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Factors affecting stunting in children aged 6-23 months in South Sumatra Province, Indonesia

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ABSTRACT

Introduction: South Sumatra Province in Indonesia has a relatively high prevalence of stunting and there is limited research about this phenomenon in this area. The study aimed to identify what factors affected stunting in children aged 6-23 months in the province. **Methods:** Using a comparative cross-sectional design involving 139 mothers with children aged 6-23 months, the study collected data from September to December 2022 via anthropometric measurements and interviews using a questionnaire. Data on parental, child, socioeconomic, and environmental factors were analysed using chi-square test and logistic regression analysis. **Results:** Overall, there were significant relationships among the following variables: child's age (p=0.031), birth length (p=0.017), and weight-for-age (WAZ) status (p<0.001) with stunting. Children in the underweight and severely underweight categories were 28.7 times at risk of stunting compared to those in the normal category of WAZ status; children aged 12-23 months had a 2.8 times risk of stunting compared to children aged 6-11 months, while stunted birth length showed a 4.6 times risk of stunting compared to that of normal birth length. **Conclusion:** This research found that child age, birth length, and WAZ status were significant factors affecting stunting in the South Sumatra Province. Given these results, this study offers recommendations for the provincial government to focus on intervention programmes that provide additional food for pregnant women with chronic energy deficiency, monitor the growth of toddlers, and manage toddlers with nutritional problems in this province.

Keywords: birth length, child age, stunting, WAZ status

INTRODUCTION

Stunting is a nutritional problem that has impacted the world, especially in poor and developing countries. Indonesia, as a country in the Southeast Asia region, has a fairly high stunting rate when compared to other Southeast Asian countries, namely 30.5% in 2018 (UNICEF 2019). The results of the Indonesian Nutrition Status Study (INSS) in 2021 still showed a prevalence of 24.4%, while the World Health Organization (WHO) targets a reduction in the prevalence of stunting to below

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20% in 2025 (Kemenkes RI, 2021). The INSS data also show that the prevalence of stunting increased 1.6 times from the age of 6-11 months to the age of 12-23 months (Sumiwi, 2023).

Stunting is defined as growth and development failure experienced by children that is caused by prolonged insufficient nutritional intake, recurrent infectious diseases, and inadequate psychosocial stimulation (WHO, 2014). Stunting is of concern as it can lead to disturbances in immunological, cognitive, and physical developments that cannot be completely repaired or become irreversible, thus increasing the risk of diseases later in life – i.e., obesity, diabetes, hypertension, and mental retardation (Mayneris-Perxachs & Swann, 2018).

The WHO summarised the various factors behind the occurrence of stunting, but each country and each region certainly has different causes. This is influenced by socio-cultural differences, as well as differences in lifestyle, food consumption patterns, weather/climate, and others. Systematic reviews using the WHO's conceptual framework on stunting in children have been conducted in Indonesia (Beal *et al.*, 2018) and Bangladesh (Islam *et al.*, 2020). Evidence shows that the determining factors for stunting in children are short birth length, non-exclusive breastfeeding, low socioeconomic status (characterised by food insecurity and lack of access to nutrition), low maternal education level, birth prematurity, low maternal height, low maternal weight and childbirth weight, and diarrhoea caused by pathogens (Beal *et al.*, 2018; Islam *et al.*, 2020). Other studies have found that growth disorders in terms of children's body length become more common as children get older. The prevalence of stunting is higher, and the risk of stunting is also greater in children aged 12–23 months compared to children aged 0–11 months (Afsana *et al.*, 2019).

We conducted this study in South Sumatra Province, the sixth most populous province in Indonesia, reaching 8,497,196 people in 2020 (BPS Sumatera Selatan Province, 2022). With such a large population, this province is faced with an extremely serious risk of overpopulation, including a high risk of child health problems (Kemenkes RI, 2021). South Sumatra Province is also home to a significant number of young people – as many as 2.8 million individuals (35% of the total population) in the province are children. In 2015, almost 500,000 children (17%) lived below the provincial poverty line. However, more households are in a vulnerable position and live on incomes just above the poverty line. The prevalence of malnutrition is relatively high, including among children from the wealthiest households (BAPPENAS-UNICEF, 2017). The prevalence of stunting in 2021 was 24.8%, including in one of the 34 provinces in the chronic-acute category (stunted >20% and wasted >5%) (Kemenkes RI, 2021).

The Indonesian government, through the Ministry of Health, has implemented various policies and programmes to reduce stunting, including specific nutrition intervention programmes related to the health sector and sensitive nutrition interventions related to the non-health sector, which are carried out in an integrated and comprehensive manner. In this nutrition intervention programme, 11 specific interventions were designed to accelerate the reduction of stunting, namely anaemia screening, consumption of blood supplement tablets for young women, pregnancy checks (antenatal care), consumption of blood supplement tablets for pregnant women, the provision of additional food for pregnant women lacking energy, monitoring the growth of toddlers, exclusive breastfeeding, providing complementary foods rich in animal protein for toddlers, managing toddlers with nutritional problems, increasing coverage and expanding immunisation, and educating teenagers, pregnant women, and their families, including triggering for behaviour change towards open defecation (Sumiwi, 2023).

Most of the previous researches in this province were carried out within a limited area or small community with simple variable pieces, so they could not describe the condition of stunting in South Sumatra (Khairani, Tjahjono & Rosidi, 2022; Louis, Mirania & Yuniarti, 2022). Therefore, this study aimed to identify what factors influence stunting in children in South Sumatra Province, particularly in those aged 6-23 months, thereby providing recommendations for the provincial government to focus on stunting intervention programmes.

MATERIALS AND METHODS

Study design

The research design was a comparative cross-sectional study. Subjects included children with normal body length-for-age *z*-score and children with body length-for-age *z*-score <-2 standard deviation (*SD*) (stunting). Respondents were mothers who had children aged 6-23 months when the study was conducted. Sample calculation used the two-proportion difference hypothesis test formula (with an estimated proportion of 0.62 in the stunting group) and the result obtained was a minimum total sample of 134 people. The sampling technique was carried out in two stages: the first stage was the selection of regions representing districts or municipalities (three regions were obtained in the province of South Sumatra, namely Palembang City, Muara Enim Regency, and Ogan Komering Ulu Regency); the second stage was selecting the sub-district with the highest prevalence (five sub-districts were obtained); and finally, the respondents were selected randomly based on data recorded at the local health office. Data collection was carried out in September-December 2022.

The inclusion criteria were mother-child pairs (children aged 6-23 months, registered at a community health centre, and had a health card), with mothers willing to sign the informed consent forms. Children with congenital diseases or syndromes that affected anthropometry and who suddenly became ill or who were undergoing certain medications when the research was conducted were excluded as research subjects. The study involved 139 mother-child pairs; 72 children were assigned to the normal group and 67 to the stunting group.

Anthropometric measurements

Anthropometric measurements were carried out by researchers, accompanied by trained health workers at the community health centres. The measurement of children's body length was carried out by one researcher using a baby length board (Kenko), with an accuracy of up to 0.1 cm. The child was measured in a lying position; the trained health workers assisted by stabilising the child on the length board and the measurement was recorded in centimetres (cm). Children's body weight was measured using a digital baby weight scale; children were weighed with minimal or no clothing in a lying or sitting position in kilograms. The instruments for anthropometric measurements had been standardised and calibrated by the district health office.

Children were grouped into the stunting and normal categories based on results of the anthropometric measurements, namely body length-for-age *z*-scores. If measurement results showed that body length-for-age was below -2*SD* (WHO median growth

Table 1. Description of study variables

Variable	*Operational definition*
Parental factors	
Mother's age	Mother's age at the time of the study. Categorised: <20 years; 20-35 years; >35 years
Mother's height	Mother's height Categorised: normal (≥150.1 cm), stunted/short (<150.1 cm)
Father's height	Father's height Categorised: normal (≥161.9 cm), stunted/short (<161.9 cm)
Maternal body mass index	Maternal body mass index by dividing body weight (kg) with quadrat of height (m^2) Categorised: underweight (BMI<18.5kg/m^2), normal (BMI 18.5 – 24.9 kg/m^2), overweight (BMI 25 – 29.9 kg/m^2), obese (BMI ≥30 kg/m^2)
Child factors	
Age	Child's age at the time of study Categorised: 6-11 months, 12-23 months
Gender	Child's gender Categorised: boy, girl
Gestational age	Age (period) when the child was in the womb (intrauterine) or the gestational age of the mother when the child was born Categorised: preterm (<37 weeks), Term (37-41 weeks), post term (≥42 weeks)
Birth weight	Child's weight at birth Categorised: low birth weight (<2.5 kg), normal birth weight (2.5-4.0 kg), high birth weight (>4.0 kg)
Birth length	The child's body length at birth with the following provisions (normal): - Male: >46.1 cm - Female: >45.4 cm Categorised: normal, stunted/short
Exclusive breastfeeding	Child's history receiving only breast milk (exclusively) at age ≤ 6 months Categorised: yes, no
Minimum dietary diversity (MDD) for children aged 6–23 months	The minimum variety of foods consumed by children aged 6–23 months, namely consuming food and drinks from at least five of the eight food groups determined on the previous day Categorised: fulfilled, not fulfilled
Minimum milk feeding frequency (MMFF) for non-breastfed children aged 6–23 months	Non-breastfed children aged 6-23 months who had at least two servings of milk on the previous day Categorised: fulfilled, not fulfilled
Minimum meal frequency (MMF) for children aged 6–23 months	Minimum meal frequency for children aged 6–23 months who eat solid, semi-solid, or soft foods (but also including dairy foods for children who are not breastfed) at least several times on the previous day Categorised: fulfilled, not fulfilled

Table 1. Description of study variables *(continued)*

Variable	*Operational definition*
Minimum acceptable diet (MAD) for children aged 6-23 months	The minimum acceptable diet for children aged 6–23 months is by assessing the minimum acceptable food during the previous day Categorised: achieved, not achieved
WAZ status	Nutritional status of children based on body weight for age Categorised: severely underweight (<-3*SD*) and underweight (-3*SD* - <-2*SD*), normal weight (-2*SD* - > +1*SD*)
Socioeconomic factors	
Domicile location	The residence of the mother and child Categorised: urban, rural
Mother's education	Formal education completed by the mother Categorised: low (elementary school, junior high school), medium (high school), high (diploma, bachelor, master, doctor)
Family income	Household income received by family every month in line with the determination of the provincial minimum wage in 2022 Categorised: high, low
Environmental factors	
Clean water source	Availability of clean water sources for drinking, cooking, and other purposes Categorised: yes, no
Toilet availability	Availability of standardised toilets at home Categorised: yes, no
Exposure to nicotine/ cigarette smoke	Whether the mother is exposed to nicotine or cigarette smoke Categorised: yes, no

standard), then the child was declared stunted, whereas if the measurement results were above -2*SD*, the child was declared normal.

Variables

Interviews were performed with the children's mothers using a questionnaire. The interview was conducted to assess the independent variables, and the validity and reliability of the questionnaire were tested. The validity of the instrument was assessed using the Pearson's correlation test (r=0.754, p<0.001) and overall, it had an acceptable reliability, with Cronbach's alpha=0.68. The independent variables studied were parental factors (including mother's age, mother's height, father's height, and mother's body mass index), child factors [including age, sex, gestational age, birth weight, birth length, exclusive breastfeeding status, minimum dietary diversity (MDD) status of children aged 6-23 months, minimum milk feeding frequency (MMFF) for non-breastfed children aged 6-23 months, minimum meal frequency (MMF) for children aged 6-23 months, minimum acceptable diet (MAD) for children aged 6-23 months, and WAZ (weight-for-age z-score) status], socioeconomic factors (including mother's education level and family's income level), and environmental factors (including domicile location, clean water sources, availability of toilets, and exposure to nicotine/cigarette smoke).

Table 2. Characteristics of stunted children and normal children in South Sumatra (*N*=139)

Variable	*n (%)*	*Normal, n (%)*	*Stunting, n (%)*	*p-value*[†]
Child's age				0.007*
6-11 months	35 (25.2)	25 (71.4)	10 (28.6)	
12-23 months	104 (74.8)	47 (45.2)	57 (54.8)	
Gender				0.030*
Girl	63 (45.3)	39 (61.9)	24 (38.1)	
Boy	76 (54.7)	33 (43.4)	43 (56.6)	
Gestational age				0.428
Term	114 (82.0)	62 (54.4)	52 (45.6)	
Preterm	20 (14.4)	8 (40.0)	12 (60.0)	
Post-term	5 (3.6)	2 (40.0)	3 (60.0)	
Birth weight				0.107
Normal	119 (85.6)	66 (55.5)	53 (44.5)	
Low	17 (12.2)	5 (29.4)	12 (70.6)	
High	3 (2.2)	1 (33.3)	2 (66.7)	
Birth length				0.003*
Normal	117 (84.2)	67 (57.3)	50 (42.7)	
Stunted	22 (15.8)	5 (22.7)	17 (77.3)	
Exclusive breastfeeding				0.516
Yes	97 (69.8)	52 (53.6)	45 (46.4)	
No	42 (30.2)	20 (47.6)	22 (52.4)	
MDD status				0.450
Fulfilled	68 (48.9)	33 (48.5)	35 (51.5)	
Not fulfilled	71 (51.1)	39 (54.9)	32 (45.1)	
MMFF status				0.621
Fulfilled	80 (57.6)	40 (50.0)	40 (50.0)	
Not fulfilled	59 (42.4)	32 (54.2)	27 (45.8)	
MMF status				0.298
Fulfilled	138 (99.3)	72 (52.2)	66 (47.8)	
Not fulfilled	1 (0.7)	0 (0.0)	1 (100.0)	
MAD status				0.115
Fulfilled	41 (29.5)	17 (41.5)	24 (58.5)	
Not fulfilled	98 (70.5)	55 (56.1)	43 (43.9)	
WAZ status				<0.001*
Normal	88 (63.3)	67 (76.1)	21 (23.9)	
Underweight & severely underweight	51 (36.7)	5 (9.8)	46 (90.2)	
Mother's age				0.942
20-35 years	96 (69.1)	49 (51.0)	47 (49.0)	
<20 years	8 (5.8)	4 (50.0)	4 (50.0)	
>35 years	35 (25.2)	19 (54.3)	16 (45.7)	
Mother's height				0.056*
Normal	88 (63.3)	51 (58.0)	37 (42.0)	
Stunted	51 (36.7)	21 (41.2)	30 (58.8)	
Father's height				0.470
Normal	77 (55.4)	42 (54.5)	35 (45.5)	
Stunted	62 (44.6)	30 (48.4)	32 (51.6)	
Mother's body mass index				0.755
Normal	77 (55.4)	37 (48.1)	40 (51.9)	
Underweight	23 (16.5)	13 (56.5)	10 (43.5)	
Overweight	29 (20.9)	17 (58.6)	12 (41.4)	
Obese	10 (7.2)	5 (50.0)	5 (50.0)	

Table 2. Characteristics of stunted children and normal children in South Sumatra (*N*=139) *(continued)*

Variable	*n (%)*	*Normal, n (%)*	*Stunting, n (%)*	*p-value*†
Domicile location				0.589
Urban	53 (38.1)	29 (54.7)	24 (45.3)	
Rural	86 (61.9)	43 (50.0)	43 (50.0)	
Mother's education				0.454
High	5 (3.6)	3 (60.0)	2 (40.0)	
Medium	69 (49.6)	39 (56.5)	30 (43.5)	
Low	65 (46.8)	30 (46.2)	35 (53.8)	
Family Income				0.392
High	40 (28.8)	23 (57.5)	17 (42.5)	
Low	99 (71.2)	49 (49.5)	50 (50.5)	
Clean water source				0.732
Yes	121 (87.1)	62 (51.2)	59 (48.8)	
No	18 (12.9)	10 (55.6)	8 (44.4)	
Toilet availability				0.480
Yes	125 (89.9)	66 (52.8)	59 (47.2)	
No	14 (10.1)	6 (42.9)	8 (57.1)	
Exposure to nicotine				0.503
No	18 (12.9)	8 (44.4)	10 (55.6)	
Yes	121 (87.1)	64 (52.9)	57 (47.1)	

MDD: Minimum dietary diversity; MMFF: Minimum milk feeding frequency; MMF: Minimum meal frequency; MAD: Minimum acceptable diet; WAZ: Weight-for-age z-score
†Chi-square test
Univariate and bivariate analyses; *$p<0.05$

Statistical analysis

We compared the factors between normal children and stunted children. Chi-square test was used to test the significance of relationship between independent variables and incidence of stunting. In addition, a calculation of the odd ratio for stunting was also carried out. Multivariate logistic regression analysis was performed to estimate how much influence the independent variables had on the dependent variable. All variables resulting from the bivariate analysis with a cut-off p-value <0.25 were included in the final model of the multivariate logistic regression, with a 95% confidence interval. All analyses were conducted using IBM SPSS Statistics for Windows, version 20.0 (IBM Corporation, Armonk, NY, USA), whereby a p-value <0.05 indicated statistical significance.

Ethics approval

This research received ethical approval from the Ethics Committee of the Faculty of Medicine, University of Indonesia – Cipto Mangunkusumo Hospital (No.KET-878/UN2.F1/ETIK/PPM.00.02/2022). In addition, permission was obtained from the South Sumatra Provincial Health Office (No.074/3198/Kes/XI/2022), the local district/municipal health service, and related institutions, as well as written consent from the children's parents.

RESULTS

Table 2 shows the factors affecting stunted children and normal children in South Sumatra Province. Most respondents lived in rural areas (61.9%). Stunting prevalence as a whole was 48.2%, more common in boys (56.6%

Table 3. Factors influencing stunting in children in South Sumatra (*N*=139)

Variable	*Adjusted*	
	OR (95% CI)	*p-value* †
Child's age		0.228
6-11 months	1	
12-23 months	2.045 (0.639-6.546)	
Gender		0.240
Girl	1	
Boy	1.755 (0.687-4.483)	
Birth weight		
Normal	1	0.305
Low	1.097 (0.185-6.504)	0.919
High	7.528 (0.569-99.596)	0.126
Birth length		0.332
Normal	1	
Stunted	2.242 (0.438-11.477)	
MAD status		0.677
Fulfilled	1	
Not fulfilled	0.803 (0.286-2.255)	
WAZ status		
Normal	1	<0.001*
Underweight & severely underweight	28.720 (9.430-87.465)	
Mother's height		0.140
Normal	1	
Stunted	2.150 (0.778-5.939)	

MAD: Minimum acceptable diet; WAZ: Weight-for-age z-score
†Logistic regression multivariate analysis
*$p<0.05$

of the study population) than in girls and the largest proportion occurred in the age range of 12-23 months (54.8%). Gender and child's age showed significant differences (p=0.030 and p=0.007, respectively). In addition, the variables of birth length and WAZ status showed significant differences (p=0.003 and p<0.001, respectively) between normal and stunted children.

Multivariate analysis of the logistic regression model shown in Table 3 revealed that the most significant influencing factor of stunting was child's WAZ status (p<0.001). Children with underweight and severely underweight nutritional statuses were 28.7 times at risk of stunting (95% CI: 9.430-87.465).

Table 4 shows the multivariate analysis results when WAZ status was not included in the analysis, given its significance as a determining factor for stunting diagnosis. The variables that significantly influenced stunting were child's age (p=0.031) and birth length (p=0.017). Children aged 12-23 months had a 2.8 times risk of stunting (95% CI: 1.098-6.900) compared to children aged 6-11 months, while stunted birth length showed a 4.6 times risk (95% CI: 1.318-16.062) of stunting compared to normal birth length.

DISCUSSION

This study was the first to be carried out in three regions of South Sumatra

Table 4. Factors influencing stunting apart from WAZ status in children in South Sumatra (*N*=139)

Variable	*Adjusted*	
	OR (95% CI)	*p-value*†
Child's age		0.031*
6-11 months	1	
12-23 months	2.752 (1.098-6.900)	
Gender		0.154
Girl	1	
Boy	1.704 (0.819-3.544)	
Birth weight		
Normal	1	0.798
Low	1.172 (0.290-4.732)	0.823
High	2.242 (0.184-27.244)	0.526
Birth length		0.017*
Normal	1	
Stunted	4.600 (1.318-16.062)	
MAD status		0.493
Fulfilled	1	
Not fulfilled	0.753 (0.334-1.695)	
Mother's height		0.220
Normal	1	
Stunted	1.633 (0.745-3.576)	

MAD: Minimum acceptable diet; WAZ: Weight-for-age z-score
†Logistic regression multivariate analysis
*p<0.05

simultaneously. It identified the factors that determine the incidence of stunting in children aged 6-23 months in South Sumatra Province.

According to this study, the child's age factor had a significant relationship with the occurrence of stunting (p=0.031); namely, children aged 12-23 months had a 2.8 times risk of stunting (95% CI: 1.098-6.900) compared to children aged 6-11 months (Table 4). This result is consistent with those of other studies that demonstrated an increased likelihood of stunting as a child's age advances (Chowdhury *et al.*, 2020; Farah *et al.*, 2021). Similar results were shown by a study conducted in Northeast Ethiopia, wherein stunting was more common in children aged 12–23, 24–35, and 36–39 months compared to children aged 6–11 months (Gebreayohanes & Dessie, 2022).

This condition may be caused by motor skills development in different age groups, wherein children aged 6-11 months tend to be in their mother's arms more often and played in limited environments (e.g., on the bed, in a room at home) because children aged under 1 year must be kept safe and free from potential hazards so as to lessen the chances of them getting infected or getting sick from exposure to the outside environment (Herzberg *et al.*, 2022). Meanwhile, children aged over 1 year (≥12 months) prefer to move freely and explore the environment, so they are more likely to be in large playrooms and open play areas, such as parks or yards, to provide opportunities for them to run, jump, or move actively. On the other hand, this opens up opportunities for infection if the outside environment turns out to be dirty and polluted or if the children played outside of parental supervision (Kwong *et al.*, 2020).

Food intake is also an influential factor, especially at the beginning of the complementary food period, when such intake is still insufficient among young children. This is compounded by the family's poor economic conditions, along with requirements that grow with age. As a result, stunting occurs more frequently at older ages because of chronic malnutrition (Gewa & Yandell, 2012). One study result showed that the nutritional intakes of stunted children (energy, protein, calcium, and phosphorus) are on average below the recommended dietary allowance (RDA). Inadequate nutritional intake, especially from total energy, can lead to physical growth deficits in children (Ismawati *et al.*, 2020).

Limited food consumption and food diversity are additional determining factors. Children aged 6-11 months tend to consume more breast milk and foods prepared by their mothers (Nicklas, O'Neil & Fulgoni, 2020) in contrast to children aged 12-23 months, who can access various foods outside the home, but do not follow/practise overtly diverse diets given the potential to consume contaminated foods and/ or foods with low nutritional content and micronutrient deficiencies (Damtie, Tefera & Haile, 2020). While one study on children's oral activity revealed that children aged <12 months had a significantly higher frequency and average duration of object-to-mouth/ hand-to-mouth contact than children aged >12 months, this measurement was carried out indoors (Tsou *et al.*, 2015). For parents, improving the quality of food at home and supervising foods obtained outside the home are necessary actions.

In terms of gender disparity, the incidence of stunting as a whole was more common in boys (66.1%) than in girls (p=0.030). Boys were 1.8 times more at risk of stunting than girls (95% *CI* 0.687-4.483). This showed that the condition in South Sumatra was not much different from those in other regions of the world (Chowdhury *et al.*, 2020; Farah *et al.*, 2021). While stunting can affect boys and girls similarly, various studies have shown differences in the prevalence of stunting based on gender. For instance, research conducted in India from 2006 to 2016 revealed that boys were more susceptible to stunting than girls and that they also faced a higher likelihood of mortality at the age of 1 year. This indicates notable sex differences in the prevalence of stunting and mortality (Alderman *et al.*, 2021). A study conducted in Bangladesh also yielded similar results. The proportion of boys (35.7%) with stunting was higher than girls (31%) in the same age range of less than 24 months (Chowdhury *et al.*, 2020). A possible explanation for these findings is that boys and girls may exhibit differences in their preferences and styles of physical activity, although these differences are general and do not apply to every individual. However, this variation can impact the amount of energy expended, as well as the balance between food intake received and energy expenditure.

Some differences that may be seen between boys and girls in terms of physical activity include the following: (1) the type of activity chosen (boys tend to be more interested in strength- and speed-oriented physical activities, while girls are more interested in physical activities which involve more subtle movements); (2) the style of play (boys tend to play more vigorously and energetically, while girls tend to play in a more organised way, involving imaginative play and social roles); (3) and the level of activity (boys generally have a higher level of physical activity than girls; they have a greater urge to move, explore, and be intense) (Rosselli *et al.,* 2020). Therefore, for boys who have more physical activity than girls, insufficient food intake can lead to an energy imbalance, making boys more prone to malnutrition and eventual stunting.

The results of a review by Thurstans *et al.* revealed that despite having larger body sizes at birth and during infancy, boys are more susceptible to malnutrition than girls under conditions of food shortages. Additionally, boys exhibit more vulnerability to infectious diseases because of differences in their immune and endocrine systems. Another significant finding is that while the incidence of low birth weight (LBW) is higher in girls, LBW boys experienced a higher mortality rate than LBW girls (Thurstans *et al.*, 2020).

The results of the analysis also showed a significant relationship between birth length and stunting (p=0.017), and the risk of stunting was 4.6 higher in children with short birth length than children born with normal birth length (95% CI: 1.318-16.062). This finding aligns with those of previous studies. An examination of the results from the 2016 Ethiopian Demographic and Health Survey showed that one of the determinants of stunting was small stature at birth (Farah *et al.*, 2021). Short birth length indicates that there has been a restriction on the child's growth while in the uterus, likely caused by the mother's health during pregnancy (e.g., infectious diseases, chronic diseases, and other health problems) or nutritional factors during pregnancy that were not adequately fulfilled (Thahir *et al.*, 2023). This is in line with the results of this study, which showed that children born with LBW were 1.1 times at risk for stunting. In addition to welfare factors in the womb, genetic factors can also affect the child's body length at birth; when parents have shorter body sizes, it is most likely that the child will have a shorter birth length (Li *et al.*, 2020). According to the results of this study, stunted mothers had a higher prevalence of stunted children (58.8%) compared to mothers with normal height (42.0%); however, this difference did not reach statistical significance (p=0.056).

It is well known that a child's height is influenced by a combination of genetic and environmental factors. Although genetic factors generally play a significant role in determining a person's height, a child's height is also influenced by environmental factors, such as good nutrition, adequate health care, and generally healthy living conditions (Thahir *et al.*, 2023). Adequate nutrition during childhood growth and an environment that supports healthy growth can help children reach their optimal height potential. Although short birth length does not directly determine stunting in children, it can serve as a predictive factor for the risk of stunting at later stages of child development.

The WAZ status of children, as indicated by the results of both bivariate (Table 2) and multivariate analyses (Table 3), revealed a significant relationship with and exerted a substantial influence on stunting. Children with WAZs in the underweight and severely underweight categories had higher odds of stunting (OR = 28.7, 95% CI: 9.430-87.465; p<0.001) than children in the normal category. In another study in Northwestern Nigeria, children with wasting were more likely to be stunted, and those who were thin and short were predominantly in the age group of 12-23 months (52.4%) (Imam *et al.*, 2021).

Weight-for-age is considered very important to ensure optimal growth in children; adequate nutrition not only supports overall growth, but also fulfils the nutritional requirements for building and repairing tissues, including bones and muscles. Conversely, if a child is underweight or has poor nutrition, his or her body may not have sufficient resources to support optimal growth. Inadequate food intake can cause weight loss and if it is sustainable, it has the potential to inhibit child growth/height, followed by decreased immunity and mucosal damage, increasing the risk of disease (Thurstans *et al.*, 2022). However, being overweight or obese can also have a negative impact; obesity can interfere with the performance of growth hormones, which can then limit a child's height (Zhang *et al.*, 2021).

In cases of malnutrition, a child's nutritional status is also determined from the time of the mother's pregnancy and can be predicted from the infant's birth weight. Maternal nutrition during pregnancy plays an important role in the regulation of foetal-placental development. When the mother is malnourished, the structure of the placenta changes, so the flow of nutrients to the foetus also changes, ultimately affecting the growth and development of the foetus and pregnancy outcomes (Thurstans *et al.*, 2022). Regarding nutrition during pregnancy, this can be well prepared if the mother is still a teenager. It is known that adolescents easily accept lifestyle changes that may determine the course of their lives. They can be protected from diseases, malnutrition, and the immediate and long-term impacts on their own and their children's health by receiving health education interventions on nutrition-related knowledge, attitudes, and practices. This knowledge includes details of food groups, diversity, micronutrient-rich food sources, sanitation, hygiene, and the impact of malnutrition (Shapu *et al.*, 2020).

Referring to the research results that identified the factors influencing stunting in South Sumatra Province such as child's age, birth length, and WAZ status, it is recommended that the provincial government implements a targeted nutrition intervention programme. This programme should prioritise providing additional food for pregnant women with chronic energy deficiency, monitoring the growth and development of toddlers, and managing toddlers with nutritional problems. Through these measures, it is hoped that the province can accelerate the reduction in stunting rates.

This study has several strengths. The researchers deliberately selected locations with diverse characteristics, encompassing both districts and cities in South Sumatra Province. This careful selection aimed to ensure that the findings were representative of the entire province. Additionally, the study examined a substantial number of variables. The limitation of this study was that for this large number of variables, the sample size may not be adequate. Therefore, it is suggested that further research can add more subjects and reach other provinces. Another limitation was that we were unable to match the subjects investigated. We have made matching efforts at the district-level subject selection stage; however, at the health service centre level, when data collection was to be carried out, the research subjects present did not match the designated subjects. Because of time, resource, and technical limitations, matching was not feasible; hence, the children present who fulfilled the study criteria were recruited as research subjects. To mitigate the impact of selection bias, we performed multivariate analysis using a logistic regression test adjusted for age and gender.

CONCLUSION

Factors that affect stunting in children aged less than 24 months vary widely. This study found evidence that a number of factors had a significant influence on the prevalence of stunting, namely child's age, birth length, and WAZ status. In alignment with the specific nutrition intervention programme outlined by the Indonesian government, it is recommended that the South Sumatra provincial government, in accelerating the reduction of stunting in its region, focuses on interventions providing additional food for pregnant women with chronic energy deficiency, monitoring the growth of toddlers, and managing toddlers with nutritional problems. Efforts to increase parents' knowledge about child nutrition need to be carried out on an on-going basis to reduce the incidence of malnutrition and to prevent stunting.

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Authors' contributions

Andreinie R, principal investigator, conceptualised and designed the study, led the data collection in the South Sumatra Province, conducted the study, data analysis and interpretation, drafted the manuscript, prepared the draft of the manuscript and reviewed the manuscript; Sekartini R, advised on the concept of study and data collection, reviewed the manuscript; Chandra DN, advised on data analysis and interpretation, assisted in drafting the manuscript, reviewed the manuscript; Mudjihartini N, advised on the examination of subject samples and reviewed the manuscript.

Conflict interests

The authors declare that they have no conflict of interest.

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