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Risk Factors of Stunting, Iron Deficiency Anemia, and Their Coexistence among Children Aged 6-9 Years in Indonesia: Results from the Indonesian Family Life Survey-5 (IFLS-5) in 2014-2015

Faktor Risiko Stunting, Anemia Defisiensi Besi, dan Koeksistensinya pada Anak Usia 6-9 Tahun di Indonesia: Hasil dari Indonesian Family Life Survey (IFLS-5) tahun 2014-2015

Mia Mustika Hutria Utami[1,2], Lilik Kustiyah[1]*, Cesilia Meti Dwiriani[1]

[1]Department of Community Nutrition, Faculty of Human Ecology, IPB University, Bogor, Indonesia
[2]Center for International Forestry Research (CIFOR), Bogor, Indonesia

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Correspondent:
Lilik Kustiyah
Lilikku@apps.ipb.ac.id

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ABSTRACT

Background: Stunting and anemia are malnutrition and have become major public health problems. The evidence is limited about the coexisting stunting and anemia (CSA) among school-aged children (SAC).
Objectives: To analyze risk factors of stunting, anemia, and their coexistence among Indonesian children aged 6-9.
Methods: This cross-sectional study used secondary data from 1,986 children aged 6-9 years from 13 out of 34 provinces in Indonesia. Risk factors of stunting, anemia, and CSA were analyzed by logistic regression.
Results: The prevalence of stunting, anemia, and CSA among children aged 6-9 years was 24.8%, 30.5%, and 8.8%, respectively. Risk factors of stunting were anemia (OR=1.355), underweight father (OR=1.587), maternal education (<12 years) (OR=1.679), short parental stature (mother: OR=2.504, father: OR=1.995), low and middle sanitation score (OR=2.356, OR=1.366), and living in a rural area (OR=1.367). Risk factors of anemia were stunting (OR=1.307), age 6-7 years (OR=1.933), and parental anemia (mother: OR=1.973, father: OR=1.692). Children aged 6-7 years (OR=1.993) and short parental stature (mother: OR=1.901, father: OR=1.620) were risk factors for CSA.
Conclusions: The coexistence of stunting and anemia as a double burden of undernutrition exists among Indonesian children. An anemic child, an underweight father, low maternal education, low and middle sanitation score, and living in a rural area increase the risk of stunting. Stunted children and parental anemia increase the risk of anemia, short parental stature increases the risk of stunting and CSA, while younger children increase the risk of anemia and CSA.

INTRODUCTION

Stunting and anemia are critical global public health problems, and the prevalence remains high in developing countries[1]. Stunting is a condition of having short stature compared to children of the same age marked by a low height-for-age z-score (HAZ) that is more than two standard deviations below the World Health Organization (WHO) Child Growth Standards median[2]. Anemia is a condition of unfulfilled body's physiological needs because insufficient red blood cells lead to less oxygen-carrying capacity, commonly caused by iron deficiency[3]. According to Indonesian Basic Health Research, the prevalence of stunting among children aged 5-12 years was 22.6% in 2018, a decrease from 30.7% in 2013[4,5]. Similarly, the prevalence of anemia among children aged 5-14 decreased from 29.4% in 2013 to 26.8% in 2018[4,5]. Stunting is considered a high and moderate public health problem, respectively. The prevalence of coexistence of stunting and anemia (CSA) among children aged 6-8 years and 6-11 years in Egypt was 8.8% and 9.9%, respectively[6]. Data analysis from 46 low- and middle-income countries showed that although there is a wide range of the prevalence of CSA among younger under-five children, the overall prevalence is considered high in these countries[7]. The prevalence of the coexistence of stunting and anemia is highly concerning as each poses a significant challenge to the health system and the children's survival. Their coexistence (CSA) would be even more treating and detrimental to the children's health[6,8].

Children aged 6 to 9 years were in a middle childhood period whose growth was generally steady and slow; however, they continued to grow physically,

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cognitively, and emotionally[9]. Good nutrition in this period is essential as the gateway to adolescence, the second window opportunity after the first one in the first 1,000 days of life. It provides a chance to overcome undernutrition and lack of growth during childhood by catching up with the growth to prevent permanent growth retardation[10]. Moreover, menarche in Indonesian female children begins at ten years, and the overall mean menarche age was 12.96 years[11]. It meant that ages 6-9 were the appropriate age period to identify risk factors of undernutrition just before the pubertal growth spurt period when the linear growth rapidly increases and prevention of iron deficiency anemia among girls before menarche to combat the extra losses during menstruation. Iron deficiency anemia significantly impacts defective growth through defective IGF-1 secretion mechanism, and stunting could contribute to iron deficiency anemia through inadequate long-term iron, vitamin A, and zinc intake that play a role in iron metabolism[12–14].

Stunting and anemia could contribute to delayed psychomotor, paying less attention, worse cognitive development or even cognitive deficit, and worse socio-emotional and academic performance[10,15,16]. The prevalence of coexistence of stunting and anemia (CSA) among children aged 6-8 years and 6-11 years in Egypt was 8.8% and 9.9%, respectively[6]. Data analysis from 46 low- and middle-income countries showed that although there is a wide range of the prevalence of CSA among younger under-five children, the overall prevalence is considered high in these countries[7]. The high prevalence of coexistence of stunting and anemia is highly concerning as each poses a significant challenge to the health system and the children's survival. Their coexistence (CSA) would be even more threatening and detrimental to the children's health[6,8,16].

Various direct and indirect factors could affect stunting, anemia, and their coexistence, including individual-, parental/household-, and community-level factors[17,18]. As seen in the frequently cited UNICEF and The Lancet frameworks, conceptual frameworks for malnutrition, stunting, and anemia share similar underlining factors for stunting and anemia, including individual-, parental/household-, and community-level factors[17,18]. Some previous studies, both at the global and national level, analyze risk factors of stunting or anemia among school-aged-children (SAC) separately[19–21]. However, no currently available studies at the national level have combined analysis of the coexistence of the two types of malnutrition as an intraindividual double burden of undernutrition with context-specific models of determinants of anemia and stunting among middle childhood aged 6 to 9 by considering menarche in the age range selection before children having a growth spurt. Thus, this study aimed to analyze the risk factors of stunting, anemia, and their coexistence among children aged 6 to 9 years in Indonesia. The coexistence of stunting and anemia is defined as having both conditions of stunting and anemia at the time of measurement.

METHODS

Participants

This study used data from the Indonesian Family Life Survey (IFLS), an ongoing comprehensive-national representative longitudinal survey conducted by the Research and Development (RAND) Corporation in the United States, collaborating with institutions such as the University of Indonesia, the University of Gajah Mada, and Survey Meter. This survey represents a large sample size of about 83% of the Indonesian population and contains over 30,000 individuals. The dataset was publicly available on the Research and Development (RAND) Corporation website. This study focuses on IFLS wave 5 data from 2014-2015 in 13 of 27 Indonesian provinces at the first survey in 1993-1994. IFLS-5 consists of various nationally representative variables to be analyzed, such as anthropometry, biochemical measurement, food frequency of consumption, and socio-economic and demographic characteristics. Specific food frequency consumption data is the most updated nationally representative beside the Indonesian Ministry of Health dataset. Data collected from children aged 6-9 years were obtained for analysis. 3,374 children aged 6-9 years were surveyed in IFLS wave 5 using two-stage stratified random sampling. In this study, the subject was chosen by using purposive sampling based on the inclusion and exclusion criteria. The inclusion criteria were children who (1) were aged 6-9 years; (2) had biological children status; (3) were living in the same house with parents; (4) had HAZ -6 SD ≤ z-score ≤6 SD. The exclusion criteria are children (1) had incomplete records for child information (age, sex, height, weight, Hb, consumption frequency) and not matched parental/household-and community-level data, (2) living in a province that only has <100 participants. The final study participants included in the analysis in this study are 1,986 paired children and parents living in 13 out of 34 provinces in Indonesia currently with complete matching data for the individual-, parental-, household-, and community-level factors. The complete sampling scheme and survey methods have been described in the IFLS overview and field reports[22].

Anthropometric Measurements, Biochemical, and Dietary Assessment

Anthropometric measurement includes the weight and height of children and parents. Personnel trained in taking physical health measurements measured each subject's body weight to the nearest tenth of a kilogram or one single decimal using a Camry model EB1003 scale. In contrast, height was measured to the nearest millimeter using a Seca plastic height board (model 213). Child nutritional status based on height-for-age (HAZ) was assessed by using World Health Organization (WHO) Anthro Plus software and categorized as stunting (HAZ <-2 standard deviations (SD)) and normal (HAZ ≥-2 SD)[5]. The parent's height is categorized as short stature and normal, including the father's height (short stature [< 160 cm], and normal [≥ 160 cm]) and the mother's height (short stature [< 150 cm] and normal [≥ 150 cm]). Body Mass Index (BMI) for parents was calculated as weight in kg divided by height in meters squared and classified according to WHO Asia-Pacific criteria specified for the Asia-Pasific population: (underweight [<18.5 kg/m^2], normal [18.5-22.9 kg/m^2], and overweight/obese [≥ 23 kg/m^2])[23].

The biochemical assessment was used to assess hemoglobin concentration. A hemoglobin test was performed by personnel trained to take physical health measurements using a Hemocue handheld meter (model Hb201+) and its respective HB201 micro cuvettes. Hospital and Home Care made the lancets. Child dan parental anemia based on Hb concentration is classified based on WHO guideline[3]. Child anemia based on Hb concentration is categorized as anemia (<11.5 g/dl) and normal (≥11.5g/dl)[3]. This category is general for global population children instead of specified for Asian population children. Based on Hb concentration, paternal anemia is categorized as anemia (<13 g/dl) and normal (≥13 g/dl), while maternal anemia is classified as anemia (<12 g/dl) and normal (≥12 g/dl)[3].

Dietary assessment using Food Frequency Questionnaire by direct interview with the mother or caregiver of children by the trained interviewer about the food consumed by children over the previous seven days. Dietary data were classified into eight out of nine food groups as a proxy to assess Child Individual Dietary Diversity Score (IDDS) to be categorized into not diverse (<5 food groups) and diverse (≥5 food groups) obtained from modification of FAO guideline. The composition of IDDS based on the recommendation from the Food and Agriculture Organization (FAO) guidelines are nine food groups, including starchy staples; eggs; meat and fish; milk and milk products; legumes, nuts, and seeds; dark green leafy vegetables; vitamin A-rich fruits and vegetables; other fruits and vegetables; and organ meat. This study used only eight food groups and excluded the organ meat food group because of the unavailable data.

Considering that the IFLS and their procedures were adequately reviewed and approved by IRBs in the United States (at RAND) and in Indonesia (at the UGM), there was no doubt about the validity and reliability of the questionnaire and the obtaining data procedures. The user's guide, questionnaire books, overview/field report, and set of codebooks were available to match all codes in the dataset of respondents' answers and the questions in questionnaires. The child, adult, and household information, anthropometric and biochemical datasets were combined and cleaned based on the inclusion and exclusion criteria. Subjects with incomplete data for at least one level factor (either individual, parental, household, or community level) were excluded. Clean data is ready to be analyzed statistically.

Potential Risk Factors

The potential risk factors for childhood malnutrition were categorized into the child, parental/household, and community-level factors. Child factors consist of child age (6-7, and 8-9 years); sex (boys and girls); child nutritional status based on HAZ (stunting and normal) and Hb (anemia and normal); and IDDS (not diverse and diverse). Parents/household factors included parents' age (<30 years and ≥30 years); education (<12 years, 12 years, and >12 years); parents' height (short stature and normal); parents' BMI (underweight, normal, overweight/obese); family size (small [≤4 people], medium [5-7 people], large [≥8 people]); sanitation score (low [<60%], medium [60-80%], high [>80%]), and household economic status (poor [tertile 1], middle [tertile 2], and wealthy [tertile 3]). Community-level factors included the housing area (rural and urban) that was classified based on criteria from the Indonesian Central Bureau of Statistics for rural-urban classification in Indonesia.

The household wealth index (WI) was used to proxy household economic status using the principal component analysis (PCA) method, and households were ranked into tertiles. WI was constructed by assigning weights to eleven household assets, including the house the family lived in; another house/building; farmland; hard crop trees; poultry; livestock/fish pond; vehicles (bicycles, cars, motorbikes, boats); savings/deposits/ stocks; receivables; jewelry; and other assets.

Sanitation score was constructed as a composite index by assigning weights, and scores to several indicators, including drinking water sources and their distance, water sources for household chores (i.e., taking baths, washing clothes) and their distance, drinking water processing, latrine facilities, wastewater disposal, and household garbage disposal. The 'improved' category was given for each indicator if the water sources were piped water into the dwelling/plot/yard or protected dug well or tubewell/borehole or protected spring or rainwater collection, or the distance of living house with a water source in one way is 0 km or inside the house, or the water is cooked/boiled before drinking, or having flush/pour flush to piped sewer system/septic tank/pit latrine, or having sewer/flowing gutter as wastewater disposal, or throwing the garbage into the trash can as household garbage disposal. Other than these were all considered unimproved to later have lower weights and scores. The categorization of 'improved' and 'unimproved' of several sanitation indicators are based on World Health Organization (WHO) guidelines by modification.

Statistical Analysis

The datasets used during the current study are available at http://www.rand.org/labor/FLS/IFLS/download.html. The data could be accessed and downloaded after the registration process. In the IFLS data, the information gathered from interviewees was recorded in seven separate questionnaire books. The child, adult, and household information and anthropometry data were combined from IFLS-wave 5 datasets, and data cleaning was performed according to both inclusion and exclusion criteria in the current study. Codebooks, an IFLS user's guide, and overview/field reports are also available and followed during the data cleaning. Subjects with incomplete data for a minimum of one level factor (either individual, parental, household, or community level) were excluded, including children who only lived with one of their parents also being excluded. Cleaning data was resulting 1,986 children with complete matching data for the child-, parental-, household-, and community-level factors.

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Data analysis was conducted using IBM Statistical Program for Social Science (SPSS) version 23.0 for Windows. This study used univariate, bivariate, and multivariate analysis. Univariate analysis was conducted to do the normality test and descriptive statistics. The normality test was conducted by using the Kolmogorov-Smirnov test. Descriptive statistics (frequency counts and percentages) summarize categorical variables, whereas mean and standard deviation (SD) present continuous variables. Bivariate analysis was conducted to examine the relationship between undernutrition (stunting, anemia, and their coexistence) and the covariates using the chi-square (χ^2) test. Multivariate analysis was conducted to examine the risk factors value or Odd Ratio (OR) using bivariate logistic regression tests. All potential risk factors that had a significant correlation (p<0.05) in the previous bivariate analysis (correlation test) were included in the multivariate analysis. The odds ratio (OR), along with the 95% confidence interval (CI), was estimated to assess association strength, and a p<0.05 was considered statistically significant in the multivariate analysis.

Ethics Approval

This study was based on a secondary analysis of the Indonesian Family Life Survey (IFLS) Wave 5 2014-2015 dataset. Institutional Review Boards in the USA (at RAND Corporation, Santa Monica, California) and the University of Gadjah Mada, Indonesia, reviewed and approved the survey and its procedures. The protocol approval number (i.e., ethical clearance number) RAND's Human Subjects Protection Committee (RAND's IRB) gave IFLS 5 was s0064-06-01-CR01. Participants and children's caretakers or guardians complete a written informed consent before enrolling in the IFLS.

RESULTS AND DISCUSSION

Subject Characteristics

Characteristics of subjects are shown in Table 1 and Table 2. More than half of the children were boys (53.4%) and aged 8-9 (51.7%). The mean age of the subject was 7.5 ± 1.1 years old. Four out of five children (78.4%) met the minimum dietary diversity based on IDDS, with the IDDS mean being 5.7± 1.4. It means most children have already consumed five out of eight food groups. Most children consumed the three highest food groups: staples, fish, meat, and egg. Most children consumed staples and animal source food (ASF) such as fish, meat, and eggs. Individual dietary diversity was expected could reflect macro and micronutrient adequacy. The present study showed that DDS has a significant correlation with stunting (p < 0.05) but not significant with anemia and CSA (p > 0.05). It is in line with a previous study among younger children in China that DDS correlates significantly with stunting but not with anemia[24]. In this study, DDS might only reflect some macro and micronutrients related to stunting, not micronutrients related to anemia which is iron.

Table 1. Characteristics of subjects, parents, and household (n=1.986)

Variables	n	%
Child characteristics		
Child sex		
Male	1,061	53.4
Female	925	46.6
Child age (years)		
6-7	960	48.3
8-9	1,026	51.7
Child IDDS		
Not Diverse	431	21.7
Diverse	1,555	78.3
Child HAZ		
Stunting	493	24.8
Normal	1,493	75.2
Child Hb (g/dl)		
Anemia	605	30.5
Normal	1,381	69.5
Child HAZ and Hb		
Coexistence of stunting and anemia (CSA)	174	8.8
Non-CSA	1,812	91.2
Parents/Household characteristics		
Father's age (years)		
<30	30	4.2
≥30	1,903	95.8
Mother's age (years)		
<30	351	17.7
≥30	1,635	82.3

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Variables	n	%
Parents nutritional status		
Father's BMI (kg/m²)		
Underweight (<18)	177	8.9
Normal (18.5-22.9)	869	43.8
Overweight/obese (≥23)	940	47.3
Mother BMI (kg/m²)		
Underweight (<18.5)	80	4.0
Normal (18.5-22.9)	593	29.9
Overweight/obese (≥23)	1,313	66.1
Father Hb (g/dl)		
Anemia (<13)	245	12.3
Normal (≥13)	1,741	87.7
Mother Hb (g/dl)		
Anemia (<12)	556	28.0
Normal (≥12)	1,430	72.0
Father's height (cm)		
Short stature (<160)	584	29.4
Normal height (≥160)	1,402	70.6
Mother height (cm)		
Short stature (<150)	777	39.1
Normal height (≥150)	1,209	60.9
Father's education (years)		
<12	1,076	54.2
12	658	33.1
>12	252	12.7
Mother education (years)		
<12	1,126	56.7
12	618	31.1
>12	242	12.2
Family size (people)		
Small (<4)	1,028	51.8
Medium (5-7)	893	45.0
Large (≥8)	65	3.3
Sanitation score (%)		
Low (<60)	160	8.1
Middle (60-80)	417	21.0
Parents/Household characteristics		
Sanitation score (%)		
High (>80)	1,409	70.9
Household WI		
Poor (tertile 1)	663	33.4
Middle (tertile 2)	666	33.5
Rich (tertile 3)	657	33.1
Housing area		
Rural	858	43.2
Urban	1,128	56.8

Values are presented as several subjects and percentages (%). The author computed these values from the Indonesian Family Life Survey wave 5 (2014 - 2015) data.
Rural-urban classification based on criteria from the Indonesian Central Bureau of Statistics for rural-urban classification in Indonesia[25]
IDDS, individual dietary diversity score; BMI, body mass index; WI, wealth index.

Parent and Household Characteristic

Parent and household characteristics are shown in Table 1 and 2. At the parent level, most fathers (95.8%) and mothers (82.3%) were aged over 30 years. The mean father and mother ages were 39.6 ± 6.7 years old and 35.3 ± 5.8 years old, respectively. More than half of fathers (54.2%) and mothers (56.7%) studied for less than 12 years, with the means of length of education being 9.5 ± 3.9 years and 9.5 ± 3.7 years, respectively. Over half of the parents have studied until formal middle education and fulfilled nine years of compulsory education.

Most fathers (70.6%) and mothers (60.9%) had normal heights, with mean heights of 162.9 ± 5.8 cm and 151.6 ± 5.3 cm, respectively. Almost half of the fathers (47.3%) were overweight/obese, and two out of three mothers were overweight/obese (66.1%), with means of BMI 23.1 ± 3.9 kg/m^2 and 25.2 ± 4.5 kg/m^2, respectively. One-fourth of mothers (28.0%) and only 12.3% of fathers were anemic, with means of Hb being 14.6 ± 1.5 g/dl and 12.6 ± 1.3 g/dl, respectively. Most of both parents were having normal height and were overweight/obese. However, more mothers were anemic compared to fathers. It is in line with a previous study in Korea that among adults aged 18-49 years and aged 50-59 years, the prevalence of iron deficiency anemia was significantly 11.7 and 3.7 times higher in females compared to males, respectively, due to the influence of menstruation and pregnancy among females[26].

At the household level, more than half of the households had small families (51.8%), with the mean family size being 4.8 (SD ± 1.3). About 33.4%, 33.5%, and 33.1% of households were considered rich, middle, and poor. More than half of the households live in urban areas at the community level (56.8%). In Indonesia, there were disparities between rural and urban areas related to access to a proper and sustainable sanitation facility, safe and sustainable drinking water and clean water for other household chores, and unequal allocation of resources[27]. People living in urban areas tend to get more benefits related to access to facilities and resources than those living in rural areas[27]. Almost three out of four households (70.9%) had good sanitation scores; the mean sanitation score was 82.9% (SD ± 12.4). It showed that most of the households in the present study have a good score in some aspects related to sanitation, such as access to drinking water and water for other household chores, latrine facility, wastewater disposal, and household garbage disposal, especially those who live in an urban area who has better access to improved sanitation facilities. In contrast, 12.2% of subjects living in rural areas still practice open defecation.

Table 2. Average of some characteristics of subjects, parents, and household

Variables	**Mean**	**Standard Deviation (SD)**
Child characteristics		
Child age (years)	7.5	1.1
Child IDDS	5.7	1.4
Child HAZ	-1.3	1.1
Child Hb (g/dl)	12.0	1.2
Parents/Household characteristics		
Father's age (years)	39.6	6.7
Mother's age (years)	35.3	5.8
Father's BMI (kg/m^2)	23.1	3.9
Mother BMI (kg/m^2)	25.2	4.5
Father Hb (g/dl)	14.6	1.5
Mother Hb (g/dl)	12.6	1.3
Father's height (cm)	162.9	5.8
Mother height (cm)	151.6	5.3
Father's education (years)	9.5	3.9
Mother education (years)	9.5	3.7
Family size (people)	4.8	1.3
Sanitation score (%)	82.9	12.4

Values are presented as mean and standard deviation. The author computed these values from the Indonesian Family Life Survey wave 5 (2014 - 2015) data.
IDDS, individual dietary diversity score; HAZ, height-for-age z-score; BMI, body mass index.

Prevalence of Stunting, Anemia, and The Coexistence of Stunting And Anemia

The prevalence of stunting among children aged 6 to 9 years was 24.8% (95% CI: 22.9 – 26.8), of which 20.0% (95% CI: 18.3-21.8) had moderate stunting, and 4.8% (95% CI: 3.9-5.9) had severe stunting. The prevalence of anemia among children aged 6 to 9 years was 30.5% (95% CI: 28.4-32.5), of which 12.8% (95% CI: 11.4-14.3) had mild anemia, 17.5% (95% CI: 15.9-1.93) had moderate anemia, and 0.2% (95% CI: 0.0-0.4) had severe anemia. The prevalence of anemia among children aged 6 to 9 years was 8.8% (95% CI: 7.6-10.1), of which 1.4% (95% CI: 0.9-2.0) had severe stunting, and moderate anemia, 0.8% (95% CI: 0.4-1.2) had severe stunting and mild anemia, 3.4% (95% CI: 2.7-4.3) had both moderate stunting and anemia and 3.2% (95% CI: 2.4-4.0) had moderate stunting and mild anemia. The means of children's HAZ and Hb were -1.3 ± 1.1 g/dl and 12.0 ± 1.2 g/dl, respectively (Table 2). Even though the means of children HAZ and Hb are considered normal, the prevalence of stunting and anemia remained above 20%.

Risk Factors of Child Stunting, Anemia, and Their Coexistence

The current study presents the prevalence of stunting, anemia, and their coexistence among children aged 6-9 years in Indonesia using IFLS wave five datasets obtained in 2014-2015. The prevalence of stunting, anemia and their coexistence in this study were 24.8%, 30.5%, and 8.8%, respectively. The prevalence of stunting in this study was lower than among children aged 5-12 years based on Basic Health Research (BHR) 2013 but higher than BHR 2018[4,5]. Meanwhile, anemia in this study was higher among children aged 5-14 based on BHR 2013 and 2018[4,5]. It indicated that the prevalence of stunting tended to decrease, and anemia fluctuated over time. However, both remain high and become Indonesian public health problems with a prevalence of ≥ 20%[5]. The high prevalence of anemia in the present study is in line with the previous study in Ethiopia that stated children aged 5-9 years were at higher risk for anemia (OR= 1.08, 95% CI: 1.04-1.12) compared to children aged 10-11 years in school-aged period[28]. The current study's findings revealed a double burden of under-nutrition (stunting and anemia) in Indonesian children aged 6-9 years. We also found that anemia was one of the risk factors for stunting and vice versa. No previous national representative study in Indonesia identified CSA among this age group (6-9 years). Multivariate analysis results of risk factors of stunting, anemia, and their coexistence were shown in Table 3, Table 4, and Table 5, respectively.

Table 3. Factor associated with stunting in multivariate logistic regression

Variables	β	OR (95% CI)	P-value
Child nutritional status (Hb)			
Anemia	0.304	1.355 (1.073-1.710)	0.011*
Father's nutritional status (BMI)			
Underweight	0.462	1.587 (1.104-2.282)	0.013*
Overweight/obese	-0.297	0.743 (0.584-0.944)	0.015*
Mother's nutritional status (BMI)			
Overweight/obese	-0.301	0.740 (0.585-0.937)	0.012*
Father's education (years)			
<12	-0.595	0.551 (0.354-0.858)	0.008*
12	-0.628	0.534 (0.352-0.809)	0.003*
Mother education (years)			
<12	0.518	1.679 (1.052-2.681)	0.030*
Father's height (cm)			
Short stature	0.690	1.995 (1.586-2.509)	0.000*
Mother height			
Short stature	0.918	2.504 (2.008-3.121)	0.000*
Sanitation score (%)			
Low	0.857	2.356 (1.620-3.428)	0.000*
Middle	0.312	1.366 (1.044-1.787)	0.023*
Housing area			
Rural	0.312	1.367 (1.083-1.725)	0.009*

The author computed these values from the Indonesian Family Life Survey wave 5 (2014 - 2015) data. This table only shows the significant risk factors of stunting among children.
Multivariate analysis obtained by logistic regression. *statistically significant at P-value < 0.05.
BMI, body mass index; CI, confidence interval; Hb, hemoglobin; OR, odds ratio.

Parents' education was a factor associated with stunting. Mother education of fewer than 12 years increased 1.7 times the risk of stunting. However, a father's education of fewer than or equal to 12 years decreased by 45% and 47% risk of stunting. This result is similar to what was observed previously in Indonesia: mothers' education levels fewer than senior high school (<12 years) increased 1.5 times risk of stunting[19]. However, the shorter years of father education become a protective factor against stunting. It could be because mothers are more responsible for preparing family food than fathers. In Indonesia, a mother is a key person or decision-maker about food and nutrition in the family. Maternal education has a much stronger association than paternal education with children's growth outcomes[29]. Achieving universal primary and middle schooling, now widely adopted in Africa and Asia, would only decrease stunting by 2.5% and 6%, respectively[29].

In comparison, upper secondary completion would reduce stunting by 10.3%[29]. Upper secondary completion means having more than 12 years of education. Expanding education among women instead of men was a strategy that had more impact in reducing stunting[29].

Table 4 Factor associated with anemia in multivariate logistic regression

Variables	β	OR (95% CI)	P-value
Child age			
6-7 years	0.659	1.933 (1.582-2.361)	0.000*
Child nutritional status (HAZ)			
Stunting	0.268	1.307 (1.043-1.639)	0.020*
Father's nutritional status (Hb)			
Anemia	0.526	1.692 (1.274-2.247)	0.000*
Mother's nutritional status (Hb)			
Anemia	0.679	1.973 (1.596-2.438)	0.000*

The author computed these values from the Indonesian Family Life Survey wave 5 (2014 - 2015) data. This table only shows the significant risk factors of anemia among children.
Multivariate analysis obtained by logistic regression. *Statistically significant at P-value < 0.05.
CI, confidence interval; HAZ, height-for-age z-score; Hb, Hemoglobin; OR, odds ratio.

This study found a similar association between parent nutritional status (BMI) and height with stunting and between parent nutritional status (Hb) and child anemia. Our study found that underweight fathers could increase 1.6 times higher risk of stunting than fathers with normal BMI. However, having only one overweight/obese parent decreased the risk of stunting by 26%, and having an overweight/obese mother reduced the risk of CSA by 31%. These findings align with a previous study among younger children in India, which found a similar association between paternal/maternal BMI and child undernutrition, including stunting[30]. It also found a similar effect of having a father but not a mother with a low BMI[30]. The highest risk of stunted children is paternal underweight among all BMI-risk of parents[30]. Both overweight/obese parents reduced the risk of child stunting[30]. Having a mother who has a normal height and is overweight or obese could reduce the risk of stunting among children compared with having a mother with a normal BMI. However, this protective effect disappears if the mothers are short-stature and overweight or obese[31]. Father-child correlations related to BMI and height were still limited, but genetic factors from fathers could affect offspring development[31].

Parental BMI affects children's body size through genetic, epigenetic and/or shared environment pathways, and parental obesity is a complex interplay surrogate marker among them. Parental obesity creates a more obesogenic environment/lifestyle[32]. Parental dietary patterns influence children's dietary patterns, including the dietary patterns of animal products[33]. Animal Source Foods (ASF) consumption reduced 31% risk of stunting among children under five[34]. Parents become gatekeepers of the family food environment, including home food availability, and as role models for children's eating behavior, should be understood regular foods to be consumed at home and which foods to avoid at home by themselves and children[33].

The current study also found that children with paternal and maternal anemia had an increased risk of 1.7 and 2 times higher anemia among children than those not have an anemic parent. These findings align with a previous study among younger children by Harding et al. that children in Nepal and Pakistan with anemic mothers increased 1.3 and 1.2 times higher risk of anemia, respectively[35]. The possible explanation is that anemic parents might be from low-income families with more difficulty purchasing and providing nutritious food for their children and themselves, resulting in inadequate intake of iron[36]. The other explanation might be caused by a disruption in red blood cell production, iron stores, or intestinal blood loss due to sharing exposure to infectious disease (i.e., helminthiasis caused by hookworm) within the same household[37].

Children with short-stature fathers and mothers increased 2 and 2.5 times higher risk factors of stunting, respectively. Similarly, in previous studies in Indonesia, Yasmin et al. showed that children with short-stature mothers (<145 cm) had an increased 1.6 times risk of stunting[19]. This phenomenon might be explained by intergenerational mechanisms linking undernutrition across subsequent generations influenced by factors such as potential genetics, shared environment, and continuity of adversity[30]. This is in line with a study in Egypt among children aged 6-11 years that the main etiologies of short-stature children were non-pathological factors like familial factors[6]. Stunted children caused by short familial statures were usually characterized by normal growth velocity from 5 years of age onwards, with the height below but parallel to the third percentile, and their bone size remains constant even with growth[38].

The risks of stunting are 2.4 times and 1.4 times higher among children from households with low and middle sanitation scores. Households with a much lower sanitation score contributed a much higher risk of stunting. This finding aligns with a previous study conducted in Indonesia, which found that a low sanitation score (<60%) could increase the risk of stunting among SAC[19]. The stunting risk could be decreased by 65% and 59% by improving household drinking water sources (i.e., water piped into the house) and improved sanitation facilities (i.e., flush toilet) as well[39].

Children living in rural areas increase a 1.4 times higher risk of stunting than those in urban areas. This result is consistent with two previous national representative studies conducted in Indonesia. The national representative study used Indonesian BHR in the 2013 datasets among children aged 6-12 years and found that children living in rural areas have a higher risk of stunting[19].

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Table 5. Factor associated with the coexistence of stunting and anemia in multivariate logistic regression

Variables	β	OR (95% CI)	P-value
Child age (years)			
6-7	0.690	1.993 (1.436-2.765)	0.000*
Mother's nutritional status (BMI)			
Overweight/obese	-0.368	0.692 (0.494-0.970)	0.033*
Father's height			
Short stature	0.482	1.620 (1.164-2.254)	0.004*
Mother's height			
Short stature	0.642	1.901 (1.377-2.624)	0.000*

The author computed these values from the Indonesian Family Life Survey wave 5 (2014 - 2015) data. This table only shows the significant risk factors of the double burden of under-nutrition (stunting and anemia) among children.
Multivariate analysis obtained by logistic regression. Values in bold indicate statistically significant at P-value < 0.05.
BMI, body mass index; CI, confidence interval; OR, odds ratio.
*statistically significant at P-value < 0.05.

Child age was associated with anemia and CSA among children at the child level. This study reveals that children in the younger age group (6-7 y) increase a 1.9 times higher risk of anemia and 2.0 times higher risk of CSA than the older age group (8-9 y). These align with a previous study conducted in Turkey, that anemia among children aged six and seven was significantly higher than in children aged eight and nine years[40]. The requirement for absorbed iron and RDA among children aged 5.5-8.5 years increase along with age but then decreases from age 9 through 13 years due to increasing basal iron losses, hemoglobin mass, and increase in tissue (non-storage iron), and it is assumed that no girls reach menarche before age 14[41]. This different RDA, along with inadequate iron intake, could explain the higher anemia found among younger children in the present study.

Child anemia increases the risk of stunting 1.4 times higher than non-anemic children. This finding is similar to a study by Getaneh et al. that anemic children could increase a 1.4 times higher risk of stunting[42]. It could be explained by the mechanism of Insulin-like Growth Factor 1 (IGF1), Transferrin (Tf), and changes in ghrelin and insulin hormone response that could be contributed to decreasing the the secretion of both Growth Hormone (GH) and IGF-1[12,43]. Our findings also showed that stunted children increase a 1.3 times higher risk of anemia than non-stunted children. This result aligns with the previous study in Nepal and Pakistan, which found that stunted children increase a 1.2 and 1.1 times higher risk of anemia, respectively[35]. This condition also increases the risk of anemia through impaired erythropoiesis and oxidative stress pathways[8,13,14].

This study used the national data set with a large sample size that covers 13 out of 34 provinces in Indonesia and measurements performed by trained professionals. To our knowledge, this is the first study that analyses the coexistence of stunting and anemia among Indonesian SAC at the individual level at a specific age period (6-9 years), which was more led to under-nutrition identification just before the second window opportunity or adolescence period begin (growth spurt among both sexes of child and menarche among females). This study also used the composite index to measure sanitation according to several sanitation aspects, which is a more comprehensive way to assess the sanitation condition of households. However, this study's limitation was that the dataset only provides 8 out of 9 food groups needed in IDDS calculation. Child IDDS calculation in this study used a proxy from food frequency consumption during the latest week instead of 24 h recall. Due to insufficient data, we could not investigate other potential risk factors related to stunting and anemia (e.g., child infection disease and nutrient intake).

CONCLUSIONS

This national study reported a very high prevalence of stunting and moderate prevalence of anemia among children aged 6-9 years, and Indonesia suffers a double burden of undernutrition (stunting and anemia). Even though some shared factors exist for both types of undernutrition, stunting and anemia are more independent than assumed. An anemic child, an underweight father, low maternal education, low and middle sanitation score, and living in a rural area increase the risk of stunting. Stunted child and parental anemia increase the risk of anemia, short parental stature increases the risk of stunting and CSA, while younger children increase the risk of anemia and CSA. Targeting stunted SAC for nutritional intervention could leave a proportion of the anemic SAC population. The Indonesian government should continue the 12 years of compulsory education program in Indonesia to address good education among females as future mother who is the key person responsible for food and nutrition in the family. Nutrition and health education programs should also include hygiene and sanitation. Improving water and sanitation facilities, particularly in rural areas, could decrease undernutrition, especially stunting. Improving the shared environment related to child food and nutrition within households is another crucial issue for improving a child's nutritional status.

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