

## ORIGINAL RESEARCH

## Risk Factors for Stunting among Children Aged 24-59 Months: A Case-Control Study in Rural Stunting Hotspots, Yogyakarta, Indonesia

## Factores de riesgo en el retraso al crecimiento entre niños de 24 a 59 meses: un estudio de casos y controles en áreas rurales de Yogyakarta, Indonesia

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## Abstract

**Background.** Stunting remains a major public health nutrition challenge in developing countries, including Indonesia, and is influenced by multiple factors at different levels. **Aims.** This study aimed to identify risk factors for stunting among children aged two to five years in Pleret and Pajangan Subdistricts, Bantul District, Yogyakarta, Indonesia. **Methods.** We conducted a case-control study between January and March 2019 with 98 children (49 cases and 49 controls) selected using multistage random sampling. Cases were defined as children with a height-for-age z-score (HAZ) < -2 SD, and controls as children with HAZ > +2 SD. Multiple logistic regression analysis was used to examine risk factors for stunting, adjusting for child, parental, and household characteristics. **Results.** Children who were breastfed for 12–23 months (AOR = 0.14; 95% CI: 0.02–0.82) or for more than 24 months (AOR = 0.21; 95% CI: 0.05–0.87) were less likely to be stunted. Short birth length increased the risk of stunting (AOR = 3.94; 95% CI: 1.40–11.1), while higher household economic status was protective (AOR = 0.17; 95% CI: 0.04–0.66). **Conclusions.** Breastfeeding duration, birth length, and household economic status are significantly associated with stunting. Strengthening breastfeeding promotion and implementing both specific and sensitive interventions may accelerate progress toward reducing stunting and improving child growth outcomes.

**Keywords:** risk factors, stunting, breastfeeding, birth length, socioeconomic

## Resumen

**Antecedentes.** La atrofia en el crecimiento sigue siendo un importante problema de salud pública en materia de nutrición para los países en desarrollo, incluida Indonesia, y está influida por múltiples factores a diferentes niveles. **Objetivos.** El objetivo de este estudio es identificar los factores de riesgo para retraso en el crecimiento entre los niños de dos a cinco años de los subdistritos de Pleret y Pajangan, distrito de Bantul, Yogyakarta, Indonesia. **Métodos.** Realizamos un estudio de casos y controles entre enero y marzo de 2019 con 98 niños (49 casos y 49 controles) seleccionados mediante muestreo aleatorio de etapas múltiples. Los casos se definieron como niños con una puntuación z de altura para la edad (HAZ) < -2 SD, y los controles como niños con HAZ > +2 SD. Se utilizó un análisis de regresión logística múltiple para examinar los factores de riesgo del retraso del crecimiento, ajustando por características del niño, los padres y el hogar. **Resultados.** Los niños que fueron amamantados durante 12-23 meses (AOR = 0,14; IC 95%: 0,02-0,82) o durante más de 24 meses (AOR = 0,21; IC 95%: 0,05-0,87) tenían menos probabilidades de sufrir retraso del crecimiento. La corta duración del parto aumentaba el riesgo de retraso en el crecimiento (AOR = 3,94; IC 95%: 1,40-11,1), mientras que un mayor nivel económico del hogar resultaba protector (AOR = 0,17; IC 95%: 0,04-0,66). **Conclusiones.** La duración de la lactancia materna, la duración del parto y la situación económica del hogar se asocian significativamente con el retraso del crecimiento. Reforzar la promoción de la lactancia materna y aplicar intervenciones específicas y sensibles puede acelerar el progreso hacia la reducción del retraso del crecimiento y la mejora de los resultados del crecimiento infantil.

**Palabras clave:** factores de riesgo, retraso del crecimiento, lactancia materna, duración del parto, situación socioeconómica.



## Introduction

Stunting is a major public health nutrition challenge in developing countries, including Indonesia.<sup>1,2</sup> It is defined as impaired linear growth, measured as a height- or length-for-age z-score less than  $-2$  standard deviations according to the World Health Organization (WHO) Child Growth Standards.<sup>3</sup> Stunting is a serious concern because it is linked to increased risks of morbidity and mortality, delayed motor and cognitive development, reduced learning capacity, greater susceptibility to central fat accumulation, and a higher likelihood of non-communicable diseases such as type 2 diabetes, cardiovascular disease, and cancer.<sup>4</sup>

More than half (53%) of stunted children under five in 2020 lived in Asia.<sup>5</sup> In Indonesia, nationally representative surveys reported that the prevalence of stunting among children under five years decreased from 37.2% in 2013 to 30.8% in 2018.<sup>2,6</sup> However, the prevalence remained considered very high<sup>7</sup> and higher than neighboring countries with comparable economic levels, such as the Philippines and Vietnam, and a country with less than half of Indonesia's per capita income, such as Cambodia.<sup>8</sup> Across 34 provinces and 514 districts, one-third of Indonesian-born children experienced stunting in 2018, ranging from 17.7% in the Jakarta Capital Region to 42.6% in East Nusa Tenggara Province. Bantul was a district in the Yogyakarta Special Region with a relatively high rate of stunting (22.9%),<sup>2,7</sup> and is currently one of the prioritized areas for the stunting reduction program in Indonesia.<sup>9</sup> Thus, examining the risk factors for stunting in children aged two to five in Bantul District, Yogyakarta Special Region, Indonesia, is necessary.

Stunting is determined by a complex set of factors operating at multiple levels.<sup>10,11</sup> According to the WHO framework, child growth outcomes are influenced by breastfeeding practices, complementary feeding, exposure to infection, and household conditions, all of which are shaped by broader community and societal factors.<sup>10</sup> While most Indonesian studies mainly used a cross-sectional design to examine the determinants of stunting at national,<sup>12-15</sup> and subnational levels,<sup>16-19</sup> we used a case-control approach to better

understand the association between stunting and its predictors. The first 1000 days of a child's life are critical for achieving optimum growth. Although there may be periods of catch-up growth in adolescence, stunting is considered to be irreversible after the child reaches two years of age.<sup>20</sup> Nonetheless, most studies in Indonesia focused on children under two years,<sup>12</sup> hence, evidence on stunting determinants among children beyond two years of age is limited. Therefore, using a case-control design, this study aimed to examine risk factors for stunting among children aged 24-59 months in Bantul District, Yogyakarta Province, Indonesia.

## Methods

### Design

This study used a case-control design between December 2018 and March 2019 in Pleret and Pajangan Subdistricts, Bantul District, Yogyakarta Special Region, Indonesia. Pleret and Pajangan were two out of 17 subdistricts in Bantul. Pleret consisted of five villages with a population of 47,626, spreading across a total area of 22.97 km<sup>2</sup>. Pajangan consisted of three villages with a population of 36,297, spreading across a total area of 33.25 km<sup>2</sup>.<sup>21</sup> The two subdistricts were included as national stunting reduction priority areas. The agriculture sector was the primary source of income for the population in these two subdistricts.<sup>22</sup>

### Samples and sampling technique

Our samples included children aged 24-59 months registered in *posyandu* in Pleret and Pajangan Subdistricts. *Posyandu* is a village-level integrated health post that provides maternal and child healthcare services, including child growth monitoring.<sup>23</sup> Cases were those with height-for-age Z-score  $<-2$  SD, whereas controls were those with height-for-age Z score  $>-2$  SD and lived within the same village as cases.

OpenEpi version 3 (https://www.openepi.com/SampleSize/SSCC.htm) was used to calculate the study sample for an unmatched case-control study. We set a 39.1% of controls exposed and an odds ratio of 6.16 based

on the previous study conducted in the same district.<sup>16</sup> We set the level of significance at 95%, power at 80%, and the case-control ratio at 1:1. Using the Kelsey formula, we obtained a minimum sample of 23 for each case and control. However, we included all eligible cases and controls in the study sites, resulting in 49 cases and 49 controls.

Samples were selected using multistage cluster sampling from two primary health centers in eight villages. Firstly, we chose one village randomly using a lottery from each primary health centre working area. Secondly, we determined *posyandu* as a unit cluster in each village using probability proportional to size. We grouped all children registered in the selected *posyandu* into stunting or non-stunting groups. All eligible cases were included in our study. When there was more than one control per case, we would select the case randomly using a lottery.

### Variables

The primary outcome of this study was stunting, which was defined as a height-for-age Z-score below minus two standard deviations (<-2 SD) from the median of the reference population based on the 2006 WHO growth standard.<sup>3</sup> Based on this score, the children were then grouped into not stunting or stunting.

Independent variables included factors at the child, parental, and household levels. Child factors were child's age (24-35 months, 36-47 months, 48-59 months), child's sex (male, female), birth rank (first, second, third or above), birth interval (<24 months, ≥24 months), gestational age at birth (≥37 weeks, <37 weeks), birth weight (≥2500 g, <2500 g), exclusive breastfeeding history (no, yes), and breastfeeding duration (<12 months, 12-23 months, ≥24 months).

Parental factors included the mother's and father's age (<30 years, ≥30 years), the mother's and father's education (<senior high school, ≥senior high school), the mother's occupation (not working, informal, formal), and the father's occupation (informal, formal). Informal jobs included those without subject to national labour legislation, income taxation, social protection or entitlement to certain employment benefits, such as

paid sick or annual leave.<sup>24</sup> Thus, we categorized civil servants and private company employees as formal occupations, whereas farmers, fishermen, labourers, and entrepreneurs or own account/family workers as informal occupations. Household-level factors included the number of children under five (≤2, >2). Household economic status was estimated based on the monthly income, which later was grouped into three quintiles (poor, middle, rich).

### Statistical analysis

Descriptive statistics were used to describe the characteristics of the study participants. The chi-square test was applied to examine the relationship between each risk factor and stunting. Variables with a p-value <0.25 were then entered into multiple logistic regression. A level of significance of 0.05 was used to determine risk factors for stunting. However, we kept the child's age, history of exclusive breastfeeding, and maternal education as fixed variables in the final model regardless of their significance. All of the analyses were done using Stata version 17.0.

### Ethical Approval

This study was ethically approved by the Research Ethics Committee at Universitas Alma Ata (reference number: KE/AA/II/779/EC/2019).

### Results

A total of 98 children participated in this study, consisting of 49 cases and 49 controls. Among the children, 51% of cases and 49% of controls were females. Children were mostly aged 24-47 months, first- and second-born, exclusively breastfed, and breastfed for two years or beyond. The majority of children had a birth interval of more than two years, birth weight equal to or more than 2500 g, and birth length equal to or more than 48 cm. The majority of maternal height was 150 cm or above. Both mothers and fathers were aged 30 years or above and completed at least senior high school. Around 57% of cases' fathers worked in informal sectors, while 51% of controls worked in formal sectors. Most cases came from poorer households, while controls were mostly from richer households (see Table 1).

**Table 1. Characteristics of stunted and non-stunted children aged 24-59 months**

Characteristics	Not stunting	Stunting	p
	n (%)	n (%)	
<i>Child factors</i>			
Child's age			0.986
24-35 months	17 (34.7)	16 (32.7)	
36-47 months	18 (36.7)	18 (36.7)	
48-59 months	14 (28.6)	15 (30.6)	
Sex			0.544
Male	25 (51.0)	24 (49.0)	
Female	24 (49.0)	25 (51.0)	
Birth rank			0.108
First	24 (49.0)	19 (38.8)	
Second	22 (44.9)	20 (40.8)	
Third or above	3 (6.1)	10 (20.4)	
Birth interval			0.685
<24 months	23 (46.9)	21 (42.9)	
>24 months	26 (53.1)	28 (57.1)	
Gestational age at birth			0.233
≥37 weeks	40 (81.6)	35 (71.4)	
<37 weeks	9 (18.4)	14 (28.6)	
Birth weight			
≥2500 g	43 (87.8)	45 (91.8)	0.505
<2500 g	6 (12.2)	4 (8.16)	
Birth length			0.061
≥48 cm	35 (71.4)	26 (53.1)	
<48 cm	14 (28.6)	23 (46.9)	
History of exclusive breastfeeding			0.269
No	12 (25.5)	17 (34.7)	
Yes	37 (75.5)	32 (65.3)	
Breastfeeding duration			0.091
<12 months	4 (8.2)	12 (24.5)	
12-23 months	9 (18.4)	7 (14.3)	
≥24 months	36 (73.4)	30 (61.2)	
<i>Parental factors</i>			
Mother's age			
<30 years	19 (38.8)	16 (32.7)	0.527
≥30 years	30 (61.2)	33 (67.4)	
Mother's height			0.037
≥155 cm	29 (59.2)	17 (34.7)	
150-154.9 cm	13 (26.5)	17 (34.7)	
<150 cm	7 (14.3)	15 (30.6)	
Mother's education			0.671
<senior high school	16 (32.7)	18 (36.7)	
≥senior high school	33 (67.3)	31 (63.3)	
Mother's occupation			0.849
Not working	27 (55.1)	25 (51.0)	
Informal	15 (30.6)	15 (30.6)	
Formal	7 (14.3)	9 (18.4)	
Father's age			0.218

Characteristics	Not stunting	Stunting	p
	n (%)	n (%)	
<30 years	13 (26.5)	8 (16.3)	
≥30 years	36 (73.5)	41 (83.7)	
Father's education			0.285
<senior high school	14 (28.6)	19 (38.8)	
>senior high school	35 (71.4)	30 (61.2)	
Father's occupation			0.418
Informal	24 (49.0)	28 (57.1)	
Formal	25 (51.0)	21 (42.9)	
<i>Household factors</i>			
Number of children under five			0.118
≤2	43 (87.8)	37 (75.5)	
>2	6 (12.2)	12 (24.5)	
Economic status			0.035
Poor	13 (26.5)	20 (40.8)	
Middle	18 (36.7)	22 (44.9)	
Rich	18 (36.7)	7 (14.3)	

As shown in Table 2, children whose birth length was less than 48 cm were 3.9 times more likely to be stunted than those whose birth length was equal to or greater than 48 cm. Compared to children who were breastfed for less than one year, those who were breastfed for one to two years (AOR: 0.16; 95% CI: 0.03-0.89) and more than two years

(AOR: 0.23; 95% CI: 0.05-0.98) had lower risks of being stunted. Children from rich families had a 5.9 times lower risk of being stunted than those from poor families. No significant relationship was found in the associations between stunting and the child's age, history of exclusive breastfeeding, and maternal education.

**Table 2. Unadjusted and adjusted odds ratios in the association between stunting and its risk factors among children aged 24-59 months**

Variables	Unadjusted			Adjusted		
	OR	95% CI	p	OR	95% CI	p
<i>Child factors</i>						
Child's age						
24-35 months	Ref			Ref		
36-47 months	1.06	0.41-2.73	0.900	1.08	0.37-3.13	0.884
48-59 months	1.14	0.42-3.09	0.799	1.37	0.45-4.20	0.580
Sex						
Male	Ref					
Female	1.09	0.49-2.39	0.840			
Birth rank						
First	Ref					
Second	1.15	0.49-2.70	0.751			
Third or above	4.21	1.01-17.5	0.048			
Birth interval						
≤24 months	Ref					
>24 months	1.18	0.53-2.62	0.685			
Gestational age at birth						

Variables	Unadjusted			Adjusted		
	OR	95% CI	p	OR	95% CI	p
≥37 weeks	Ref					
<37 weeks	1.78	0.69-4.61	0.236			
Birth weight						
≥2500 g	Ref					
<2500 g	0.64	0.17-2.41	0.507			
Birth length						
≥48 cm	Ref			Ref		
<48 cm	2.21	0.96-5.10	0.063	3.90	1.40-10.90	0.009
History of exclusive breastfeeding						
No	Ref			Ref		
Yes	0.61	0.25-1.47	0.270	0.82	0.30-2.24	0.691
Breastfeeding duration						
<12 months	Ref			Ref		
12-23 months	0.26	0.06-1.16	0.078	0.16	0.03-0.89	0.037
≥24 months	0.28	0.08-0.95	0.041	0.23	0.05-0.98	0.047
<i>Parental factors</i>						
Mother's age						
<30 years	Ref					
≥30 years	1.31	0.57-2.99	0.527			
Mother's height						
≥155 cm	Ref					
150-154.9 cm	2.23	0.87-5.70	0.094			
<150 cm	3.66	1.24-10.8	0.018			
Mother's education						
<Senior high school	Ref			Ref		
≥Senior high school	0.84	0.36-1.92	0.671	1.55	0.57-4.22	0.392
Mother's occupation						
Not working	Ref					
Informal	1.08	0.44-2.65	0.867			
Formal	1.39	0.45-4.23	0.568			
Father's age						
<30 years	Ref					
≥30 years	1.85	0.69-4.97	0.222			
Father's education						
<Senior high school	Ref					
≥Senior high school	0.63	0.27-1.47	0.287			
Father's occupation						
Informal	Ref					
Formal	0.72	0.33-1.60	0.419			
<i>Household factors</i>						
Number of children under five						
<2	Ref					
≥2	2.32	0.79-6.80	0.124			
Economic status						
Poor	Ref			Ref		
Middle	0.79	0.31-2.03	0.630	1.21	0.42-3.54	0.725
Rich	0.25	0.08-0.77	0.016	0.17	0.05-0.67	0.011

## Discussion

This study found that short birth length was associated with an increased risk of stunting. This finding supports several previous studies, including those conducted in Indonesia.<sup>14, 25, 26</sup> A longitudinal study in Bogor, Indonesia, highlighted that children with a birth length <48 cm had a shorter survival time to stunting than those with a birth length >48 cm (6 months vs. 17 months).<sup>25</sup> Longitudinal studies in low-resource countries, including the Democratic Republic of Congo, Guatemala, India, and Pakistan, also revealed that birth length was the strongest predictor of stunting, suggesting that early fetal growth may program long-term linear growth.<sup>27</sup> While our study did not find a significant association between maternal height and stunting, maternal nutrition during pregnancy might serve as a modifiable determinant of fetal birth length and, thus childhood stunting.<sup>27</sup> Therefore, enhancing maternal nutrition during conception and preconception periods will be beneficial for improving fetal and child growth. Such interventions may include providing adequate balanced energy-protein diets, antenatal iron-folic acid supplementation, multiple micronutrient supplementation, and the prevention of infections during pregnancy.

Our study suggested that longer breastfeeding duration was a protective factor against stunting. Following the WHO framework, early weaning practice is among breastfeeding factors negatively affecting stunting.<sup>10</sup> In line with our findings, a systematic review in 137 developing countries found that discontinued breastfeeding was one of the risk factors for stunting.<sup>28</sup> In Mexico, any breastfeeding that was provided under six months or continued after six months gave protective effects against stunting compared to those without breastfeeding.<sup>11</sup> The effect of breastfeeding continuation on stunting could be mediated through the prevention of diarrhea.<sup>28</sup> The mechanism is relevant to low- and middle-income country settings where children may be exposed to unsafe complementary food due to limited access to unimproved water, sanitation, and hygiene (WASH) systems.<sup>11</sup> However, we could not include childhood diarrhea because the data were not available. Therefore, enhancing breastfeeding

promotion programs with a robust support system from families, communities, and public health actors to improve continued breastfeeding practices,<sup>29</sup> thus helping reduce childhood stunting, should be prioritized.

We found that being in a rich household was significantly protective against stunting. Following previous research,<sup>12, 13, 15, 30</sup> our study revealed that being in rich households was linked to a lower risk of stunting. The protective effect may be due to several factors: wealthier families often have better access to high-quality and diverse foods, improved food security, and greater availability of healthcare and nutrition services.<sup>15, 30</sup> Our findings highlight the importance of nutrition-sensitive interventions that target household economic status. Relevant strategies may include agricultural development, food security initiatives, social protection programs, and the economic empowerment of women.<sup>31, 32</sup>

This study's strength was the use of a case-control design, which provides conclusions on cause-and-effect linkages. This article also examined key determinants of stunting, including factors at the child, parental, and household levels, including breastfeeding duration for at least one year, an important factor rarely assessed in many studies. This study highlighted risk factors for stunting particularly in stunting locus areas that are prioritized for accelerating stunting reduction program by the Government of Indonesia. Nevertheless, the study has several limitations. First, the data collected was limited to the district level. Second, other known risk factors for stunting, such as infectious diseases, diets, and food security, were not collected. Finally, data on exclusive and continued breastfeeding relied on the mothers' memory which might lead to recall bias.

## Conclusion

Our findings suggested that stunting was associated with child factors, such as birth length and breastfeeding duration. The household-level factor that was significantly linked to stunting was household economic status. Future research should consider using a more advanced design to establish the causal-effect relationship between exposures

and stunting as the outcome (e.g., cohort studies, randomized controlled trials) and a larger sample size. Public health actors and policymakers should consider behaviour change communications to strengthen breastfeeding promotion up to two years of age and beyond, as well as enhance prenatal nutrition to improve birth outcomes that contribute to the intergenerational malnutrition cycle. Such programs and interventions should particularly target those among disadvantaged populations (e.g., poor households).

### Competing Interests

The authors declare that they have no conflict of interest.

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