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Prevalence of Malaria among Malnutrition Under-five Children Admitted in Nutrition Centers in Northern Bahr el Ghazal State, South Sudan

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Authors' contributions

This work was carried out in collaboration between all authors. Author OO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The ongoing conflict in South Sudan has led to the disruption of health care services with a high burden of infectious diseases, a widespread food insecurity and elevated child malnutrition with malaria being a major cause of co-morbidity among malnourished children. This study assessed the prevalence of malaria among malnourished children and assessed the relationship between malaria and malnutrition among malnourished children in an area with a high degree of malaria transmission.
Study Design: This was a retrospective chart review of children 6 month-5years admitted at the nutrition centers
Place and Duration of Study: 49 nutrition centers in Northern Bahr el Ghazal state of South Sudan

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between January 2017 and December 2017.
Methodology: A retrospective chart review of sociodemographic, anthropometric and malaria testing data extracted from the treatment cards and registers of malnourished children admitted at the nutrition centre analysed using descriptive and inferential statistic by means of SPSS version 21. Chi square test was used to conduct bivariate analysis to assess the factors associated with malaria at a significant level of 5%.
Results: Among the 2124 malnourished children admitted into the nutrition program, 873 (41.1%) had severe acute malnutrition (SAM) and 1251(58.9%) had moderate acute malnutrition. The prevalence of malaria was higher among children with moderate acute malnutrition with 43.2% being positive on testing to malaria compared to 36.4% among children with severe acute malnutrition and bivariate analysis done showed a significant association between malaria and nutritional status (p=0.001).
Conclusion: Study highlighted the need for routine screening and testing for malaria to be included in the management protocols for all children admitted into both Outpatient Therapeutic Program and Supplementary Feeding Program in all Nutrition treatment centers to reduce the impact of malaria being a major co-morbidity in the treatment outcome of the children.

Keywords: Malaria; malnutrition; outpatient therapeutic program; supplementary feeding program.

1. INTRODUCTION

Malaria and under-nutrition are the two major causes of childhood mortality in sub-Saharan Africa [1]. Each year, malaria kills more than 800,000 people annually, of which 91% of them reside in Africa and 85% of them are under five children and under-nutrition is considered to be the underlying cause for more than half of deaths of under-five children [2,3]. In South Sudan with the escalation of the conflict since 2013, after emerging as a sovereign state from decades of civil war, the country now faces poverty, lack of health care infrastructure, high burden of infectious diseases and a widespread food insecurity and elevated child malnutrition [4,5,6].

The Food Security and Nutrition Monitoring System (FSNMS) survey conducted in 2017, showed that more than three-fourths (76 percent) of the households across the country faced moderate to severe food insecurity which was higher than the 67 percent reported in 2016 [7]. The study also observed overall deterioration in acute malnutrition compared to the same period in 2016 with the Global Acute Malnutrition (GAM) being above the emergency threshold of 15 percent in nine out of the ten states in this assessment, while seven states had GAM above 15 percent in the same period in 2016 [7].

The malaria Indicator survey done in 2013 showed that approximately 95% of South Sudan is endemic of malaria, with high transmission in the country throughout the year and the leading cause of illness and death in children under five years. The malaria prevalence among children aged 0-59 months was 30 percent [8]. A causal study done in the Northern Bahr el Ghazal state showed that malaria is one of the drivers of acute malnutrition and both malnutrition and malaria prevalence had a seasonal pattern and relationship. The state has the highest GAM rate and highest child morbidity with malaria being responsible for over 60% of this [9].

The available evidence on the relationship between malaria and under-nutrition in the form of wasting and underweight are debatable, a facility based case control study in Ethiopia reported wasted and underweight children are at higher risk to contract malaria specifically to *Plasmodium falciparum* than well-nourished children [10]. Likewise, immunological studies in Papua New Guinea and Ghana reported a higher prevalence of malaria among wasted children that well-nourished children [11,12]. However, an observational follow-up study in a rural area of Senegal indicated that wasted children were at lower risk of experiencing at least one subsequent clinical malaria attack while other studies conducted in Western Ethiopia, Kenya, Gambia and Uganda showed that there was no relationship between baseline nutritional status and subsequent incidence of malaria among the children studied [13,14,15,16,17]. A previous study in South Sudan among school children showed that nutritional status was not associated with the occurrence of malaria [18].

The World Health Organization (WHO) Integrated Management of Childhood Illness initiative is aimed at combining efforts to promote the appropriate case management of serious

infectious diseases such as malaria with nutritional interventions, immunisation programmes, and other disease prevention and health promotion activities to ensure more effective reduction in child mortality than implementing any one of the components separately [19]. Thus, if malaria increases the risk of malnutrition, prevention and effective management of malaria among malnourished children may have the potential for enhancing the survival of children in regions with malaria endemicity. In the light of this, the South Sudan Community Management of Acute Malnutrition (CMAM) guideline was revised in order to address effective management of co-morbidities associated with malnutrition and the guideline included testing and treatment for malaria as part of the package of interventions for children with severe malnutrition admitted for outpatient therapeutic care (OTP) but not for children with moderate malnutrition admitted into the supplementary feeding programme (SFP) [20]. However not all implementing partners have commenced implementing full package of intervention as recommended in the revised guideline which roll out started in 2017 in the various nutrition treatment centers in the country especially testing and treatment of malaria.

This study was conducted to determine the prevalence of malaria among malnourished children and assess the relationship between malaria and malnutrition among under five children in 49 nutrition centers in Northern Bahr el Ghazal state in South Sudan which is one of the states with a high degree of malaria transmission and where the new CMAM guidelines was being piloted.

2. MATERIAL AND METHODS

2.1 Design

This was a retrospective chart review of children 6 month-5years admitted at the nutrition centers.

2.2 Study Population and Setting

The study was facility-based, conducted in 49 nutrition centers in Northern Bahr el Ghazal state where the full package of the revised Community Management of Acute Malnutrition (CMAM) guideline which include malaria testing and treatment was being implemented during the study period. The nutrition centers provided both outpatient therapeutic care [OTP] and supplementary feeding programme [SFP] for management of severe and moderate acute malnutrition respectively.

Out-patient Therapeutic Programme (OTP) - A nutrition programme designed for nutritional treatment and medical care for Severe Acute Malnutrition (SAM) without medical complications used Ready to use Therapeutic Food(RUTF) at an outpatient care site.

Supplementary Feeding Programme (SFP): A nutrition programme designed for treatment of Moderate Acute Malnutrition (MAM) in vulnerable groups (such as children 6-59months and Pregnant and Lactating Women), uses specific energy and nutrient dense supplementary food rations and provides routine medical treatment at an outpatient site.

The Nutrition centers were managed by Concern Worldwide in collaboration with the UNICEF and MOH in Aweil North and Aweil West Counties in Northern Bahr el Ghazal State. The state has one of the highest Global Acute Malnutrition rate and malaria prevalence in South Sudan. All malnourished children aged 6months - 5 years admitted at nutritional centers between January and December 2017 were recruited into the study.

Anthropometric measurements: The nutritional status of the children admitted into the nutrition centre were assessed by trained nutrition providers in the facilities using internationally recognised standard criteria, [21,22] and managed according to the CMAM guideline [20].

Acute malnutrition/ wasting - is defined by Low Mid- Upper Arm Circumference [MUAC], low Weight-for-Height/ Length [WFH/L]), or the presence of bilateral pitting oedema.

Moderate Acute Malnutrition (MAM) – Description of under nutrition (wasting) level. For children 6-59M, it encompasses children ≥ -3 Z-scores and < -2 Z- scores (WFH/L) or MUAC ≥11.5cm and < 12.5cm.

Severe Acute Malnutrition (SAM) - Description of under nutrition level. For children 6-59M, it encompasses children falling less than -3 Z-scores (WFH/L), or MUAC < 11.5cm, or presence of bilateral pitting oedema.

Malaria testing and Treatment: Health workers in the nutrition centers conducted malaria testing for all the children and those positive were

treated using the national malaria guideline. The test was done using a fingerpick Rapid Diagnostic Test (RDT) for malaria (ParaCheck-Pf device, Orchid Biomedical Systems). This test, based on detection of histidine-rich protein 2, is able to detect *Plasmodium falciparum* antigen in the peripheral circulation.

All the children found to be RDT-positive were treated with a six-dose regimen of Artemisinin Combination Therapy (ACT) according to WHO guidelines, irrespective of symptoms [23].

2.3 Data Collection and Statistical Analysis

The data was extracted from the treatment cards and registers from the nutrition centers of all malnourished children admitted January and December 2017 and entered into a Micros Excel spreadsheet (Microsoft, Redwoods, WA, USA). The variable data included age, sex, grade of malnutrition and record of Paracheck Pf results. Data was analysed using SPSS version 21. Descriptive data is presented with qualitative variables presented as proportions and quantitative variables summarised as means with their standard deviations. Univariate analysis was done by generating frequencies of the variables and bivariate analysis was done using chi-square test association. Chi square test was used to conduct bivariate analysis was used to assess the factors associated with positive RDT test at significant level of 5%.

3. RESULTS AND DISCUSSION

3.1 Socio-demographic Characteristics

A total of 2124 children under-five children who were admitted into the nutrition program participated in the study. Of these, 925(43.5%) were males and 1199 (56.5%) were females. 445 (21.0%) of the children were in the age range of 6months- 23 months and 1679 (79.0%) were in the age range of 24- 59 months with mean age of 36 $\pm$ 3.4 months (Table 1).

3.2 Analysis of the Factors Associated with Malnutrition

Among the 2124 malnourished children admitted into the nutrition program, 873 (41.1%) had severe acute malnutrition (SAM) and 1251(58.9%) had moderate acute malnutrition (MAM) using the standard classification criteria. 227(30.0%) of male had severe acute malnutrition compared with 596(49.8%) among female client admitted at the nutrition centre and significant association was found between sex and malnutrition (p=0.0047). Likewise, a significant association was found between age and malnutrition, 104(23.4%) of children 6month-24month had severe acute malnutrition compared with 769(45.8%) of children 25month-59months admitted at the nutrition centre who had severe acute malnutrition (p=0.004) (Table 1).

3.3 Prevalence of Malaria among Malnourished Children at the Nutrition Centers

The analysis of the malaria testing done in the nutrition centers, 212(47.6%) of children aged 6 - 23months tested positive for malaria using RDT compared to 647(38.5%) of children 24-59months tested positive for malaria using RDT and the association between age and malaria was found to be statistically significant (p=0.0018).

Among the males admitted into the nutrition centre, 376(40.7%) tested positive to malaria compared to 483(40.3%) among females who tested positive for malaria but no association was found between sex and malaria.

The logistic regression analysis shows that children 6months-23months are 40% more likely to have malaria than children 24month-59months while children with severe malnutrition are 26% less likely than children with moderate malnutrition to have malaria. A significant association was found between malaria and nutritional status (p=0011) and the prevalence of malaria is higher among children with moderate acute malnutrition than children with severe acute malnutrition, 317(36.4%) of children with severe acute malnutrition tested positive for malaria compared with 542(43.2%) children with moderate acute malnutrition who tested positive for malaria (Table 2).

3.4 Discussion

This study population were children with severe and moderate acute malnutrion admitted to the nutritional centers for Outpatient Treatment Program(OTP) and Supplementary Feeding Program (SFP) and do not include children with stunting (chronic malnutrition) or those without

any form of malnutrition unlike most studies which included children with different forms of malnutrition and well-nourished children.

There were more children with moderate malnutrition than severe malnutrition among the children enrolled in the nutrition centres. More of the female children had severe acute malnutrition compared with male client admitted at the nutrition centre and significant association was found between sex and malnutrition. This finding is similar to other studies in rural areas of Nigeria and Ethiopia which reported significant higher malnutrition rate among female children than males [24,25]. However other study among malnourished children in a southern district in Ethiopia found prevalence of severe malnutrition higher among male than female [26]. Similarly, a Standardized Monitoring and Assessment of Relief and Transitions (SMART) survey conducted by Concern Worldwide in the study location found Global acute malnutrition higher among male than female [27]. The higher prevalence of severe malnutrition among female more than male could be a pointer towards disparity in nutrition and various studies carried out in regard to any nutritional discrimination of girl child were equivocal [28,29].

In this study, we found significant association between age and malnutrition, with older children with severe malnutrition than younger children admitted at the nutrition centres. This is similar to studies in Ethiopia which found older children

Table 1. Socio demographic profile of children admitted at the nutrition centre

Variable	Severe acute malnutrition N=873 N(%)	Moderate acute malnutrition N= 1251	Total N=2124	chi-square	P value
Sex					
Male	277(30.0)	648(70.0)	925	84.23	0.0047
Female	596(49.8)	603(50.2)	1199		
Age					
6-23 months	104(23.4)	341(76.6)	445	73.11	0.004
24-59 months	769(45.8)	910(54.2)	1679		
Mean age 36+*3.4months*					

Table 2. Prevalence of malaria among malnourished children at the nutrition centers (logistic regression)

Variable	Positive test for malaria N=859 n (%)	Negative test for malaria N=1265 n (%)	Total N=2124	OR(95%CI)	Chi-square	P value
Age						
6-23months	212(47.6)	233(52.4)	445	1.4(1.18-1.79)	12.11	0.0018
24- 59months	647(38.5)	1032(61.5)	1679			
Sex						
Male	376(40.7)	549(59.3)	925	1.015(0.85- 1.21)	0.837	0.04
Female	483(40.3)	716(59.7)	1199			
Malnutrition status						
Severe Acute Malnutrition	317(36.4)	556(63.6)	873	0.74(0.62-0.89)	10.16	0.0011
Moderate Acute Malnutrition	542(43.2)	709(56.8)	1251			

were more likely to have under-nutrition as compared to the younger ones [14,28]. One of the reasons suggested for this could be as a result of short birth interval in the locality, care givers may give more attention to the younger children and neglect the older ones which predispose the later to malnutrition even though the birth interval was not assessed in this study.

However other studies conducted in Ethiopia and Cameroon reported that children in the older age group (26+ months) are at a significantly lower risk of being malnourished compared to the younger age groups [30,31,32,33]. However, the SMART survey in the same project location found no significant association between age and grade of malnutrition [27].

Analysis of the malaria testing done in the nutrition centers showed that malaria prevalence was higher among younger children than older children and the association between age and malaria was found to be statistically significant. This may be due to the younger children who have not yet developed immunity to malaria and thus more vulnerable than the other children. This is similar to study among school children in Rwanda which found higher prevalence of malaria among younger age group [34]. However, the South Sudan 2013 malaria indicator survey and a study in Uganda that analysed the country malaria indicator survey data found prevalence of malaria increased with age [8,35].

Among the children admitted into the nutrition centre the prevalence of malaria was more among the male children than the female children though no association was found between sex and malaria. This is similar to a study among children in Uganda which observed malaria prevalence for the male children was 19.8 % and that of the female children was 19.6%, thus suggesting gender may not be a significant risk factor for malaria [36]. However, the prevalence of malaria was reported higher among male than female in the South Sudan Malaria Indicator Survey [8].

Most studies on association between malaria and malnutrition compared prevalence between malaria in wasting generally or underweight or stunted children with non-malnourished children and the relationship between malaria and malnutrition reported by these studies have been controversial or debatable with some reporting association while others found no association between malnutrion and malaria. However, there are very limited studies which compared malaria between various grade of malnutrition (mild, moderate and severe) like done in this study which compared the prevalence of malaria between moderately acute malnutrition and severe acute malnutrition. In this study a significant association was found between malaria and nutritional status and found that prevalence of malaria is higher among children with moderate acute malnutrition than children with severe acute malnutrition. This is similar to finding in a case control study done by Kweku et al. in Ghana among children living in an area of the country hyper endemic for malaria which found malaria prevalence higher among children with moderate acute malnutrion than those with severe acute malnutrition though not significant [37]. However, a study conducted in nutritional centre by MSF in Ethiopia reported that malaria prevalence was significantly associated with grade of malnutrition: Paracheck Pf was positive in respectively 5%, 8% and 10% of children with mild, moderate and severe malnutrition [38]. The higher prevalence of malaria in moderately malnourished children than severe children may be because of better nutrient needed for the malaria parasite to replicate and survive which is more readily available in the moderately malnourished than severe children. This is supported by a new molecular study which has demonstrated that the malaria parasite, plasmodium, has the ability to sense and actively adapt to the host's nutritional status, with mice eating fewer calories possessing a significantly lower parasitic load [39].

4. CONCLUSION

This study shows the value of routine malaria screening in malnourished children, especially for all children with any form and grade of malnutrition and not only those with a severe grade of malnutrition as currently practised in South Sudan and some other countries.

We thus recommend that malaria testing and treatment should be included in the management protocols for all children admitted into both Outpatient Therapeutic Program and Supplementary Feeding Program in all Nutrition treatment centers to reduce the impact of malaria being a major co-morbidity in the treatment outcome of the children.

ETHICAL APPROVAL

The State Ministry of Health, Lol State reviewed and cleared the use of data, contents and publication of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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