Effect Of The One Egg One Day Program On Changes In Zinc Levels And Anthropometric Status In Stunted Toddlers

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ABSTRACT

Stunting remains a serious public health problem in Indonesia. In this context, hair zinc levels serve as a sensitive long-term biomarker for assessing chronic zinc deficiency, a condition that is very common in stunted toddlers and directly contributes to stunted linear growth, while anthropometric status (especially the Height/Age z-score) provides an objective measure of impaired growth outcomes. Locally resource-based nutritional interventions, such as the consumption of omega-3-rich chicken eggs, offer significant strategic potential as a complete nutritional package rich in high-quality protein, zinc, omega-3 fatty acids (DHA), and various other essential micronutrients.

This study aimed to analyze the effectiveness of the one egg a day program on changes in hair zinc levels and anthropometric status in stunted toddlers.

The study used a pre-experimental design with a static group comparison approach. Data collection was conducted twice: a pre-test and a post-test. The data collected included the anthropometric status of stunted toddlers (height and weight) and zinc levels obtained from hair samples. Hair samples were taken from the back of the head by cutting 1.5-3 cm from the hair roots of the respondents. The data obtained were then analyzed using a paired t-test.

The One Egg a Day, One Egg program significantly increased hair zinc levels and anthropometric status (Z-score) in stunted toddlers, with a 2-tailed sig of 0.000 for each.

The use of omega-3 chicken eggs can be an alternative support option to address stunting in Indonesia through diversification of processed chicken egg products within the One Egg One Day program.

Introduction

Stunting, or failure to thrive in children due to chronic malnutrition, remains a serious health problem for infants, toddlers, and children in Indonesia. This problem stems from inadequate nutritional intake during the first 1,000 days of life, from pregnancy to age two, which leads to stunted physical and cognitive development (Martony, 2023). In infants, this often begins with suboptimal feeding practices, such as non-exclusive breastfeeding or the use of nutritionally deficient complementary foods (MP-ASI). The impact continues in toddlers and children, which is not only evident in their short stature for their age, but also makes them more susceptible to infectious diseases and experiences delayed brain development that can lead to decreased learning ability and productivity in adulthood. Although stunting rates in Indonesia have shown a decline, its persistently high prevalence reflects complex, multidimensional challenges, including poverty, limited access to nutritious food, inadequate parenting, and problems with sanitation and clean water (Fajrini et al., 2024).

In some Indonesian communities, there is still a misperception that short stature in toddlers is normal and nothing to worry about as long as the child is active and doesn't get sick often. This assumption is often rooted in the understanding that links body shape primarily to hereditary factors or "innate," thus ignoring the possibility of chronic nutritional problems. Parents may be relieved that their child has a good appetite and rarely experiences serious illness, without realizing that short stature is an early sign (stunting) that actually indicates the child has experienced long-term malnutrition. This perception that normalizes the condition is one of the biggest obstacles to stunting prevention efforts, because it prevents parents from seeking accurate information, regularly monitoring their child's growth at the integrated health post (posyandu), and taking early action such as improving diet and hygiene, which can ultimately worsen the long-term impact on the child's brain development and future (Yuda, 2023).

According to the World Health Organization (WHO), stunting remains a significant global nutrition challenge. Globally, an estimated 148.1 million children under five, or 22% of all children under five worldwide, were stunted in 2022. This figure reflects the enormous burden borne by global public health, with the majority of cases concentrated in low- and middle-income countries. The WHO emphasizes that stunting is not simply a matter of short stature, but a clear indicator of chronic malnutrition and an unfavorable environment early in a child's life, which has serious consequences for cognitive development and long-term health (WHO, 2023). Meanwhile, in Indonesia, the Indonesian Ministry of Health reported that the prevalence of stunting among toddlers showed a significant downward trend, but the rate remains relatively high. Based on the results of the 2023 Indonesian Nutritional Status Survey (SSGI), the national stunting rate was at 21.5%, down from 24.4% in 2021 and 27.7% in 2019. While this progress is commendable and is approaching the WHO target of below 20%, the 21.5% figure means that approximately one in five toddlers in Indonesia still suffers from stunting. The Indonesian government continues to intensify various specific and sensitive nutrition interventions to achieve the stunting prevalence target of 14% by 2024 (Kemenkes RI, 2024).

Stunting is defined as a condition of impaired growth and development in children due to chronic malnutrition, repeated infections, and inadequate psychosocial stimulation, characterized by a child's height being shorter than the standard for their age. The causes of stunting are multidimensional and interrelated, including direct factors such as inadequate maternal and child nutritional intake and infectious diseases; indirect factors such as parental ignorance of nutritional parenting patterns, limited access to nutritious food, and inadequate health services; and underlying factors such as poverty, low maternal education, and poor environmental sanitation (Jeniawaty et al., 2024). The mechanism of stunting begins with inadequate food intake in quantity and quality, especially during the first 1,000 days of life (from the fetus to the age of 2 years), which causes deficiencies of important micronutrients such as iron, zinc, and protein. This malnutrition is exacerbated by repeated infections (such as diarrhea and acute respiratory infections) that increase energy and nutrient needs, while reducing nutrient absorption in the intestine. This combination of nutritional deficiencies and infectious burden inhibits the production of the growth factor IGF-1 (Insulin-like Growth Factor 1), disrupts cell function, energy metabolism, and ultimately inhibits cell proliferation and organ development, including the brain and bones, which ultimately manifests as linear growth failure (stunting) and impaired cognitive development (Sasmito et al., 2025).

Stunting has both short-term and long-term impacts, significantly impairing an individual's quality of life and burdening a nation's socioeconomic development. In the short term, stunting makes children more susceptible to infectious diseases such as diarrhea and pneumonia due to a weakened immune system, experiences decreased appetite, and faces delays in motor and cognitive development, which can be seen in suboptimal learning abilities and social interactions (Permana et al., 2025). The long-term impacts are even more worrying, where stunting contributes to permanently inhibited brain development which leads to low academic achievement and intellectual capacity, increases the risk of degenerative diseases such as obesity, diabetes, and heart disease in adulthood, and ultimately results in low economic productivity and a repeated cycle of poverty when they become parents who then give birth to children at risk of stunting (Nugroho et al., 2021)

In an effort to address stunting, Indonesia has launched various national programs. The national stunting program in Indonesia is implemented through an integrated and coordinated strategy, culminating in the Technical Coordination Meeting (Rakortek) for the Acceleration of Stunting Reduction, chaired directly by the President. The core of this program is intervention, divided into two types: specific nutrition interventions and sensitive nutrition interventions (Titoni et al., 2024). Specific interventions are aimed directly at targets in the First 1,000 Days of Life (HPK) and are managed by the health sector, including the provision of iron tablets for pregnant women, the promotion of exclusive breastfeeding and complementary feeding, zinc supplementation, complete immunization, and the provision of additional food. Meanwhile, sensitive interventions are managed by various ministries and non-health institutions (such as the Ministry of Villages, Disadvantaged Regions and Transmigration, the Ministry of Public Works and Housing, the Ministry of Social Affairs) which aim to improve indirect causal factors, such as the provision of access to clean water and sanitation (STBM), social security (PKH, BPNT), increasing food security, and community education and empowerment through integrated health posts (Posyandu) which have been modernized into Posyandu Plus (Subardi et al., 2024).

Direct management for toddlers identified as stunted is carried out in stages, starting at primary health care facilities. At the integrated health post (Posyandu), toddlers detected as short (based on height-for-age measurements) are referred to the Community Health Center (Puskesmas) to confirm the diagnosis and identify the cause. Management is holistic, focusing not only on providing additional food or supplementation (such as "tapioca") but also including close growth monitoring, parenting education and feeding practices for parents, management of comorbidities (such as diarrhea and worm infections), and developmental stimulation to support cognitive abilities (Murib et al., 2024). For cases accompanied by severe medical complications or growth failure, toddlers will be referred to a hospital for more intensive treatment by a pediatrician. This approach emphasizes that stunting management requires ongoing collaboration between health workers, integrated health post (Posyandu) cadres, and especially the family as the spearhead of daily care (Ruhulessin et al., 2024).

Meeting the nutritional needs of stunted toddlers in Indonesia is a critical and urgent intervention that plays a key role in breaking the cycle of stunting, as it aims not only to catch up on physical growth but also to restore and maximize brain development that has been disrupted by chronic malnutrition. Proper nutritional intake, especially protein, zinc, iron, and various other essential micronutrients in adequate quantities and quality, can stimulate growth hormone production, improve the function of a weakened immune system, and provide essential fuel for the formation of neural connections, thus directly protecting children's cognitive future and preventing permanent damage. In the Indonesian context, this effort is the foundation of any stunting management program, because without intensive and sustainable nutritional improvements, other stimulation efforts and increasing access to health care will not be maximally effective. Therefore, providing targeted and quality nutrition is a fundamental investment in producing a generation that is not only healthier but also more intelligent and productive (Wulan & Purba, 2024)

One concrete effort to address the problem of stunting is to ensure that stunted toddlers consume chicken eggs, especially omega-3 eggs. Omega-3 eggs have enormous potential as a solution for treating stunted toddlers in Indonesia. Their rich nutritional content, particularly high-quality protein, choline, iron, zinc, and vitamin B12, is crucial for supporting a child's physical growth and brain development. The advantage of omega-3 eggs lies in their higher content of the essential fatty acids EPA and DHA compared to regular eggs. DHA is a crucial component for the formation of nerve cells and intelligence in children. With a relatively affordable price and easy access, omega-3 eggs can be an effective and efficient "superfood" for improving the nutritional quality of toddlers, particularly in preventing and mitigating the impact of stunting that hinders the potential of the nation's future generation (Suksesty et al., 2020).

Diversifying processed chicken egg products is a key strategy to increase acceptance and ensure nutritional intake for stunted toddlers, who often have difficulty eating or are picky eaters. Eggs can be processed into various attractive shapes and flavors that children love, such as soft steamed egg pudding, sweet egg muffins, cute-shaped egg nuggets, or mixed into porridge, cream soup, and steamed rice. Flavor innovation can be achieved by mixing other nutritious ingredients such as spinach puree, carrots, or powdered anchovies to enhance flavor and vitamin and mineral content. This approach not only overcomes boredom but also "covertly" introduces the nutrient-dense nutrients from eggs (protein, choline, omega-3) into the daily diet, effectively helping meet daily nutritional needs that are crucial for accelerating the improvement of nutritional status and growth and development of stunted toddlers (Tugiyanti et al., 2024).

The implementation of the "One Day One Egg" program could be a concrete breakthrough strategy. This program is proposed to specifically target toddlers from low-income families identified as at risk or already experiencing stunting. Its implementation could be integrated with integrated health posts (Posyandu), government social assistance programs, or collaboration with local farmers to ensure a sustainable supply of omega-3 eggs. In addition to egg distribution, this program should be accompanied by education for parents on the importance of balanced nutrition and how to properly process eggs to maintain their nutritional value. A holistic approach, from production and distribution to education, will maximize the impact of the "One Day One Egg" program in accelerating the fulfillment of toddlers' nutritional needs and reducing stunting rates in Indonesia.

Research Purposes

This study aims to analyze the effectiveness of the one egg one day program on changes in hair zinc levels and anthropometric status in stunted toddlers

Methods

The research design used was pre-experimental with a static group comparison design approach. The target population in this study were stunted toddlers in the working area of the Sooko Community Health Center, Mojokerto Regency. The sampling technique used was probability sampling with cluster sampling. Data collection was carried out twice: a pre-test and a post-test. In this pre-test stage, the research team measured initial data on the research respondents. The data collected were the anthropometric status of stunted toddlers (height and weight) and zinc levels obtained from hair samples of stunted toddlers. Hair samples were taken from the back of the head by cutting 1.5-3 cm from the respondent's hair roots. This initial data will later be used for pre-test data on each respondent. Furthermore, the research respondents were given an intervention of consuming eggs containing omega 3 in the form of ready-to-eat food for a period of 2 months. After another 2 months, data measurements were taken again. Final data collection was conducted by re-measuring the anthropometric status of stunted toddlers (height and weight) and zinc levels obtained from hair samples of stunted toddlers after the intervention. The measurement results were then recorded on an observation sheet and used as the final data for the study. The collected data were then analyzed. Zinc levels were determined at the Dian Husada Hospital Pharmacy Laboratory. Zinc levels in the research samples were analyzed using the Atomic Absorption Spectrophotometer (AAS) method. The data obtained were then analyzed using a paired t-test.

Result

a. Characteristics of research respondents

Table 1. Frequency distribution based on the characteristics of research respondents

No	Characteristics	Amount	Percentage
1	Gender :		
	Male	3	23,1%
	Female	10	76,9%
2	History of diarrhea :		
	Never had diarrhea	6	46,2%
	Have had diarrhea	7	53,8%
3	History of upper respiratory tract infections :		
	Never had an upper respiratory tract infection	12	92,3%
	Have had an upper respiratory tract infection	1	7,7%
4	History of worm infestation :		
	Never had worm infestation	3	23,1%
	Have had worm infestation	10	76,9%
Total		13	100%

Source: Primary research data, 2025

Based on the research results, the data obtained shows that most of the respondents in this study were women, namely 10 respondents (76.9%), more than half of the respondents had experienced diarrhea, namely 7 respondents (53.8%), almost all respondents had never experienced upper respiratory tract infections, namely 12 respondents (92.3%), and most of the respondents had experienced worms, namely 10 respondents (76.9%).

b. Changes in zinc levels in research respondents

Table 2. Frequency distribution of respondents based on changes in hair zinc levels from two measurements

No	Hair zinc levels	Initial measurement (pretest)		Final measurement (posttest)	
		Amount	Percentage	Amount	Percentage
1	Normal (≥ 150 ppm)	0	0,0%	0	0,0%
2	Low (< 150 ppm)	13	100%	13	100%
	Total	13	100%	13	100%
	Minimum	108,80		115,20	
	Maximum	118,20		125,40	
	Mean	112,0923		119,0846	
	Std Deviation	2,60367		2,73522	

Source: Primary research data, 2025

From the results of the initial data collection (pre-test), it was found that all respondents had zinc levels in the hair in the low category (<150 ppm), with a minimum hair zinc level of 108.80 ppm, a maximum hair zinc level of 118.20 ppm, and an average hair zinc level of 112.09 ppm. Furthermore, the study respondents were given an intervention of consuming omega 3 chicken eggs for 2 months. From the results of the final data collection (post-test), it was found that all respondents had zinc levels in the hair in the low category (<150 ppm), with a minimum hair zinc level of 115.20 ppm, a maximum hair zinc level of 125.40 ppm, and an average hair zinc level of 119.08 ppm.

Table 3. Effect of the one day one egg program on changes in zinc levels in research respondents

	Paired Differences					t	Sig (2-tailed)
	Mean	Std Deviation	Std Error Mean	95% CI of the Difference			
				Lower	Upper		
Hair zinc levels (pre-test) – (post-test)	-6,99231	0,22899	0,6351	-7,12068	-6,85393	-110,098	0,000

Source: Primary research data, 2025

Based on the results of the analysis of hair zinc levels from two measurements, the average hair zinc level (pre-test) was 112.09 < the average hair zinc level (post-test) of 119.08, so descriptively it was concluded that there was a difference in the average hair zinc levels in the research respondents from two measurements. Based on the output of the paired sample test, the Sig (2-tailed) value was 0.000 < 0.05, so it can be concluded that the one day one egg program has an effect on changes in zinc levels in stunted toddlers.

c. Changes in anthropometric status of research respondents

Table 4. Frequency distribution of respondents based on changes in anthropometric status from two measurements

No	Changes in anthropometric status	Initial measurement (pretest)		Final measurement (posttest)	
		Amount	Percentage	Amount	Percentage
1	Severely stunted	0	0,0%	0	0,0%
2	Stunted	13	100%	13	100%

3	Normal	0	0,0%	0	0,0%
4	Tall	0	0,0%	0	0,0%
	Total	13	100%	13	100%
	Minimum	-2,865		-2,441	
	Maximum	-2,333		-2,000	
	Mean	-2,66031		-2,23300	
	Std Deviation	0,200578		0,173342	

Source: Primary research data, 2025

Based on the initial data collection (pre-test), all respondents were found to have stunted anthropometric status, with a minimum Z-score of -2.865 SD, a maximum Z-score of -2.333 SD, and a mean Z-score of -2.66031 SD. Furthermore, the study participants were given an intervention of consuming omega-3 chicken eggs for two months.

Based on the final data collection (post-test), all respondents were found to have stunted anthropometric status, with a minimum Z-score of -2.441 SD, a maximum Z-score of -2.000 cm, and a mean Z-score of -2.23300

Table 5. The effect of the one day one egg program on changes in anthropometric status in research respondents

	Paired Differences					t	Sig (2-tailed)
	Mean	Std Deviation	Std Error Mean	95% CI of the Difference			
				Lower	Upper		
Z Score (pre-test) – (post-test)	-4.427308	0.115503	0.032035	-0.49710	-0.357510	-13.339	0,000

Source: Primary research data, 2025

Based on the results of the analysis of anthropometric status (Z score) from two measurements, the average Z score (pre-test) was -2.66031 < the average Z score (post-test) of -2.23300, so descriptively it was concluded that there was a difference in the average anthropometric status of the research respondents from two measurements. Based on the output of the paired sample test, the Sig value (2-tailed) was 0.000 < 0.05, so it can be concluded that the one day one egg program has an effect on changes in anthropometric status (Z score) in stunted toddlers

Discussion

a. The effectiveness of the one day one egg program on changes in zinc levels in research respondents

From the results of the initial data collection (pre-test), it was found that all respondents had zinc levels in their hair in the low category (<150 ppm), with a minimum hair zinc level of 108.80 ppm, a maximum hair zinc level of 118.20 ppm, and an average hair zinc level of 112.09 ppm. Furthermore, the study respondents were given an intervention of consuming omega 3 chicken eggs for 2 months. From the results of the final data collection (post-test), it was found that all respondents had zinc levels in their hair in the low category (<150 ppm), with a minimum hair zinc level of 115.20 ppm, a maximum hair zinc level of 125.40 ppm, and an average hair zinc level of 119.08 ppm. Based on the results of the analysis of hair zinc levels from two measurements, the average hair zinc level (pre-test) was 112.09 < the average hair zinc level (post-test) of 119.08, so descriptively it was concluded that there was a difference in the average hair zinc levels in the research respondents from two measurements. Based on the output of the paired sample test, the Sig (2-tailed) value was 0.000 < 0.05, so it can be concluded that the one day one egg program has an effect on changes in zinc levels in stunted toddlers

The definition of hair zinc levels in stunted toddlers refers to the measurement of the concentration of the mineral zinc accumulated in the hair strands of stunted infants under five years of age. Stunting is a chronic growth disorder characterized by a child's height significantly below the standard for their age, often caused by long-term malnutrition. Hair zinc levels are used as a biomarker to assess overall body zinc status (Safitri et al., 2025). Unlike blood tests that reflect zinc levels at a given time, hair zinc levels provide a snapshot of zinc exposure and storage over a longer period (several months), thus indicating chronic zinc deficiency, which is an important micronutrient contributing to stunted linear growth (Zakaria et al., 2022).

Hair zinc levels in stunted toddlers are generally significantly lower than those in typically developing toddlers. This low zinc concentration in hair reflects an inadequate daily dietary intake of zinc, which is essential for essential metabolic processes, including cell growth, immune function, and nervous system development (Rosa et al., 2022). This accumulated zinc deficiency then disrupts growth hormone production and cell division, ultimately leading to stunted growth. Therefore, the finding of low hair zinc levels in stunted toddlers not only serves as a diagnostic marker of nutritional deficiency but also confirms zinc's crucial role in the pathophysiology of stunting, highlighting the importance of zinc-rich nutritional interventions as part of stunting prevention and management strategies (Dahrianti et al., 2021).

Omega-3-enriched chicken eggs, whether consumed whole or in processed forms such as pudding or cakes, are a highly potential nutritional intervention for stunted toddlers. This is because eggs are a source of high-quality animal protein with complete biological value, meaning they contain all the essential amino acids needed for cell growth and repair. These amino acids are crucial for growth hormone (IGF-1) synthesis and tissue formation, which are impaired in stunted toddlers. Furthermore, eggs are rich in various important micronutrients such as iron, choline, and vitamins A and B12, all of which play a synergistic role in supporting children's physical and cognitive development. The main advantages of eggs are their ease of preparation and preparation, as well as their generally high acceptability among toddlers, making them an ideal food for nutritional improvement programs.

The uniqueness of omega-3 chicken eggs lies in their fat profile, which has been modified through chicken feed rich in omega-3 sources, such as fish oil or flaxseed. Omega-3 fatty acids, particularly DHA (docosahexaenoic acid), are known to be vital for the development of a child's brain and central nervous system. In stunted toddlers, who often experience neurocognitive developmental deficits, adequate DHA intake can help overcome this gap. Furthermore, there is a synergistic relationship between fat and micronutrient absorption. The presence of healthy fats in omega-3 eggs can increase the bioavailability of fat-soluble minerals. Although zinc is not directly fat-soluble, a healthy intestinal environment with adequate fat intake can support the integrity of the intestinal wall and the overall nutrient absorption process, thus indirectly helping optimize zinc absorption from other foods consumed together.

The primary mechanism by which omega-3-rich chicken egg consumption improves zinc levels in the body and hair of stunted toddlers begins at the gut level. Omega-3 fatty acids, particularly DHA and EPA, play a crucial role in strengthening the integrity of the intestinal barrier by reducing local inflammation and increasing the production of mucin, which protects the intestinal wall. A healthy, non-inflamed gut allows for more efficient zinc absorption. Furthermore, the phospholipids in egg yolks can form complexes with zinc, making it more readily absorbed by enterocytes. Egg protein, rich in the amino acids histidine and cysteine, also functions as a natural chelator, increasing zinc bioavailability, ensuring more of the mineral can be transported from the intestinal lumen into the bloodstream for distribution to various tissues, including hair follicles.

Once absorbed, the combination of nutrients in omega-3 eggs supports the redistribution of zinc to peripheral tissues and its stabilization within hair follicles. Omega-3s play a role in reducing levels of the stress hormone cortisol and suppressing the production of pro-inflammatory cytokines such as IL-6, which are known to interfere with zinc transport between tissues. With reduced systemic inflammation, more zinc is freely circulated and can be utilized for essential metabolic processes. The sulfur amino acids in eggs (methionine and cysteine) are critical components for the synthesis of metallothionein, a zinc-binding protein that regulates zinc storage and release within cells. This mechanism ensures stable zinc availability for incorporation into the growing hair structure, ultimately reflected in increased hair zinc levels, a biomarker of long-term zinc status.

Promoting the consumption of omega-3-rich chicken eggs or their derivatives can be an effective dual strategy: first, to provide the direct macro- and micronutrient support needed to stimulate catch-up growth, and second, to create a more optimal digestive environment for the absorption of zinc and other minerals. While eggs may not be the highest source of zinc compared to red meat or shellfish, their unique combination of carrier protein, absorbent fat, and zinc content makes them an excellent catalyst. Implementing them in community programs, such as providing one omega-3-rich egg per day or incorporating them into complementary foods in areas with high stunting prevalence, offers an affordable, sustainable, and impactful solution for preventing and reducing stunting rates and improving the zinc status of toddlers.

b. The effectiveness of the one day one egg program on changes in anthropometric status (Z score) in research respondents

From the results of the initial data collection (pre-test), it was found that all respondents had anthropometric status in the short category (stunted), with a minimum Zscore of -2.865 SD, a maximum Zscore of -2.333 SD, and an average Zscore of -2.66031 SD. Furthermore, the research respondents were given an intervention of consuming omega 3 chicken eggs for 2 months. From the results of the final data collection (post-test), it was found that all respondents had anthropometric status in the short category (stunted), with a minimum Zscore of -2.441 SD, a maximum Zscore of -2.000 cm, and an average Zscore of -2.23300. Based on the results of the analysis of anthropometric status (Zscore) from two measurements, the average Zscore (pre-test) was -2.66031 < the average Zscore (post-test) of -2.23300 so that descriptively it was concluded that there was a difference in the average anthropometric status of the research respondents from two measurements. Based on the output of the paired sample test, the Sig value (2-tailed) is 0.000 < 0.05, so it can be concluded that the one day one egg program has an effect on changes in anthropometric status (Z score) in stunted toddlers

The anthropometric status of stunted toddlers is defined as a condition where the body size does not reach the growth standards set by WHO, which is specifically measured through the height-for-age (H/U) parameter and is stated in Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2020 concerning Child Anthropometric Standards. Stunting itself is a form of growth failure due to the accumulation of long-term nutritional deficiencies, which is manifested in the child's body (Ayukarningsih et al., 2024). This anthropometric status does not simply describe a child's short stature, but is a composite indicator that reflects the child's history of malnutrition, health, and socioeconomic development. Therefore, assessing anthropometric status is a critical and objective step in identifying stunting in a population (Wahyuningsih et al., 2023).

In this context, height-for-age (H/A) is a core anthropometric parameter, while the Z-score serves as a statistical tool to quantify how far a child's height deviates from the median of a healthy reference population. A toddler is considered stunted if their H/A Z-score falls below -2 standard deviations (SD). This Z-score provides a consistent and internationally standardized scale, allowing valid comparisons across time, regions, and different population groups (Putri et al., 2025). Thus, anthropometric status (represented by a combination of height/age and Z-score) serves as a reliable, objective, and very important measurement tool for stunting incidence for monitoring, planning intervention programs, and evaluating the success of stunting reduction efforts at the national and global levels (Mimi et al., 2021).

Omega-3 rich chicken eggs offer significant potential as a nutritional intervention to address stunting because they are a complete and easily absorbed nutrient package. Their high-quality protein content, complete with essential amino acids, acts as a fundamental building block for growth hormone synthesis, bone formation, and muscle tissue development, all of which are key processes in promoting height growth. Furthermore, eggs are rich in essential micronutrients such as iron, vitamin A, vitamin B12, and choline. Deficiencies in these nutrients have long been associated with stunted linear growth. By providing a broad spectrum of macro- and micronutrients in a single food source, regular consumption of omega-3 rich chicken eggs can help meet critical nutritional needs to support catch-up growth in stunted toddlers.

The unique advantage of these eggs lies in their omega-3 fatty acid content, specifically DHA (Docosahexaenoic Acid), which is added to chicken feed. This fatty acid is not only vital for children's cognitive and neurological development, but also plays a role in reducing chronic inflammation, which is often found in children living in environments with poor sanitation. Chronic inflammation is known to disrupt growth hormone pathways and suppress appetite, thus directly inhibiting growth. By suppressing this inflammatory response, omega-3s help create a more optimal metabolic environment so that nutrients from food can be allocated to growth, rather than to combat inflammation. This synergy between high-quality protein, growth-supporting micronutrients, and anti-inflammatory omega-3s is what makes these eggs so potent in directly improving anthropometric status, as measured by an increase in the Height/Age Z-score.

The primary mechanism by which omega-3-rich chicken egg consumption improves anthropometric status begins with the provision of easily absorbed essential nutrients. The high-quality protein in eggs supplies all the essential amino acids required for the synthesis of Insulin-like Growth Factor-1 (IGF-1) and growth hormone, which directly stimulate bone and tissue growth. Omega-3 fatty acids, particularly DHA, play a critical role by improving the integrity of enterocyte (intestinal) cell membranes, thereby increasing the efficiency of absorption of essential micronutrients such as zinc, iron, and vitamin A from the entire diet. This process optimizes the availability of building blocks fundamental to skeletal development and height increase.

At the systemic level, repair mechanisms occur through modulation of the metabolic and inflammatory environments. Stunting is often associated with chronic, low-grade inflammation due to subclinical infections or unhygienic environments, which impair growth hormone function. Omega-3 fatty acids in eggs serve as precursors for the potent anti-inflammatory molecules resolvin and protectin, thereby suppressing the pro-inflammatory cytokine response that inhibits growth. By reducing this inflammatory burden, nutrients previously used to combat inflammation can be redirected to support anabolic processes and linear growth. This unique combination of direct nutrient supply and the creation of a conducive metabolic environment ultimately enables sustained improvements in height-for-age (H/A) Z-scores.

Promoting the consumption of omega-3-rich chicken eggs or processed products (such as boiled eggs, egg pudding, or cakes) can be an effective and sustainable intervention strategy. Its advantages lie in its ease of production, relative affordability, and high acceptability among toddlers. In the context of stunting reduction programs, this egg-based intervention can be integrated into supplementary feeding programs (PMT) for high-risk toddlers or through nutrition education for parents to include one egg in the daily menu. In the long-term, increased overall nutritional intake from omega-3 eggs is expected to translate directly into improved anthropometric status, namely by reducing the proportion of toddlers with a height/age Z-score below -2 SD, ultimately contributing significantly to reducing stunting prevalence at the community level.

Conclusion

a. The one-day-one-egg program affected zinc levels in stunted toddlers with a Sig (2-tailed) value of 0.000.
b. The one-day-one-egg program affected anthropometric status (Z-score) changes in stunted toddlers with a Sig (2-tailed) value of 0.000.

Research Limitations

a. The relatively short duration of the intervention (2 months) may be a major obstacle to observing significant changes in anthropometric status, given that stunting is a chronic condition that requires a long time to improve. Changes in height/age z-score and hair zinc levels (as long-term biomarkers) require a longer intervention period to show meaningful results
b. Controlling confounding variables is a complex challenge. Other dietary intake outside the program, the frequency of infections, environmental sanitation conditions, parenting practices, and maternal education levels are variables that are difficult to control strictly, yet can significantly influence intervention outcomes. Dietary assessment methods that rely on recall also have the potential to introduce bias in reporting nutritional intake
c. Research conducted on a specific population with specific socioeconomic characteristics, dietary habits, and stunting prevalence may not be fully generalizable to stunted toddler populations in other regions with different contexts. Non-random sampling can also limit the sample's representativeness

d. Without a blinding procedure and a placebo control group, there is potential bias in outcome measurements. Although anthropometric measurements and zinc levels were objective, the expectations of researchers and participants (performance bias) may have influenced adherence to the intervention protocol and outcome reporting. These limitations do not diminish the value of the study's findings, but they provide important context for understanding the scope and applicability of the intervention's results

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