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Anemia and Body Mass Index Among Children in Malaria Endemic Area

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ABSTRACT

Anemia is a prevalent global health issue frequently encountered by children. Anemia in children may result from iron deficiency or malaria. Anemia, malaria, and the nutritional state of children are believed to be interconnected. This study aimed to examine the correlation between anemia prevalence and the nutritional status of children in malaria-endemic regions, as indicated by TB and/or BMI values. The participants in this study were 394 boys and girls aged over 11 years. The collected data comprised hemoglobin (Hb) levels indicative of anemia, with height, weight, upper arm circumference, and sitting height, which reflect the child's nutritional health. Furthermore, data collecting was conducted about the amount of parental education as a kind of support. The data were evaluated, revealing the correlation between anemia occurrence and children's nutritional state. The findings indicated no significant correlation between the prevalence of anemia with the nutritional status of children, their height, or the educational attainment of parents. One finding indicated a modest significant correlation between the prevalence of anemia and the height of boys. The results indicate that the incidence of anemia does not significantly affect the nutritional status of children

Keywords: *Anemia, Malaria, Children, Nutritional state.*

INTRODUCTION

Anemia is a disorder characterized by an inadequate quantity of red blood cells or insufficient oxygen-carrying capacity to fulfill physiological requirements. Globally, anemia remains a significant health problem. One of the main causes of anemia is iron deficiency (ID), and this condition is widely experienced by children because they have higher iron requirements to support growth and development. Approximately 600 million preschool and school-aged children worldwide are afflicted by anemia [1,2]. Anemia and ID have adverse effects on the cognitive and physical development of children [1].

Anemia can also be affected by malaria [3]. An individual affected with malaria may develop anemia as a result of the lysis of infected erythrocytes. Plasmodium falciparum infects all stages of erythrocytes, leading to anemia in both acute and chronic infections. Malaria is the primary cause of anemia in endemic regions and places with elevated transmission rates. The World Health Organization (WHO) approximates that in 2016, there were around 216 million cases and 445,000 fatalities due to malaria. The majority of these fatalities were attributable to anemia, either directly or indirectly [4,5].

The relationship between iron and malaria is intricate and contentious. Iron deficiency is prevalent in regions endemic to malaria. It induces anemia, and in young children, iron deficiency correlates with neurodevelopmental delays. Malaria does not induce iron shortage. Nonetheless, iron deficiency and malaria frequently occur concurrently in the same patient. In certain regions, regular elemental iron treatment after malaria has demonstrated efficacy in facilitating recovery from anemia [5,6].

Iron deficiency is closely related to malnutrition that affects children's growth. Body Mass Index (BMI) is a simple measuring tool to monitor nutritional status. According to Thompson, nutritional status has a positive correlation with hemoglobin concentration, meaning that the worse a person's nutritional status, the lower the person's hemoglobin levels [7,8]. Based on this background, the purpose of this study was to analyze the relationship between the incidence of anemia and the nutritional status of children in malaria-endemic areas represented by height and BMI values.

MATERIAL AND METHODS

Research Design

A cross-sectional analysis of children in Melaka Regency, East Nusa Tenggara was conducted in this study from January to March 2024. The inclusion criteria were 394 children (boys and girls) older than 11 years old. The exclusion criteria included kidney problems, congenital blood abnormalities, blood cancers, and malaria within the previous month.

Sampling Technique

Randomly selected sample that fulfills inclusion and exclusion criteria. This sampling has been accepted by the Faculty of Medicine and Veterinary Medicine (FKKH) Ethic Committee of Nusa Cendana University, and the parents of the subjects have signed an informed consent form.

Hemoglobin (Hb) and Anthropometric Assessment

The Quick-Check® hemoglobin test was used to measure the levels of hemoglobin (Hb). The anthropometric test instruments were height, weight, upper arm circumference, and sitting height tests. BMI calculations and height-for-Age-Z score (HAZ) were also carried out from anthropometric results. In addition, interviews were conducted to determine the education of parents and the history of malaria of each subject.

Data Analysis

The SPSS program was used to analyze the data

RESULT AND DISCUSSION

A total of 394 child subjects aged 11 to 18 years were collected. Subjects consisted of 191 boys and 203 girls (Table 1). Overall, the subjects were in excellent health. Blood samples were taken alternately and immediately placed in a cooler box with ice packs and transported to the Institute of Tropical Diseases at Airlangga University in Surabaya, Indonesia, after venipuncture in EDTA tubes.

Table 1. Number and gender of research subjects

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Boys	191	48.5	48.5	48.5
	Girl	203	51.5	51.5	100.0
	Total	394	100.0	100.0	

From the results of the hemoglobin test conducted, it can be seen whether the subject is anemic or not. The average hemoglobin level of the participants was 11.66 ± 2.43 g/dL, with 54.8% of the subjects classified as anemic. Of the 394 subjects, 216 were anemic, and 178 did not have anemia (normal). Anthropometric measurements and interviews were also conducted on all subjects. The results of anthropometric measurements can reveal the BMI, HAZ, and nutritional status of the subjects. The average BMI obtained was 17.96 ± 2.97. Furthermore, the results showed that 327 subjects had good nutritional status, while 67 others had poor nutritional status. The results are shown in Table 2.

Table 2. Descriptive data

Variable		Frequency	%	Mean ± SD	Median (min – max)
Gender					
	Boys	191	48.5		
	Girls	203	51.5		
Age (Year)				14,32 ± 1,48	14,25 (10,50 – 18,83)
Weight				40,45 ± 9,05	39,50 (20,10 – 75,70)
HAZ				-1,64 ± 0,85	-1,65 (-3,99 – 0,58)
	Severely stunted	24	6,1		
	Stunted	114	28,9		
	Posible stunted	165	41,9		
	Normal	91	23,1		
BMI				17,96 ± 2,97	17,51 (8,75 – 31,31)
Nutritional status					
	Malnutrition	67	17,0		
	Good nutrition	327	83,0		
Arm Circumference				22,15 ± 3,11	22,0 (11,0 – 32,5)
Sitting Height				100,73 ± 30,86	108,9 (59,0 – 158,4)
Father education					
	< Junior high school	200	50,8		
	Senior high school	162	41,1		
	College	32	8,1		
Mother education					
	< Junior high school	198	50,3		
	Senior high school	158	40,1		
	College	38	9,6		
Hb				11,66 ± 2,43	11,6 (4,7 – 18,9)
Anemia					
	Yes	216	54,8		
	No	178	45,2		

Anemia in children over 11 years is classified as normal with Hb > 12 g/dL, mild anemia with Hb 11-11.9 g/dL, moderate anemia with Hb 8-10.9 g/dL, and severe anemia with Hb < 8 g/dL [9]. To evaluate HAZ, the criteria are as follows: a Z value of less than -3 indicates severe stunting, a Z value between -3 and -2 indicates stunting, and a Z value ranging from -2 to 2 is considered normal [10].

The relationship between the incidence of anemia and HAZ scores in children residing in malaria-endemic regions was analyzed utilizing Spearman's correlation test. The analysis of the anemia HAZ score relationship in boys yielded a p value of 0.034 ($p < 0.05$) and a r value of 0.153 (0.0 - <0.2). However, the results for girls showed a p value of 0.249 ($p > 0.05$). The findings are detailed in Table 3.

Table 3. The relationship between anemia and HAZ score

Gender	Variable	Descriptive		p	r
		Mean ± SD	Median (min – max)		
Boy	Hb	11,83 ± 2,34	12,10 (4,70 – 17,40)	0,034*	0,153
	HAZ	-1,81 ± 0,90	-1,83 (-3,99 – 0,33)		
Girl	Hb	11,52 ± 2,51	11,40 (5,00 – 18,90)	0,249	-0,082
	HAZ	-1,49 ± 0,77	-1,56 (-3,61 – 0,58)		

*Significant: (p < 0,05)

The results indicated that in boys, there was a substantial albeit weak positive correlation between the incidence of anemia and height, whereas in girls, no significant correlation was observed between these variables.

Table 4. The relationship between anemia and nutritional status

Gender	Anemia	Nutritional status		p
		Malnutrition	Good Nutrition	
Boy	Yes	26 (53.1%)	65 (45.8%)	0.475
	No	23 (46.9%)	77 (54.2%)	
Girl	Yes	11 (61.1%)	114 (61.6%)	1.000
	No	7 (38.9%)	71 (38.4%)	

The results of the test examining the relationship between anemia and nutritional status are displayed in Table 4, utilizing the Chi-Square test for analysis. In boys, the p value was calculated as 0.475 (p > 0.05), indicating that there is no significant relationship between the incidence of anemia and nutritional status. Similarly, in girls, the p value was found to be 1.000 (p > 0.05), suggesting that there is also no significant relationship between the incidence of anemia and nutritional status.

This study indicates that there is no significant relationship between the incidence of anemia in children living in malaria endemic areas and their height or nutritional status. One of the findings indicates a relatively weak significant correlation concerning the association between height and the occurrence of anemia in boys. This result aligns with the findings of Kleigman RM et al (2016) [11], which indicate that there is no impact or relationship between anthropometric measurements and anemia. Nonetheless, this contradicts findings from a study indicating that anemia is prevalent among children with malnutrition status [12,13].

The findings of this study suggest that the lack of a significant relationship may be attributed to the occurrence of anemia not being affected by insufficient nutritional intake, but rather by a history of malaria. The prevalence of anemia in girls may also be affected by various factors, including menstruation and a history of iron tablet consumption.

The nutritional status of children is closely linked to the incidence of anemia, which is also influenced by the level of parental education. The findings from the analysis of the correlation between education level and anemia, utilizing the chi-square test, are presented in Table 5.

Table 5. The relationship between anemia and education level

Level of education		Anemia		p
		Yes	No	
Father	<Junior high school	112 (51,9%)	88 (49,4%)	0,421
	Senior high school	90 (41,7%)	72 (40,4%)	
	College	14 (6,5%)	18 (10,1%)	
Mother	<Junior high school	102 (47,2%)	96 (93,9%)	0,415
	Senior high school	92 (42,6%)	66 (37,1%)	

Level of education	Anemia		p
	Yes	No	
College	22 (10,2%)	16 (9%)	

The analysis of the relationship between anemia and father's education yielded a p value of 0.421 (p > 0.05), indicating no significant relationship. Similarly, the examination of mother's education resulted in a p value of 0.415 (p > 0.05), also suggesting no significant relationship with anemia. The findings contradict a study indicating that maternal education significantly influences the prevalence of anemia in children. A higher level of education can significantly impact parents' selection of nutritious food for their children. The reduction of anemia incidence in children is essential [14].

The findings of this study suggest that the negligible relationship may be affected by additional elements, including economic variables and awareness of technological readiness. Even with a relatively low level of education, it remains possible for parents to possess adequate economic resources to ensure that their children's nutritional needs are adequately met.

1. CONCLUSION

This study examines the correlation between anemia prevalence and nutritional status in children residing in malaria-endemic regions. Data from hemoglobin level measurements indicate that numerous youngsters suffered from anemia. Nevertheless, when the correlation between anemia prevalence and nutritional status was analyzed, no significant association was found between the two. The correlation between anemia prevalence and parental education levels further substantiates this claim.

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