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RELATIONSHIP BETWEEN ZINC SUPPLEMENTATION AND GROWTH PARAMETERS IN CHILDREN AGED 1-5 YEARS: A CROSS SECTIONAL STUDY

Heny Yuniarti[1]*, Joko Wahyu Wibowo[2], Shofi Khofsoftun Purjaningsih[3]
[12]Nutrition Department, Faculty of Medicine, Sultan Agung Islamic University, Semarang, Indonesia
[3]Faculty of Medicine, Sultan Agung Islamic University, Semarang, Indonesia

E-mail: henyyuniarti@unissula.ac.id

Abstract

Zinc deficiency is a prevalent form of micronutrient malnutrition worldwide, particularly in developing countries, and is linked to impairments in cognitive, emotional, and physical development in children. This study aimed to investigate the association between zinc supplementation and growth changes in height and weight among children aged 1 to 5 years at Bangetayu Health Center, Semarang. Employing a cross-sectional analytical observational design, the study involved 60 children, equally divided between those receiving zinc supplementation and those not supplemented. Anthropometric measurements and child health records (KIA books) were utilized for data collection. The findings revealed a statistically significant association between zinc supplementation and improved growth parameters: 83.3% of supplemented children exhibited increased height (PR = 5.000; 95% CI = 2.444–10.228), and 69.8% showed increased weight (PR = 2.304; 95% CI = 1.530–3.475), with p-values < 0.001. Zinc's critical role in hormone regulation, immune function, and bone metabolism underpins its contribution to linear growth. Despite limitations including the short study duration and limited control of confounding variables, the results underscore the importance of zinc supplementation combined with adequate nutrition and ongoing health supervision to enhance growth outcomes in young children.

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INTRODUCTION

Zinc deficiency is among the most prevalent forms of micronutrient malnutrition worldwide and constitutes a significant public health concern, particularly in developing countries. This condition adversely affects children, leading to impairments in cognitive function, social-emotional development, language acquisition, motor skills, and reduced immunity resulting from compromised lymphocyte function. Toddlers, in particular, have elevated zinc requirements to support optimal growth, immune function, and tissue repair. Key risk factors contributing to zinc deficiency include inadequate nutritional intake, infectious diseases, birth conditions, and adverse socioeconomic and environmental factors.[2,3] According to the World Health Organization, approximately 31% of the global population suffers from zinc deficiency, with the highest prevalence observed in Africa and Southeast Asia. In Indonesia, the condition affects an estimated 36.1% of children.[4] Infections such as diarrhea, acute respiratory infections, and helminthiasis exacerbate zinc deficiency by increasing metabolic demands and impairing nutrient absorption, thereby establishing a bidirectional relationship between infection and malnutrition.[5]

Dietary intake, encompassing energy, protein, carbohydrates, and micronutrients such as zinc, constitutes a critical factor in the prevention of stunting and infections in children. Zinc is involved in the regulation of growth-related hormones, including somatomedin, osteocalcin, testosterone, thyroid hormones, and insulin, and is found in high concentrations in bone tissue, underscoring its essential role in childhood growth.[6] The linear growth of toddlers is significantly influenced by adequate zinc levels, and zinc deficiency can lead to stunting, which adversely affects both physical and cognitive development.[7] Studies have demonstrated that zinc supplementation, administered at doses of either 3 mg or 20 mg per day, can effectively promote increases in both height and weight among stunted toddlers.[7,8] Certainly, providing zinc supplementation starting from the first day of life (the first 1,000 days) has been demonstrated to effectively prevent reductions in height and weight in toddlers.[9]

The association between zinc supplementation and improvements in height (H) and body weight (BW) among toddlers requires further investigation, owing to limitations in prior studies, including small sample sizes and the absence of consistent monitoring of nutritious food intake in stunted children. Although required in minimal quantities, zinc is essential for growth, necessitating an adequate daily intake.[6,7] This study aims to investigate the relationship between zinc supplementation and its effects on changes in height (H) and body weight (BW) among toddlers aged 1 to 5 years at Bangetayu Health Center.

METHOD

This study implemented an analytical observational design with a cross-sectional approach. The researcher did not administer any intervention but rather observed the association between the exposure (zinc supplementation) and the outcomes (height and weight) simultaneously. This design is appropriate for examining relationships between independent and

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dependent variables. Ethical approval was obtained from the Bioethics Commission for Medical and Health Research at the Faculty of Sultan Agung Islamic University, Semarang (No. 175/IV/2025/Bioethics Commission), as well as from the Bangetayu Health Center, Semarang.

This study was conducted at the Bangetayu Health Center, Semarang City, over a period of two months, from January to February 2025. The target population comprised all toddlers aged 1 to 5 years, while the accessible population included toddlers within this age range residing in the Bangetayu Health Center's catchment area. Inclusion criteria encompassed toddlers aged 1 to 5 years who lived within the Health Center's service area, possessed a Kesehatan Ibu dan Anak (KIA) book, and consented to participate in the study. Toddlers who declined participation were excluded from the study.

This study involved 58 toddlers as participants. The independent variable was zinc supplementation, while the dependent variables were the height (TB) and weight (BB) of toddlers aged 1 to 5 years. These dependent variables were measured to evaluate the effect of zinc supplementation on child growth. Data collection included measurements of height and weight using standardized anthropometric instruments, complemented by secondary data from Maternal and Child Health (KIA) books to verify the accuracy of growth records and zinc supplementation history.

Upon obtaining approval, data collection was carried out on toddlers who met the inclusion and exclusion criteria. The sample included both normal and stunted toddlers who had received zinc supplementation in the form of zinc sulfate syrup at a dosage of 20 mg/5 ml, administered once daily after meals. Univariate analysis was performed to describe respondent characteristics such as age, gender, parental education, and zinc supplementation status. Bivariate analysis was conducted using the Chi-square test, appropriate for categorical and independent data. The results demonstrated a p-value of less than 0.001, indicating a statistically significant association between zinc supplementation and changes in the height and weight of toddlers.

RESULTS

The results indicated that the majority of participants were male (56.6%) and aged between 12 and 36 months (68.3%). Additionally, 70% of the respondents' parents had completed primary education, whereas 30% had attained higher education. Among the participants, 50% received zinc supplementation in the form of syrup, while the remaining 50% did not receive any supplementation (Table 1).

In this study, 83.3% of children receiving zinc supplementation demonstrated increased height, whereas only 16.7% of children without supplementation showed height gains. Chi-square analysis revealed a statistically significant association between zinc supplementation and height increase

($p = 0.001$). The prevalence ratio (PR) of 5.0 indicates that children supplemented with zinc were five times more likely to experience growth in height compared to those who were not supplemented (95% confidence interval [CI]: 2.444–10.228) (Table 2).

A total of 69.8% of children who received zinc supplementation experienced weight gain, compared to only 30.2% of children without supplementation. Chi-square analysis yielded a p-value of 0.001, indicating a statistically significant association between zinc supplementation and

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weight gain in children. The prevalence ratio (PR) of 2.308 suggests that children receiving zinc supplementation were approximately 2.3 times more likely to gain weight than those who did not receive supplementation, with a 95% confidence interval (CI) of 1.533 to 3.475 (Table 3).

The study results indicated that among 60 children aged 1–5 years who participated at Bangetayu Health Center, Semarang, 71.7% experienced an increase in body weight, while 60% showed an increase in height. The mean difference in weight and height gain was 0.1, with an average weight gain of 0.2 and an average height gain of 0.1 (Chart 1).

Table 1. Respondent Characteristic

Charateristic	Total (n=60)	Percentage (%)
Sex		
Male	32	53,3
Female	28	46,6
Age		
12 – 36 Months	41	68,3
37 – 60 Months	19	31,6
Parent's Education		
Basic Education (SD - SMP)	42	70
Higher Education (SMA - S1)	18	30
Zinc		
Yes	30	50
No	30	50

Table 2. Analysis of the Relationship Between Zinc Supplementation and Height Gain in Toddlers Over One Month

No	Zinc Supplementation	Toddler's Height				Total		PR (Prevalence Rate)	Chi Square Test	CI
		Increased		Not-Increased						
		f	%	f	%	f	%			
1.	Yes	30	83,3	0	0	30	50	5.000	<0,001*	2.444-
2.	No	6	16,7	24	100	30	50			10.228
	Total	36	100	24	100	60	100			

*Significantly Difference

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Table 3. Results of the Analysis of the Association Between Zinc Supplementation and Body Weight in Toddlers Over a One-Month Period

No	Suplementasi Zinc	Toddler's Weight				Total		PR (Prevalence Rate)	Chi Square Test	CI
		Increased		Not-Increased						
		f	%	f	%	f	%			
1.	Yes	30	69,8	0	0	30	50	2.308	<0,001*	1.533-
2.	No	13	30,2	17	100	30	40			3.475
	Total	43	100	17	100	60	100			

* Significantly Difference

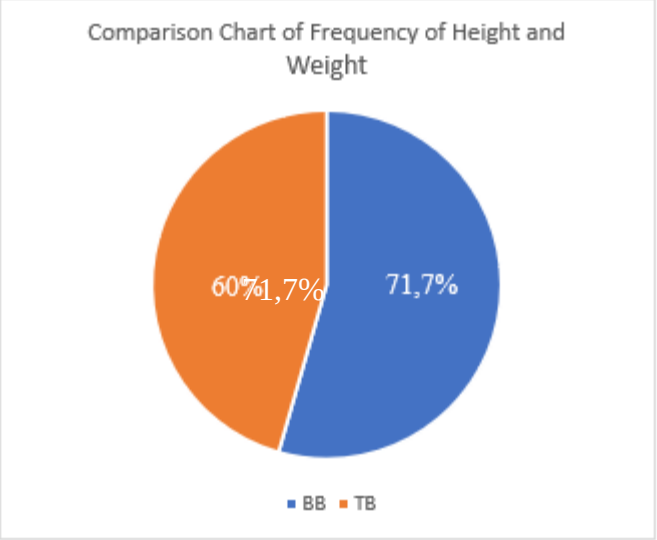

Chart 1. Comparison Chart of Frequency of Height and Weight

DISCUSSION

Higher levels of parental education have been demonstrated to reduce the risk of stunting in children by approximately 3 – 5%. This highlights the critical role of parental education as a key determinant of family nutritional status. Parents with greater educational attainment are more likely to possess enhanced knowledge regarding nutrition, hygiene, and appropriate health care practices, which contribute to improved dietary habits and overall child development. Therefore, enhancing parental education represents a potentially effective strategy for addressing childhood stunting and promoting family well-being.[7,10] This study revealed that 30% of the parents possessed a higher level of education, and among children of these highly educated parents, zinc supplementation was administered, which positively influenced the growth of the child.

Zinc plays a crucial role in the growth and development of children by facilitating the activation and synthesis of growth hormone (GH) and stabilizing cellular membranes.[11] Several studies have reported an increase in height and weight among 15 children following zinc supplementation, with observed improvements of 16.12% in height and 5.6% in weight, respectively.[11,12] In this study, the majority of children who received zinc supplementation for one

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month therefore this studi is comprising 30 respondents (83.3%) for height and 69.8% for weight and demonstrated an increase in both parameters. In contrast, only 6 children (16.7%) exhibited increased height and 13 children (30.2%) showed increased weight among those who did not receive zinc supplementation.

Zinc is essential for bone growth, interacting with various hormones including somatomedin-C, osteocalcin, testosterone, thyroid hormone, and insulin, thereby facilitating hormonal mediation and supporting the activity of growth hormone.[12] Zinc's role in bone metabolism, as well as its function as a component of metalloenzymes, polymerase stabilizers, and membrane-stabilizing free ions, further underscores the critical importance of zinc supplementation. Deficiency in zinc has been demonstrated to adversely affect growth hormone regulation by decreasing levels of IGF-1, growth hormone receptors, and growth hormone binding protein RNA, which can impede linear growth and hinder increases in both height and weight.[13,14] The findings of this study demonstrate a significant association between zinc supplementation and increases in both height and weight among children at the Bangetayu Health Center, Semarang, as evidenced by Chi-Square analysis conducted on 60 respondents.

This study presents several limitations that should be considered in interpreting the findings. Data collection was limited to a one-month period at the Bangetayu Health Center, Semarang, which may not have been sufficient to observe significant or sustained changes in height and weight among toddlers receiving zinc supplementation. Moreover, the study did not account for potential confounding variables such as existing health conditions during the intervention, which could have influenced growth outcomes. In addition, critical determinants of child growth and development such as environmental sanitation, household income, immunization history, maternal education, breastfeeding practices, and baseline nutritional status were not included in the analysis. The absence of detailed information regarding prior zinc supplementation further limits the ability to isolate the effects of the intervention. Therefore, while the findings suggest a positive association between zinc supplementation and growth, future studies should employ longer observation periods, control for potential confounders, and incorporate comprehensive nutritional and health histories. Zinc supplementation should be implemented alongside consistent health monitoring and a balanced diet to ensure optimal child development.

CONCLUSION

This study concluded that there is a significant association between zinc supplementation and improvements in both height and weight among children aged 1 – 5 years at the Bangetayu Health Center, Semarang. A total of 30 children (83.3%) who received zinc supplementation demonstrated an increase in height, while 30 children (69.8%) showed an increase in weight. The results of the Chi-Square test indicated a statistically significant effect of zinc supplementation on height ($p = 0.001$; PR = 5.000; 95% CI = 2.444–10.228) and weight ($p = 0.001$; PR = 2.304; 95% CI = 1.530–3.475). These findings suggest that zinc supplementation substantially enhances the likelihood of linear growth and weight gain in children within the studied age range.

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