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Original Article

Medical and non-medical factors associated with stunting in infants and toddlers aged 3-59 months in Palembang

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Abstract

Background Although the prevalence of stunting in South Sumatera is estimated to be relatively high, there have been few studies to date on stunting and the factors associated with it in the region.

Objective To determine the proportion of stunting in infants and toddlers aged 3-59 months at Mohammad Hoesin General Hospital (RSMH), Palembang, South Sumatera, and to identify medical and non-medical factors associated with stunting in these children.

Methods A cross-sectional study was conducted at RSMH from April to September 2023. Stunting was defined according to the WHO standard and combined with a growth pattern that reflects chronic malnutrition. We recorded the proportion of stunting as well as data on several potential medical and non-medical risk factors of stunting.

Results A total of 183 subjects met the inclusion criteria. The overall proportion of stunting was 65/183 (35.5%). The proportion of stunting was higher in boys (39.6%) and in children <2 years of age (38.2%). Medical risk factors significantly associated with stunting were infectious disease [OR 4.13 (95%CI 1.91 to 8.94); P=0.001] and chronic disease [OR 3.02 (95%CI 1.56 to 5.85); P=0.001]. The only non-medical factor significantly associated with stunting was low paternal education level [OR 2.45 (95%CI 1.17 to 5.15); P=0.016].

Conclusion During the study period, over a third of pediatric patients at RSMH experienced stunting. Infectious disease, chronic disease, and low paternal education level were significant risk factors that contributed to the occurrence of stunting. **[Paediatr Indones. 2024;65:17-25; DOI: https://doi.org/10.14238/pi65.1.2025.17-25]**.

Keywords: *stunting; risk factors; children*

Nutrition is one of the main factors that affect optimal child growth and development. Stunting, a chronic malnutrition form, is one of the various nutritional disorders that remains a global health problem. *The World Health Organization* (WHO) in 2021 reported that 149.2 million, or 22.2%, of children worldwide had stunted growth.[1] *Studi Status Gizi Indonesia*/SSGI (The 2022 Indonesian Nutritional Status Study) that encompassed 34 provinces showed that the national stunting rate had decreased from 24.4% in 2021 to 21.6% in 2022. Despite the decrease, the rate of stunting is still classified as high (>20%), based on WHO criteria.[1,2] Furthermore, data in Indonesia has not distinguished between stunting caused by nutritional or non-nutritional factors (genetic, hormonal, or familial).[2,3]

The WHO defines stunting as a length or height for age below -2 standard deviation (SD) on the WHO growth chart. This condition is caused by chronic

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malnutrition and/or an increased need for nutrients due to chronic disease.[4] Weight faltering always precedes stunting and can occur from the prenatal period and continue after birth. A study in Malawi showed that babies born shorter were at higher risk of experiencing length faltering during infancy.[5] The strongest predictor of stunting at 12 months of age in the study was growth faltering that occured in the first three months of life. If the average weight-for-age Z score (WAZ) in the first three months of life is <-1 SD, then the risk of stunting at 12 months of age increases 14 times.[5,6]

Factors that potentially influence the appearance of stunting can be classified as underlying, intermediate, and immediate. Underlying determinants include maternal characteristics (age, height, physical and mental health, and nutritional status), household characteristics (socioeconomic status, religion, parental education, occupation, and decision-makers in the family), and regional characteristics (social, economic, political, and security conditions). Intermediate determinants consist of the number of family members, which affects food competition, access to clean water, hygiene and sanitation, air pollution from cigarette smoke, preventive and curative health services, practices of breastfeeding and complementary feeding, recurrent deficiencies, and chronic infections. Immediate determinants include intrauterine growth retardation, inadequate energy intake, and nutrient absorption, leading to inadequate calories needed for growth.[7]

Prayudhy *et al*.[8] studied children aged 6-59 months in the agricultural area of Kota Liwa, West Lampung Regency, Indonesia, and identified the risk factors for stunting in children to be short birth length (males <46.1 cm and females <45.6 cm), low birth weight (LBW), low protein intake, and lack of sanitation access. Budhathoki *et al*.[9] studied children under five years of age from 2001 to 2006 in Nepal and found that stunting was more common in babies born in poor families compared to those born in wealthy families. Families living in the hills had a lower risk of stunting than those living in the Tera plains, and babies born to uneducated mothers had a higher risk of stunting than those born to educated mothers. Sugiyanto *et al*.[10] studied children aged 6-59 months in the Bontang area of East Kalimantan and found that the risk of stunting decreased if the mother's height was 150 cm or greater, the mother had at least a high school education, the infant received exclusive breastfeeding, and the family was of high economic status. There have been little to no data on factors related to the occurrence of stunting in South Sumatera, and there has been no comprehensive study on the accurate diagnosis of stunting.

In our hospital, Mohammad Hoesin General Hospital (RSMH), a referral hospital in Palembang, South Sumatera, Indonesia, it is estimated that over half of patients treated by the Pediatric Nutrition and Metabolic Disease Division are stunted or severely stunted. The purpose of this study was to determine the proportion of stunting in infants and toddlers aged 3 to 59 months at RSMH and to identify medical and non-medical risk factors for stunting.

Methods

An analytical observational study with a cross-sectional design was conducted in the outpatient and inpatient wards of the Child Health Department of RSMH from April to September 2023. The study population consisted of infants and toddlers aged 3 to 59 months whose parents signed a written informed consent to participate in the study. We excluded children who did not meet stunting criteria, had a history of low birth weight, lacked previous height or length data, had limb deformities or abnormalities such as fractures, tumors, or limb amputations, severe edema, spastic cerebral palsy, and other conditions that required special anthropometric measurements.

The comprehensive criteria for diagnosing stunting consisted of length- or height-for-age <-2 standard deviations (SD) according to the WHO growth reference standards, combined with an inadequate growth pattern or a history of weight deceleration that reflects chronic malnutrition, and the presence of red flags. Growth rate was calculated for subjects under two years of age using the WHO weight and length increment table or when weight age < height age < chronological age. Meanwhile, in subjects older than two years, bone age was also assessed. Furthermore, we defined red flags as follows: (1) inadequate calorie intake, including due to improper breastfeeding management and feeding practices, gastroesophageal reflux disease

(GERD), cleft palate, or disorders of oral neuromotor coordination, (2) inadequate absorption of nutrients, e.g. due to cow's milk protein allergy, iron deficiency anaemia, biliary atresia, cholestasis, or helminthiasis, and (3) increased energy metabolism due to chronic infection (i.e. tuberculosis, human immunodeficiency virus infection, urinary tract infection) and chronic diseases (i.e. congenital heart disease, malignancy, thalassemia, hyperthyroidism, severe persistent asthma). Non-medical evaluated included the education and income level of parents, number of siblings, exposure to cigarette smoke, and water source. Water source was considered good when the family used government-supplied tap water for household clean water needs such as drinking, cooking, or bathing. Access to health services was determined in terms of distance from the family residence to the nearest health center, travel time, and the cost incurred to reach health services.

Participants were recruited consecutively. Interviews were then conducted to complete the demographic data questionnaire. Growth history and medical conditions were evaluated using medical records and a growth monitoring book. Length measurement was carried out using an infantometer for infants and children under two years of age or a length shorter than 87 cm, while the height of older children was measured using a stadiometer. All accessories, such as hats, hair pins, solid headbands, shoes, and sandals were removed prior to measurements. Weight was measured using a weighing scale. We removed heavy clothes and diapers during weighing. Weight and length or height results were plotted on the WHO growth chart to obtain Z scores for length-for-age (LAZ) or height-for-age (HAZ), weight-for-age (WAZ), and weight-for-length/height (WHZ).

The SPSS version 22 (IBM, Armonk, New York) was used for all analysis. The normality of numerical data was tested using the Kolmogorov-Smirnov method. Analysis of the association between medical and non-medical factors and stunting was performed using the chi-square or Fisher's exact test, for which a P value of <0.05 was considered statistically significant. Multivariate analysis was performed on risk factors with P values of <0.25 to obtain a logistic regression model that could be used to calculate the probability of stunting.

Results

A total of 183 children were included in the study, of whom 101 (55.2%) were male and 123 (67.2%) were <2 years old. The lowest weight was 2.65 kg and the highest was 30.3 kg, with a median weight of 7.95 kg. The shortest body length was 51 cm and the tallest was 112 cm, with a median of 74 cm. More than half of the subjects (101/183; 55.2%) had normal weight-for-length/height Z-scores, but of these, 23/101 (22.8%) experienced stunting. Among subjects <2 years of age, 51/123 (41.5%) showed abnormal growth rate.

Subject characteristics are shown in **Table 1**. The overall proportion of stunting in this study was 65/183 (35.5%). Stunting was more prevalent in boys [40/101 (39.6%)], children below 2 years of age [47/123 (38.2%)], severely wasted children [27/52 (51.9%)], and children with abnormal growth rates [47/51 (92.2%)].

Eighteen of the 60 children >2 years of age were stunted. Bone age was delayed in all of them.

Table 2 shows that 35/183 (19.1%) subjects had infectious disease. Among those with infectious disease, 22/35 experienced stunting. The most common infectious disease was pulmonary tuberculosis (TB), which affected 17 subjects; 11 of them experienced stunting. Meanwhile, 105/183 (57.4%) subjects suffered from chronic disease, 48/105 (45.7%) of them were classified as stunting. Congenital heart disease (CHD) was found in 27/105 (25.7%) of the subjects with chronic disease, of which 18/27 were classified as stunting. Patent ductus arteriosus (PDA) was the most common CHD, accounting for 11 subjects.

Regarding non-medical factors (**Table 3**), the majority of fathers [147/183 (80.3%)] had completed high school or higher education). Paternal education level was the only non-medical factor studied that was a significant risk factor for stunting [OR 2.45; 95%CI 1.17 to 5.15; P=0.016]. Most mothers [144/183 (78.7%)] had also completed a high school education or higher. Although the proportion of stunting was lower among children of mothers with high education level, the difference was not statistically significant [OR 1.55; 95%CI 0.75 to 3.18; P=0.235]. Paternal and maternal income levels, paternal and maternal smoking, number of siblings, water source, and access to health resources were not found to be significant risk factors of stunting.

Table 1. Characteristics of the subject

Characteristics	Total (N=183)	Stunting (n=65)	Non-stunting (n=118)
Sex, n (%)			
Male	101 (55.2)	40 (61.5)	61 (51.7)
Female	82 (44.8)	25 (38.5)	57 (48.3)
Age, n (%)			
≤2 years	123 (67.2)	47 (72.3)	76 (64.4)
>2 years	60 (32.8)	18 (27.7)	42 (35.6)
Median weight (range), kg*	7.95 (2.65-30.3)	6.71 (2.3)**	8.6 (3.99-30.3)
Median height (range), cm*	74 (51-112)	69.92 (10.7)	79 (54-112)
Nutritional status, n (%)			
Severely wasted	52 (28.4)	27 (41.5)	25 (21.2)
Wasted	27 (14.8)	15 (23.1)	12 (10.2)
Normal	101 (55.2)	23 (35.4)	78 (66.1)
Overweight	1 (0.6)	0 (0)	1 (0.8)
Obesity	2 (1,0)	0 (0)	2 (1.7)
Median mid-parental high (MPH) (range), cm*	163.5 (139-178)	161.37 (8.3)	164 (141-178)
Growth pattern, n (%)[a]			
Abnormal	51 (41.5)	47 (92.2)	4 (7,8)
Normal	72 (58.5)	0 (0)	72 (100)
Retarded bone age, n (%)[b]	18 (100)	18 (100)	0 (0)

*Kolmogorov- Smirnov; **mean (SD), [a]only for subjects aged ≤2 years (n=123), [b]only for stunted subjects aged >2 years (n=18)

Table 2. Distribution of medical factors

Medical factors	Total (N=183)	Stunting (n=65)	Non-stunting (n=118)
Infectious disease	35 (19.1)	22 (62.9)	13 (37.1)
Pulmonary tuberculosis	17 (48.6)	11 (64.7)	6 (35.3)
HIV Infection	3 (8.6)	2 (66.7)	1 (33.3)
Lymphadenitis tuberculosis	6 (17.1)	2 (33.3)	4 (66.7)
HIV infection + pulmonary TB	1 (2.9)	1 (100)	0 (0)
Persistent/chronic diarrhea	3 (8.6)	1 (33.3)	2 (66.7)
CMV infection	3 (8.6)	3 (100)	0 (0)
Presumptive tuberculosis	2 (5.6)	2 (100)	0 (0)
Chronic disease	105 (57.4)	48 (73.8)	57 (48.3)
Congenital heart disease	27 (25.7)	18 (37.5)	9 (5.3)
Epilepsy	31 (29.5)	9 (18.8)	22 (38.6)
Gastrointestinal disorders	8 (7.6)	6 (12.5)	2 (43.9)
Thalassemia	2 (1.9)	0 (0)	2 (43.9)
Acute leukemia	12 (11.4)	3 (6.3)	9 (15.8)
Cow's milk allergy	2 (1.9)	2 (4.2)	0 (0)
Laryngomalacia	8 (7.6)	7 (14.6)	1 (1.8)
CAH	1 (0.95)	0 (0)	1 (1.8)
ITP	1 (0.95)	0 (0)	1 (1.8)
Solid tumors	6 (5.7)	2 (4.2)	4 (7.0)
Cholestasis extrahepatic	1 (0.95)	0 (0)	1 (1.8)
Chronic kidney disease	6 (5.7)	1 (2.1)	5 (8.8)

Results of bivariate analysis of medical factors can be seen in **Table 4**. Both infectious disease [OR 4.13; 95%CI 1.91 to 8.94] and chronic non-infectious disease [OR 3.02; 95%CI 1.56 to 5.85] were significantly associated with stunting.

Six risk factors with P value of <0.25 were analyzed further by logistic regression to identify risk factors independently associated with stunting: infectious disease, chronic non-infectious disease, paternal education, maternal education, parental income, water source, and access to healthcare. Multivariate analysis revealed that infectious disease, chronic non-infectious disease, and paternal education factors remained significant risk factors in the final model. In this model, the probability to experience stunting when a child had a chronic non-infectious disease or had a father with a low education level was 64.6%. When both risk factors were present, the risk for stunting was increased to 78.4%. When all three risk factors were present, the probability to experience stunting was 99.9%. The resulting formula from the logistic regression model was as follows:

y = 21.476 + (21.609 x infectious disease) + (20.924 x chronic disease) + (1.155 x level of paternal education)

Table 3. Distribution of nonmedical factors

Non-medical risk factors	Total (N=183)	Stunting (n=65)	Non-stunting (n=118)	OR 95%CI	P value
Paternal education status, n (%)					
Low	36 (19.7)	19 (19.2)	17 (14.4)	2.45 (1.17 to 5.15)	0.016
High	147 (80.3)	46 (70.8)	101 (95.6)		
Maternal education status, n (%)					
Low	39 (21.3)	17 (26.2)	22 (18.6)	1.55 (0.75 to 3.18)	0.235
High	144 (78.7)	48 (73.8)	96 (81.4)		
Parental income status, n (%)					
Low	91 (49.7)	37 (56.9)	54 (45.8)	1.57 (0.85 to 2.88)	0.148
High	92 (50.3)	28 (43.1)	64 (54.2)		
Paternal income status, n (%)					
Low	133 (72.7)	50 (76.9)	83 (70.3)	1. 41 (0.7 to 2.83)	0.339
High	50 (27.3)	15 (23.1)	35 (29.7)		
Maternal income status, n (%)					
Low	171 (93.4)	62 (95.4)	109 (92.4)	1.71 (0.45 to 6.54)	0.431
High	12 (6.6)	3 (4.6)	9 (7.6)		
Paternal smoker, n (%)					
Yes	121 (66.1)	40 (61.5)	81 (68.6)	0.73 (0.39 to 1.38)	0.334
No	62 (33.9)	25 (38.5)	37 (31.4)		
Maternal smoker, n (%)					
Yes	2 (1.1)	1 (1.5)	1 (0.8)	1.83 (0.11 to 29.72)	0.667
No	181 (98.9)	64 (98.5)	117 (99.2)		
Number of siblings, n (%)					
>3	8 (4.4)	4 (6.2)	4 (3.4)	1.87 (0.45 to 7.73)	0.381
≤3	175 (95.6)	61 (93.8)	114 (96.6)		
Water source, n (%)					
Poor	60 (32.8)	17 (26.2)	43 (36.4)	0.62 (0.32 to 1.21)	0.156
Good	123 (67.2)	48 (73.8)	75 (63.6)		
Access to health services, n(%)					
Inaccessible	11 (6)	2 (3.1)	9 (7.6)	0.384 (0.08 to 1.84)	0.215
Accessible	172 (94)	63 (96.9)	109 (92.4)		

Table 4. Bivariate analysis of medical factors

Medical factors	Stunting (n=65)	Non-stunting (n=118)	OR (95%CI)	P value
Infectious disease, n(%)				
Yes	22 (33.8)	13 (11.0)	4.13 (1.91 to 8.94)	0.001
No	43 (66.2)	105 (89.0)		
Chronic disease, n(%)				
Yes	48 (73.8)	57 (48.3)	3.02 (1.56 to 5.85)	0.001
No	17 (26.2)	61 (51.7)		

Discussion

Stunting is an important issue in child nutrition. Several studies have revealed different risk factors of stunting. In this study, we evaluated the role of medical factors (chronic infectious disease and chronic non-infectious disease) and non-medical factors as risk factors of stunting in infants and toddlers aged 3-59 months at RSMH. We used comprehensive criteria to carefully define stunting.

Of 183 subjects, 35 had infectious disease; 22/35 (62.9%) subjects with infectious disease experienced stunting. Pulmonary TB was the most common infectious disease, found in 17/35 (48.6%) children with infectious disease; over half of the subjects with pulmonary TB experienced stunting (11/17). A previous study reported that children with stunting were 2.96 times more likely to develop pulmonary TB than toddlers with normal nutritional status.[11] TB infection can disrupt nutrient absorption and metabolism, leading to inadequate weight gain or weight loss. Infection is a direct cause because it causes nutrients to be used for tissue repair or cell damage. Infectious diseases can decrease food intake, interfere with nutrient absorption, cause direct nutrient loss, and increase metabolic needs. In this condition, there is a two-way interaction between nutritional status and infectious disease. Malnutrition can increase the risk of infectious disease, while infections can cause malnutrition. If this is not addressed immediately and occurs over a long period, it can disrupt food intake processing, thus increasing the risk of stunting in children.[12] We found a significant association between infectious disease and stunting on bivariate analysis, with an OR of 4.13 (95%CI 1.91 to 8.94; P=0.001). Our findings were consistent with a study in Pekanbaru, Riau, Indonesia, which reported found that toddlers with infectious diseases were four times more likely to experience stunting compared to toddlers who did not have infectious disease in the last month.[13] Another study by Subroto et al. found a significant association between infectious disease and stunting in toddlers. Toddlers with infectious diseases were three times more likely to experience stunting than those without infectious diseases.[14]

Of 105 subjects who had chronic non-infectious diseases, 45.7% experienced stunting. The most common chronic non-infectious disease associated with stunting was CHD; 18/27 subjects affected experienced stunting. All of them had acyanotic CHD, PDA being the most frequent. On bivariate analysis, chronic non-infectious disease was significantly associated with stunting, with an OR of 3.02 (95%CI 1.56 to 5.85; P=0.001). A study reported that the prevalence of stunting in children with CHD was 45.4%, and the risk of malnutrition is higher in children with moderate to severe heart failure and moderate to severe anemia.[15] Malnutrition in children with heart failure related to CHD is caused by the increase of metabolic needs. It is complicated by the low energy intake due to the inability of the children with CHD to tolerate large portion of fluids and meals.

Anemia is also reported to be associated with malnutrition in children with congenital heart disease. Malnourished children generally experience anemia due to bone marrow hypoplasia, iron deficiency, vitamin B12 deficiency, vitamin A deficiency, and folate deficiency. The most important trigger for severe malnutrition in children with congenital heart disease (although more common in cyanotic heart disease) is pulmonary hypertension.[16] This finding is consistent with a study which also noted the impact of pulmonary hypertension on growth and nutrition in cyanotic and acyanotic heart disease, finding that cyanotic patients with pulmonary hypertension were more affected than acyanotic children with hypertension.[16] The preferred reason that pulmonary hypertension leads to malnutrition in children with cyanotic heart disease is the compensated metabolic acidosis caused by hypoxia. In addition, chronic hypoxia, anorexia, and inefficient nutrient processing at the cellular level are also involved.[16]

We also analyzed several non-medical factors, including parental education, parental income, number of siblings, parental smoking habits, water source, and access to healthcare. The analysis showed that low paternal education level was a significant risk factor for stunting. Children from fathers with low education levels were 2.45 times more likely to experience stunting. Rakotomanana et al. found that children whose fathers had post-secondary education were less likely to experience stunting.[17] High paternal education improves the household's economic status because it is closely related to job opportunities and higher income. This, in turn, increases the purchasing power to provide food for the household.[18] On the other hand, we found no significant association between maternal education level and the occurrence of stunting. In contrast, Sugiyanto et al. found that children with highly educated mothers had a 1.83 times lower risk of stunting.10 Mothers with higher education are expected to have good nutritional knowledge that prioritizes the provision of nutritious food for family members, especially children. Lack of information about nutrition can lead to poor-quality food intake for children. The higher the mother's education level, the better her knowledge on proper nutrition for her children, which can reduce the risk of stunting in children. Maternal education influences the care of toddlers, the allocation of family food, especially for toddlers, and the mother's knowledge of her baby's health. Mothers with higher education understand more about healthy living behaviors, increasing the health of their toddlers, and avoiding contagious diseases, among other benefits.[19]

Children exposed to tobacco smoke by their parents are more likely to experience stunting, especially if the mother smokes. This may be due to the fact that exposure to tobacco smoke during childhood may predispose children to respiratory tract infections, such as pneumonia, and other respiratory conditions, disrupting growth and development.20 However, this study found no significant association between paternal smoking and maternal smoking with the occurrence of stunting. These results differ from a study by the *Indonesia Family Life Survey* (IFLS), which reported that children whose fathers had moderate or high smoking intensity tended to have a higher likelihood of stunting by 3.47 percentage points.[20] A previous study reported that toddlers with fathers who smoke have a 1.8-fold risk of experiencing stunting, and when both parents smoke the risk of stunting is increased further by 3.591 times.[21] The differences between our findings and those of other studies in this regard may have been due to several factors, such as research methodology, sample size, study design, and control factors used.

We found no association between the number of siblings and the occurrence of stunting. In contrast, a study in Vietnam reported that families with ≥3 children were at 2.47 times the risk of having stunted children compared to families with <3 children.[22] The number of children and family members affects the distribution of food, as the more children there are in the family, the higher the competition for food and other needs.[23] Furthermore, access to clean water and sanitation is the sixth *Sustainable Development Goals* target. Many studies have shown that sanitation, clean water, and other components of environmental health are related to stunting. Without adequate clean water and sanitation, reduction of the prevalence of stunting will not be achieved.[24] Access to clean water for drinking, bathing, and washing can come in the form of tap or refillable bottled water. A study in a district of Yogyakarta, Indonesia, showed a significant association between sanitation and clean water provision with the occurrence of stunting in toddlers.[25] However, in our study, we found no such association. The Yogyakarta study had a case-control design, was smaller in sample size (45 stunted and 45 control subjects), and defined clean water sanitation use as water provision using the clean water sanitation inspected by the Special Region of Yogyakarta Health Office with 11 assessed indicators. In our study, water sanitation was assessed only based on the use of government-supplied tap water as clean water source.

The distance to the nearest health services may serve as one of the barriers in utilizing health services. In our study, access to health services showed no significant association with the occurrence of stunting; 94% of the subjects were reported as having easy access to health services. Similarly, a previous study, in which 70.6% of subjects had easy access to health services, reported no association between access to health services with caregiving practices of stunted toddlers.[26] Access to health services is more easily achieved because most subjects already have transportation options to reach health facilities, so they do not experience difficulties in reaching health facilities.

In conclusion, the proportion of stunting in infants and children aged 3-59 months in the outpatient and inpatient pediatric ward at RSMH during the study period was 35.5%. The medical factors that significantly affected the occurrence of stunting were chronic infectious diseases and chronic non-infectious diseases. Low paternal education level was the sole non-medical factor that significantly affected stunting. It is important to look for red flags in children with weight faltering to find medical or non-medical factors that can be managed in early stage to prevent the occurence of stunting.

Conflict of interest

None declared.

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