Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 2
February 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2024; 25(2): 25725-25745 https://doi.org/10.18697/ajfand.139.25270

Date	Submitted	Accepted	Published
	18th August 2024	26th November 2024	4th March 2025

INSUFFICIENT ZINC INTAKE IS A PREDICTOR OF STUNTING AMONG CHILDREN AGED 6-59 MONTHS IN STUNTING LOCUS OF BOGOR REGENCY, WEST JAVA, INDONESIA

Nadiyah N[1]*, Jus'at I[1] and SR Marsidi[2]

Nadiyah Nadiyah

*Corresponding author email: nadiyah@esaunggul.ac.id

[1]Department of Nutrition, Faculty of Health Sciences, Universitas Esa Ungggul, Jakarta, Indonesia

[2]Department of Psychology, Faculty of Psychology, Universitas Esa Unggul, Bekasi, Indonesia

ABSTRACT

Stunting is a widespread public health issue and remains a significant challenge in many parts of the world, especially in developing countries such as Indonesia. It has far-reaching consequences for both individual well-being and societal progress. The purpose of this study was to identify the risk factors for stunting in children aged 6-59 months in the stunting locus in Indonesia. This cross-sectional study was conducted in Ciampea Udik Village, a stunting locus, among 124 children selected using a multistage sampling. Dietary intake data, including energy, macronutrients, vitamins, and minerals, were collected through two non-consecutive 24-hour food recalls. Household characteristics, pregnancy, infection, hygiene, breastfeeding, and growth monitoring practices were assessed using adapted National Basic Health Research questionnaires, the age in months was computed in WHO Anthro Software based on the birth and interview dates, body height was evaluated by a stadiometer having an accuracy of 0.1 cm. Variables having p-values <0.25 in bivariable logistic regression, including child age, iodine level in household salt, mother's education, child order, birth spacing, ARIs, pneumonia, diarrhea, vitamin A, calcium, iron, and zinc intakes, were analysed using multivariable logistic regression. Age 24-59 months (AOR=2.52; 95% CI 1.13-5.63) and low zinc intake (AOR=3.08; 95% CI 1.29-7.33) were significant predictors of stunting ($p<0.05$). Poor iodine level in household salt may contribute to stunting ($p<0.1$) in the stunting locus area. Low zinc intake was the most significant risk factor for stunting. Aside from that, the low iodine levels in household salt might be linked to stunting. Therefore the program's aims of increasing zinc intake using iodized salt could help have an influence on lowering stunting. It is highly recommended that a collaboration between nutrition academics and local government occur in order to design a sound nutrition education program to increase daily consumption of local food high in zinc and the usage of iodized salt.

Key words: Stunting, locus, zinc, iodine, development, sustainability, child, local

https://doi.org/10.18697/ajfand.139.25270

INTRODUCTION

Stunting is a widespread public health issue and remains a significant challenge in many parts of the world, especially in some developing countries, including Indonesia. Although the prevalence of stunting among under-five children in Indonesia has decreased since 2018, intensive efforts are still needed to reduce the current prevalence rate of stunting from 21.6% [1] to the government's target of 14% [2] by 2024.

Stunting is the impairment of growth and development of children caused by chronic malnutrition, especially during childhood [3]. It manifests as a low height-for-age, indicating that a child is shorter than the average height for their age group. The height-for-age z-score is commonly used to assess stunting, with a z-score less than -2 standard deviations indicating stunting growth [4]. The designated stunting locus is one such area where stunting has emerged as a major concern. The term "locus" refers to a specific geographical location or region with a higher prevalence of stunting in its population.

Stunting is the result of complex interactions among nutritional deficiencies, maternal health, and environmental factors [5]. Adequate intake of vitamins and minerals is essential for normal child growth and development, particularly vitamins A, D, B1 (thiamine), B9 (folate), B12 (cobalamin), and C, as well as minerals such as calcium, iron, zinc, and iodine. Each of these nutrients plays a critical role in supporting physiological processes necessary for growth. Vitamin A is essential for immune function and cellular growth, while vitamin D supports calcium absorption and bone mineralization [6]. B-vitamins are key cofactors in energy metabolism and cellular function, with deficiencies linked to poor growth outcomes in children [7]. Minerals like calcium and iron are also indispensable, promoting bone development and red blood cell formation, respectively [8, 9]. However, deficiencies in these nutrients remain widespread in Indonesia, exacerbating the risk of stunting [10].

Pregnancy is a critical period for fetal growth and development, with maternal nutritional status directly impacting the health and growth trajectory of the child. Maternal deficiencies in vitamins and minerals during pregnancy increase the risk of low birth weight and stunted growth in children [11]. For instance, iodine is a key micronutrient needed for thyroid hormone synthesis, which regulates fetal growth, neural development, and skeletal growth [12, 13]. In Indonesia, despite mandated salt iodization to achieve iodine content of at least 30 mg/kg per the Indonesian National Standard (SNI) 3556:2016, many households still use salt with insufficient iodine levels, putting both pregnant women and children at risk of iodine deficiency [14].

Zinc, an essential trace element, plays a particularly significant role in child growth. Zinc is involved in multiple cellular functions, including DNA and RNA synthesis, immune function, and cell division, all of which are fundamental to growth and development [15]. Zinc deficiency is prevalent in Indonesian children and is associated with impaired growth and a higher risk of stunting, even in children who appear otherwise healthy [16]. These issues not only exacerbate growth deficits but also increase the likelihood of pediatric morbidities, underscoring the need for adequate zinc intake and growth monitoring in early childhood [17].

Moreover, recent research highlights that older children are at a greater risk of stunting in Indonesia, potentially due to the cumulative effects of nutrient deficiencies and socio-economic challenges over time [18]. This emphasizes the importance of addressing stunting at the earliest stages of development through interventions that focus on maternal and child nutrition, environmental factors and rigorous growth monitoring.

Despite the Indonesian government's and partners' strong emphasis on reducing stunting, it remains a significant public health issue, implying that some risk factors are still being unidentified (such as maternal and child healthcare, nutrition quality, sanitation or cultural beliefs). Their involvement in reducing stunting is critical since it has a significant impact on public health, human capital, and the country’s long-term development. Therefore, the purpose of this study was to explore the multifaceted causes and consequences of stunting in children aged 6-59 months within the stunting locus, with a particular focus on the critical role of micronutrient intake, maternal health, and environmental factors. Addressing these factors through comprehensive nutritional and policy interventions is essential to improve growth outcomes and reduce the long-term impacts of stunting on children in stunting locus.

MATERIALS AND METHODS

Study Design and Location

A cross-sectional study was conducted From May to July 2024, in Ciampea Udik Village, a stunting locus. Ciampea Udik is located in Bogor Regency, 74 kilometers south of Jakarta, Indonesia's capital city. According to the 2014 census, the district's total population is expected to be 7.993 people, with 555 under-five children. There are nine integrated healthcare centers in the village and the prevalence of stunting in 2023 was 32%.

Study Population and Sampling

The source population included all 6-59 month-old children from Ciampea Udik, a total of 555. The sample size was obtained using the hypothesis test of one proportion [19] with 95% confidence interval, statistical power of 80%, considering the proportion of stunting in Bali Province [20] as 8%, and the proportion of stunting in West Java Province as 16.3% [20], with a 15% non-respondence rate. The result of the sample size determined was 124 children.

A multistage random technique was used to select the sample. First, cluster proportional random sampling was conducted across Ciampea Udik's nine integrated healthcare centers (IHCs), which served as study locations.

The sample was drawn from each of the nine IHC based on their proportion to the total number of children. The second stage is purposive sampling, which selected children based on specified inclusion and exclusion criteria.

The inclusion criteria required that participants had resided in Ciampea Udik for at least 6 months, were willing to participate in interviews, and had the ability to understand and respond to questions in the local language. The exclusion criteria were: 1). Children and parents were unable to participate in the research until the completion of the study; 2) Children moved residences; and 3) Children had body length/height z-score for ages <-6 SD or >+6 SD. Z-scores of height for age beyond the following ranges are considered outliers and should be evaluated or eliminated from the analysis [21]. After analysing the HAZ data, no outlier z scores were detected in this study.

Data Collection

The questionnaires of household characteristics, pregnancy, infection, hygiene, breastfeeding and growth monitoring practices were adapted from the National Basic Health Research questionnaires [22]. Household characteristics consisted of family socioeconomic indicators, family size, household sanitation, and salt iodine concentration.

Interviews were conducted with mothers or caregivers of children. Two major researchers supervised fifteen trained enumerators who collected data. Body height measurements were taken with a stadiometer having an accuracy of 0.1 cm. It was measured in an upright position with the back of the head, shoulder blades, buttocks, and heels in contact with the backboard. The age in months was computed in WHO Anthro Software based on the birth and interview dates. The iodine rapid test reagent was used to determine the iodine content of household salt typically prepared for children meal. To determine the level of iodine in salt, place one tablespoon in a white and clean container, the salt was dripped 1-2 times with iodine rapid test reagent, and the color change was noticed. If there was no change in color, the salt did not contain iodine. If the salt turned light blue, it contained less than 30 ppm of iodine. If the color shifted to dark blue/dark purple, the salt had at least 30 ppm of iodine. This qualitative test for iodine in salt, commonly used worldwide, involves a simple spot-testing kit that utilizes a starch-based reagent. When iodine is present, it reacts with the starch, turning the sample blue, which serves as an immediate indicator of iodine content. These rapid test kits are cost-effective and easy to use in field settings, making them suitable for quick assessments at households [23].

Pregnancy data included parity, birth spacing, pregnancy check, Iron Folic Acid (IFA) tablet consumed, birth weight and length, and postpartum vitamin A supplementation. Infection and hygiene data included pulmonary tuberculosis, acute respiratory tract infection (ARI), pneumonia, diarrhea, and hand washing practice. The data on infections included those diagnosed by health workers (doctors/nurses/midwives) in the previous month, such as ARI, pulmonary TB, and diarrhea. Pneumonia infection was measured using diagnoses from health workers in the previous year. History of infections was classified as yes or no.

The data on breastfeeding and growth monitoring practices included four variables: delivering colostrum, exclusive breastfeeding, height monitoring, and vitamin A supplementation for children one year ago. Data on dietary intake were collected using a food recall form twice in 24 non-consecutive days. Intake data included 14 variables including energy, carbohydrate, protein, and fat, as well as vitamins (A, D, B1, B12, B9, C) and minerals (calcium, iron, zinc, and iodine) intake.

Data Processing and Analysis

WHO 2005 guidelines were utilized when processing height data to determine if it was "stunting" or "not stunting." After collecting the child's height, age, and gender, the z-score of height or length for age (HAZ) was calculated to match the child's age and gender. HAZ was calculated automatically by WHO Anthro Software after entering the child's age, height, and gender. WHO defines stunted as HAZ < -2 SD, while normal/not stunted is HAZ ≥ -2 SD. This classification is based on standard deviations from the WHO reference population's age-specific median height.

Household socio-economic indicators consist of parental education and family income. Education was classified as high if the lowest education level is senior high school, and low if the highest level of education is junior high school. The income was determined using the 2023 Bogor Regency Regional Minimum Wage/RMW (IDR 4,520,212 = US$ 286.74 per month). Household income was categorized as <RMW and ≥RMW.

The number of family members determines family size, which was classified as small (≤4 people) or large (>4 people). Sanitation was a composite variable that included the following variables: the primary water supply for home and drinking uses, the quality of drinking water, the method of waste disposal, waste storage, the frequency of washing the bathtub and latrine use. The overall score for the sanitation variable was calculated by adding the scores from these variables, and the mean score (61) was used as the cut off. Sanitation was divided into two categories: at risk (<mean total score) and lower-risk (≥ mean total score).

The iodine content in household salt was classified based on the National Standardization Agency's cut off, with less iodine salt being salt that does not contain iodine and/or has less than 30 ppm, and salt with at least 30 ppm iodine being classified as adequate iodine [24].

Birth intervals were classified as lower-risk (≥3 years) or at risk (<3 years) based on a three-year cut off [25]. The number of Iron Folic Acid (IFA) tablet taken during pregnancy was calculated using the number of IFA tablets recommended by the Ministry of Health. Pregnant women are advised to take one IFA tablet per day for at least 90 days throughout pregnancy [26], hence this study categorized it as insufficient (<90 tablets) or sufficient (≥90 tablets).

Vitamin A supplementation during postpartum was measured by the number of vitamin A capsules consumed. If the mother taken only one capsule of vitamin A, it was considered insufficient, whereas two capsules were considered sufficient. The Ministry of Health's Guidelines for Health Services for Postpartum Mothers recommend 200,000 IU of vitamin A during postpartum, which is given in the form of two red vitamin A capsules. The first vitamin A capsule is given shortly after delivery, followed by the second capsule 24 hours later.

Birth weights were classified as low (<2500 grams) or normal (≥2500 grams). Birth length was classified according to WHO child growth standards. Male child was classified as short if his birth length was less than 46.1 cm, and female child as short if it was less than 45.4 cm.

The history of giving colostrum was divided into two categories: disposing of away some/all and giving it altogether. Growth monitoring was based on a record of length/height measurements 1 year ago, namely seldom (<2 times) and frequently (≥2 times). The history of vitamin A supplementation in children was categorized according to the standards from the Ministry of Health. Vitamin A supplements are administered at Integrated Healthcare Center in both February and August. At 6-11 months old, babies are given one blue vitamin A capsule containing 100,000 IU. When children are 12 to 59 months old, they are given one red vitamin A capsule containing 200,000 IU. Vitamin A is considered sufficient if taken once for infants aged 6-11 months and twice for children aged at least 12 months.

After calculating energy and nutrient intake using the updated Nutrisurvey, its adequacy was compared to the latest Indonesian Dietary Recommendation based on age, gender, and median body weight according to WHO 2015 standards.

https://doi.org/10.18697/ajfand.139.25270

Energy and macronutrient intakes were considered adequate if it exceeds 90% (>90%) of the Recommended Dietary Adequacy (RDA), and deficient if it falls below 90%. Micronutrient intake was considered adequate if it exceeds 77% (>77%) of the RDA, and deficient if it falls below 70%, with the exception of iodine intake. All children did not consume enough iodine, hence the cut off is based on the average value (10%), divided into >10% of the RDA and <10% of the RDA.

Descriptive statistics were presented in the table. Variables having p-value <0.25 in binary logistic regression, including child age, iodine level in household salt, mother's education, child order, birth spacing, ARIs, pneumonia, diarrhea, vitamin A, calcium, iron, and zinc intakes (Table 3), were examined in multivariable logistic regression. The model was developed using a backward likelihood ratio with 0.1 probability removal. The OR was defined with a 95% confidence interval to demonstrate the strength of the relationship, and a p-value <.05 was used to indicate statistical significance. The resulting model's goodness of fit was examined using the Hosmer-Lemeshow test at p-value ≥ 0.05 (0.325), model classification accuracy was observed with 58.1% properly classified, and multicollinearity was determined with standard errors of beta coefficients at >1.

Ethics

This research obtained ethical approval from the Esa Unggul University Code of Ethics Enforcement Council, Research Ethics Committee. Permit letters were acquired from both the Bogor Regency Health Office and the Bogor District and National Unity and Politics Agency of Bogor Regency.

RESULTS AND DISCUSSION

This study analysed data from 124 children with the most (65.3%) children falling within the age of 24-59 months. Parental level of education is typically low among fathers (57.3%) and mothers of children (61.3%). The majority of children households (81.5%) earn less than the regional minimum wage. Almost half (49.2%) of children are not exclusively breastfed (Table 1). Most children have insufficient energy intake (54.8%), carbohydrates (74.2%), thiamine (77.4%), folate (78.2%), vitamin C (82.3%), calcium (87.9%), iron (78.2%). Majority of children (96%) had iodine sufficiency less than 10% RDA (Table 2).

Child age and zinc consumption were both statistically significant predictors of stunting (p<0.05). The 24-59 months age group is 2.52 (AOR=2.52; 95% CI 1.13-5.63) times more likely to have stunting than children aged 0-23 months. Children with low zinc intake are 3.08 (AOR=3.08; 95% CI 1.29-7.33) times more likely to be stunted than children with adequate zinc intake (Table 4).

The study's findings revealed that the child's age and a lack of zinc intake were statistically significant predictors of stunting among children in stunting locus villages. Children aged 24-59 months have a 2.98 (AOR=2.98; 95% CI 1.27-7.02) times higher risk of stunting than children aged 0–23 months. Those who do not consume adequate zinc are 2.71 (AOR=2.71; 95% CI 1.23-5.99) times more likely to suffer from stunting than those who do (Table 4).

Children aged 24-59 months are 2.98 times as likely to be stunted than children aged 0-23 months. This study is consistent with previous research in East Nusa Tenggara, which found that children aged 24 to 35 months are 2.08 times more likely to develop stunting than children aged 0 to 11 months [27]. Research in three Indonesian districts, Klaten, Sikka, and Jayawijaya, also demonstrate that older age is a significant risk factor for childhood stunting [18].

The elevated risk of stunting in older children might be because children between 24-59 months are more active than earlier ages, resulting in higher energy loss, allowing protein to be digested as an energy source to compensate for insufficient energy needs. Half of stunted children get adequate protein intake, but most of them consume insufficient carbohydrates and fats. Because of a lack of carbohydrate and fat consumption, the role of protein that is supposed to be for cell growth can alter to that of an energy source [28]. Aside from that, the increased risk of stunting in older children could be due to mothers or caregivers giving more attention and care to their younger siblings/newborn babies.

Another predictor of stunting is a low zinc intake. Children with low zinc intake are 2.71 (AOR=2.71; 95% CI 1.23-5.99) times more likely to be stunted than children with adequate zinc intake. A study on children aged 24-60 months in Lampung found significant variations in mean zinc levels between stunting and non-stunting children ($p = 0.01$). Stunted children had a reduced mean zinc level (45.06 ± 12.21) compared to non-stunting children (58.77 ± 12.98). When compared to non-stunting children, serum zinc levels are lower in stunting children [29]. Similarly, study on children aged 12-14 months in Surabaya reveals that stunting children have a lower zinc intake than non-stunting children [30]. Research on children aged 2 to 5 years in West Sumatra showed that stunted children have considerably lower hair zinc levels than normal children [31].

Zinc, an essential element found in the body, has numerous important effects on the growth of children [32]. Zinc is involved in cell division and growth and immunological response [33, 34]. Zinc deficiency has been shown to impede growth [35, 36]. Zinc deficiency is one of the most prevalent forms of micronutrient malnutrition in worldwide, yet it is also one of the least recognized [37, 38]. It is a significant growth restricting factor in children leading to stunting in both seemingly healthy [39] and undernourished children [40]. In besides raising the likelihood of many other pediatric morbidities [41], the consequences of significant zinc deficiency include cognitive decline [42], recurring infections and diarrhea [43], and slowed wound recovery [44].

The highest rates of zinc deficiency were among children aged 6-23 months and those from rural, low-income and food-insecure households. Low income was discovered to be a substantial determiner of zinc deficiency (OR 4.0; 95% CI = 2.22-6.00). Stunting (OR 1.37; 95% CI = 1.06-1.76) and serum vitamin A deficiency (OR 1.80; 95% CI = 1.43-2.26) were related with an increased risk of zinc deficiency. Sufficient vitamin A consumption was an essential factor in preventing zinc deficiency [45].

Poor iodine level in household salt may contribute to stunting ($p<0.1$) in the stunting locus area. The diets of all children in this research did not meet the iodine requirement. The majority of children (96%) have iodine intakes that are less than 10% of the RDA. Many countries' diets did not meet iodine requirement unless salt is added with it (46). By 2020, 124 nations had issued rules requiring salt iodization, with 21 countries remained in the voluntary iodization stage. As a result, 88% of the global population uses iodized salt [46].

Iodine is an essential micronutrient found in thyroid hormone. Normal growth and development require adequate iodine intake. If the iodine requirement is not met, growth may be restricted [47]. Low thyroid hormone levels can be caused by a lack of iodine. Thyroid hormone plays an important role in growth hormone/GH function [48]. Indonesia required salt fortification with iodine, as stated in Indonesian National Standard (SNI) 3556:2016. Iodine content of salt must be at least 30 mg/kg [24].

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

Low zinc intake was the most significant risk factor of stunting. Aside from that, the low iodine level in household salt may contribute to stunting. Therefor the program's aims of increasing zinc intake and using iodized salt could help the program have an influence on lowering stunting.

Addressing global zinc deficiency and raising zinc intake necessitates context-specific approaches and an integrated approach of complementary, evidence-based interventions. It is highly suggested that there is a collaboration between nutrition academics and local governments to design and consistently distribute local food high in zinc, which is more acceptable and affordable to undernourished children.

It is critically important for local governments to rebuild salt fortification program commitment among salt producers and to monitor salt iodine level. The community should be also educated how to store appropriately iodized salt for daily consumption.

ACKNOWLEDGEMENTS

The researchers are grateful to the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia for the research grant. Much appreciated to the Ciampea Udik Public Health Center, Ciampea Udik Village Office, and volunteers from integrated healthcare centers for their assistance with this research.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

Table 1: The characteristics of household, history of infection, pregnancy, Childbirth, postpartum, breastfeeding, and growth monitoring for children aged 6-59 months in the stunting locus village of Ciampea Udik, Bogor Regency in 2023 (n=124)

Characteristics		n	%
Household characteristics			
Gender	Male	62	50.0
	Female	62	50.0
Age	6-23 months	45	36.3
	24-59 months	79	63.7
Stunting	No	61	49.2
	Yes	63	50.8
Iodine level in household salt	Adequate	60	48.4
	Inadequate	64	51.6
Family size (person)	<= 4	53	42.7
	>4	71	57.3
Father's education	High	53	42.7
	Low	71	57.3
Mother's education	High	48	38.7
	Low	76	61.3
Family income	>= RMW	23	18.5
	< RMW	101	81.5
Sanitation	Adequate	64	51.6
	Poor	60	48.4
Pregnancy, childbirth and postpartum			
Child order	>3	15	12.1
	2-3	73	58.9
	1	36	29.0
Birth spacing	≥3 years	78	62.9
	<3 years	46	37.1
Gestational age at first check	<14 weeks	110	88.7
	>=14 weeks	14	11.3
IFA tablet consumed during pregnancy	>=90 tablets	85	68.5
	<90 tablets	39	31.5
Birth attendant	Health worker	122	98.4
	Non-health worker	2	1.6
Consumption of vitamin A at postpartum	>= 2 times	57	46.0
	< 2 times	67	54.0
Birth weight	Normal	118	95.2
	Low	6	4.8

Birth length	Normal	107	86.3
	Short	17	13.7
Infection and hygiene practices			
ARIs	No	74	59.7
	Yes	50	40.3
Pneumonia	No	114	91.9
	Yes	10	8.1
Pulmonary TB	No	121	97.6
	Yes	3	2.4
Diare	No	87	70.2
	Yes	37	29.8
Washing hands routinely	Yes	101	81.5
	No	23	18.5
Breastfeeding and growth monitoring			
Breastfeeding initiation	<1 hour	66	53.2
	>= 1 hour	58	46.8
Colostrum (n= 293)	All given	101	81.5
	Partially/entirely disposed	23	18.5
Exclusive breastfeeding	Yes	63	50.8
	No	61	49.2
Body height measurement per year	>= 2 times	117	94.4
	< 2 times	7	5.6

RMW: Regional Minimum Wage; IFA: Iron Folic Acid; ARI: Acute Respiratory Tract Infection; TB: tuberculosis

Table 2: Energy and nutrient intakes of 6-59 month-old children in the stunting locus village of Ciampea Udik, Bogor Regency, 2023 (n=124)

Intake variables	RDA[1] (%) Median±SE	RDA level[2]	n	%
Energy	88±3.6	Adequate	56	45.2
		Deficient	68	54.8
Protein	169±7.2	Adequate	118	95.2
		Deficient	6	4.8
Fat	103±5.4	Adequate	78	62.9
		Deficient	46	37.1
Carbohydrate	68±3.3	Adequate	32	25.8
		Deficient	92	74.2
Vitamin A	189±14.6	Adequate	117	94.4
		Deficient	7	5.6
Thiamine	44±3.4	Adequate	28	22.6
		Deficient	96	77.4
Folate	34±6.9	Adequate	27	21.8
		Deficient	97	78.2
Vitamin C	19±5.1	Adequate	22	17.7
		Deficient	102	82.3
Calcium	26±9.1	Adequate	15	12.1
		Deficient	109	87.9
Iron	43±3.2	Adequate	27	21.8
		Deficient	97	78.2
Zinc	86±4.9	Adequate	88	71.0
		Deficient	36	29.0
Cobalamin	72±3.2	Adequate	65	52.4
		Deficient	59	47.6
Iodine	1.8±0.3	≥10% RDA	5	4.0
		<10% RDA	119	96.0

[1] RDA: Recommended Dietary Allowance; [2] Deficient energy and macronutrients intake are defined as less than 90% of the national RDA, while adequate is defined as 90% or more. Deficient micronutrient intake is less than 77% of the RDA, while adequate is 77% or more

Table 3: Relationship between study variables and stunting among children aged 6-59 months in stunting locus village, Ciampea Udik, Bogor Regency, 2023 (n=124), p<0.25

Variable	Stunting	Normal	COR (95% CI)	p
Household characteristics				
Age				.030
6-23 months	17 (37.8)	28 (62.2)	1	
24-59 months	46 (58.2)	33 (41.8)	2.29 (1.08 – 4.86)	
Iodine level in household salt				.050
Adequate	25 (41.7)	35 (58.3)	1	
Poor	38 (59.4)	26 (40.6)	2.05 (1.00 – 4.19)	
Mother's education				.090
High	29 (60.4)	19 (39.6)	1	
Low	34 (44.7)	42 (55.3)	0.53 (.26 – 1.11)	
Pregnancy				
Child order				
1	15 (41.7)	21 (58.3)	1	
2-3	42 (57.5)	31 (42.5)	.93 (.27 – 3.18)	.912
>3	6 (40.0)	9 (60.0)	1.89 (.85 – 4.26)	.121
Birth spacing				.106
≥3 years	44 (69.8)	34 (55.7)	1	
<3 years	19 (30.2)	27 (44.3)	.54 (.26 – 1.14)	
Infection and hygiene practice				
ARIs				.214
No	41 (55.4)	33 (44.6)	1	
Yes	22 (44.0)	28 (56.0)	0.63 (.31– 1.30)	
Pneumonia				.060
No	61 (53.5)	53 (46.5)	1	
Yes	2 (20.0)	8 (80.0)	0.22 (.04 – 1.07)	
Diarrhea				.062
No	51 (55.4)	41 (44.6)	1	
Yes	12 (37.5)	20 (62.5)	.47 (.22 – 1.04)	
Vitamin A				.242
Adequate	61 (52.1)	56 (47.9)	1	
Deficient	2 (28.6)	5 (71.4)	.37 (.07 – 1.97)	
Calcium				.157
Adequate	5 (33.3)	10 (66.7)	1	
Deficient	58 (53.2)	51 (46.8)	2.28 (.73 – 7.09)	

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 2
February 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Iron					.109
Adequate	10 (37.0)	17 (63.0)	1		
Deficient	53 (54.6)	44 (45.4)	2.05	(0.85 – 4.92)	
Zinc					.026
Adequate	39 (44.3)	49 (55.7)	1		
Deficient	24 (66.7)	12 (33.3)	2.51	(1.12 – 5.65)	

ARI: Acute Respiratory Tract Infection

Table 4: Factors influencing stunting in children aged 6-59 months in stunting locus village, Ciampea Udik, Bogor Regency, 2023 (n=124)

Variable	AOR (95% CI)	p
Age (months)		
0-23	1	
24-59	2.52 (1.13-5.63)	.025[a]
Iodine level in household salt		
Adequate	1	
Poor	1.97 (.93-4.18)	.078[b]
Zinc intake		
Adequate	1	
Deficient	3.08 (1.29-7.33)	.011[a]

[a]$p<0.05$; [b]$p<0.1$

REFERENCES

1. **Ministry of Health of the Republic of Indonesia.** Indonesian Nutritional Status Survey 2022. https://layanandata.kemkes.go.id/katalog-data/ssgi/ketersediaan-data/ssgi-2022 *Accessed 10 July 2024.*

2. **Ministry of Health of the Republic of Indonesia.** Guidelines for Technical Implementation of Nutrition Surveillance. 2021. https://repository.kemkes.go.id/book/581 *Accessed 10 June 2024.*

3. **Nadiyah, Briawan D and D Martianto** Risk factors of stunting among 0—23 month old children in Bali Province, West Java and East Nusa Tenggara. *J. Gizi dan Pangan.* 2014; **9(2)**.

4. **Prendergast AJ and JH Humphrey** The stunting syndrome in developing countries, Paediatr. Int. Child Health. 2014; **34(4).** doi: https://doi.org/10.1179/2046905514Y.0000000158

5. **Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, De Onis M, Ezzati M, Grantham-McGregor S, Katz J, Martorell R and R Uauy** Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet.* 2013; 382.

6. **WHO Guideline:** Vitamin A supplementation in infants and children 6 – 59 months of age. World Health Organization. 2011. https://www.who.int/publications/i/item/9789241501767 *Accessed 10 May 2024.*

7. **Imdad A, Mayo-Wilson E, Haykal MR, Regan A, Sidhu J, Smith A and ZA Bhutta** Vitamin A supplementation for preventing morbidity and mortality in children from six months to five years of age. *Cochrane Database of Systematic Reviews*. 2022.

8. **Jinnah BA** Comprehensive Review of Minerals and Vitamins Synergy: Impacts on Childhood and Adolescent Bone Development. *Am. J. Heal Med. Nurs. Pract.* 2023; **8(4)**.

9. **Cerami C** Iron Nutriture of the Fetus, Neonate, Infant, and Child. *Ann. Nutr. Metab.* 2017; **71(3)**.

10. **Ministry of Health Republic of Indonesia.** Basic Health Research 2018. https://www.litbang.kemkes.go.id/laporan-riset-kesehatan-dasar-riskesdas/ *Accessed 21 May 2023.*

11. **Alderman H, Behrman JR, Glewwe P, Fernald L and S Walker** Evidence of Impact of Interventions on Growth and Development during Early and Middle Childhood. In: Disease Control Priorities. *Child and Adolescent Health and Development.* 2017; **8(3)**.

12. **Abel MH, Caspersen IH, Sengpiel V, Jacobsson B, Meltzer HM, Magnus P, Alexander J and AL Brantsæter** Insufficient maternal iodine intake is associated with subfecundity, reduced foetal growth, and adverse pregnancy outcomes in the Norwegian Mother, Father and Child Cohort Study. *BMC Med.* 2020; **18(1)**.

13. **Thaisriwong C and V Phupong** Nutrition during Pregnancy. *Thai J. Obstet. Gynaecol.* 2023; **31(6)**.

14. **Gorstein J** Some Considerations of Some Indicators to Determine the Success of the IDD Elimination Program in Indonesia. Gizi Indonesia. 2014; **28(2).**

15. **Ceballos-Rasgado M, Lowe NM, Moran VH, Clegg A, Mallard S, Harris C, Montez J and M Xipsiti** Toward revising dietary zinc recommendations for children aged 0 to 3 years: a systematic review and meta-analysis of zinc absorption, excretion, and requirements for growth. *Nutrition Reviews.* 2023; **81.**

16. **Chandra DN** Fueling growth and preventing stunting: the role of animal protein in achieving optimal nutrition - Indonesia's National Nutrition Day 2023 Theme. *World Nutr. J.* 2023; **6(2)**.

17. **Willoughby JL and CN Bowen** Zinc deficiency and toxicity in pediatric practice. *Current Opinion in Pediatrics*. 2014; **26**.

18. **Torlesse H, Cronin AA, Sebayang SK and R Nandy** Determinants of stunting in Indonesian children: Evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. *BMC Public Health.* 2016; **16(1):**1–11.

19. *Lwanga SK and S Lemeshow* Sample Size Determination in Health Studies: A Practical Manual. Geneva: WHO; 1991.

20. **Ministry of Health of the Republic of Indonesia.** Indonesian Nutritional Status Study 2023. https://layanandata.kemkes.go.id/katalog-data/ssgi/ketersediaan-data/ssgi-2023 *Accessed 15 July 2024.*

21. **WHO.** Child Growth Standars. https://www.who.int/tools/child-growth-standards/software *Accessed 3 September 2023.*

22. **The Health Development Policy Agency Repository.** 2018 Basic Health Research Questionnaire. https://repository.badankebijakan.kemkes.go.id/id/eprint/4616/ *Accessed 15 May 2023.*

23. **WHO.** Asessment of Iodine Deficiency Disorders and Monitoring Their Elimination. *World Hear Organ.* 2014; **28(2):**1–108. https://apps.who.int/iris/handle/10665/43781 *Accessed 3 September 2023.*

24. **National Standardization Agency of Indonesia.** Indonesian National Standard 3556:2016 Iodized Consumable Salt. 2016; **1**:1–12. www.bsn.go.id *Accessed 15 May 2023.*

25. **Santosa A, Arif EN and DA Ghoni** Effect of maternal and child factors on stunting: partial least squares structural equation modeling. *Clin. Exp. Pediatr.* 2022; **65(2)**:1–8.

26. **Nadiyah, Dewanti LP, Mulyani EY and I Jus'at** Nutritional anemia: Limitations and consequences of Indonesian intervention policy restricted to iron and folic acid. *Asia Pac. J. Clin. Nutr.* 2020; **29**:S55–73.

27. **Suratri MAL, Putro G, Rachmat B, Nurhayati, Ristrini, Pracoyo NE, Yulianto A, Suryatma A, Samsudin M and R Raharni** Risk Factors for Stunting among Children under Five Years in the Province of East Nusa Tenggara (NTT), Indonesia. *Int. J. Environ Res. Public Health.* 2023; **20(2)**:1–13.

28. **Wolfe RR** Regulation of muscle protein by amino acids. *J. Nutr.* 2017; **147(12):** 550–556.

29. **Berawi KN, Hidayati MN, Susianti, Perdami RRW, Susantiningsih T and AM Maskoen** Decreasing zinc levels in stunting toddlers in Lampung Province, Indonesia. *Biomed. Pharmacol. J.* 2019; **12(1):**1–5.

30. **Losong NHF and M Adrani** Differences in Hemoglobin Levels, Iron and Zinc Intake in Stunting and Non-Stunting Under Five Children. *Amerta. Nutr.* 2017; **1(2):** 1–7.

31. **Noftalina E, Mayetti M and A Afriwardi** The Relationship between Zinc Levels and Mother's Parenting Patterns with the Incident of Stunting in Children Aged 2 - 5 Years in Panti District, Pasaman Regency, Scientific. *J. Batanghari Univ. Jambi.* 2019; **19(3):**1–5.

32. **Liu E, Pimpin L, Shulkin M, Kranz S, Duggan CP, Mozaffarian D and WW Fawzi** Effect of zinc supplementation on growth outcomes in children under 5 years of age. *Nutrients*. 2018; **10:**1–20.

33. **King JC** Zinc: An essential but elusive nutrient. *American Journal of Clinical Nutrition*. 2011; **94:**1–6.

34. **Terrin G, Canani RB, Di Chiara M, Pietravalle A, Aleandri V, Conte F and M De Curtis** Zinc in early life: A key element in the fetus and preterm neonate. Nutrients. 2015; **7:**1–20.

35. **Salgueiro MJ, Zubillaga MB, Lysionek AE, Caro RA, Weill R and JR Boccio** The role of zinc in the growth and development of children. *Nutrition*. 2002; **18:**1–10.

36. **Kambe T, Fukue K, Ishida R and S Miyazaki** Overview of inherited zinc deficiency in infants and children. *J. Nutr. Sci. Vitaminol*. 2015; **61:**1–3.

37. **Kumssa DB, Joy EJM, Ander EL, Watts MJ, Young SD, Walker S and MR Broadley** Dietary calcium and zinc deficiency risks are decreasing but remain prevalent. *Sci Rep.* 2015; **5:**1–11.

38. **Wessells KR and KH Brown** Estimating the Global Prevalence of Zinc Deficiency: Results Based on Zinc Availability in National Food Supplies and the Prevalence of Stunting. 2012; **7(11):**1–11.

39. **Nakamura T, Nishiyama S, Futagoishi-Suginohara Y, Matsuda I and A Higashi** Mild to moderate zinc deficiency in short children: Effect of zinc supplementation on linear growth velocity. *J. Pediatr.* 1993; **123(1)**:1–5.

40. **Ruz M, Castillo-Duran C, Lara X, Codoceo J, Rebolledo A and E Alalah** A 14-mo zinc-supplementation trial in apparently healthy chilean preschool children. *Am. J. Clin. Nutr.* 1997; **66(6)**:1–8.

41. **Fischer Walker CL, Rudan I, Liu L, Nair H, Theodoratou E, Bhutta ZA, O'Brien KL, Campbell H and RE Black** Global burden of childhood pneumonia and diarrhoea. *The Lancet.* 2013; **381:**1–12.

42. **Levenson CW and D Morris** Zinc and neurogenesis: Making new neurons from development to adulthood. *Adv. Nutr.* 2011; **2(2):**1–5.

43. **Lazzerini M and H Wanzira** Oral zinc for treating diarrhoea in children. *Cochrane Database of Systematic Reviews*. 2016; 1–133.

44. **Lin PH, Sermersheim M, Li H, Lee PHU, Steinberg SM and J Ma** Zinc in wound healing modulation. *Nutrients*. 2018; **10:**1–20.

45. **Goyena EA, Maniego ML V, Ducay AJD, Musa MCA and I Angeles-Agdeppa** Dietary zinc intake and the underlying factors of serum zinc deficiency among preschool children in the Philippines. *Philipp J. Sci.* 2021; **150(3)**.

46. **Zimmermann MB and M Andersson** Global perspectives in endocrinology: Coverage of iodized salt programs and iodine status in 2020. *European Journal of Endocrinology*. 2021; **185:**1–9.

47. **Farebrother J, Naude CE, Nicol L, Sang Z, Yang Z, Andersson M, Jooste, PL and MB Zimmermann** Systematic review of the effects of iodised salt and iodine supplements on prenatal and postnatal growth: study protocol. *BMJ Open.* 2015; **5(4):**1–8.

48. **Farebrother J, Naude CE, Nicol L, Sang Z, Yang Z, Jooste PL, Andersson M and MB Zimmerman** Effects of iodized salt and iodine supplements on prenatal and postnatal growth: A systematic review. *Advances in Nutrition.* 2018; **9:**219–37.

https://doi.org/10.18697/ajfand.139.25270