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Risk factors for the coexistence of anemia and vitamin A deficiency (VAD) among children under five in Indonesia

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Abstract. Anemia and vitamin A deficiency (VAD) are forms of malnutrition that may coexist due to shared metabolic pathways and risk factors. This study aimed to identify the risk factors for the coexistence of anemia and VAD among children under five years of age in Indonesia. It employed a cross-sectional analysis using secondary data from the 2023 Indonesian Health Survey, involving 628 children aged 0–59 months, representing an estimated population of 284,784 through complex sample analysis. The prevalence of anemia was 16.1%, VAD was 9.1%, and their coexistence was 2.9%. Bivariate analysis showed significant associations between social assistance (p=0.012), availability of improved sanitation facilities (p=0.020), completeness of antenatal care (ANC) services (p=0.031), and a history of acute respiratory infection (ARI) (p<0.001) with the coexistence of anemia and VAD. Multivariate analysis indicated that children with ARI in the previous month had a higher risk of coexistence (OR=1.517; 95% CI:1.288–2.995; p=0.049), whereas those from households receiving social assistance had a lower risk (OR=0.371; 95% CI:0.187–0.734; p=0.004). These findings highlight the importance of controlling infectious diseases and strengthening social protection to prevent the coexistence of anemia and VAD in children under five.

1 Introduction

Among young children, anemia and vitamin A deficiency (VAD) remain major public health concerns because both conditions contribute to poor growth, developmental impairment, and increased susceptibility to illness and death [1]. The coexistence of anemia and VAD may further worsen child health and development outcomes [2].

Previous studies have reported a close association between anemia and VAD. A meta-analysis found that stunted children with VAD had a 1.54-fold higher risk of iron-deficiency anemia, while those without vitamin A supplementation had a 1.37-fold higher risk [3]. Similarly, preschool children with VAD in Chongqing, China, had 2.56-fold

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higher odds of anemia [4]. Therefore, this study aimed to identify determinants of their coexistence in children under five years of age.

2 Methods

This study analyzed secondary data from the 2023 Indonesian Health Survey (SKI) using a cross-sectional design. A total of 628 children aged 0–59 months with complete anthropometric, hemoglobin, and serum retinol data were included. Children with valid height-for-age z-scores (–6 SD to +5 SD) were eligible, while those with incomplete or unmatched records were excluded. Weight and height/length were measured using standardized procedures and converted into z-scores. Hemoglobin concentration was assessed using Hemocue Hb201+, while serum retinol was measured using high-performance liquid chromatography (HPLC) and ultra-performance liquid chromatography (UPLC). Independent variables were grouped into subject, family, maternal and child health, and environmental factors, including demographic characteristics, socioeconomic status, maternal factors, health service utilization, supplementation, infectious diseases, sanitation, hygiene practices, and access to clean water.

All variables were described descriptively. Coexistence was defined as the simultaneous presence of anemia and VAD. Data were analyzed using WHO Anthro, Microsoft Excel 2021, and IBM SPSS 22.0 with a complex sample design approach, representing an estimated population of 284,784 children. Descriptive statistics were presented as frequencies and proportions. Bivariate associations were assessed using the Rao–Scott Chi-square test. Variables with $p<0.25$ in the bivariate analysis were selected as candidate covariates and entered into the multivariable complex sample logistic regression model. Consequently, only variables meeting this predefined selection criterion were retained for multivariable analysis. The complex sample approach accounted for weighting, stratification, and clustering. Adjusted odds ratios (AOR), 95% confidence intervals (CI), and p-values were reported, with significance set at $p<0.05$.

3 Results and discussion

3.1 Prevalence of anemia, vitamin A deficiency (VAD), and their coexistence

The prevalence of anemia among children under five was 16.1%, slightly higher in rural than urban areas (Table 1). Rural–urban disparities have been linked to socioeconomic and maternal factors, including household wealth, inadequate dietary intake, maternal education, employment status, number of children, and maternal age [5, 6].

Table 1. Prevalence of anemia, VAD, and their coexistence.

Variable	Urban		Rural		Urban + Rural	
	n	*Weighted* (%)	n	*Weighted* (%)	n	*Weighted* (%)
Hemoglobin level						
Normal	333	161,900 (84.5)	175	77,114 (82.7)	508	239,014 (83.9)
Anemia	75	29,610 (15.5)	45	16,158 (17.3)	120	45,769 (16.1)
Serum retinol level						
Normal	371	172,705 (90.2)	197	86,115 (92.3)	568	258,821 (90.9)
VAD	37	18,805 (9.8)	23	7,157 (7.7)	60	25,963 (9.1)

Coexistence of anemia and VAD						
No	395	185,839 (97.0)	210	90,628 (97.2)	605	276,467 (97.1)
Yes	13	5,671 (3.0)	10	2,644 (2.8)	23	8,216 (2.9)
Total	408	191,511 (100)	220	93,272 (100)	628	284,784 (100)

Note: *n*=represents the number of respondents (n=628), indicating unweighted data
Weighted refers to the estimated population (n=284,784) obtained through complex sample analysis with weighting to ensure national representativeness

The prevalence of VAD was 9.1%, with a higher proportion in urban areas than in rural areas, consistent with the 2023 SKI (9.8%) [7]. However, vitamin A supplementation coverage remains low (43.9%), indicating gaps in program implementation. VAD contributes to increased susceptibility to infections, impaired growth, and visual disorders, thereby elevating child morbidity and mortality [8].

Anemia–VAD coexistence was present in 2.9% of children aged 0–59 months. This relationship is biologically plausible, as VAD disrupts erythropoiesis and iron metabolism, increasing the risk of anemia [9]. Previous evidence suggests that VAD increases the risk of anemia in children (OR=2.56; 95% CI:1.15–5.70), and that combined vitamin A–iron supplementation yields better hematological outcomes than iron alone [4].

3.2 Associations of subject characteristics, family characteristics, environmental sanitation, and health status with the coexistence of anemia and VAD

Several factors were significantly associated with the coexistence of anemia and VAD among children under five, including social assistance (p=0.012), improved sanitation (p=0.020), completeness of antenatal care (ANC) services (10T) (p=0.031), and a history of acute respiratory infection (ARI) (p<0.001) (Table 2). The observed association between social assistance and coexistence may reflect differences in socioeconomic conditions between households receiving and not receiving social assistance. Previous studies have reported that socioeconomic disadvantage is often associated with limited access to nutritious foods, healthcare services, and other resources related to child nutritional status [10].

Table 2. Associations of subject characteristics, family characteristics, environmental sanitation, and health status with the coexistence of anemia and VAD.

Variable	Normal		Coexistence		*p value**
	n	**Weighted (%)**	**n**	**Weighted (%)**	
Social assistance					
No	419	189,160 (68.4)	15	7,273 (73.1)	0.012
Yes	186	87,307 (31.6)	8	1,042 (12.5)	
Availability of improved sanitation facilities					
No	565	261,522 (94.6)	20	8,131 (97.8)	0.020
Yes	40	14,945 (54.4)	3	185 (2.2)	
Completeness of ANC services (10T standard)					
Complete	168	86,296 (31.2)	2	848 (10.2)	0.031
Incomplete	437	190,171 (68.8)	21	7,468 (89.8)	
History of acute respiratory infection (ARI)					
No	579	265,394 (96.0)	1	70 (0.8)	<0.001
Yes	26	11,073 (4.9)	22	8,245 (99.2)	

Note: *n*=represents the number of respondents (n=628), indicating unweighted data
Weighted refers to the estimated population (n=284,784) obtained through complex sample analysis with weighting to ensure national representativeness
*P-values were derived from the Rao–Scott Chi-square test.

Improved sanitation and complete ANC services were also significantly associated with coexistence. Similar associations have been reported in previous studies, where inadequate sanitation was linked to a higher burden of infectious diseases and poorer nutritional outcomes among children [11]. In this study, 89.8% of mothers of children with coexisting anemia and VAD did not receive complete ANC services according to the 10T standards. Previous evidence has shown that inadequate ANC utilization is associated with fewer opportunities for nutrition counseling, health monitoring, and supplementation during pregnancy [12]. ANC plays a critical role in promoting balanced nutrition and preventing malnutrition in early life.

A history of ARI was also significantly associated with the coexistence of anemia and VAD (p<0.001). This observation supports existing evidence on the association between infections and micronutrient deficiencies. Previous evidence has shown that recurrent infections are often associated with increased metabolic demands, reduced appetite, impaired nutrient utilization, and poorer micronutrient status. In addition, VAD may compromise immune function, thereby increasing vulnerability to infections and reflecting the intricate relationship between infection and nutrition [13].

3.3 Risk factors for the coexistence of anemia and vitamin A deficiency

Table 3 shows that a history of acute respiratory infection (ARI) and receipt of social assistance were significantly associated with the co-occurrence of anemia and VAD. After adjustment for potential confounders, children with a history of ARI had higher odds of coexisting anemia and VAD than those without a recent history of ARI (AOR=1.517; 95% CI:1.268–2.995; p=0.047). Similar findings have been reported in previous studies on associations between ARI and vitamin A deficiency in children, including a higher likelihood of night blindness (AOR=3.14; 95% CI:1.02–9.70) [14].

Previous studies have reported associations between infectious diseases and micronutrient deficiencies. Recurrent infections have been linked to increased metabolic demands, reduced appetite, altered nutrient utilization, and poorer micronutrient status [11]. The association between vitamin A deficiency and infectious morbidity supports the notion that nutritional status and infection are mutually related [1].

Table 3. Risk factors for the coexistence of anemia and VAD.

Variables	Category	AOR	95% CI	*p-value**
History of ARI	No (ref)	-	-	0.047
	Yes	1.517	1.268–2.995	
Social assistance	No (ref)	-	-	0.004
	Yes	0.371	0.187–0.734	

Note : AOR=adjusted odds ratio; CI=confidence interval. Adjusted odds ratios were obtained from multivariable complex sample logistic regression analysis. Variables with p<0.25 in the bivariate analysis were included as candidate covariates in the multivariable model.
* Statistical significance was set at p<0.05.

Households receiving social assistance had lower odds of coexistence after adjustment for other variables (AOR=0.371; 95% CI:0.187–0.734; p=0.004). Social assistance programs target poor and vulnerable populations and have been associated with improved food access and food security among beneficiary households [15]. The observed association may reflect differences in socioeconomic and food security conditions between households receiving and not receiving social assistance.

This study found that recent ARI and social assistance were significant predictors of concurrent anemia and VAD among Indonesian children under five years. ARI was positively associated with coexistence, while social assistance showed a protective association. As this study used a cross-sectional design, causal relationships could not be established. Further longitudinal studies are recommended.

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