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# Combatting stunting: The vital role of animal protein in early childhood nutrition

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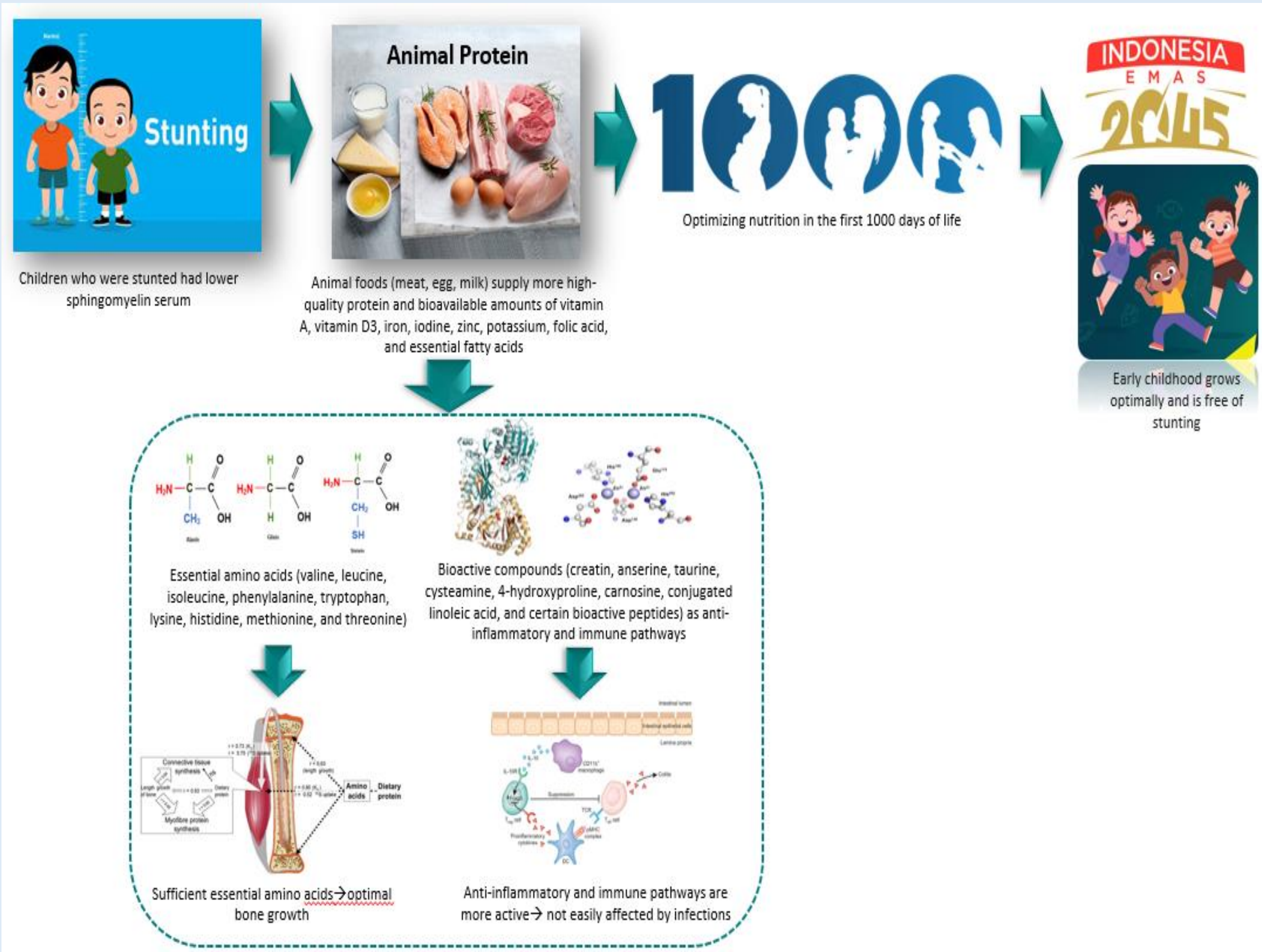
**ABSTRACT**

Stunting is a global issue that significantly affects the quality of human resources and a nation's future competitiveness. Therefore, this study aimed to explore the role of animal protein in preventing stunting in early childhood using an exploratory approach. The procedures were carried out using a qualitative descriptive design by conducting a literature review and collecting secondary data. The results showed that animal foods (eggs, milk, and meat) contained bioactive compounds and essential amino acid profiles (valine, leucine, isoleucine, phenylalanine, tryptophan, lysine, histidine, methionine, and threonine), indicating the ability to provide the required nutrients and prevent stunting. In addition, optimizing nutrition in the first 1000 days of life starting from the conception phase until the age of 2 years by consuming a variety of nutritious foods containing animal protein at every meal was expected to prevent the condition. The results also revealed that providing sufficient animal foods that were physically and economically accessible to all individuals in society was a major challenge. Therefore, efforts were needed from the government to realize the goal of reducing stunting in Indonesia.

**Keywords:** Stunting, Early Childhood, Animal Foods, Protein






## INTRODUCTION

To achieve the Golden Indonesia Vision 2045, developing the quality of human resources is the first pillar. Therefore, efforts are needed to overcome problems related to the preparation of quality human resources. In this context, the problem faced and included as part of the double burden of malnutrition is stunting, which has a major impact on society, particularly in terms of health and economic productivity [1]. Several studies have shown that children who experience stunting typically have brain growth and development challenges, leading to low Intelligence Quotient (IQ). This low IQ has been reported to have an impact on children's cognitive abilities, which reduces competitiveness and productivity as well as hinders national economic growth in the future [2-3]. In addition to being manifested by impaired neurocognitive development [4], stunting can heighten the risk of morbidity and mortality in early life as well as increase susceptibility to developing various diseases later in life [5]. Health services and socioeconomics have also been reported to be negatively affected by the condition.

The prevalence of stunting was found to be relatively high in Indonesia, reaching 21.6%, according to the Indonesian Nutrition Status Survey (SSGI) conducted in 2022 [6]. Meanwhile, East Kalimantan Province reported a rate of 23.9% [7], with a target reduction of 14% in 2024 [8]. This target reduction was set by the President in Presidential Regulation Number 72 of 2021 concerning accelerating the reduction of stunting and fulfilling Sustainable Development Goals (SDGs) [1]. Several studies have reported that stunting requires complete, comprehensive, integrated, and multisectoral solutions and treatment as well as interdisciplinary efforts. Consequently, the government, through various policies, continues to make efforts towards reducing the prevalence of stunting, including interventions to improve nutrition, considering that the condition is closely related to malnutrition.

In line with these results, adequate intake of macronutrients (carbohydrates, protein, fat) and micronutrients (vitamins and minerals) is necessary for the growth and development of children. In addition, children who experience stunting tend to have significantly lower levels of essential amino acids compared to others indicating the need to provide alternatives sourced from animal foods to support growth. There is also a need for public awareness of the importance of nutrition, specifically adequate animal protein. Therefore, this study aims to explore the role of animal protein in preventing stunting in early childhood.

**Study Methodology:** An exploratory approach was used through literature studies and secondary data obtained from the official website of the Ministry of Health of Indonesia, the National Population and Family Planning Board (BKKBN), the state minister for the Empowerment of State Apparatus and Bureaucratic Reform (Ministry of PANRB), and the Bappeda of East Kalimantan Province. Subsequently, the data obtained was identified and analyzed using qualitative descriptive methods. A study related to the role of animal foods in preventing stunting was conducted using the following stages (Figure 1):

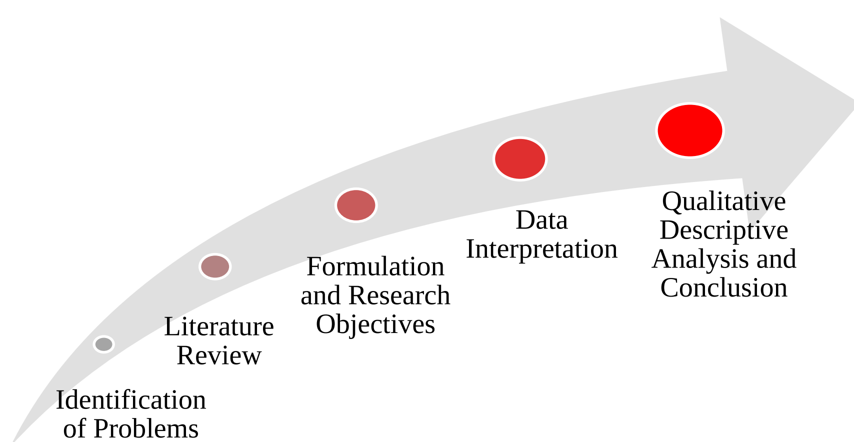



**Figure 1.** Research Stages

## RESULTS AND DISCUSSION

**Stunting:** Stunting refers to disruption in the growth and development of children due to chronic malnutrition. This condition is characterized by height for age below 2 standard deviations on the World Health Organization

(WHO) growth curve stipulated by the Minister of Health Regulation of Indonesia Number 2 of 2020 concerning Child Anthropometric Standards [6]. The World Health Organization considered stunting to be a public health problem when the prevalence among children <5 years old reached >20%. Stunting or linear growth retardation often started during pregnancy and continued until the age of 2 years [9]. In addition, linear growth was associated with lean tissue accretion and increased future energy requirements, indicating the need for adequate nutritional intake [10]. Stunting could occur in the intrauterine with a prevalence of 20-30% [11] and was most severe in the first 1000 days from conception to 2 years of age. The first 1000 days following fertilization are essential for children and mothers to get the correct nutrition, as reported by [12]. Malnourishment during pregnancy can result in stunted fetal growth or intrauterine development, which may increase the chances of low birth weight for unborn babies [13-14]. On the other hand, insufficient childhood nutrition can lead to long-lasting epigenetic metabolic changes, resulting in poor health outcomes later in life [12]. Changes in food consumption patterns and epigenetic metabolism linked with high-calorie intake exacerbate child stunting; consequently, increasing risk factors for non-transmissible diseases such as hypertension, type 2 diabetes, and cardiovascular disease [12].

Low birth weights were common in prematurely born infants, and persons who were intolerant to lactose had a higher risk of stunting [14]. Stunting was also brought on by poor eating practices, several underlying medical issues, such as illnesses, and recurrent parasite infections, such as worms, which can obstruct the absorption of nutrients [13]. This suggested that a family's social and economic circumstances had little bearing on the prevalence of stunting [14].

Stunting can be attributed to various factors, including limited parenting knowledge on nutritional health before, during, and after childbirth (leading to inadequate breastfeeding), poor prenatal and postnatal healthcare services of subpar quality; scarcity of nutrient-rich food options and insufficient sanitation compounded with unhygienic water supply that result in recurring infections detrimental for a child's growth [1]. Additionally, the World Health Organization acknowledges several variables that contribute to stunted development:

Family factors, such as genetics, maternal health during pregnancy, home sanitation, socio-cultural, level of education, knowledge, and family income [3] revealed that maternal height had a significant relationship with the incidence of stunting. Short mothers (<150 cm) were 6.11 times more likely to have stunted children than those who were tall (>150 cm). These results showed that genetic factors also influenced children’s height. However, nutrition during pregnancy and growth had a more significant impact, indicating the need to optimize environmental factors, such as nutrition [3].

Inadequate exclusive breastfeeding: children who were not exclusively breastfed had less immunity (body resistance) and were easily exposed to infections.

Inadequate provision of complementary breast milk food: complementary breast milk with insufficient nutritional content causes inadequate nutritional needs of the child.

**Infection:** infectious diseases, including diarrhea, worm infections, and respiratory tract infections affected stunting. Children who suffer from worm infections often experience anemia, which could inhibit growth because parasitic worms use the nutrients consumed for growth and reproduction, leading to low absorption of nutrients [3][11]. Due to environmental enteric, dysfunctional parasitic infection directly through local intestinal inflammation caused systemic inflammation and immune activation through an adaptive immune response. Immune activation requires a lot of energy and metabolism, which directly or indirectly (through a decrease in IGF-1) diverts calories and nutrients from other physiological processes, such as linear growth in energy exchange [11].

In line with previous studies, stunting had short-term and long-term impacts. Short-term impacts were increased morbidity and mortality rates, decreased cognitive, motor skills, suboptimal physical body size, metabolic disorders in children and language development, as well as increased health costs. Meanwhile, long-term impacts were decreased height, increased obesity, decreased cognitive abilities at school, decreased intellectual capacity or intelligence and disruption of the structure and function of nerves and brain cells and reduced work productivity [15]. Stunted children could improve the condition through 1) nutritional therapy by a pediatrician, ensuring that foods meet their nutritional needs, 2) provision of medical management by the family, specifically parents, and 3) providing animal foods as a source of protein to children in every meal menu. Stunting could be prevented through various efforts, such as:

Ensuring age-appropriate nutritional intake involves several key practices. For the first 6 months, it is crucial to implement early initiation of breastfeeding and provide exclusive breastfeeding on demand. From 6 to 23 months, complementary feeding should be introduced alongside breast milk. This complementary food must be timely, adequate, rich in animal protein, safe, and prepared correctly. Parents frequently visit the Posyandu (Integrated Healthcare Center) to monitor their children's health conditions, growth, and development. Parents were required to complete all immunizations according to schedule. Providing complete basic immunization to children was conducted to prevent infectious diseases and reduce the risk of experiencing stunting.

Planning a pregnancy and maintaining proper nutritional intake for mothers during this period is important. In addition, it is important for pregnant women who experience anemia to consume blood supplement tablets. Pregnant women were encouraged to receive quality routine Antenatal Care (ANC) during pregnancy by professional health workers at the nearest health facility, which had complete medical equipment and was easy to access. Antenatal Care visits during pregnancy allowed mothers to receive education regarding healthy eating patterns and the importance of breastfeeding as well as complementary feeding practices [16]. In addition, the frequency and regularity of ANC visits and the implementation of service standards were significantly related to stunting prevention [3].

**Animal Foods as Protein Source:** The problem of stunting should not be separated from the issue of food insecurity. Lack of food accessibility is closely related to reduced food consumption, which can negatively impact nutritional status. Prolonged chronic malnutrition affected cognitive and physical development, which was manifested through height and weight, so nutritional supplementation was very important to support children's optimal growth and development and avoid stunting [3,12,17]. Children who consumed sufficient and nutritious food tended to be healthier and had good growth because their nutritional needs were met. The nutritional adequacy of the population, particularly in Indonesia, was assessed based on the per capita daily consumption levels of energy and protein. The adequacy index of calorie and protein consumption based on the recommended standards from the National Food and Nutrition Widyakarya in 2018, was 2.100 kcal and 57 grams of protein [6], but based on the recommended dietary allowance for adult protein intake is 0.83 g per kilogram of body weight per day (g/kg/bw/day) and children 0-6 months is 1.14-1.77 (g/kg/bw/day) (Table 1). The following protein requirements are based on age [18].

**Table 1.** The protein requirements are based on age

| **Age** | | **Recommended Detary Protein (g/kg/bw/day)** |
|---|---|---|
| Adults | | 0.8 |
| Adults (men and women) | | 0.83 |
| Children | <19 years | 0.85-1.2 |
| | 6 month-18 years | 0.82-1.31 (female) |
| | | 0.85-1.31 (male) |
| | 0-6 months | 1.14-1.77 |

Source: [18]

Protein was an essential macronutrient that the body needed in large quantities (Table 1) [19-21], playing a crucial role in various physiological processes and contributing significantly to the nutritional quality of our diet [21]. This plays an important role in growth including providing signals and regulating anabolic processes such as cell growth and differentiation, body repair, and health maintenance [21]. An inadequate protein intake can lead to growth retardation in children, affecting both height and weight [18]. High protein deficiency also could lead to kwashiorkor, hypoalbuminemia, metabolic disorders, and developmental delays, consequently, adequate protein intake was required [20-22]. Protein could be obtained from 2 sources, namely plants (vegetables) and animals. However, animal foods such as eggs, milk, meat, and fish were superior because it contained more complete essential amino acids needed by the body compared to the amino acids found in protein plant-based [12, 20]. The animal protein contained essential amino acids such us valine, leucine, isoleucine, phenylalanine, tryptophane, lysine, histidine, methionine, and threonine (Table 2) which could not be synthesized in the human body but must be obtained from the food consumed each day [20,23]. Essential amino acids are required for the activation of the mechanistic target of rapamycin complex 1 (mTORC1), which regulates the growth of chondral plates (the areas of bone where growth occurs) and skeletal muscle growth. Since the body cannot synthesize these amino acids, they must be obtained through food [19, 24]. The balanced intake of essential amino acids supports optimal growth, immune function, and overall health [21].

**Table 2.** The composition of essential amino acids in animal food

| Amino Acid Composition | The Daily Requirement of The Human Body (g) | The Content of Essential Amino Acids in 100 g of the Products | | |
|---|---|---|---|---|
| | | **Chicken Eggs** | **Whole Milk** | **Meat*** |
| Valine | 3-4 | 0.846 | 0.210 | 0.91 |
| Leucine | 4-6 | 1.078 | 0.309 | 1.34 |
| Isoleucine | 3-4 | 0.668 | 0.168 | 0.78 |
| Phenylalanine | 2-4 | 0.679 | 0.164 | 0.84 |
| Methionine | 2-4 | 0.376 | 0.079 | 0.49 |
| Tryptophane | 1 | 0.159 | 0.038 | 0.40 |
| Lysine | 3-5 | 0.908 | 0.265 | 1.80 |
| Threonine | 2-3 | 0.549 | 0.139 | 0.98 |

Source: [18, 25]*

Dietary proteins vary in digestibility depending on their source. Animal-based proteins from meat, cheese, and dairy products are generally highly digestible, with a high proportion of their amino acids absorbed by the body [21,26]. Animal foods supply more high-quality protein and bioavailable amounts of vitamin A, vitamin D3, iron (containing ~26% to 68% heme iron), iodine, zinc, potassium, folic acid, and essential fatty acids which were greater than plant foods as well as several bioactive compounds [12,27-29]. The content of bioactive compounds in animal foods plays an important role in health, specifically in anti-inflammatory, immune pathways [30-32], and prevention diseases [33-34] such as creatin, anserine, taurine, cysteamine, 4-hydroxyproline, carnosine, conjugated linoleic acid, and certain bioactive peptides [28]. Furthermore, the bioactive compounds and complete amino acid profile in animal foods had consequences for meeting the need for amino acid intake, making animal foods a quality source of protein in preventing stunting.

**Role of Animal Foods in Preventing Stunting:** Animal foods had a significant role in meeting children's daily nutritional needs because the food contained a complete amino acid profile, bioactive compounds, bioavailable lysine, sulfur and threonine, iron, zinc, vitamins, and B12 which were needed for children's growth and development [19,22,35]. Children who experienced stunting significantly tended to exhibit lower levels of essential amino acids (tryptophan, isoleucine, leucine, valine, methionine, threonine, histidine, phenylalanine, lysine), 3 conditionally essential amino acids (arginine, glycine, glutamine), 3 non-essential amino acids (aspargine, glutamate, serine) and citrulline than those who do not experience stunting [36-37]. According to [10], children were at greater risk of choline deficiency due to poor diet. Insufficient levels of essential amino acids in stunted children could harm several metabolic pathways that play diverse roles in human health. These included 1) methionine as a precursor of homocysteine, cysteine, and taurine, and the main methyl donor in polyamine synthesis, 2) tryptophan as a precursor for niacin, serotonin, and neuromodulator in intestinal enterochromaffin cells, 3) lysine as a precursor of carnitine and necessary for structural modification of collagen, 4) threonine as the main secretory component of the protective mucus of the intestinal lining, 5) histidine played a role in protein methylation, structure and function of hemoglobin, is a precursor of both histamine and carnosine and 6) phenylalanine as a tyrosine precursor and substrate for catecholamine synthesis.

In this study, children who were stunted had lower sphingomyelin serum. The serum had a central role in creating lateral structures in the membrane of toll-like receptors, class A and B scavenger receptors, and insulin receptors, and was involved in cell signaling, activation, as well as differentiation of T cells. Sphingomyelins were the primary lipid component of myelin and were important for the myelination of the nervous system during children's development. Furthermore, myelination of the central nervous system depended on the mTORC1 pathway and activation of mTORC1 because this process required sufficient amino acids, so animal foods contributed to supplying protein as a source of essential amino acids [33].

Animal food products and their derivatives vary greatly, generally grouped into 3 commodities, namely meat, eggs, and milk. Red meat (originating from ruminants such as cattle, buffalo, goats, and sheep) contains protein, and folic acid [28][38]. Meat contains bioactive compounds, such as vitamins, peptides, minerals, and fatty acids, which are beneficial to human health. It also provides a balanced profile of essential amino acids, including those rich in sulfur, and is abundant in highly biologically essential proteins (Table 3) [38-39].

**Table 3.** The benefits of food bioactive compounds from animal sources

| Source | Food Bioactive Compounds | Benefit |
|---|---|---|
| Meat Products | Vitamins, peptides, mineral, fatty acids | Beneficial to human health and provides nutrients for protein synthesis |
| | Taurine, choline, alpha-lipoic acid, l-carnitine, conjugated linoleic acid, glutathione, creatine, coenzyme Q10, bioactive peptides | |
| Milk | Bioactive peptides in whey | Regulates specific and non-specific immune responses |
| Egg | Ovalbumin, ovomucin, ovotransferrin, lysozyme, and avidin | Contains anti-bacterial and immunoprotective activity |

Source: [38]

Red meat has 1.5-2 times more bioavailable iron compared to iron originating from plants (vegetables) [28,34]. In addition, iron was an important component of hemoglobin and was important in supporting optimal growth and development in children as well as a key element in optimizing the first 1000 days. The iron content in red meat could help prevent anemia which has the risk of causing stunting. Anemia was a public health problem in Indonesia that could be experienced by all age groups from children to the elderly. Adolescent girls who suffered from anemia when pregnant were at risk of giving birth to children with low birth weight (LBW) and stunting. This harmed the development and growth of children. The high prevalence of anemia in adolescent girls and food intake patterns related to the occurrence of anemia were influenced by the knowledge and attitudes of adolescent girls about anemia. The study conducted at SMA Negeri 1 Kuaro in Paser Regency, East Kalimantan Province, revealed that while many female students had good knowledge and attitudes about anemia, most of them followed inadequate eating patterns for its prevention [40]. Cow's milk was biologically rich in calories and high-quality protein which was likely to overcome amino acid deficiencies in children [2]. Milk contained several important micronutrients such as calcium, stimulating the secretion of hormones that promote bone and tissue growth, namely insulin-like growth factor-1 (IGF-I), vitamin A, riboflavin, vitamin B12 [19]. The protein contained in milk was different from those in meat, so it had a different influence on growth, and differences in the quality of the protein in each food also influenced the secretion of IGF-1 [41]. This plays an important role in controlling the secretion of growth hormone in the pituitary gland [10] and a daily consumption of approximately 200-600 ml of milk by toddler was associated with a 30% increase in circulating IGF-1 [42]. In addition, the consumption of dairy products and red meat during pregnancy was closely related to the birth weight, length, and health status of the infant and could reduce the risk of iron deficiency in breast-fed children [28].

Eggs are an animal food product that is relatively affordable, easy to obtain, and simple to process compared to other animal foods. They are also rich in essential macronutrients and micronutrients, including carbohydrates, protein, calcium, iron, choline, phosphorus, potassium, sodium, vitamin A, thiamine (vitamin B1), riboflavin (vitamin B2), and lipids such as phospholipids and polyunsaturated fatty acids [43-47].The total protein content chicken egg is around 12-13% by weight, which are mainly distributed in the albumen and yolk at a ratio around 4:3 [48]. The composition of macronutrients and micronutrients contained in eggs is extremely important for optimal brain development and immunity [23, 49-50]. Serving eggs to children aged above 6 months every day for 6 months based on research could reduce stunting by 47% [51-52].

There was a clear correlation between stunting and the consumption of animal food products, such as eggs, fish, meat, and fresh milk [19]. Children who ate more than one kind of animal food had more health benefits, according to [19] and children with energy and protein intakes below 70% recommended dietary allowances have a 1.3 times higher risk of stunting [53-54]. It is essential to eat an adequate and varied amount of animal protein during pregnancy and the early stages of childbirth to prevent stunting and decrease the risk of malnutrition in early life [5,22]. Consuming animal proteins foods during this critical period (the first 1000 days of children starting) can improve growth, cognitive function and nutritional status of children [53,55]. Public awareness about the importance of consuming adequate animal protein needs to be increased, and efforts should be initiated to optimize the use of local animal protein sources that can be easily accessed through family food security.

## CONCLUSION

In conclusion, stunting was related to malnutrition and stunted children tended to have significantly lower levels of essential amino acids, 3 conditionally essential amino acids, and 3 non-essential amino acids than children who were not stunted. Insufficient levels of essential amino acids harmed several metabolic pathways, so adequate protein intake was required. Animal foods (such as eggs, milk, and meat) contain bioactive compounds and a complete profile of essential amino acids (valine, leucine, isoleucine, phenylalanine, tryptophan, lysine, histidine, methionine, and threonine), indicating the ability to provide the needed nutrients and prevent stunting. In addition, optimizing nutrition in the first 1000 days of children starting from the conception phase until 2 years old by consuming a variety of nutritious foods containing animal protein at every meal was expected to prevent stunting. Providing sufficient animal foods that were physically and economically accessible to all individuals in society was a challenge that needed to be addressed by the government to realize the target of reducing stunting in Indonesia.

**Authors' contributions:** Hamdi Mayulu: Developed the idea, conceptualized the project, wrote the manuscript, and designed the methodology. Endang Sawitri: Contributed to the idea, participated in writing, collected data, and was involved in reviewing and editing.

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