

## Nutritional status and malaria infection in primary school-aged children

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### Abstract

**Background** The most common nutritional problem affecting the pediatric population in developing countries is protein energy malnutrition (PEM). The nutritional problem may be caused by a variety of factors, most of which are related inadequate food intake and infection. One of the highest causes of morbidity and mortality in endemic areas is malaria. Malaria infection and nutritional status have been suggested to be interrelated.

**Objective** To assess for a relationship between nutritional status and malaria infection in children.

**Methods** This cross-sectional study was conducted in October and November 2010 in primary school children at Panyabungan City, North Sumatera Province. Peripheral thick and thin blood smear examinations were done to confirm the diagnosis of malaria. Participants were divided in two groups (malaria-infected and uninfected) by consecutive sampling. Nutritional status was determined by body weight and height measurements based on the 2000 Centers for Disease Control and Prevention (CDC) chart. The mild and moderate malnutrition classification was further sub-divided into stunted and wasted, based on the 2007 NCHS/WHO chart. Chi-square test was used to analyze the relationship between nutritional status and malaria infection.

**Results** There were 126 children in each group. Significant differences in mild-moderate malnutrition were found between the malaria-infected and uninfected groups (23.8% vs. 46.8%, respectively;  $P=0.011$ ). There were also significant differences between the malaria-infected and uninfected groups with regards to chronic malnutrition type: stunted (20.0% vs. 37.3%, respectively;  $P=0.042$ ) and stunted-wasted (6.7% vs. 28.8%, respectively;  $P=0.008$ ) in both groups of the children with mild-moderate malnutrition.

**Conclusion** There are significantly more children with mild-moderate malnutrition in the uninfected group than in the malaria-infected group, furthermore, of those with mild-moderate malnutrition, there are significantly more stunted and stunted-

wasted children who were uninfected than malaria-infected. [Paediatr Indones. 2015;55:209-14].

**Keywords:** nutritional status, malaria infection, children

Nutritional status is the most important determinant of health status in individuals, especially during the growth period of childhood and adolescence. The most common nutritional problem affecting young populations in developing countries is protein-energy malnutrition, which may result from inadequate food intake and infection.<sup>1</sup> The relationship between nutritional

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status and disease is complex, because disease often results in undernutrition, and undernutrition increases susceptibility to disease, particularly severe disease.<sup>2</sup>

Malaria is a major cause of morbidity and mortality in tropical and subtropical regions.<sup>2</sup> Although typically a tropical illness, more than 1,500 cases are diagnosed in the US each year.<sup>3,4</sup> In 2008, there were 247 million cases of malaria and nearly one million deaths, mostly among children living in Africa. Malaria is the world's fourth leading cause of death in children younger than 5 years of age.<sup>4</sup> In Indonesia, malaria remains a major public health problem, especially in Java and Bali.<sup>5</sup> Using the annual parasite incidence (API) measurement, malaria stratification is high in Eastern Indonesia, medium in areas of Kalimantan, Sulawesi and Sumatra, and low in Java-Bali. In 2008 to 2009, there was a decline in API from 2.47 per 1000 population to 1.85 per 1,000 population.<sup>6</sup>

The population residing in malaria-endemic areas generally live under conditions that lead to poor nutritional status. The groups at highest risk for the adverse effects of malaria, children and pregnant woman, are also most affected by poor nutrition.<sup>7</sup> Malaria affects child nutrition, as it can cause anorexia, diarrhea, vomiting, fever, and excessive use of protein to overcome infection.<sup>8</sup> Shankar cites several studies from 1920 to 1940 in Corsica, Algeria, Vietnam, Turkey, and Ghana stating that malaria was more frequent and severe among those who were undernourished, where a study in Gambia shows no significant association between malaria infection and nutritional status.<sup>7</sup>

The aim of this study was to assess for a relationship between nutritional status and malaria infection in children, and to compare the acute and chronic malnutrition among children with malaria infection and without infection who had mild-moderate malnutrition.

## Methods

This cross-sectional study was conducted in 7 primary schools in Mandailing Natal District, North Sumatera Province from October to November 2010. The inclusion criteria were children aged 6 to 13 years, agreed to blood smear examinations and lived in the

study's location. Children with tuberculosis, nephrotic syndrome, heart disease, severe malnutrition, and obesity were excluded.

Peripheral thick and thin blood smear examinations were performed to confirm malaria diagnoses. Participants were divided in two groups (malaria-infected and uninfected) by consecutive sampling. Nutritional status was determined by body weight and height measurements based on the 2000 CDC Chart. The mild-moderate malnutrition classification was subdivided into stunted and wasted based on the 2007 NCHS/WHO. We used a calibrated Camry scale for weighing, with a precision of 0.1 kg and capacity of 125 kg. A microtoise scale with a precision of 0.5 cm and capacity of 2 meters was used to measure height.

We used questionnaires to obtain information about the subjects' identity, number of siblings, as well as parental education, income, and employment. This study was approved by the Medical Ethics Committee of the University of North Sumatera Medical School.

We analyzed data using SPSS version 14.0. Chi-square test was used to analyze the relationship between nutritional status and malaria infection. We assessed the comparison between acute and chronic malnutrition and malaria infection in children who had mild-moderate malnutrition. The significance level was accepted to be  $P < 0.05$ .

## Results

A total of 252 children met the inclusion criteria and were eligible for analysis, consisting of 126 malaria-infected children and 126 uninfected children (**Table 1**). The mean age, weight, height, and gender were similar between groups. The paternal and maternal education histories were mostly in the primary school level for both groups. The most common parental occupation was farming, and most earned <500,000 IDR for both groups. The most common plasmodium species was *Plasmodium falciparum*.

There were significantly more children with mild-moderate malnutrition in the uninfected group than in the infected group ( $P=0.011$ ) (**Table 2**). However, there were no significant differences in normal weight or overweight between the two groups.

The highest prevalence of malnutrition type in

the malaria-infected group was acute malnutrition (wasted, 43.3%), while that of the uninfected group was chronic malnutrition (stunted, 37.3%). Chi-square analysis revealed significant differences in chronic

malnutrition between the two groups in the categories of stunted and stunted-wasted, where more stunted and stunted-wasted children in uninfected group (P=0.042 and P=0.008, respectively) (Table 3).

**Table 1.** Characteristics of subjects

Characteristics	Malaria infected (n=126)	Malaria uninfected (n=126)
Mean age (SD), years	9.3 (1.66)	9.5 (1.92)
Gender, n (%)		
Male	62 (49.2)	63 (50.0)
Female	64 (50.8)	63 (50.0)
Mean weight (SD), kg	23.7 (5.50)	22.8 (5.85)
Mean height (SD), cm	123.1 (10.45)	124.5 (11.70)
Mean number of siblings (SD), n	4.8 (2.07)	4.6 (2.47)
Paternal education, n (%)		
Primary school	61 (48.4)	87 (69.0)
Intermediate school	39 (31.0)	17 (13.5)
High school	24 (19.0)	17 (13.5)
Graduate	2 (1.6)	5 (4.0)
Maternal education, n (%)		
Primary school	77 (61.1)	94 (74.6)
Intermediate school	28 (22.2)	16 (12.7)
High school	21 (16.7)	14 (11.1)
Graduate	0	2 (1.6)
Parental occupation, n (%)		
Farmer	107 (84.9)	99 (78.6)
Entrepreneur	14 (11.1)	19 (15.0)
Government employee	3 (2.4)	6 (4.8)
Unemployed	2 (1.6)	2 (1.6)
Parental monthly income, n (%)		
< IDR 500,000	101 (80.1)	93 (73.8)
IDR 500,000 – 2,000,000	23 (18.3)	24 (19.0)
IDR 2,000,000 – 5,000,000	2 (1.6)	5 (4.0)
> IDR 5,000,000	0	4 (3.2)
Plasmodium species, n (%)		
<i>Falciparum</i>	124 (98.0)	-
Mixed <i>falciparum</i> + <i>vivax</i>	2 (1.58)	

**Table 2.** Comparison of nutritional status of malaria-infected and uninfected children

Nutritional status	Malaria infected (n= 126) n(%)	Malaria uninfected (n=126) n(%)	P value
Normal	84 (66.7)	63 (50.0)	0.138
Mild-moderate malnutrition	30 (23.8)	59 (46.8)	0.011
Overweight	12 ( 9.5)	4 (3.2)	0.364

**Table 3.** Comparison of malnutrition type in malaria-infected and uninfected children with mild-moderate malnutrition

Malnutrition type	Malaria infected (n= 30) n(%)	Malaria uninfected (n=59) n(%)	P value
Unwasted-unstunted	9 (30.0)	14 (23.7)	0.080
Wasted	13 (43.3)	6 (10.2)	0.073
Stunted	6 (20.0)	22 (37.3)	0.042
Stunted-wasted	2 (6.7)	17 (28.8)	0.008

## Discussion

We found that most subjects had normal nutritional status, and a small portion were overweight. Mild-moderate malnutrition was found in malaria-infected children, but less than in uninfected children. A previous study in Mandailing Natal in 2004 found that the average nutritional status of malaria-infected and uninfected children was normal, but mild-moderate malnutrition was higher in malaria-infected children and normal nutritional status was higher in uninfected children.<sup>9</sup>

There are some potential explanations as to why there are higher numbers of malaria-infected children with normal nutritional status. A child with an acute malaria infection suffers weight loss, but after adequate anti-malarial treatment, the child's weight can return to normal.<sup>10</sup> In addition, there is increased awareness of the need to improve food intake in children after malaria infection, so that normal body weight can be achieved. This is also a parameter of the success of government programs to improve nutrition in cases of malaria infection control.<sup>6</sup> Furthermore, the degree of malaria parasitemia may have been lower, so as not to effect meaningful weight loss. However, one study found no correlation between the degree of parasitemia with changes in body weight in children infected by malaria.<sup>10</sup> In our study, we did not assess the degree of parasitemia, the duration of infection, or the nutritional status of children after anti-malarial treatment. Further study is needed with more thorough methods.

Underweight children are thought to have increased susceptibility to malaria for a variety of reasons, most notably through reduced immune system function. When a child is undernourished, he is unable to mount an appropriate immune response to the malaria parasite, due to reduced T-lymphocytes, impaired antibody formation, decreased complement formation, and the atrophy of the thymus and other lymphoid tissues.<sup>2,11</sup> Another study in West Africa found no association between malnutrition and malaria morbidity, but malnourished children had a more than two-fold higher risk of dying than non-malnourished children.<sup>12</sup>

We found that the majority of malaria-infected children with mild-moderate malnutrition had acute (wasted) malnutrition, characterized by

underweight. Furthermore, all were infected with *falciparum* malaria. For uninfected children with mild-moderate malnutrition, the most common type of malnutrition was stunting and wasting. Another study in preschool children in malaria-endemic areas of sub-Saharan Africa found that children with malnutrition, particularly stunting, may down-regulate the anti-*Plasmodium falciparum* antibody response, thus providing a protective effect against malaria infection.<sup>13</sup> A longitudinal study in Papua New Guinea compared anthropometric measurements in patients with malaria humoral immune responses to specific malarial antigens and found that stunting, but not wasting, had a protective effect against *falciparum* malaria. The mechanism may be related to an improved ability of malnourished children to produce certain cytokines in response to stimulation by specific malarial antigens.<sup>14</sup> There are several factors associated with the occurrence of stunting in children. Malaria infection, low birth weight, low family income, and low maternal body mass index significantly affects stunting in children under 2 years of age.<sup>15</sup> A study in Zambia found a high prevalence of stunting in preschool children, but the low micronutrient status of children in the study did not contribute to retardation of linear growth.<sup>16</sup>

We conducted this study in primary school children above 5 years of age, in which the majority of children had *falciparum* malaria infection and most had acute malnutrition. The children with mixed infection (*falciparum* and *vivax* malaria) both experienced chronic malnutrition. A study in southern Nigeria showed significant weight loss in children with acute *falciparum* malaria infection, and recurrent parasitemia of *Plasmodium falciparum* was associated with the failure to gain weight in children.<sup>10</sup> Other studies found that infection with *Plasmodium falciparum* was associated with acute malnutrition.<sup>1</sup> A Kenyan study found that although children continue to experience clinical episodes of uncomplicated malaria throughout the first decade of life, the effect of malaria on nutritional status appears to be greatest during the first 2 years of life.<sup>17</sup> *Plasmodium vivax* is also considered to be a cause of acute malnutrition in children under 5 years of age, and *vivax* malaria was found to be significantly higher in underweight children.<sup>18</sup>

We found low family socioeconomic levels in both the malaria-infected and uninfected groups, including

relatively low family income, low parental education and a relatively large number of children in the family. A study in elementary school children in Cameroon found a high prevalence of malnutrition in uninfected children due to low socioeconomic status, inadequate food intake due to low appetite, and metabolic disorders. A limited household food supply and traditional eating habits are also thought to affect malnutrition in primary school children.<sup>19</sup> Maternal education and maternal health-seeking behavior were associated with better child nutrition. Improved household economic status, increased household resources and a community environment around the home are considered to have a positive effect in improving child nutrition.<sup>20</sup> Other study reported that the risk of malaria was higher in children who were underweight, who lived at lower altitudes, and who lived in households where drugs were not kept at home.<sup>21</sup>

In conclusion, there is a significant relationship between higher prevalence of mild-moderate malnutrition and lack of malaria infection in children. Significantly more uninfected children have mild-moderate malnutrition than malaria-infected children. We also find significantly more chronic malnutrition in the uninfected group than in the malaria-infected group.

### Conflict of interest

None declared.

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