



Association of Immunoglobulin (IgG, IgM) and Hemoglobin Level with Nutritional Status in Stunted Children Under Five: A Preliminary Study

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Abstract. Stunting in children under five remains a major public health concern, closely associated with nutritional status, anemia, and immune function. Immunoglobulins, particularly IgG and IgM, play a crucial role in adaptive and innate immune responses, while hemoglobin (Hb) levels reflect anemia status. Understanding the interplay between immunity, anemia, and nutritional indicators such as body weight (BW) and body height (BH) is essential for developing early detection and intervention strategies. This study aimed to analyze the association of IgG, IgM, and Hb levels with nutritional status among stunted and non-stunted children. This cross-sectional study included 8 children under five years of age. Data collected comprised Hb levels, IgG and IgM concentrations, and anthropometric measurements (BW/U and BH/U). Statistical analyses were performed using the Mann-Whitney U test and Spearman's rank correlation, with a significance level set at $p < 0.05$. The mean Hb concentration was 12.21 ± 1.82 g/dL (range 9–14), IgG 1068.38 ± 162.47 mg/dL (839–1369), and IgM 117.88 ± 50.98 mg/dL (74–225). IgG levels showed a meaningful correlation with body weight ($p = 0.021$), hemoglobin ($p = 0.001$), and body length ($p = 0.001$). IgM levels were only significantly associated with hemoglobin ($p = 0.001$). This preliminary study highlights a meaningful relationship between immunoglobulins (IgG, IgM), hemoglobin levels, and nutritional status in children under five. The findings suggest that impaired immune function may contribute to anemia and poor growth outcomes. Despite the small sample size, this study provides important pilot data supporting the integration of immune markers in the assessment of stunting. Larger-scale studies are warranted to validate these associations and strengthen the evidence base for policy and intervention

Keywords: stunting; hemoglobin; immunoglobulin G (IgG), immunoglobulin M (IgM), nutrition status; children under five .

1 Introduction

One of the pressing health challenges in developing countries, including Indonesia, is stunting, which is generally caused by chronic malnutrition and recurrent infections in early life. Children with poor nutritional status have a risk of death from infectious diseases reaching approximately 45% in children under five years of age, demonstrating the close relationship between malnutrition and immunity. Malnutrition weakens the immune system through decreased immune function, while recurrent infections exacerbate inflammation and nutrient deprivation, creating a pathological cycle that worsens children's nutritional and growth conditions. This reciprocal relationship confirms that stunting results from a complex interaction between immune function, infection, and nutritional deficiencies[1, 2]. In the context of immunology, immunoglobulins, particularly IgG and IgM, play a crucial role in the humoral immune response and reflect immune competence and exposure to infection. Research by Abrams et al., (2023), demonstrated that adequate protein intake can increase IgM and IgG levels, confirming the direct influence of nutritional adequacy on immunological function[1]. Conversely, Primo et al. (2010) explained that chronic infection triggers sustained immune activation and inflammation that impair erythropoiesis, leading to anemia and reduced nutritional status. Increased antibodies against flagellin and bacterial lipopolysaccharide (anti-LPS) have been associated with decreased length-for-age (LAZ) z-scores and hemoglobin levels, indicating that immune activation and inflammation play a crucial role in the development of growth retardation. Results from the SHINE trial conducted in Zimbabwe indicate that exposure to environmental pollution and recurrent enteric infections increase the risk of anemia and stunting, even when overt diarrheal symptoms are absent[3]. Common pediatric infections, such as rotavirus and enteropathogenic *Escherichia coli*, can interfere with nutrient absorption, ultimately leading to stunting, anemia, and growth retardation. These factors are interrelated in worsening children's nutritional status, underscoring the importance of addressing the roles of infection and pollution in stunting prevention[4]. Other studies have shown that mutations in immune signaling genes, such as the HOIP component of the LUBAC complex, can impair antibody production and exacerbate chronic inflammation[5–7]. Liang et al. reviewed the relationship between food antigens, intestinal barrier dysfunction, and the development of metabolic and immunological diseases. Intestinal barrier dysfunction mediates the effects of food antigen exposure, chronic inflammation, and nutrient malabsorption, thereby contributing to chronic failure to thrive[8]. Overall, this evidence reinforces the concept of the nutrition-immunity-infection trio, where immunological biomarkers such as IgG, IgM, and hemoglobin (Hb) reflect the physiological mechanisms involved in stunting[9]. Although research advances have provided a deeper understanding of these relationships, empirical evidence directly linking immunological and hematological markers to the nutritional status of children in Indonesia remains very limited. This is due to differences in dietary patterns, environmental conditions, and exposure to infectious diseases in Indonesia compared to Africa and South Asia. Based on this description, it can be concluded that stunting is a complex manifestation of the interaction between nutritional status, immune function, and exposure to infection, where an imbalance in one component can exacerbate the other. The limited empirical evidence

regarding the relationship between immunological (IgG, IgM) and hematological (Hb) biomarkers and the nutritional status of stunted children in Indonesia indicates a knowledge gap that needs to be bridged through locally context-based research. A scientific approach integrating nutrition, immunology, and environmental health will provide a more comprehensive understanding of the pathophysiological mechanisms of stunting in the Indonesian child population.

The aim of this study was to analyze the relationship between immunoglobulin (IgG and IgM) and hemoglobin (Hb) levels and nutritional status in stunted and non-stunted toddlers in Indonesia. This will provide a scientific evidence base for developing early detection strategies and immunological-based nutritional interventions to prevent stunting

2 Method

This preliminary cross-sectional study examined the relationships between immunoglobulin (IgG and IgM) and hemoglobin (Hb) levels and the nutritional status of stunted and non-stunted toddlers. Purposive sampling was employed to select toddlers aged 0-5 years who were identified as stunted or of short stature based on anthropometric measurements and Z-scores (> -3 SD). Participants were excluded if they were currently ill (e.g., with digestive disorders) or had chronic diseases (e.g., autoimmune diseases). The final sample included eight toddlers from the Fisherman's Health Center in Gresik Regency. Data collection involved anthropometric measurements, body weight assessment using a digital scale, height measurement with a stadiometer, and laboratory examinations for IgG and IgM. Immunoturbidimetry was used for IgG, while immunoturbidimetry enhanced with polyethylene glycol (PEG) was used for IgM; hemoglobin was measured using Hemocue. The immunoturbidimetry method for IgG demonstrates a strong correlation with the reference ELISA D-dimer method. The PEG-enhanced immunoturbidimetric method for IgM quantification uses PEG in the buffer. Ethical approval was obtained from the KEPK Faculty of Health Sciences, Universitas PGRI Adi Buana Surabaya (certificate No. 130-KEPK, dated July 12, 2023). Statistical analyses included multiple correlation and linear regression, with significance set at $p < 0.05$.

3 Result and Discussion

3.1 Result

Table 1. Analysis of Immunity and Hemoglobin Levels in Relation to Toddler Weight and Height

Assessment Indicators	Mean; SD; Min-Max	p-Value			
		Spearman's rho		Mann-Whitney	
		Immunity *TB, Hb*TB	Immunity *BB, Hb*BB	Immunity *Hb	Immunity *TB
IgG	1068.38; 162.474; 839-1369	0,102	0,021	0.001	0,001

IgM	117.88; 50.983; 74-225	0,058	0,058	0.001	0,059
Hemoglobin	12.21; 1.822; 9-14	0,453	0,713		
BB/U	9.03; 2.062; 6-13				
TB/U	78.52; 10.032; 64-93				

primary data sources, 2023

Based on the table above, IgG is significantly related to body weight ($p=0.021$), hemoglobin ($p=0.001$), and height ($p=0.001$, Spearman's rho), indicating a connection with nutritional status (weight/height) and hemoglobin levels. IgM is significantly related to hemoglobin ($p=0.001$), but not to body weight and height ($p\approx 0.05-0.06$). Hemoglobin does not show a direct significant relationship with body weight or height, but is significantly associated with IgG and IgM. In summary, immune status (IgG, IgM) is closely related to anemia (Hb) and nutritional status in toddlers.

3.2 Discussion

IgG reflects long-term antigenic exposure, while IgM marks the early response to infection. The relationship between IgG and hemoglobin, as well as anthropometric indicators, suggests that exposure to chronic infection or inflammation is associated with anemia and suboptimal growth. Research shows a significant relationship between nutritional status, hemoglobin levels, and anemia in children. Children with poor nutritional status are more susceptible to anemia, characterized by subnormal hemoglobin levels (less than 11 g/dL). Anemia in this condition indicates a reduction in red blood cell mass and hemoglobin, which reduces the ability to carry oxygen to body tissues. Furthermore, nutritional deficiency anemia also impacts suboptimal growth, as poor nutritional status can exacerbate anemia. Chronic infection or inflammation, reflected in high IgG levels, can contribute to this anemia, disrupting a child's growth and development[10]. In this context, immune status, as reflected by IgG levels, as a marker of long-term antigen exposure, is closely associated with chronic anemia and suboptimal growth. High IgG levels may contribute to anemia through the mechanism of autoimmune hemolytic anemia, where IgG acts as an autoantibody that attaches to red blood cells and triggers red blood cell destruction by macrophages in the spleen. Furthermore, chronic infection or inflammation disrupts iron metabolism and decreases erythropoietin production, which inhibits the formation of new red blood cells (erythropoiesis). Thus, prolonged systemic inflammation characterized by elevated IgG levels can cause anemia through a combination of red blood cell destruction and inhibition of new red blood cell production, ultimately impacting a child's physiological growth[11]. These results align with those of Spaan et al. (2025), who demonstrated that chronic inflammation or persistent infection can reduce children's nutritional status, induce anemia, and contribute to growth retardation[6]. This study strengthens the evidence that autoimmune mechanisms, particularly the destruction of red blood cells by IgG antibodies, exacerbate anemia in children with existing nutritional deficiencies. Boisson et al. (2025) further clarified this relationship by demonstrating that dysfunction in immune signaling pathways involving proteins such as HOIP in LUBAC increases the risk of

chronic inflammation and immunodeficiency, which in turn worsens anemia and impairs growth[7].

Recent studies have shown a strong link between iron deficiency anemia and stunting in toddlers. A 2024 meta-analysis reported that children with iron deficiency anemia have a higher risk of stunting than children without anemia. Several large population studies have also confirmed that anemia and stunting often co-occur and are interrelated as determinants of nutritional problems in children. This strengthens the understanding that the correlation between anemia and stunted growth is not an isolated event, but rather part of a broader epidemiological pattern. Anemia, particularly that caused by iron deficiency, disrupts the supply of oxygen and nutrients to a child's tissues, which in turn hinders optimal growth and overall physical development[12, 13]. Previous research indicates that iron-deficiency anemia is a significant contributor to stunting in children. A meta-analysis by Valitutti et al. (2024) found that children with iron deficiency anemia have a higher risk of stunting than those without anemia. These results reinforce the association between anemia and stunted growth and suggest a bidirectional relationship within broader epidemiological contexts[14]. Although IgG is associated with anemia, additional factors, including nutritional deficiencies and other medical conditions, also contribute to deteriorating nutritional status and impaired growth. A limitation of this study is the incomplete control of environmental variables, such as diet and socioeconomic status, which may influence a child's overall nutritional status.

IgM showed a significant correlation with hemoglobin, but its relationship with growth indicators did not reach the conventional level of significance. The Spearman correlation value for IgM to Hb was recorded at $p < 0.001$, while for body weight (BW) and height (HB), it was in the p range of approximately 0.058 to 0.059. This pattern suggests that acute immune activation, as reflected in IgM levels, goes hand in hand with a decline in hematological status, but is not immediately visible as a long-term change in body size. Immunologically, IgM is an antibody rapidly produced in the early stages of antigen exposure, predominantly in the primary response, and highly effective in activating the complement system. Elevated IgM levels indicate a relatively recent infection, rather than a long-term chronic inflammatory state. This property explains why IgM correlates with rapidly responding variables, such as hemoglobin, but is less correlated with slowly changing linear growth or weight indicators. The literature also confirms IgM's role as an early antibody in the humoral response and its potential effector through complement activation (10).

The relationship between IgM and child growth is weaker than that of hemoglobin because IgM is a marker of an acute immune response with a short peak, whereas anthropometrics, such as linear growth and weight, reflect long-term biological processes. Child growth is more influenced by low-grade chronic inflammation, intestinal mucosal dysfunction, and growth hormone resistance, rather than by transient immune surges, as indicated by IgM levels. Studies on environmental enteric dysfunction suggest that chronic intestinal inflammation leads to systemic inflammation, impaired nutrient absorption, and growth hormone resistance, ultimately inhibiting linear growth and weight gain in children. Therefore, the absence of a strong correlation between IgM and anthropometric indicators is consistent with IgM's role as a marker of acute infection

exposure, while growth is more influenced by the ongoing burden of chronic inflammation.

3.3 Research Limitations

Several limitations of this study should be acknowledged. Although a significant correlation was observed between IgM and hemoglobin, the associations with other growth indicators, such as weight and height, were not as pronounced. This limitation may be attributed to the cross-sectional study design, which does not allow for assessment of long-term cause-and-effect relationships. Future longitudinal studies with regular measurements of IgM levels, hemoglobin, and growth indicators are necessary to clarify the long-term associations among these variables. Another limitation concerns the restricted range of environmental factors considered. Variables such as diet, chronic infections, and socioeconomic conditions, which can influence children's nutritional status and growth, may not have been fully controlled. This limitation could affect the validity and generalizability of the findings. Consequently, future research should incorporate a broader range of environmental variables to provide a more comprehensive understanding.

4 Conclusion

This preliminary study demonstrated a significant association among immunoglobulin (IgG and IgM) levels, hemoglobin, and nutritional status in children under 5 years of age. Clinically, high IgG levels were associated with anemia and impaired growth, indicating that chronic inflammation may affect red blood cell production and nutritional status in children. Although the sample size is limited, these findings support the integration of immune markers in stunting assessment. Further research with larger sample sizes, other inflammatory biomarkers (e.g., IL-6, TNF- α , IL-10), and longitudinal approaches is needed to validate these results and strengthen the evidence base for health policies on stunting management and more effective interventions (e.g., natural/local approaches).

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