

## Risk factors of stunting in Indonesian children aged 1 to 60 months

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### Abstract

**Background** The Indonesian province of Aceh has a high prevalence of stunting. Identifying risk factors for stunting may help prevention efforts. *The Growth Diagrams of Indonesian Children* are a specific tool to diagnose stunting in Indonesian pediatric populations.

**Objective** To determine the risk factors of stunting in children aged 1-60 months using the *Growth Diagrams of Indonesian Children*.

**Methods** This observational, analytic study with case-control design was conducted in the Lawe Alas District, Southeast Aceh, Indonesia to compare prior risk factors exposure between stunted children (cases) and non-stunted children (controls) from January-April 2018. Subjects were children aged 1-60 months and recruited by consecutive sampling.

**Results** The subjects comprised 97 cases and 97 controls, totaling 194 subjects, internal risk factors of stunting were short birth length (OR 2.87; 95%CI 1.24 to 6.61; P=0.011), inadequate calorie intake (OR 2.37; 95%CI 1.32 to 4.27; P=0.004), non-exclusive breastfeeding (OR 3.64; 95%CI 2.01 to 6.61; P<0.001), chronic diarrhea (OR 6.56; 95%CI 3.33 to 13.01; P<0.001) and upper respiratory tract infections (OR 3.47; 95%CI 1.89 to 6.35; P<0.001). External risk factors of stunting were unimproved sanitation (OR 2.98; 95%CI 1.62 to 5.48; P<0.001), unimproved water sources (OR 2.71; 95%CI 1.50 to 4.88; P=0.001), low family income (OR 2.49; 95%CI 1.38 to 4.49; P=0.002), low paternal educational level (OR 2.98; 95%CI 1.62 to 5.48; P<0.001), low maternal educational level (OR 2.64; 95%CI 1.38 to 5.04; P=0.003), and living in households with >4 family members (OR 1.23; 95%CI 0.69 to 2.17; P=0.469). Regression analysis showed that the dominant risk factor of stunting was chronic diarrhea (OR 5.41; 95%CI 2.20 to 13.29; P<0.001).

**Conclusion** The history of chronic diarrhea and non-exclusive breastfeeding are the main risk factors of childhood stunting. [Paediatr Indones. 2021;61:12-9 ;

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**Keywords:** stunting; growth diagrams of Indonesian children; risk factors

Stunting reflects a disruption of linear growth due to poor physical condition or chronic malnutrition from pre-natal to post-natal periods.<sup>1,2</sup> Stunting may contribute to slowed mental growth, decline of cognitive function, and poor study capacity in school.<sup>2</sup> Stunting is determined by the body length-for-age (LAZ) or height-for-age (HAZ) index, with Z-score less than -2 standard deviations (SD), in the 2006 WHO Growth Standards.<sup>3</sup>

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However, the 2006 WHO Growth Standards are not always applicable to all populations for assessing child growth due to differing racial, demographic, and growth patterns among the world's nations.<sup>4,5</sup> The *Growth Diagrams of Indonesian Children* was designed with the reference of children's growth specifically in Indonesia.<sup>6</sup>

According to the World Health Organization (WHO), approximately 151 million (22%) children under five-years-old in 2017 were affected by stunting. More than half of children with stunting are from Asia.<sup>7</sup> In Indonesia, the prevalence of stunting was 30.8% in 2018, according to the *National Basic Health Research Report (Riset Kesehatan Dasar; Riskesdas)*,<sup>8</sup> which was classified as high by the WHO.<sup>7</sup> The prevalences of stunting in Southeast Aceh District from our previous study were 36.2% by the *Growth Diagrams of Indonesian Children* and 46.8% by the 2006 WHO Growth Standards.<sup>9</sup>

Stunting in Indonesian children requires preventive strategies, such as early intervention on risk factors. Thus, identification of risk factors is needed for better interventional strategies. Risk factors for stunting can be classified as internal or external.<sup>2</sup> Internal risk factors include chronic malnutrition, intrauterine growth retardation (IUGR), non-exclusive breastfeeding, and chronic infection.<sup>2,10-12</sup> External factors include unimproved sanitation, unimproved water sources, low parental socioeconomic level, and large numbers of family members living in one household.<sup>12-15</sup> Little is known about the risk factors of stunting in the Southeast Aceh District, therefore, we aimed to assess the dominant risk factors affecting stunting prevalence using the *Growth Diagrams of Indonesian Children*.

## Methods

We conducted this observational analytic study with case-control design in Lawe Alas, Southeast Aceh District between January and April 2018 to compare prior risk factors exposure between stunted children (cases) and non-stunted children (controls). The subjects comprised 97 cases and 97 controls, totaling 194 subjects were children aged 1 to 60 months selected by consecutive sampling. Children with malignancy, autoimmune diseases, bone or

chromosomal abnormalities, conditions that can affect linear growth, or those who received long-term steroid therapy were excluded. Subjects' data were collected from anthropometric measurements and interviews using a questionnaire. The study were approved by the Health Research Ethical Committee Medical Faculty of Universitas Sumatera Utara and H. Adam Malik General Hospital.

Socio-demographic data collected were gender, age, gestational age, and birth weight. The independent variables of this study included birth length, daily calorie intake, history of breastfeeding, history of chronic diarrhea, history of acute respiratory infection (ARI), sanitation condition, water source condition, parental income, paternal and maternal education level, and number of family members living in the household. Daily calorie intake was considered to be inadequate if total calories recalled in previous 24 hours did not achieve the recommended dietary allowance (RDA) for the subjects' age.<sup>16</sup> Breastfeeding was considered to be exclusive if subjects were given only breast milk in the first 6th months of life (except for medicine, vitamins, or mineral supplements).<sup>17</sup> Sanitation was considered to be improved for households with private toilets and their own septic tank. Water sources were considered to be improved if the water source was clean, within a closed container, and a minimum of 10 meters away from the trash receptacle.<sup>18</sup> Parental income was classified based on the monthly minimum wage in Aceh District, which was Indonesian Rupiah (IDR) 2,700,000 in 2018.<sup>19</sup> Parental educational level was classified as low if below high school (high school, vocational secondary school, Islamic senior high school, Islamic vocational senior high school in Indonesia).<sup>20</sup> Chronic diarrhea was defined as three or more defecations within 24 hours and changes in consistency occurring in 7 days or more.<sup>21</sup> Acute respiratory infection (ARI) was defined as infection affecting one part of the respiratory tract occurred within 14 days.<sup>22</sup>

Weights of young children not yet able to stand were measured using a *Seca 725* infant scale, while weights of children able to stand were measured with a *Seca 803* footprint scale. The infants wore only underwear during the weight measurement. Subjects' body lengths/heights were measured by a *Seca 334* infant scale for those under 2 years, or a *Seca 206* microtoise for children above 2 years. Subjects were

barefooted while body length/height was measured. Anthropometric data were plotted in *Growth Diagrams of Indonesian Children* to determine subjects' stunting status.<sup>6,9</sup>

To identify risk factors of stunting, we first conducted a bivariate analysis between potential risk factors and proportion of stunting. Chi-square test was used to analyze for a possible correlation between risk factors and proportion of stunting in each group. Variables with P value <0.25 were included in multivariate analysis with double logistic regression model. Variables were considered significant for P values <0.05 (95% confidence interval).

## Results

A total of 194 subjects were included. Characteristics of subjects are shown in **Table 1**. Bivariate analysis revealed the following significant internal risk factors: short birth length (OR 2.87; 95%CI 1.24 to 6.61), inadequate daily calorie intake (OR 2.37, 95%CI 1.32 to 4.27), chronic diarrhea (OR 6.56; 95%CI 3.33 to 13.01), history of acute respiratory infection (OR 3.47; 95%CI 1.89 to 6.35), and non-exclusive breastfeeding (OR 2.37; 95%CI 1.32 to 4.20). The significant external risk factors, were as follows: unimproved sanitation (OR 2.98; 95%CI 1.62 to 5.48), unimproved water source (OR 2.71; 95%CI 1.50 to 4.88), low total parental income (OR 2.49; 95%CI 1.38 to 4.49), low paternal education level (OR 2.98; 95%CI 1.62 to 5.48), and low maternal education level (OR 2.64; 95%CI 1.38 to 5.04). The results of the bivariate analysis of possible risk factors and proportion of stunting are shown in **Table 2**.

**Table 1.** Characteristics of study subjects

Characteristics	(N=194)
Sex, n (%)	
Male	101 (52.1)
Female	93 (47.9)
Median age (range), months	18 (1.0-60.0)
Median weight (range), kg	9.2 (2.6-21.0)
Mean height/length (SD), cm	78.16 (12.6)
Median birth weight (range), grams	2,700 (2100.0-3900.0)
Median birth length (range), cm	48 (45.0-51.0)

The significant risk factors in the bivariate analysis were analyzed further with double logistic regression model analysis, as shown in **Table 3**. History of chronic diarrhea (OR 5.41; 95%CI 2.20 to 13.29) and history of non-exclusive breastfeeding (OR 4.54; 95% CI 1.84 to 11.16) were the main risk factors for stunting.

## Discussion

A previous study found that the proportion of stunting was significantly lower using the *Growth Diagrams of Indonesian Children* compared to the 2006 WHO *Growth Standards* (36.2% to 46.8%, respectively; P<0.001).<sup>9</sup> Furthermore, a study reported that Indonesian boys (SD 1.47) and girls (SD 1.43) were lower in height compared to American children.<sup>6</sup> *The Growth Diagrams of Indonesian Children* had good specificity (98.66%) for diagnosing stunting in the Indonesian pediatric population.<sup>9</sup>

Nutritional status in the first 1,000 days of life affects future quality of life. Intrauterine growth retardation (IUGR) is a reflection of maternal malnutrition.<sup>1,2</sup> The IUGR may result in decreased birth length, and put the child at risk of further stunting. A study in Bogor, West Java, reported that birth length of < 48 cm was a risk factor for stunting.<sup>23</sup> In agreement with their findings, we noted that 22.7% (OR 2.87, 95%CI 1.24 to 6.61) of stunted subjects had a history of short birth length.

An Iranian study reported that low consumption of cow's milk products and nuts was associated with stunting in children below 5 years.<sup>24</sup> A previous study also reported associations between nutritional status of children and daily calorie intake of protein, fat, zinc and carbohydrates.<sup>25</sup> In our study, 69.1% of stunted subjects had inadequate daily calorie intake. Since 24-hour food recall was done to collect daily calorie intake data, parents' educational level, memory, and the survey itself may have led to biases. As such, we did not attempt to elucidate details on the macro or micronutrients present.

Breastfeeding has many benefits for infants in the first six months of life, such as less frequent diarrhea or other gastrointestinal symptoms and increased immunity. Such benefits have been associated with breastmilk composition including lactoferrin,

**Table 2.** Analysis of possible risk factors and proportion of stunting based on *Growth Diagrams of Indonesian Children* (N=194)

Possible risk factors	<i>Growth Diagrams of Indonesian Children</i>		Total N	OR (95%CI)	P value
	Stunted, n(%)	Non-stunted, n(%)			
Short birth length					
Yes	22 (22.7)	9 (9.3)	31	2.87	0.011
No	75 (77.3)	88 (90.7)	163	(1.24 to 6.61)	
Total daily calorie intake					
Inadequate	67 (69.1)	47 (48.5)	114	2.37	0.004
Adequate	30 (30.9)	50 (51.5)	80	(1.32 to 4.27)	
Exclusive breastfeeding					
No	68 (70.1)	38 (39.2)	106	3.64	<0.001
Yes	29 (29.9)	59 (60.8)	88	(2.01 to 6.61)	
Chronic diarrhea					
Yes	53 (54.6)	15 (15.5)	68	6.56	<0.001
No	44 (45.4)	82 (84.5)	126	(3.33 to 13.01)	
History of ARI					
Yes	53 (54.6)	25 (25.8)	78	3.47	<0.001
No	44 (45.4)	72 (74.2)	116	(1.89 to 6.35)	
Sanitation					
Unimproved	73 (75.3)	49 (50.5)	122	2.98	<0.001
Improved	24 (24.7)	48 (49.5)	72	(1.62 to 5.48)	
Water source					
Unimproved	68 (70.1)	45 (46.4)	113	2.71	0.001
Improved	29 (29.9)	52 (53.6)	81	(1.50 to 4.88)	
Parental total income					
Low	68 (70.1)	47 (48.5)	115	2.49	0.002
High	29 (29.9)	50 (51.5)	79	(1.38 to 4.49)	
Paternal education					
Low	73(75.3)	49 (50.5)	122	2.98	<0.001
High	24 (24.7)	48 (49.5)	72	(1.62 to 5.48)	
Maternal education					
Low	78 (80.4)	59 (60.8)	137	2.64	0.003
High	19 (19.6)	38 (39.2)	57	(1.38 to 5.04)	
Household family members					
> 4 people	45 (46.4)	40 (41.2)	85	1.3	0.469
≤ 4 people	52 (53.6)	57 (58.8)	109	(0.69 to 2.17)	

**Table 3.** Double logistic regression analysis of risk factors for stunting

Risk factors	OR	95%CI	P value
Short birth length	2.35	0.88 to 6.26	0.087
Inadequate total daily calorie intake	1.75	0.73 to 4.17	0.205
History of non-exclusive breastfeeding	4.54	1.84 to 11.16	0.001
History of chronic diarrhea	5.41	2.20 to 13.29	<0.001
History of ARI	1.56	0.66 to 3.68	0.306
Unimproved sanitation	2.03	0.50 to 8.24	0.321
Unimproved water source	1.51	0.42 to 5.31	0.525
Low parental income	0.54	0.11 to 2.49	0.430
Low paternal education level	0.84	0.23 to 3.03	0.794
Low maternal education level	0.78	0.27 to 2.27	0.653

immunoglobulin, and other secretory products not found in cow's milk.<sup>26</sup> Non-exclusive breastfeeding was correlated to the proportion of stunting in Sri Lanka and Central Java.<sup>27,28</sup> This finding was in agreement with ours: 70.1% (OR 3.64; 95%CI 2.01 to 6.61) of stunted subjects were not exclusively breastfed.

Children in developing countries frequently suffer from infections, which are a leading cause of mortality. Environmental conditions are worsened by poor sanitation and densely populated.<sup>29</sup> Moreover, infection and malnutrition have a two-way relationship. Children with frequent infections are more prone to malnourishment and children with malnutrition are more prone to infectious disease.<sup>30,31</sup> Chronic diarrhea and ARI are the most common types of infection found in Indonesian children below five years. *The 2013 National Basic Health Research (Riskesdas)* reported that Aceh had the third highest prevalence of ARI in children.<sup>32</sup> In our study, history of diarrhea was the most dominant risk factor of stunting in children below five (OR 6.56; 95%CI 3.33 to 13.01). Studies in the USA, Brazil, and Somalia also found that chronic diarrhea was a significant risk factor of stunting.<sup>29,33,34</sup> In addition to diarrhea and ARI, tuberculosis and worm infections are common in developing countries.<sup>32</sup> However, we did not include these infections in our survey because of difficulties in diagnosis.

External risk factors such as sanitation and clean water sources were also keys in preventing stunting. As mentioned, poor sanitation was associated with infections in children.<sup>35</sup> According to the Cumming theory, poor water, sanitation, and hygiene (WASH) conditions affect child growth.<sup>36</sup> Clean water was defined as a water source that fulfilled the physical, microbiological, chemical, and radioactive criteria. Nevertheless, a simple indicator of clean water source is not having color and taste. Improved sanitation consists of having access to facilities for the safe disposal of human waste (feces and urine) and having the ability to maintain hygienic conditions.<sup>18,36</sup> Hand hygiene also has a role in preventing pathogen transmission.<sup>37,38</sup> A study found that unimproved sanitation and unimproved water sources had significant relationships with stunting.<sup>39</sup> Similarly, 75.3% of stunted subjects had unimproved sanitation dan 70.1% of stunted subjects had unimproved water

sources.

Total family income can affect fulfilment of family nutritional needs. Low income families tend to have reduced quality, quantity, and variety of food, as reported in Ethiopia and Madagascar studies that showed a relationship between stunting and poverty.<sup>40,41</sup> An Indonesian study conducted in North Maluku Province study reported that children in low income families had 43.1 times higher risk of stunting than children in middle income families.<sup>42</sup> We also noted that subjects whose parents' total income was below the minimum monthly wage set by the Aceh District had a 2.49 (95%CI 1.38 to 4.49) times higher risk of stunting than a children whose parents' total income was above minimum wage.

Parents with low educational level tend to have inadequate information about nuturing children's growth and development, including nutritional needs. We found that low paternal and maternal education level increased the risk of stunting, as found in a study.<sup>43</sup> Furthermore, a previous study noted that efforts to improve maternal knowledge reduced the proportion of stunting.<sup>14</sup> In addition to low parental education and income, large numbers of household members living together may exacerbate the problem of inadequate child nutrition. In Ethiopia, children who lived with 8-10 household members had a 4.44 times higher risk and children who lived with 5-7 household members had 2.97 times higher risk than children who lived with 2-4 household members.<sup>15</sup> In contrast, we found that the risk of stunting was not different between children living with >4 household members vs. living with ≤4 household members. This result may have been affected by the family planning (*Keluarga Berencana*) program, which had been well-implemented in Lawe Alas village. As such, the majority of families in Lawe Alas had ≤4 household family members.

Limitations of our study were the lack of data on family nutritional status and parasite infection in children, so we did not include those risk factors in the study. We recommend multicenter study with a larger sample size be conducted in the future. In conclusion, the dominant main risk factors of stunting in Lawe Alas, Southeast Aceh is are chronic diarrhea and non-exclusive breastfeeding. Multivariate analysis revealed that children with history of chronic diarrhea and history of non-exclusive breastfeeding had 5.41

times and 4.54 times higher risk of stunting.

## Conflict of Interest

None declared.

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