		**Univariate analysis**	
	n	**%**	**n**	**%**	**OR [IC]**	**p-value**
Mode of admission						0,007
Direct	617	18.70	14	0.42	1	
Referral	2552	77.33	117	3.55	0.49[0.28-0.86]	0.014
Fever						0.564
No	201	6.09	10	0.30	1	
Yes	2968	89.94	121	3.67	1.22[0.63-2.36]	0.564
Severe pallor						0,002
No	2023	61.30	100	3.03	1	
Yes	1146	34.73	31	0.94	1.82[1.21-2.75]	0.002
Convulsions						0,004
No	2304	69.82	80	2.42	1	
Yes	865	26.21	51	1.55	0.58[0.41-0.84]	0.004
Number of convulsions						<0.0001
≤ 2	440	13.33	5	0.15	1	
≥ 3	434	13.15	63	1.91	0.07[0.03-0.19]	<0.0001
Coma						<0.0001
No	3119	94.52	77	2.33	1	
Yes	50	1.52	53	1.61	0.02[0.01-0.03]	<0.0001
Lethargy						<0.0001
No	2521	76.39	38	1.15	1	
Yes	648	19.64	93	2.82	0.10[0.07-0.15]	<0.0001
Vomiting						0.583
No	2248	68.12	90	2.73	1	1.000
Yes	921	27.91	41	1.24	0,89[0.61-1.31]	0.581

Factors related to patients' clinical signs on admission and intra-hospital mortality hyperthermia ≥ 39°C (p< 0.0001), poor general condition (p< 0.0001), altered consciousness (p< 0.0001), respiratory distress (p< 0.0001) and dehydration (p< 0.0001) were significantly associated with intra-hospital mortality (Table 5).

Table 5. *Relationship between factors related to patients' clinical signs on admission and in- hospital mortality of severe malaria cases at the National Hospital of Niamey, 2016-2020.*

	Intra-hospital mortality					
	Yes		**No**		**Univariate analysis**	
	n	**%**	**n**	**%**	**OR [IC]**	**p-value**
Hyperthermia (≥39°)						<0.0001
No	2420	73.33	62	1.88	1	
Yes	689	20.88	68	2.06	0.25[0.18-0.37]	<0.0001
General condition						<0.0001
Good	2515	76.21	8	0.24	1	
Bad	654	19.82	123	3.73	0.01[0.00-0.03]	<0.0001
Conjunctiva						0.048
Normo coloured	1086	32.91	56	1.70	1	
pale	2083	63.12	75	2.27	1.43[1.00-2.04]	0.048
Consciousness						<0.0001
No	2626	79.58	38	1.15	1	
Yes	543	16.45	93	2.82	0.08[0.05-0.12]	<0.0001
Respiratory distress						<0.0001
No	3014	91.33	110	3.33	1	
Yes	155	4.70	21	0.64	0.26[0.16-0.44]	<0.0001
Hydration state						<0.0001
No	3015	91.36	61	1.85	1	
Yes	154	4.67	70	2.12	0.04[0.03-0.06]	<0.0001

3.2.5. Biology-related Factors

Children with a blood glucose level >7mmol had a 6.87 times greater risk of death than those with a blood glucose level <2.5mmol/ul 6.869[2.472-19.084], p<0.0001. Blood glucose levels between 2.5-7 mmol/ul increased the risk of death by 3, 3.186[2.218-4.578], p<0.0001. Hyperparasitemia > 1000/ul p (<0.0001). Hyperleukocytosis > 12000/mm^3 (p<0.0001) was significantly associated with death (Table 6).

Table 6. *Relationship between patients' biological signs and intra-hospital mortality of severe malaria cases at the National Hospital of Niamey, 2016-2020, univariate analysis.*

	Intra-hospital mortality					
	Yes		**No**		**Univariate analysis**	
	n	**%**	**n**	**%**	**OR [IC]**	**p-value**
Thick drop (p/ul)						<0.0001
<1000	2130	64.55	49	1.48	1	
1000 à 10000	618	18.73	45	1.36	0.32[0.21-0.48]	<0.0001
>10000	421	12.76	37	1.12	0.26[0.17-0.41]	<0.0001
Haemoglobin (g/dl)						0.970
<5	1029	31.18	44	1.33	1	1
5 à 10	1731	52.45	71	2.15	1.04[0.71-1.53]	0.832
>10	397	12.03	16	0.48	1.06[0.59-1.90]	0.842
Number of white blood cells (/mm³)						<0.0001
≤12000	1426	43.21	40	1.21	1	1
>12000	1674	50.73	91	2.76	0.52[0.35-0.75]	<0.0001
Blood glucose (mmol/ul)						<0.0001
<2.5	514	15.58	66	2.00	1	
2.5 to 7	1514	45.88	61	1.85	3.19[2.22-4.58]	<0.0001
>7	214	6.48	4	0.12	6.87[2.47-19.08]	<0.0001

3.2.6. Factors Related to Clinical Forms of Severe Malaria

Children with severe anaemic malaria were 2.8 times more likely to die in hospital than those without severe anaemic malaria 2.79 [1.89-4.11], p<0.0001. The neurological form (p=0.005) and the hypoglycaemic form (p<0.0001) were identified as factors significantly associated with patient death (Table 7).

Table 7. *Relationship between clinical forms of severe malaria and intra-hospital mortality cases at the National Hospital of Niamey, 2016-2020, univariate analysis.*

	In-hospital mortality					
	Yes		**No**		**Univariate analysis**	
	n	**%**	**n**	**%**	**OR [IC]**	**p-value**
Anaemic form						<0.0001
No	1509	45.73	94	2.85	1	
Yes	1660	50.30	37	1.12	2.79[1.89-4.11]	<0.0001
Neurological form						0.005
No	2233	67.67	77	2.33	1	
Yes	936	28.36	54	1.64	0.59[0.41-0.41]	0.005
Hypoglycaemic form						<0.0001
No	3030	91.82	114	3.45	1	
Yes	139	4.21	17	0.52	0.30[0.17-0.52]	<0.0001
Renal failure form						0.142
No	3095	93.79	125	3.79	1	
Yes	74	2.24	6	0.18	0.49[0.21-1.16]	0.142
Mixed form						0.575
No	2809	85.12	114	3.45	1	
Yes	360	10.91	17	0.52	0.85[0.51-1.44]	0.575

3.2.7. Multivariate Analysis

According to this model, patients older than 48 months (p=0.034) have an 8.14 times higher risk of death than patients younger than 24 months. Also patients who had a seizure (p=0.032) had a 3.26 times higher risk of death than those who did not have a seizure. Lethargy (p=0.012) increased the risk of death by 7.34 times compared to non-

lethargic patients (Table 8).

Table 8. *Multivariate model of potential predictors of severe malaria in-hospital mortality at the National Hospital of Niamey 2016-2020, multivariate analysis.*

	Intra-hospital mortality					
	Yes		**No**		**Multivariate analysis**	
	n	**%**	**n**	**%**	**OR [IC]**	**p-value**
Age group						
<24 Mois	977	29.61	53	1.61	1	
24 à 48 Mois	1716	52.00	67	2.03	1.41[0.44-4.50]	0.556
>48 Mois	476	14.42	11	0.33	8.14[1.17-56.78]	0.034
Thick drop						
<1000p/ul	2130	64.55	49	1.48	1	
1000 à 10000p/ul	618	18.73	45	1.36	0.33[0.10-1.05]	0.062
>10000p/ul	421	12.76	37	1.12	0.39[0.11-1.42	0.158
Number of white blood cells						
≤12000/mm³	1426	43.21	40	1.21	1	
>12000/mm³	1674	50.73	91	2.76	0.42[0.15-1.18]	0.102
Hypoglycaemic form						
No	3030	91.82	114	3.45	1	
Yes	139	4.21	17	0.52	0.04[0.01-0.32]	0.002
Hyperthermia						
<39	2420	73.33	62	1.879	1	
≥39	689	20.88	68	2.061	0.17[0.06-0.47]	0.001
Convulsions						
No	2304	69.82	80	2.424	1	
yes	865	26.21	51	1.545	3.26[1.10-9.62]	0.032
Number of convulsion						
≤ 2 convulsions	440	13.33	5	0.152	1	
≥ 3 convulsions	434	13.15	63	1.909	0.06[0.01-0.26]	<0.001
Lethargy						
No	2521	76.39	38	1.15	1	
Yes	648	19.64	93	2.82	7.34[1.56-34.49]	0.012
Coma						
No	3119	94.52	77	2,33	1	
Yes	50	1.52	53	1.61	0.04[0.01-0.14]	<0.001
General condition						
Good	2515	76.21	8	0.24	1	
Bad	654	19.82	123	3.73	0.02[0.00-0.17]	<0.001
Consciousness						
No	2626	79.58	38	1.15	1	
Yes	543	16.45	93	2.82	0.13[0.04-0.44]	0.001
Hydration state						
No	3015	91.36	61	1.85	1	
Yes	154	4.67	70	2.12	0.11[0.03-0.32]	<0.001
History of Malnutrition						
No	2803	84.94	42	1.27	1	
Yes	366	11.09	89	2.70	0.08[0.02-0.24]	<0.001

4. Discussion

This study not only determined the intra-hospital case fatality of severe malaria, but also the main factors associated with death. The case fatality of severe malaria was 4% in the present study in Niamey. Djadou et al in Togo in 2018 had a similar result of 4.1% in children aged 1-59 months [8]. Our rate is lower than those found in Niger by Soumana et al in children aged 0-59 months at Lamordé National Hospital in 2015 and Kamayé et al in children aged 1 month to 15 years at Niamey National Hospital in 2016, who found 16.90% and 14.50% respectively [7, 9]. This case fatality is high in most countries in Africa south of the Sahara. It was 10.10% in Sikasso in 2014, 14.50% in Cotonou in 2013, 11.1% in Dakar in 2014, 18%, 27.8% and 26.3% in two studies in Brazzaville, 17.8% in Kinshasa [10-15]. The efforts made by our governments and their partners in terms of diagnosis, management and prevention of malaria have helped to reduce this lethality, which nevertheless remains high.

In our study, the risk of intra-hospital mortality in children over 48 months of age was 2.34 times higher than in those

under 24 months of age. Soumana et al. in Niger found a 1.5 times higher mortality risk in children under 1 year of age [9]. This could be explained by the fact that this age group corresponds to the period when a child has lost maternal antibodies and progressively develops partial immunity to malaria [16, 17].

According to the origin of the patients, 52.70% of the deaths were from rural areas with a statically significant correlation. According to the National Institute of Statistics (EDSN MICS IV, 2012) children from rural areas were twice as likely to die [18]. In contrast, Esso in 2013 found no difference in Côte d'Ivoire [19].

Maternal age over 30 years was a risk factor for in-hospital mortality. On the other hand, Soumana et al in Niger found age below 20 years as a risk factor for death [9]. Ossou et al in Congo Brazzaville in 2011, Assev et al in Côte d'Ivoire in 2008 and Kouéta et al in Burkina Faso made the same finding [14, 20-21].

In Niger, malnutrition affects one child in five according to the national statistics institute [18]. It can be at the root of paediatric tropical pathology. There is often an accumulation of risks since in developing countries, under nutrition is frequently associated with anaemia and digestive parasitosis [21, 22]. However, in our study, severe acute malnutrition was a protective factor against death from severe malaria. Several authors in the literature have found severe acute malnutrition to be a risk factor for death from severe malaria in children, Ouermi et al in 2017 in Burkina, Augustin et al in 2018 in Democratic Republic of Congo and Adademy et al in Benin in 2015 [23-25]. Kamayé et al in Niger found no association between severe malaria death and malnutrition [7].

In our study, unvaccinated children had a 1.99 times higher risk of in-hospital mortality than those who were vaccinated. There are no data in the literature regarding the link between childhood vaccination and severe malaria mortality. However, according to the World Health Organisation, regular immunisation protects children against the most deadly diseases. According to the WHO, every year, immunisation prevents about 2 5million child deaths [26, 27]. For this reason, it recommends an expanded programme of childhood immunisation against various childhood diseases.

Analysis of the clinical profile of children showed that severe pallor was associated with the risk of death. Our result is corroborated by those of Ouermi in Burkina in 2017 in children hospitalised for severe malaria and of Sidi in Niger in 2019 in children hospitalised for severe malaria with haemoglobinuria [24, 28]. Lethargy, convulsion, were risk factors for in-hospital mortality. Kamayé and al in Niger and Augustin in Congo made the same observation in children with severe malaria [7, 25]. Other clinical manifestations, in particular hyperthermia above 39°C, altered general condition and consciousness, respiratory distress, number of convulsions ≥ 3, coma were identified as factors significantly associated with death related to severe malaria. Other authors did not find this association, namely Gbadoe et al in Togo in 2007 and Koueta and al in Burkina Faso [14, 29].

Biologically, hyperglycaemia > 7 mmol was a risk factor for in-hospital mortality from severe malaria. Hyperparasitemia ≥ 1000/ul, hyperleukocytosis > 12000/mm^3 were statistically significant for in-hospital mortality. The same observation was made by Ouermi and al in Burkina Faso [24], although severe anaemia is the primary course of morbidity, no significant association was found between severe malaria mortality and severe anaemia in the present study. The same is true of many other studies conducted on the African continent and beyond [30-32]. This could simply be due to the availability of blood products and a better understanding of its pathogenesis. Nevertheless Edelu et al in Nigeria and Sow et al in Guinea found severe anaemia as an associated factor in children hospitalised with severe malaria [33-34]. Among the factors significantly associated with the univariate analysis, the multivariate logistic regression made it possible to retain three of them, namely the age of the patients greater than four years, convulsion and lethargy. Augustin et al in the Democratic Republic of Congo found the following factors in the multivariate analysis: coma, convulsion and severe malnutrition [25]. Sow and colleagues in Guinea Conakry found age over two years, convulsion, anaemia and respiratory distress to be factors in this model [34].

The major factors associated with death from severe malaria in children: patient age above 48 months, convulsion and lethargy, should be taken into account to reduce the mortality rate in children in the inpatient setting.

Potential limitations of the study we encountered difficulties in this study, as in any retrospective work. Data on certain factors such as socio-economic data of patients and mothers, and biological examinations were not available due to poorly filled out files and poor archiving in certain departments.

5. Conclusion

Severe malaria in children is still a major problem in the paediatric wards of the national hospital in Niamey. It is the leading cause of hospitalisation for children aged 0-59 months (24.50%) with a lethality of 4%. The main factors associated with death having been identified (age over 48 months, convulsion, lethargy), the fight against these factors with a view to decrease the lethality of severe malaria requires a certain number of actions such as the improvement of the technical platform in paediatric services, communication campaigns, a change of behaviour must be carried out in the direction of the populations with the aim of fighting against the various associated factors. The government should also continue and strengthen the policy of free care for children less than five years of age in order to considerably reduce hospital mortality linked to severe malaria.

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