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RESEARCH ARTICLE

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Maternal, Child, and Household Risk Factors for Children with Stunting

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Abstract:

Background: Stunting is a major public health issue in Indonesia. It affects children's physical and cognitive development, educational outcomes, and quality of life, increasing the risk of chronic diseases in adulthood. Addressing the determinants of stunting is vital for achieving the sustainable development goal of zero hunger.

Objective: The study aims to identify maternal, child, and household risk factors for stunting in West Bandung Regency, Indonesia.

Methods: This cross-sectional study was conducted on 122 children from 10 villages in the Padalarang area. Stunting status was measured by a doctor and verified by a pediatrician based on WHO growth standards. The demography, household, maternal, and child risk factors were collected using the standard Indonesia Basic Household Health Research (Riskesdas) questionnaire. Statistical analysis was used for the Chi-square and Fisher Exact test, while logistic regression was used to determine a model on the most important risk factors. Data analysis was done using the SPSS v.25 program.

Results: Out of 119 evaluable datasets, 87 children were classified as stunted, with 44 stunted and 43 severely stunted. The majority of stunting was observed in boys aged 24–59 months, mostly with low parental education levels and underweight status. Significant risk factors for stunting included a history of low birth weight, lack of maternal immunization against Tetanus Toxoid, and insufficient intake of animal-based proteins. The multivariate analysis identified age, protein deficiency, and diarrhea as critical predictors.

Conclusion: Stunting is predominantly influenced by demographic factors, low parental educational level, nutritional insufficiency, and diarrhea. Targeted nutritional interventions and healthcare strategies focusing on protein intake and managing diarrhea among young children can effectively mitigate stunting rates in this region.

Keywords: Children, Household, Maternal, Risk factor, Stunting, Community health.

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1. INTRODUCTION

Stunting is still a health problem in Indonesia and around the world. The Sustainable Development Goals (SDGs) state that it is the second indicator that must be completed to achieve zero goals by 2030. World Health Organization (WHO) data finds that Indonesia is the fifth largest country with the highest number of stunted children, with a prevalence of 30–39% [1-4]. Although there has been a significant decrease compared to the previous years, the incidence of stunting still makes Indonesia a country with a high stunting rate [2, 3]. Based on data from the Indonesian Ministry of Health in 2018, Indonesia has the highest prevalence of stunting in Southeast Asia compared to Vietnam (23%), Thailand (16%), and Singapore (4%). The incidence of stunting is projected to be 127 million in 2025 worldwide. It is estimated that 56% of stunted children live in Asia and 36% in Africa. The incidence of stunting in Indonesia in 2018 decreased to around 29.6%–30.8%, which is still above the WHO standard of 20% [1, 2]. Stunting is the impact of chronic nutritional problems in the first 1,000 days of a child's life. Stunting is influenced by many factors, from the maternal phase to the postnatal stage. Factors that influence the incidence of stunting include inadequate nutrition in pregnant women, chronic diseases suffered by a child from birth, the number of children living in the same house, and the socioeconomic status of the family [2-4]. Other main factors causing stunting in Indonesia are poverty, lack of access to clean water, poor environmental conditions, and lack of clean and healthy living behavior [3-5]. All these factors contribute to a greater risk of illness and death in children with stunting [2, 6, 7]. The cause of stunting is the interaction of household, environmental, socioeconomic, and cultural aspects, as explained in the framework of the WHO [2, 8, 9]. The results of a previous literature review show that risk factors for stunting were 3.82 times in babies with birth weight <2.500 grams. Another risk factor is maternal education, with 1.67 times, and the low household income factor significantly increases the risk of stunting by two times. Poor sanitation factors increase the risk five times, while inadequate sanitation is another dominant factor [4, 10]. Feeding practices for children must be of primary concern. Breastmilk and complementary food are essential in the first two years of life. Lack of animal-based protein intake increases the incidence of stunting. Premature babies, babies with low birth weight, and babies with a history of linear fetal growth are at risk of developing nutritional problems and are susceptible to stunting [4, 11]. Stunting is influenced by many factors, starting from the maternal phase or during pregnancy until postnatal. Stunting is also caused by household, environmental, socioeconomic, and cultural factors. Determining the main factors for reducing stunting is important so policymakers know what to target to implement targeted policies and programs [4, 6, 7].

2. MATERIALS AND METHODS

This cross-sectional observational study, based on data from 122 children with stunting (total sampling) from the community health posts (Posyandu) in 10 villages in Padalarang District, West Java, Indonesia, was meticulously conducted from August to October 2023. The data was reconfirmed with measurements performed by a doctor and verified by a pediatrician. Three incomplete data points were excluded, leaving 119 for analysis.

The data was verified and a comprehensive physical examination was conducted, which included measuring the child's height and weight with utmost care. Children with comorbid congenital heart disease, malignancy, and chronic illnesses such as cerebral palsy were excluded. A digital infant or baby scale was used to measure the weight of children under two years old, ensuring accuracy to the nearest 0.01 kg. For children older than 24 months, a balanced or electronic floor scale was used.

The recumbent length measurement was used for children less than 24 months old or for infants and toddlers who could not stand. An operator aligned the infant's head against the top of the headboard of the infantometer or length board, and an assistant straightened the infant's body and legs, ensuring the feet were parallel to the footboard. For children ≥ 24 months old or children who could stand, measurements were made using a stadiometer (Frankfurt Plane). The children were made to stand straight, with heads, buttocks, shoulder blades, calves, and heels touching the back of the wall. The feet faced outward at a 60 degree angle, and the arms hung loosely at the sides with palms facing the thighs. The horizontal bar of the stadiometer was lowered until the hair was compressed to the crown of the head. The measurement was made to the nearest 0.1 cm. The average of the three closest measurements was recorded. Stunting was determined based on anthropometric Z-score according to WHO child growth standards (body length/Age or height/Age < -2 SD), consisting of short (stunted) body length or height/age -2 – -3 SD and very short (severely stunted) body length/height <-3 SD.

The data for demography, household, maternal, and child risk factors was collected using questionnaires from the Indonesia Basic Household Health Research (Riskesdas), which have been validated. The questionnaire was completed by parents who had stunted children, with the assistance of cadres and health workers. These local community members played a crucial role in facilitating the data collection process and ensuring the participation of households. Statistical analysis used the Chi-square test and Fisher Exact test for the bivariate variable test (for statistical significance, a p-value less than 0.05 was considered significant). A logistic regression analysis test was conducted if the bivariate test of the variable was less than or equal to 0.25. The logistic regression analysis was used to determine a model for stunting based on the most critical risk factors one by one (for statistical significance, a p-value less than 0.05 was considered significant). Data analysis was done using the SPSS v.25 program. This research was approved by the Health Research Ethics Committee (KEPK) of Bandung Islamic University, Number 192/KEPK-Unisba/VI/2023.

3. RESULTS

The study's results were based on the data from 119 children (from data collected from 122 stunted children) from 10 villages in the Padalarang district, who had been examined and verified. The data from three children was incomplete, so physical examinations were conducted only on 119 children. The results of 119 children showed that 32 (26.9%) were normal, while 87 (73.1%) were stunted. Of the 87 children, 44 were short (stunted), and 43 children were very short (severely stunted). The results of the study on 119 children showed that 54.6% were female, 55.5% were 24–59 months old, 11.8% had low birth weight (LBW), 37.8% were wasting (underweight) based on body weight/age, 37.0% were short (stunted) based on body length or height/age, and 66.4% had good nutritional status (well nourished), which was determined based on body weight/length or height. The characteristic demographic of the subjects can be seen in Table **1**.

In this study, a total of 87 children with stunting were identified. Among them, 50.5% were short (stunted), 63.2% were aged 24–59 months, 50.6% were male, with low father and mother education (< senior high school) and low family income, 44.8% wasting (underweight), and 24.1% with multiple neck lymphadenopathy ≥ 1 cm. The demographic characteristics and clinical features of stunted children are presented in Table **2**.

Table 1. Characteristics of subjects.

Characteristic	Median	Minimum–Maximum	Amount (n = 119)	Percentage (%)
Age (month)	29	2–60	-	-
Age classification - < 24 - 24–59	-	-	53 66	44.5 55.5
LBW - Yes - NO	-	-	14 105	11.8 88.2
Gender - Male - Female	-	-	54 65	45.4 54.6
Body length or height/age - Normal - Short (stunted) - Very short (severely stunted)	-	-	32 44 43	26.9 37.0 36.1
Stunting (n = 87) - Short (stunted) - Very short (severely stunted)	-	-	44 43	50.6 49.4
Body weight/age - Very wasting (severely underweight) - Wasting (underweight) - Normal - Risk of overweight	-	-	33 45 40 1	27.7 37.8 33.6 0.9
Nutritional status (Body weight/length or height) - Severely wasted - Wasted - Normal	-	-	12 28 79	10.1 23.5 66.4

Table 2. Demographic characteristics and clinical features of children with stunting.

Characteristic and Clinical Features	Amount (n = 87)	Percentage (%)
Age - < 24 - 24–59	32 55	36.8 63.2
Gender - Male - Female	44 43	50.6 49.4
Father's education - Low (< Senior high school) - High (≥ Senior high school)	55 32	63.2 36.8
Mother's education - Low (< Senior high school) - Tinggi (≥ Senior high school)	61 26	70.1 29.9

(Table 2) contd.....

Characteristic and Clinical Features	Amount (n = 87)	Percentage (%)
Parent's Income - < IDR 3,480,795 - ≥ IDR 3,480,795	81 6	93.1 6.9
Family members - ≤ 4 people - > 4 people	40 47	46.0 54.0
Maternal gestational age - High risk (<20 – >35 years old) - Standard risk (20 – 35 years old)	68 19	78.2 21.8
Clinical features of children with stunting	-	-
Anemic conjuctiva - None - Yes	66 21	75.9 24.1
Neck lymphadenopathy ≥ 1 cm and multiple - None - Yes	66 21	75.9 24.1
Body weight/age - Very wasting (severely underweight) - Wasting (underweight) - Normal - Risk of overweight	31 39 17 0	35.6 44.8 19.6 0
Nutritional status (body weight/body length or body weight/body height) - Severely Wasted - Wasted - Normal	10 22 55	11.5 25.3 63.2

This comprehensive research identified several risk factors in children with stunting, such as being in the age group of 24–59 months, having a history of LBW, having mothers who did not receive Tetanus Toxoid (TT) immunization, and having a diet with less frequent intake of animal-based proteins. These findings, when compared to normal children, are detailed in Tables **3-6**, demonstrating the thoroughness of our investigation.

Table 3. Demographic risk factors for stunting compared to normal children.

Risk Factors	Stunting, n (%)		p	Prevalence Ratio (PR)
	Yes	No		
Age (months)§ - <24 - 24–59	32 (26.9) 55 (46.2)	21 (17.6) 11 (9.3)	0.005*	0.7
Gender§ - Male - Female	44 (37.0) 43 (36.1)	10 (8.4) 22 (18.5)	0.06	-
Father's education§ - Low (< senior high school) - High (≥ senior high school)	55 (46.3) 32 (26.9)	16 (13.4) 16 (13.4)	0.19	-
Mother's education§ - Low (< senior high school) - High (≥ senior high school)	61 (51.3) 26 (21.8)	19 (16.0) 13 (10.9)	0.27	-
Parent's income§ - < IDR 3,480,795 - ≥ IDR 3,480,795	81 (68.2) 6 (5.0)	26 (21.8) 6 (5.0)	0.06	-

Note: §Chi-square test; ^Fisher exact test; *p < 0.05, significance.

Table 4. Household risk factors for stunting compared to normal children.

Risk Factors	Stunting, n (%)		p
	Yes	No	
Family members§ - ≤ 4 people - > 4 people	40 (33.6) 47 (39.5)	15 (12.6) 17 (14.3)	0.93

(Table 4) contd.....

Risk Factors	Stunting, n (%)		p
	Yes	No	
Transport costs to primary health care are affordable^ - yes - no	78 (65.5) 9 (7.6)	29 (24.4) 3 (2.5)	0.59
Closed household waste disposal§ - yes - no	35 (29.4) 52 (43.7)	19 (16.0) 13 (10.9)	0.06
Open household waste disposal§ - yes - no	51 (42.8) 36 (30.3)	14 (11.8) 18 (15.1)	0.15
Hand washing behavior^ - yes - no	83 (69.7) 4 (3.4)	30 (25.2) 2 (1.7)	0.51

Note: §Chi-square test; ^Fisher exact test; *p < 0.05, significance.

Table 5. Child risk factors for stunting compared to normal children.

Risk Factors	Stunting, n (%)		p	Prevalence Ratio (PR)
	Yes	No		
LBW^ - yes - no	14 (11.8) 73 (61.3)	0 (0) 32 (26.9)	0.009*	1.4
Anemic conjunctiva§ - yes - no	21 (17.6) 66 (55.5)	5 (4.2) 27 (22.7)	0.32	-
Neck lymphadenopathy > 1cm, multiple^ - yes - no	21 (17.6) 66 (55.5)	4 (3.4) 28 (23.5)	0.12	-
Fever (last one month)§ - yes - no	26 (21.8) 61 (51.3)	9 (7.6) 23 (19.3)	0.85	-
Cough < 2 weeks (last one month)§ - yes - no	33 (27.7) 54 (45.4)	10 (8.4) 22 (18.5)	0.50	-
Diarrhea (last one month)^ - yes - no	19 (16.0) 68 (57.1)	3 (2.5) 29 (24.4)	0.09	-
Pneumonia (last one year)^ - yes - no	4 (3.4) 83 (69.7)	2 (1.7) 30 (25.2)	0.51	-
High fever (last one year)§ - yes - no	13 (10.9) 74 (62.2)	5 (4.2) 27 (22.7)	0.93	-
Cough (last one year)§ - yes - no	37 (31.1) 50 (42.0)	11 (9.3) 21 (17.6)	0.42	-
Exclusive breastfeeding^ - yes - no	77 (64.7) 10 (8.4)	31 (26.1) 1 (0.8)	0.15	-
Vegetable-based Vit A intake (last 24 hours)§ - yes - no	45 (37.8) 42 (35.3)	18 (15.1) 14 (11.8)	0.66	-
Plant-based proteins intake (last 24 hours)§ - yes - no	54 (45.4) 33 (27.7)	21 (17.6) 11 (9.3)	0.72	-
Animal-based proteins intake (last 24 hours)^ - yes - no	1 (0.8) 86 (72.3)	5 (4.2) 27 (22.7)	0.005*	0.2
Egg intake (last 24 hours)§ - yes - no	32 (26.9) 55 (46.2)	13 (10.9) 19 (16.0)	0.70	-

(Table 5) contd.....

Risk Factors	Stunting, n (%)		p	Prevalence Ratio (PR)
	Yes	No		
Child additional food intake program (last one year)^ - yes - no	18 (15.1) 69 (58.0)	4 (3.4) 28 (23.5)	0.23	-

Note: §Chi-square test; ^Fisher exact test; *p < 0.05, significance.

Table 6. Maternal risk factors for stunting compared to normal children.

Risk Factors	Stunting, n (%)		p	Prevalence Ratio (PR)
	Yes	No		
Maternal gestational age^ - High risk (<20 – >35 years old) - Standard risk (20 – 35 years old)	68 (57.1) 28 (23.5)	19 (16.0) 4 (3.4)	0.19	-
Pregnancy check-up by health workers^ - yes - no	85 (71.4) 2 (1.7)	32 (26.9) 0 (0)	0.53	-
Maternal height measurement in pregnancy^ - yes - no	70 (58.8) 17 (14.3)	28 (23.5) 4 (3.4)	0.43	-
Maternal body weight measurement in pregnancy^ - yes - no	83 (69.8) 4 (3.3)	32 (26.9) 0 (0)	0.28	-
Blood pressure measurement in pregnancy^ - yes - no	84 (70.5) 3 (2.5)	32 (27) 0 (0)	0.39	-
Upper arm circumference measurement in pregnancy§ - yes - no	75 (63.0) 12 (10.1)	27 (22.7) 5 (4.2)	0.80	-
TT immunization in pregnancy^ - yes - no	74 (62.2) 13 (10.9)	32 (26.9) 0 (0)	0.01*	0.7
Iron supplementation intake in pregnancy^ - yes - no	80 (67.2) 7 (5.9)	31 (26.1) 1 (0.8)	0.31	-
Maternal Additional Food Intake program^ - yes - no	9 (7.6) 78 (65.5)	0 (0) 32 (26.9)	0.05	-
Delivery methods^ - Normal - Sectio cesaria	76 (63.9) 11 (9.3)	29 (24.3) 3 (2.5)	0.45	-
Referral delivery^ - yes - no	17 (14.3) 70 (58.8)	4 (3.4) 28 (23.5)	0.27	-

Note: §Chi-square test; ^Fisher exact test; *p < 0.05, significance.

Table 7. Stunting risk factor model based on logistic regression test.

Risk Factors	p	Exp (B)	95%CI
Age	0.004*	4.04	1.58–10.33
Maternal additional food intake	0.99	-	-
Animal-based proteins intake in children	0.024*	0.01	0.01–0.71
Diarrhea in children	0.034*	4.83	1.13–20.61

Note: Regression logistic test with backward (wald), *p < 0.05, significance.

Our multivariate logistic regression test, employing the backward (Wald) method, yielded a significant probability of 0.744 from the Hosmer and Lameshow Goodness of Fit Test, indicating the suitability of the test model for further analysis. This insightful result, with the overall percentage figure increasing from 73.1% to 76.5%, provides a solid foundation for our research.

Our results, obtained by meticulously analyzing each risk factor with $p \leq 0.25$ (Table 7), revealed that age, animal-based protein intake in the last 24 hours, and diarrhea in the last month were the determinant risk factors related to stunting.

4. DISCUSSION

Based on the results, males and females did not differ in this study, even though the ratio of boys was slightly higher. This research is different from previous research, which found that stunting in children is more common in boys and is one of the risk factors for stunting [4, 12, 13]. Previous research also stated that this was a result of boys' vulnerability to infections and other diseases that could disrupt children's growth [11, 12, 14]. According to the World Health Organization (WHO), sex-based biology is not included in the framework of stunting, even though boys are generally more susceptible to stunting than girls in developing countries. However, the mechanisms have not been cleared. One possibility is the diversity of biological factors, living conditions, and differences in eating patterns due to cultural perceptions about gender differences [2, 4].

Most of the stunted children were aged 24–49 months, which is similar to previous research [12, 15]. The prevalence of stunting is higher in children aged 24–59 months in India, Nepal, and Pakistan [15]. This research also found that children aged 24–59 months were found to have higher stunting cases than younger ones (0–23 months). The finding also followed 2018 Riskesdas data, which shows that the number of stunting cases tends to be more significant as age increases [16]. Stunting can start when the child is still in the womb. It occurs due to inadequate nutritional intake of pregnant women, which can have an impact on babies having low birth weight (LBW). Especially when mothers do not get adequate intake over a long period, which is worsened by inadequate sanitation and hygiene at home, all these factors can increase the risk of infectious diseases and subsequently disrupt children's growth and development [12, 17].

The impact of the transition from breastfeeding, where most children are given breast milk until 24 months, is a significant area of study. As breastfeeding gradually decreases as the child ages, combined with limited complementary feeding and lack of food diversity, which is very important for a child's growth and development, it becomes an intriguing topic for researchers in child health and development. Focusing on the first two years of a child's life is essential [2, 4, 18]. Other factors include low father and mother education level, family income less than the minimum district income, number of family members of more than 4 people, and high-risk maternal gestational age (< 20 years, > 35 years) [4, 19-21]. Parents with low education have limited adequate information about caring for children's growth and development [19, 22]. The level of education is also related to knowledge about nutrition; a mother who does not have good knowledge on following up on monitoring children's growth and development, such as inadequate feeding practices and inadequate access to health services, will have problems in maintaining their children's nutritional status [2, 4, 12].

Nutrition and health education programs are crucial, particularly for mothers with children under five years old, in terms of hygiene and sanitation [4, 23]. Educated women have been found to have a longer life expectancy, reduced mortality rates, and increased overall knowledge of children's health and nutritional status [15, 24]. The influence of culture in many Asian countries still leads parents to prioritize their son's education. However, the education and occupation of parents, especially mothers, are crucial. Children with highly educated mothers have been shown to grow better [2, 4, 25], emphasizing the importance of maternal education in child health.

Poverty is closely linked to a lack of nutrient intake and limited food availability. Low education levels further compound this, leading to limited access to health facilities, clean water, and good sanitation. It is crucial that we recognize the role of education in combating poverty and its associated health risks [4, 26]. Low family income causes food insecurity, can worsen diet quality, and is associated with an increased risk of nutritional variations, which can potentially improve undernutrition, leading to stunting [2, 4, 27]. A large number of family members can cause a decrease in the amount of food given to children, resulting in inadequate nutrition [27, 28]. The relationship between maternal age during pregnancy and stunting is that the younger the mother's age during pregnancy, the greater the incidence of stunting in her child. The risk of stunting decreases with increasing maternal age at birth [4, 29].

Children born to mothers younger than 19 years old have a 30–40% increased risk of stunting at two years and failure to complete school. This impact is largely due to the mother's lack of experience, independence in determining foods with optimal nutrition, and poor habits in maintaining cleanliness and health [30, 31]. Young mothers must receive assistance to ensure good nutrition and their children's education [4, 31].

Conversely, mothers aged 35 years or older face a 30% increase in the risk of giving birth to a premature baby. These older mothers often grapple with an increased risk of comorbid diseases such as obesity, diabetes, and hypertension, which are usually associated with complications during pregnancy. Understanding these challenges is crucial in providing the best care for these mothers [30, 31].

In this study, it was found that 24.1% of stunted children have neck lymphadenopathy ≥ 1 cm, a higher percentage than the 18.3% reported in previous research. This suggests a significant coexistence of malnutrition and childhood tuberculosis. Furthermore, a previous study observed underweight, wasting, and stunting in 68.4%, 63.3%, and 53.3% of tuberculosis cases, respectively [32]. These findings underscore the need for more detailed diagnosis in health settings, particularly in clinical findings and ancillary examinations, to effectively address this issue.

Based on nutritional status (body weight/age), the majority of stunted children are wasting (underweight) and very wasting (severely underweight), while based on body weight/length or height, the majority are well nourished (normal). Previous studies found a relationship between undernutrition and stunting in children [33], suggesting that undernutrition can lead to stunting. It also emphasizes the importance of providing nutrition and comprehensive health services to thin (wasting) children to minimize wasting on linear growth. This holistic approach to care is crucial, as severe or repeated wasting can contribute to stunting, but the highest prevalence of stunting cannot be explained solely by wasting alone [34, 35].

Various theories suggest that wasting can cause stunting. Other evidence also indicates that stunting causes wasting, which shows a new perspective on how wasting and stunting are related. However, the explanation for this still needs to be improved. Further research is required to understand the underlying mechanisms and identify programmatic implications [35]. Failure to thrive (weight faltering) is defined as inadequate weight gain at an early age, which needs to be appropriately managed so that the baby returns to growth according to the growth curve and does not become chronically malnourished or stunted. Growth monitoring, especially in communities and primary health facilities, is a crucial practice that can be carried out according to the Indonesian Minister of Health in 2020. Its importance cannot be overstated in preventing chronic malnutrition or stunting [11, 36].

This research underscores the urgency of the issue, showing that stunting is more common in children aged 24–59 months. While interventions are currently targeted at ages 0–23 months in the first 1000 days of a child's life, there is a pressing need to increase the focus of interventions on children aged 24–59 months. Previous research also provides evidence regarding the effects of stunting. It emphasizes the need for timely provision of additional food to meet the increasing nutritional needs, especially in preschool-aged children. This highlights health professionals' and policymakers' responsibility and commitment to addressing this issue [15].

Stunting is an interrelated process throughout the life cycle. The period between conception and the first two years of life (first 1000 days) is the most responsive if prevention or intervention is carried out, while in the period between two years of age or middle childhood and adolescence, a process of pursuing linear growth can occur. However, improvements in cognitive development still cannot be explained with certainty [11, 37]. This study found that low birth weight (LBW) babies were 1.4 times more likely to become stunted, underscoring the significant impact of low birth weight on stunting. In addition to the problem of inadequate intake, low birth weight is a major risk factor for stunting, including babies with linear fetal growth, small gestational age (SGA) without linear fetal growth, and prematurity. The large number of babies born with low birth weight presents a significant challenge for health workers to ensure optimal growth in the first 1000 days of life, thereby preventing future growth disorders or stunting [7, 11, 37].

Lack of animal-based protein intake has a higher risk of stunting, and it was found that it is a protective factor for stunting. Premature babies, babies with low birth weight, and babies with a history of linear fetal growth are at risk of developing nutritional problems and are susceptible to stunting. Likewise, babies with inadequate feeding practices are introduced to a baby's diet to provide additional nutrients and energy when given breast milk and complementary foods, solid or semi-solid. Protein and zinc are often associated with nutrients that can improve stunting. Both are type 1 nutrients that respond to stopping the growth process if there is a deficiency, and both are very dependent on intake from outside the body. Animal-based protein and breast milk contain complete amino acids and have high absorption capacity, so both are highly recommended to be consumed in quantities appropriate to children's needs during periods of rapid growth. Beef, fish or seafood, poultry, and milk contain lots of insulin-like growth factor-1 (IGF-1). This hormone plays a crucial role in a child's growth and height and helps with the maturation and protection of digestive tract digestibility [11, 38]. Providing high-quality protein (animal-based proteins) ensures that children's protein and zinc needs are met during a period of rapid growth, especially in the first two years of life (golden period) [11].

In this study, the protective effect of TT immunization on neonatal health was evident. Mothers who did not receive TT immunization during pregnancy were found to have a higher risk of stunting. Stunting, in this context, refers to the impaired growth and development that children experience due to poor nutrition, repeated infection, and inadequate psychosocial stimulation. After analyzing socio-economic, demographic, and health system factors related to other variables, such as antenatal care (ANC) and iron supplementation, the results of previous studies further reinforced the substantial protective effect of antenatal vaccination on neonatal motility [39, 40]. Previous research also found that adequate doses of TT immunization were 1.97 times higher if given to women who made four ANC visits than those who made infrequent visits. This occurs 2.39 times more often in rural areas than in urban areas. Immunization is a preventive measure to protect women during pregnancy and can reduce undesirable impacts on health during infancy [40].

TT immunization for pregnant women is closely linked to ANC visits. The frequency of these visits plays a crucial role in maintaining the health of both the mother and the baby. It is important to remember that the more often pregnant women check their pregnancies, the better the health outcomes for both will be. This underscores the role of the mother in taking responsibility for her and her baby's health, empowering her with the knowledge that regular ANC visits can significantly improve health outcomes.

This study identified age and loose stools (diarrhea) in the last month as the most significant risk factors for child stunting. Our findings also highlighted the protective role of animal-based protein intake in preventing stunting in children. This underscores the importance of a balanced diet, empowering healthcare professionals, nutritionists, policymakers, and researchers in child development and public health to make informed decisions for child health.

Studies on child growth and development have found that disturbances in children's attainment of body length begin to occur as early as one month old. This early onset underscores the urgency in addressing these issues to ensure optimal child growth and development [12, 41].

Previous research found that the prevalence of stunting was higher in older children around 28 months, possibly due to repeated exposure to undernutrition and infection. In many countries, the prevalence of stunting is low in older children, *i.e.*, after 28 months, possibly because most exposure decreases, has less impact on older children, and is accompanied by catch-up growth. Catch-up growth, in this context, refers to the accelerated growth in children who have experienced a period of growth restriction. The highest prevalence age for stunting is less consistent in various countries. The prevalence of stunting and the increasing gradient of stunting prevalence based on age vary across parts of the world, living standards, and gender [42]. Diarrhea can trigger malnutrition due to anorexia, malabsorption, protein loss due to enteropathy, and fasting in children with diarrhea. Insufficient intake and malabsorption caused by disease, especially recurrent diarrhea, are the main causes of malnutrition, including stunting [43, 44]. Environmental enteric dysfunction (EED) occurs in developing countries with poor sanitation and limited public health resources, in conjunction with microbial and parasitic contamination of food and water [43, 45].

Nutritional deficits that occur during the early development of the gastrointestinal tract can disrupt its maturation and facilitate the occurrence of environmental enteric dysfunction (EED) in infancy or early childhood. EED, a condition prevalent in developing countries with poor sanitation and limited public health resources, is a significant factor contributing to the high prevalence of stunting. Children with EED experience a lack of micronutrients absorbed in the small intestine, which can reduce appetite and growth of intestinal villi, thereby inhibiting children's growth [43, 46].

Feeding practices for children are paramount, with breastfeeding and complementary food being the most crucial foods in the first two years of life. Mother's milk, a quality source of babies' nutrient needs, and quality complementary foods are important and the cornerstone for optimal growth and development [11, 47]. Understanding and implementing good breastfeeding and complementary feeding practices form a solid foundation for preventing stunting. Regular monitoring of growth and development from birth is not just essential, but it is a key strategy. Identifying inadequate weight gain and managing it appropriately is the easiest way to prevent stunting [2, 4, 11].

Overcoming stunting and environmental enteric dysfunction (EED) requires a comprehensive approach. Nutritional interventions, while important, may not always produce the expected results in children who have experienced stunting and changes in intestinal morphology and function [36, 48]. Therefore, efforts to overcome stunting should also include increasing access to clean drinking water, improving hygiene and environmental sanitation, and providing adequate nutrition with macronutrients, micronutrients, and vitamins [36, 49].

Stunting is a complex issue caused by household, environmental, socio-economic, and cultural factors. Our study, with its observational cross-sectional design, provides valuable insights. However, further research using alternative methods is crucial to establish cause-and-effect relationships with risk factors in children with stunting.

5. LIMITATIONS

Our research, while informative, is an initial study using a cross-sectional design that cannot conclusively establish a causal relationship. Further study with alternative methods and exploring other risk factors is important and urgent to avoid bias and advance our understanding of childhood stunting. Examining biomarker factors, which we have not yet explored, is also essential for future research in this field.

CONCLUSION

This study concludes that stunting is a complex issue. Stunting risk factors include young mothers who received no Tetanus Neonatorum Vaccines (TT), having low education levels, showing poor habits of cleanliness and health maintenance, and having limited access to health services. Other factors for stunting were children with a history of low birth weight, a diet with fewer animal-based proteins, and health-related factors, especially diarrhea. Implementing specialized nutritional programs that emphasize adequate protein consumption and comprehensive healthcare strategies to manage and treat diarrhea effectively can substantially lower the incidence of stunting among young children in this region. These targeted interventions are crucial for ensuring proper growth and development in early childhood, thereby addressing one of the primary health challenges faced by the community.

AUTHORS' CONTRIBUTIONS

It is hereby acknowledged that all authors have accepted responsibility for the manuscript's content and consented to its submission. They have meticulously reviewed all results and unanimously approved the final version of the manuscript.

LIST OF ABBREVIATIONS

ANC	=	Antenatal Care
BH	=	Body Height
BW	=	Body Weight
EED	=	Environmental Enteric Dysfunction

LBW	=	Low Birth Weight
TT	=	Tetanus Toxoid
WHO	=	World Health Organization

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This research has been approved by the health research ethics committee (KEPK) of Bandung Islamic University, Indonesia, number 192/KEPK-Unisba/VI/2023.

HUMAN AND ANIMAL RIGHTS

All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was provided by the guardians.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data and supportive information are available on request due to privacy restrictions.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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