

Short Research Article

Interaction between malnutrition and severe malaria

Summary:

Problem: Malnutrition and malaria are responsible of high mortality in Niger. The interaction between malnutrition and malaria remains controversial.

Methodology: We analyzed the retrospective data (2014 and 2015) of 974 malarious children referred to the pediatric departments of the Niamey National Hospital. Malnutrition is assessed by measuring MUAC. The criteria for the severity of malaria are those defined by the World Health Organization (WHO) in 2015. The objective is to assess the relative risk between malnutrition and the severity of malaria.

Results: Nine thirty-four percent (9.34% or 91/974) of patients were malnourished, of which 38.4% (35/91) were severely malnourished and 61.54% (56/91) were moderately malnourished. 79.12% (72/91) of the malnourished had severe malaria compared with 20.88% (19/91) who had uncomplicated malaria (RR = 0.7, p = 0.3). The severity of malnutrition does not affect the severity of malaria. 14.28% (5/35) of the malnourished had died of malaria (RR = 1.6, p = 0.2). Forty percent (2/5) of the severely malnourished died of malaria, compared to 60% (3/5) of the moderately malnourished (RR = 0.9, p = 0.6). The leading causes of death among malnourished people were severe anemia (80%) and shock (20%).

Conclusion: Global acute malnutrition is a factor of severity of malaria. However, the severity of malnutrition does not affect the severity of malaria. There is no statistically significant difference in risk of malaria death between moderate malnourished and severe malnourished.

Keywords: Interaction, Malnutrition, Malaria, Severe, Niger

INTRODUCTION

Malnutrition and malaria are the main causes of mortality in sub-Saharan Africa. Niger faces these two major challenges. On the one hand, it faces a recurring food crisis that mainly affects children under 5 and on the other hand, it is confronted with malaria which is one of the main causes of hospitalization and death of children. 5 200 000 cases of malaria and 10,000 deaths were recurrent in 2015 (1). 2 to 2.5 million people are food insecure in 2017. The global acute malnutrition rate was 11.4% in 2016 and 13.9% in 2017 (2). The rate of severe acute

malnutrition is 1.9% while the critical threshold set by WHO is 2% (3). Child mortality in Niger is one of the highest in the world. It is about 198/1000 (4). This malnutrition leads to stunting, cognitive delay, vulnerability to diseases, a reduction in their productivity and finally a decrease in their life expectancy (5). Low birth weight of the newborn and the risk of a pathology associated with malaria in the mother are the main consequences of malaria in pregnant women (6), (7). In children, malaria has a negative impact on their physical and cognitive performance through school absenteeism and brain damage during neuro-malarial attacks (8).

The relationship between malnutrition and malaria remains complex and controversial. This problem is all the more difficult to elucidate, as in Niger, malnutrition and malaria occur most often concomitantly in children because during the food lean season (June, July) succeeds the season of high transmission of malaria (August, September, October).

Several hypotheses have been put forward to explain the relationship between malnutrition and malaria: The first claims that malnutrition and malaria act synergistically. Indeed, previous studies suggest that malaria may increase the incidence and severity of malnutrition, while malnutrition may increase the risk of infection including malaria (9), (10), (11). The second hypothesis defends an antagonistic effect between malnutrition and malaria. Indeed, some studies have shown that malnutrition would protect against severe forms of malaria as others have shown that malaria increases the risk of malnutrition (12). Finally, the last hypothesis shows that malnutrition is not associated with malaria (13), (14). The divergence of results and lack of consensus on this point illustrate the complexity of the interaction between malaria and malnutrition (15). There is a vicious circle between malaria and malnutrition (13) so that the question of their interaction remains.

It is in this context that we conducted a two-year retrospective study at Pediatric Services A and B of the National Hospital of Niamey (HNN) to describe the interaction between malnutrition and severe malaria by calculating the risk. relationship between the two affections.

METHODOLOGY

1) Type and site of study

This is a descriptive and retrospective two-year study (2014-2016), which aims to describe the relationship between malnutrition and the severity of malaria. She was taken to Pediatric Services A and B of Niamey National Hospital.

2) The study population

63 The study population consists of 974 children aged 0 to 15, hospitalized in the Pediatric HNN
64 Malaria Department. All children included are confirmed malarious by a thick drop.

65 **2) Data collection tools**

66 The data was collected using survey cards. The variables collected made it possible to describe
67 the epidemiological, clinical and biological characteristics of patients with both malaria and
68 malnutrition.

69 **3) Variables analyzed**

70 The main factors studied are the severity of malaria and malnutrition. Severe malaria has been
71 defined by the presence of at least one of the WHO criteria of severity (16) which are: Coma
72 (Glasgow less than 11 in adults and Blantyre less than 3 in children); prostration, repeated
73 convulsions (≥ 2 / 24h), jaundice (Bilirubin $> 50 \mu\text{mol} / \text{L}$ (3 g / dl) with parasitaemia $> 100,000$
74 / μL), pulmonary edema, abnormal bleeding, shock, Metabolic acidosis (A base deficit of $> 8 \text{ mEq}$
75 / L or bicarbonate $< 15 \text{ mmol} / \text{L}$ or lactate $\geq 5 \text{ mmol} / \text{L}$), hypoglycemia ($< 2.2 \text{ mmol} / \text{L}$), severe
76 anemia ($\text{Hb} \leq 5 \text{ g} / \text{dl}$ / $\text{Ht} \leq 15\%$ with parasitaemia $> 10,000 / \mu\text{L}$ in children under 12 years,
77 ($< 7 \text{ g} / \text{dl}$ and $< 20\%$ in adults) with parasitaemia $> 10,000 \text{ P} / \mu\text{L}$), renal failure (Creatinine > 265
78 $\mu\text{mol} / \text{L}$ (3 mg / dL) or urea $> 20 \text{ mmol} / \text{L}$) and hyper-parasitaemia ($> 10\%$) (16).

79 Malnutrition was characterized by MUAC (Mid Upper Arm Circumference). A value less than 11
80 cm is interpreted as severe malnutrition while a value between 11 and 12.4 is interpreted as
81 moderate malnutrition (17).

82 **4) Statistical analysis**

83 The data was captured and analyzed using the software EPI INFO version 7.3.0. The
84 multivariate analyzes made it possible to study the associations between malaria and
85 malnutrition. The relative risk (RR) between malnutrition and the factors of severe malaria on
86 the one hand and malnutrition and the risk of death on the other hand were calculated.

87 **RESULTS**

88 **1. Epidemiological characteristics**

89 Nine hundred and seventy four patients (974) infected with *Plasmodium falciparum* were
90 included in the study. 83.06% (809) of the malaria cases were complicated. 9.34% (N = 91/974)
91 of the patients were malnourished. The mean age of the patients was 53.69 months (6 = 41.23
92 [3; 168]). The sex ratio was 1.28.

2. Clinical features

Seventy-nine point twelve percent (79.12% or 72/91) of the malnourished had severe malaria (RR = 0.7, p = 0.3). 74.29% (26/35) of the severely malnourished had severe malaria and only 25.71% (9/35) had uncomplicated malaria. 82.14% of the moderately malnourished (46/56) had severe malaria and only 17.86% (10/56) had uncomplicated malaria (RR = 1.5, p = 0.4).

The main clinical manifestations of severe malaria among malnourished people are severe anemia (46.1%), neuroludism (7.6%) and digestive disorders (5.1%).

14.28% (5/35) of the malnourished had died of malaria (RR = 1.6, p = 0.2). Forty percent (2/5) of the severely malnourished died of malaria, compared to 60% (3/5) of the moderately malnourished (RR = 1.9, p = 0.6). The leading causes of death among malnourished people were severe anemia (80%) and shock (20%).

3. Nutritional and biological characteristics

Thirty eight point forty six percent (38.46% or 35/91) of patients were severely malnourished and 61.54% (56/91) were moderately malnourished. The mean parasite density of the patients was 4947 P / μ L. The average hemoglobin was 7.7 g / dL. 21.3% of patients had a hemoglobin level of less than 5 g / dL otherwise had severe anemia. The average blood glucose was 3.7 mmol / L. 28.9% had a blood glucose lower than 2.2 mmol / L. Table I summarizes the association between severe malaria and sickle cell disease.

Table I: Relationship between severe malaria and malnutrition.

Etat Nutritionnel	Heath statut			
Nutritional statut	Severe malaria	Non complicated malaria	RR	P*
Global Malnutrition	79,12% (72 /91)	20,88% (19/91)	0,7	0,3
Severe Malnutrition	74,29% (26/35)	25,71% (9/35)	1,5	0,4
Moderated Malnutrition	82,14% (46/56)	17,86% (10/56)		
Nutritional statut	Death			
Global Malnutrition	14,28% (5/35)		1,6	0,2
Severe Malnutrition	40% (2/5)		0,9	0,6
Moderated Malnutrition	60% (3/5)			

112 **DISCUSSION**

113 This retrospective study describes the interaction between nutritional status and the
114 severity of malaria in children referred to the pediatric departments of the Niamey
115 National Hospital. Nine hundred and seventy four (974) files are reviewed over a two-
116 year period from January 2014 to December 2015 were reviewed.

117 This study shows that children with acute global malnutrition are more likely to have
118 severe malaria. Indeed, 79.12% (72/91) of the malnourished had severe malaria
119 compared to only 20.88% (19/91) who had uncomplicated malaria (RR = 0.7, p = 0.3).
120 This observation was frequently encountered in the literature (18), (12), (19) even
121 though there were opposite hypotheses or those that found no association between
122 malaria and malnutrition (20), (13). The study of the interaction between malnutrition
123 and malaria is complex because of the multifactorial aspects of each of these two
124 conditions. Consequently, due to many confounding factors, the assessment of the effect
125 of malnutrition on malaria, and vice versa, requires the use of an appropriate
126 methodology (15). The immune system of malnourished children is weak and therefore
127 less able to fight against infections in general and malaria in particular (21).

128 On the other hand, the severity of malnutrition does not affect the severity of malaria, ie
129 severe malnutrition does not make more severe malaria than moderate malnutrition.
130 Indeed, the prevalence of severe malaria is respectively 74.29% (26/35) and 82.14%
131 (46/56) among the severely malnourished and moderately malnourished. The
132 difference is not statistically significant.

133 The lethality attributable to malaria is 14.28% (5/35) among malnourished people.
134 There is no statistically significant difference in risk of death between moderate
135 malnutrition and severe malnutrition. In fact, 60% (3/5) of the dead are moderately
136 malnourished and 40% (2/5) of the dead are severely malnourished.

137 This study shows that 38.4% (35/91) of our study population are severely
138 malnourished and 61.54% (56/91) are moderately malnourished. Malnutrition and
139 malaria are two major burdens in countries south of the Sahara (22). Indeed, 5.9 million
140 children suffer from severe acute malnutrition worldwide (23) of which nearly 3 million
141 children under five die each year (21) and 70% of malnourished live in the three
142 countries of Sahel : Mali, Niger and Chad (23). In Niger, 2 to 2.5 million people were food

insecure in 2017. The global acute malnutrition rate was 13.9% in 2017 (2). The rate of severe acute malnutrition was 1.9% (24). Infant and child mortality is 198/1000 (4) and one of the highest in the world is.

Malnutrition and malaria are governed by many social, epidemiological, biological and economic determinants (13). Alternatives such as "cash for work" or "unconditional cash transfer" have been proposed to relieve poor families where malnourished people are most often found (25). The most sustainable approach is the establishment of moderate malnutrition recovery centers (CRENAM) and recovery centers for severe malnutrition (CRENIS).

CONCLUSION

Malnutrition and malaria are major causes of death among children in the Sahel countries. Global acute malnutrition is a factor of severity of malaria. The severity of malnutrition does not affect the severity of malaria. The risk of death attributable to malaria is not affected by the severity of malnutrition.

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