

## Environmental, Maternal, and Socioeconomic Factors Associated with Stunting among Under-Five Children in Pengadegan Village, Sumedang Regency: A Cross-Sectional Study

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### Abstract

**Background:** Stunting remains a major public health issue reflecting chronic undernutrition during early childhood. In Sumedang Regency, the prevalence of stunting is 27.6%. This study aimed to identify environmental, maternal, and socioeconomic factors associated with stunting among under-five children in Pangadegan Village, Sumedang Regency.

**Method:** A cross-sectional study was conducted in May 2023 among 170 children aged 5 years or younger. Data were collected through structured interviews and anthropometric measurements. Independent variables included drinking water quality, sewage facilities, maternal anemia during pregnancy, maternal nutritional status during pregnancy, birth weight, exclusive breastfeeding, history of infectious diseases, maternal education, and family income. This study performed multivariable analyses to estimate prevalence ratios (PRs) with 95% confidence intervals (CIs).

**Results:** The prevalence of stunting was 28.8%. In adjusted analysis, inadequate sewage facilities (PR: 3.38; 95% CI: 1.25–11.28), unsafe drinking water (PR: 3.38; 95% CI: 1.50–7.60), low maternal hemoglobin during pregnancy (PR: 2.64; 95% CI: 1.05–6.64), and non-exclusive breastfeeding (PR: 2.36; 95% CI: 1.03–5.38) were significantly associated with stunting.

**Conclusion:** Environmental sanitation and maternal factors were significantly associated with stunting. Interventions such as improving drinking water quality and sewage facilities, early detection of maternal hemoglobin during pregnancy, and implementing exclusive breastfeeding may support stunting reduction in this setting.

**Keywords:** Breastfeeding, Maternal hemoglobin, Sanitation, Stunting.

### INTRODUCTION

Stunting is a condition of chronic malnutrition that causes growth disorders in children under five years of age, characterized by a child's height-for-age or length-for-age below the normal reference, i.e., less than -2 standard deviations (SD) on the World Health Organization (WHO) growth curve.<sup>1</sup> Globally, the prevalence of stunting in 2022 was 21.3%, and in 2023 it became 22.3%.<sup>2,3</sup> According to UNICEF data in 2021, Southeast Asia had a stunting rate of 27.4%.<sup>4</sup> In 2020, Timor-Leste ranked as having the highest stunting with a prevalence at 48.8%, followed by Indonesia (31.8%), and Laos in third position with a prevalence of 30.2% (Asian Development Bank / ABD, 2020).<sup>5</sup> Stunting in Indonesia has decreased from 24.4% in 2021 to 21.6% in 2022 (SSGI, 2021) (4). In West Java, the prevalence of stunting in 2022 is 20.2%, the prevalence of stunting in Indramayu Regency is 18.4%, and the prevalence of stunting in Garut Regency is 23.6%, where the highest stunting area in West Java is Sumedang Regency, which is 27.6%.

Stunting is influenced by many factors, from the maternal or during pregnancy until postnatal stage. Factors that influence the incidence of stunting include environmental, maternal factors, exclusive breastfeeding, and infectious diseases.<sup>6</sup> A previous meta-analysis study showed that the impact of water, sanitation, and hygiene (WASH) on child stunting is significant when it comes to lack of sanitation in

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Received: April 23rd, 2025  
Accepted: February 11th, 2026  
Published: February 28th, 2026

72% of the studies.<sup>7</sup> In addition, children exposed to contaminated drinking water had a 3.3 times higher risk of stunting (OR 3.328; 95% CI 1.681-6.587).<sup>8</sup> The result of the systematic review in 2023 found nine studies examined the correlation between maternal anemia and stunting in children.<sup>9</sup> Exclusive breastfeeding also plays a role, children who did not receive exclusive breastfeeding had a 2.9 times higher risk of stunting compared to children who received exclusive breastfeeding. These findings show a significant influence of non-exclusive breastfeeding on the incidence of stunting (p-value < 0.0001).<sup>10</sup>

The significant impact of stunting has prompted the Indonesian government to launch several integrated intervention programs for the prevention and management of stunting. The Rancakalong Public Health Center (Puskesmas) in Sumedang Regency initiated the 'Gempur' Stunting Health Promotion Program (Puring), an initiative developed by the health educators at the Rancakalong Public Health Center to reduce and prevent stunting.<sup>11</sup> During the screening of children for stunting in February and August 2019, the stunting prevalence rate in Rancakalong successfully declined to 19.8%, falling below the 20% threshold set by the WHO. However, despite the implementation of intervention programs such as 'Gempur' Stunting, the prevalence of stunting remains relatively high in certain areas, including Pangadegan Village, which is still within the Rancakalong District.<sup>12</sup> Nevertheless, available research regarding the modifiable factors influencing the incidence of stunting in children remains limited, particularly in Sumedang Regency. Therefore, this study aimed to identify modifiable determinants of stunting among children in Pangadegan Village, Sumedang Regency, in 2023.

## METHOD

### Participants and Study Design

The design of this study was cross-sectional, conducted in May 2023 at two posyandus (integrated health posts) in Pangadegan Village, Sumedang Regency. The study identified a total population of 370 children aged 1–5 years from the village health records as the source for recruitment. Using a consecutive sampling technique, a final sample of 170 children was identified. Out of the total population, these 170 children were successfully recruited and met eligibility criteria. The inclusion criteria were children aged 1–5 years residing in Pangadegan Village whose parents or guardians provided informed consent to participate. The exclusion criteria were children with incomplete data on the independent variables in the research questionnaire.

### Measurements and Procedure

This study employed primary data obtained through direct interviews and structured questionnaires capturing study variables, along with anthropometric measurements of under-five children. Secondary data were retrieved from the Maternal and Child Health Handbook. Before data collection, parents who agreed first completed the research-informed consent form. Validity and reliability tests have been conducted on the questionnaire.

The dependent variable in this study was stunting, defined as a height-for-age z-score < -2 SD, categorized as stunting (Z score < -2 SD) and not stunting (Z score ≥ -2 SD). Midwives obtained anthropometric measurements of toddlers from Pangadegan village; two measurements were taken for each toddler. If the results of 2 measurements differ, the average of the two measurements is used. Independent variables included drinking water quality, sewage facilities, history of anemia among pregnant women, history of nutritional status among pregnant women, history of exclusive breastfeeding, history of infectious diseases, mother's highest level of education, and family income. Drinking water data are obtained from assessments of mothers of toddlers and are considered to meet the requirements if the water is clear, odorless and tasteless, at normal temperature, free of bacteria, and contains minimal mineral content. Sewage facility data are obtained from assessments of mothers of toddlers and are considered to meet the requirements if the sewage canal is closed, connected to the sewer, separated from fecal waste, does not emit odors, and does not attract vectors. The mother's hemoglobin (Hb) data during pregnancy are obtained from the Mother and Child Health book record. Pregnant women are anemic if the Hb level is <11 mg/dl. The nutritional status of pregnant women is classified as inadequate if the increase in maternal weight during pregnancy is < 15 kg; if the mother's weight during pregnancy rises by ≥ 15 kg, it is categorized as good nutrition, according to the Mother and Child Health book record. Exclusive breastfeeding assessment refers to the intake of breast milk alone for 6 months, without any other additions. Children with a history of infection: if, within one month, the child has diarrhea and/or Acute Respiratory Infection (ARI) two or more times. Mother's

education was categorized as good if she graduated from high school and as poor if she did not, and family income was classified as greater than the Sumedang provincial minimum wage or less than or equal to the Sumedang regional minimum wage (3,400,000 rupiahs).

### Statistical Analysis

Univariate analysis was conducted to describe the characteristics of the study variables. Bivariate analysis was performed using chi-square tests to assess the relationship between independent and dependent variables. Multivariate analysis was conducted to determine the strength of associations between determinants of stunting that could be modified, using backward selection and logistic regression. Candidate independent variables are bivariate variables; those with p-values <0.25 are included in the test model to assess the influence of multiple risk factors on the incidence of stunting, using the Prevalence Ratio (PR). This study has received ethical approval under the number 04A/Etik Penelitian/FKUKI/2023.

### RESULT

The total number of respondents in this study was 170 toddlers who met the inclusion and exclusion criteria. 18% of the study population was excluded due to incomplete data on the independent variables in the questionnaire. Based on univariate analysis, it is known that toddlers who experience stunting are 28.8% (49 people), males account for 52.9% (90 people), drinking water quality meets the requirements (72.4%), and waste facilities meet the requirements (87.1%). 82.9% of pregnant women were not anemic. There were 55.9% of pregnant women with malnutrition, 71.8% were exclusively breastfed, and 76.5% of toddlers did not experience infectious diseases. The mother's highest level of education was not high school; 73.5% did not graduate from high school. Family income was less than or equal to the Sumedang regional minimum wage by 64.7%.

**Table 1. Environmental, Maternal, and Socioeconomic Characteristics of Under-Five Children in Pangadegan Village, Sumedang Regency, in 2023**

Variable	Frequency (n)	Percentage (%)
Gender		
Female	80	47.05
Male	90	52.95
Drinking Water Quality		
Safe	123	72.35
Unsafe	47	27.65
Sewage Facility		
Adequate	148	87.06
Inadequate	22	12.94
Maternal Anemia during Pregnancy		
Normal $\geq$ 11 g/dL	141	82.94
Anemia < 11 g/dL	29	17.06
Maternal Nutritional Status during Pregnancy		
Good	75	44.12
Poor	95	55.88
Exclusive Breastfeeding		
Yes	122	71.76
No	48	28.24
History of Infectious Disease		
No	130	76.47
Yes	40	23.53
Maternal Education		
Good (graduated from high school or higher)	45	26.47
Poor (not graduated from high school or lower)	125	73.53
Family Income		
>3,400,000	60	35.29
$\leq$ 3,400,000	110	64.71

**Table 2. Proportion Distribution of Modifiable Risk Factors of Stunting in Pangadegan Village, Sumedang Regency, in 2023**

Variable	Nutritional Status of Toddlers				Total	P-value
	Stunting		Not Stunting			
	n	%	n	%		
Drinking Water Quality						
Safe	24	19.51	99	80.49	123	0.0001
Unsafe	25	53.19	22	46.81	47	
Sewage Facility						
Adequate	35	23.65	113	76.35	148	0.0001
Inadequate	14	63.64	8	36.36	22	
Maternal Anemia during Pregnancy						
Normal < 11 g/dL	15	51.74	14	48.26	29	0.003
Anemia > 11 g/dL	34	24.11	107	75.89	141	
Maternal Nutritional Status during Pregnancy						
Good or above	15	20.00	60	80.00	75	0.024
Less	34	35.79	61	64.21	95	
Exclusive Breastfeeding						
Yes	26	21.31	96	78.69	122	0.001
No	23	47.92	25	52.08	48	
History of Infectious Disease						
No	37	28.46	93	71.54	130	1.000
Yes	12	30.00	28	70.00	40	
Maternal Education						
Good (graduated from high school or higher)	16	35.56	29	64.44	45	0.255
Poor (not graduated from high school or lower)	33	26.40	92	73.60	125	
Family Income						
>3,400,000	35	32.41	73	67.59	108	0.381
≤3,400,000	16	25.81	46	74.19	62	

Table 2 presents the associations between risk factors and stunting. Variables with p-values <0.05 included drinking water quality, sewage facilities, anemia status during pregnancy, exclusive breastfeeding, and maternal nutritional status during pregnancy. Variables not significantly associated with stunting were history of infectious diseases (p = 1.00), maternal education (p = 0.25) and family income (p = 0.38).

In multivariate analysis, all candidates included in the model are analyzed to obtain an overall percentage value. The waste facility obtained a PR of 3.76, 95% CI: 1.25-11.28, and p-value: 0.018. This explains that toddlers whose waste facilities do not meet the requirements will experience stunting 3.76 times compared to having eligible waste facilities, drinking water quality variables obtained PR: 3.38, 95% CI: 1.50-7.60, p-value 0.003) this explains that toddlers with unfit drinking water quality are at risk of 3.38 times stunting compared to toddlers who have decent drinking water quality. Maternal Hb variable during pregnancy obtained PR: 2.64, 95% CI: 1.05-6.64, p-value 0.039, where toddlers born to mothers with Hb < 11 g/dL had a 2.6 times risk of stunting compared to toddlers from mothers with Hb ≥11 g/dL. Exclusive breastfeeding variable obtained PR: 2.36, 95% CI: 1.03-5.38, p-value 0.041, meaning that toddlers who are not exclusively breastfed have a 2.36 times risk of stunting compared to solely breastfed toddlers.

**Table 3. Results of Adjusted Risk Factors of Stunting that Can Be Modified in Pangadegan Village, Sumedang Regency, in 2023**

Variable	PR	95% CI	P-Value
Drinking Water Quality	3.38	1.50-7.60	0.003
Sewage Facilities	3.76	1.25-11.28	0.018
Anemia status of pregnant women	2.64	1.05-6.64	0.039
Exclusive breastfeeding	2.36	1.03-5.38	0.041

## DISCUSSION

The prevalence of stunting in this study was 28.8%, slightly higher than that reported in Sumedang Regency (27.6%). This study examined environmental, maternal, and socioeconomic factors associated with stunting among children under five years old in Pangadegan village, Sumedang Regency, in 2023. The findings indicate that drinking water quality, sewage facilities, maternal anemia status during pregnancy, maternal nutritional status during pregnancy, and exclusive breastfeeding were significantly associated with stunting. In contrast, no significant associations were observed for history of infectious diseases, maternal education, or family income. The lack of association for these variables may be attributable to differences in measurement methods, contextual factors such as social, cultural, and behavioral variations, or differences in sample size compared with previous studies.

### Drinking Water Quality and Stunting

In this study, unsafe drinking water quality was associated with 4.7-fold higher risk of stunting compared with adequate drinking water (95% CI: 2.27–9.69). This finding is consistent with previous research by Hasan et al. which stated that children with inadequate access to safe drinking water had a 4.62-fold increased risk of stunting (95% CI: 1.92–11.08).<sup>8</sup> According to Permenkes RI No. 32/2017, safe drinking water should be colorless, tasteless, odorless, and free from chemical and microbiological contamination.<sup>9</sup> Exposure to unsafe drinking water may increase susceptibility to infections caused by waterborne pathogens.

### Sewage Facilities and Stunting

Inadequate sewage facilities were associated with a 5.6 times higher risk of stunting (95% CI: 2.19–14.58). This finding is in agreement with previous research by Hasan et al. which found a 4.60-fold increased risk of stunting among children living in households with poor sewage facilities (95% CI: 2.11–10.08). Sewage facilities are considered inadequate when drainage systems are open, not connected to proper sewerage, and not separated from fecal waste, conditions that may promote environmental contamination and vector breeding. Similar findings have been reported by Gernauli et al. in Ogan Ilir, Palembang, where poor household waste management, including stagnant water and accumulated garbage, was associated with increased bacterial growth and a higher risk of infectious diseases.<sup>10</sup> These conditions may contribute to repeated infections and impaired nutrient absorption, thereby increasing the risk of stunting.<sup>15</sup>

### Maternal Anemia during Pregnancy and Stunting

The results of this study state that pregnant women with Hb < 11 g/dl have a 2.6 times higher risk of stunting than mothers who are not anemic (95% CI: 1.05–6.64). Similar findings were reported, indicating that pregnant women with anemia have a 2.3-fold higher risk of having stunted children.<sup>16</sup> Intrauterine oxygen supply from pregnant women with anemia to their babies will be reduced due to low maternal Hb. If sustainable, it causes low oxygen levels in the baby and disrupts the baby's growth in the womb.

### Exclusive Breastfeeding and Stunting

Children who were not exclusively breastfed had a 3.40 times higher risk of stunting compared with those who were exclusively breastfed (95% CI: 1.67–6.93). This finding is consistent with a previous study reporting a significant association between non-exclusive breastfeeding and stunting (OR: 2.65, 95% CI: 1.14–6.16).<sup>12</sup> Exclusive breastfeeding is defined as the provision of breast milk alone, without additional liquids or foods, for the first six months of life. The World Health Organization (WHO) recommends exclusive breastfeeding during this period, followed by the introduction of appropriate complementary foods while continuing breastfeeding up to two years or beyond. Exclusive breastfeeding provides optimal nutrition and supports immune function during early life. In contrast, non-exclusive breastfeeding may increase the risk of infections and inadequate nutrient intake, which can contribute to growth faltering and stunting.

The limitation of this study was that it did not conduct direct observation of environmental variables such as drinking water quality and sewage facilities, even though the study found that the most influential factor in the incidence of stunting was environmental. The health promotion efforts made by Rancakalong health leader through the 'Gempur' stunting with activities including stunting counseling,

building partnerships, monthly toddler weighing, and providing additional food are expected to have a major impact on reducing the prevalence of stunting in Pangadegang Village.<sup>11</sup>

## CONCLUSION

This study found several factors significantly associated with stunting among under-five children in Pangadegang Village, Sumedang Regency, namely drinking water quality, sewage facilities, maternal anemia status during pregnancy, and exclusive breastfeeding. Among these, inadequate sewage facilities showed the strongest association with stunting (PR = 3.76; 95% CI: 1.25–11.28; p = 0.018).

Strengthening preventive strategies is essential to reducing the burden of stunting. These include improving maternal nutrition during the preconception, pregnancy, and lactation periods; addressing adolescent and high-risk pregnancies; promoting safe water, sanitation, and hygiene practices; supporting optimal breastfeeding practices (early initiation and exclusive breastfeeding); and preventing childhood infections through appropriate healthcare and immunization.

## ETHICS APPROVAL

This study received ethical approval (04A/Etik Penelitian/FKUKI/2023).

## ACKNOWLEDGMENTS

The authors gratefully acknowledge all respondents and participants involved in this study.

## COMPETING INTEREST

All authors declare that there are no conflicts of interest.

## FUNDING

This study received no external funding.

## UNDERLYING DATA

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

## DECLARATION OF ARTIFICIAL INTELLIGENCE USE

We confirm that there is no artificial intelligence (AI) used at any stage of the study, including data collection, analysis, visualization, etc. All work in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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