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Structural determinants of stunting among children aged 0–59 months: A PLS-SEM analysis of family, environmental, and health factors in Banten, Indonesia

Determinan struktural stunting pada anak usia 0–59 bulan: Analisis PLS-SEM terhadap faktor keluarga, lingkungan, dan kesehatan di Banten, Indonesia

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Abstract

Stunting remains a major public health problem among children under five years of age in Indonesia, particularly among socioeconomically vulnerable families. Previous studies have mostly examined stunting determinants separately and rarely analyzed their structural relationships. This study aimed to analyze the structural relationships between family economic pressure, access to health facilities, feeding practices, and child nutritional status using Partial Least Squares Structural Equation Modeling (PLS-SEM). A cross-sectional study was conducted from July to September 2025 in Sumur District, Banten Province, Indonesia, involving 402 mothers with children aged 0–59 months from families at risk of stunting. Data were collected through structured interviews, anthropometric measurements and standardized questionnaires. Data were analyzed using SPSS 23 and SmartPLS 3.0. PLS-SEM analysis showed that family economic pressure significantly influenced feeding practices (β = 0.321; p < 0.001), and access to health facilities positively affected feeding practices (β = 0.130; p = 0.024). However, feeding practices did not significantly influence HAZ (β = 0.015; p = 0.768). Birth weight was associated with the nutritional status of the child. In conclusion, these findings highlight the importance of strengthening economic resilience and improving access to supportive health services in family based stunting prevention strategies.

Keywords: Economic pressure, feeding practices, nutritional status, PLS-SEM, stunting

Abstrak

Stunting masih menjadi masalah kesehatan masyarakat utama pada anak balita di Indonesia, terutama pada keluarga dengan kerentanan sosial ekonomi. Penelitian sebelumnya umumnya menelaah determinan stunting secara terpisah dan jarang menganalisis hubungan struktural antarvariabel secara simultan. Penelitian ini bertujuan untuk menganalisis hubungan struktural antara tekanan ekonomi keluarga, akses terhadap fasilitas kesehatan, praktik pemberian makan, dan status gizi anak menggunakan pendekatan *Partial Least Squares Structural Equation Modeling* (PLS-SEM). Penelitian *cross-sectional* dilakukan pada Juli hingga September 2025 di Kecamatan Sumur, Provinsi Banten, Indonesia, dengan melibatkan 402 ibu yang memiliki anak usia 0–59 bulan dari keluarga berisiko stunting. Data dikumpulkan melalui wawancara terstruktur, pengukuran antropometri, dan kuesioner terstandar. Analisis data dilakukan menggunakan SPSS 23 dan SmartPLS 3.0. Hasil analisis PLS-SEM menunjukkan bahwa tekanan ekonomi keluarga berpengaruh signifikan terhadap praktik pemberian makan (β =

0,321; p < 0,001), sedangkan akses terhadap fasilitas kesehatan juga berpengaruh positif terhadap praktik pemberian makan (β = 0,130; p = 0,024). Namun, praktik pemberian makan tidak berpengaruh signifikan terhadap HAZ (β = 0,015; p = 0,768). Berat badan lahir tetap berhubungan dengan status gizi anak. Kesimpulan, pentingnya penguatan ketahanan ekonomi keluarga dan peningkatan akses terhadap layanan kesehatan yang mendukung dalam strategi pencegahan stunting berbasis keluarga.

Kata Kunci: Praktik pemberian makan, status gizi, PLS-SEM, stunting, tekanan ekonomi

Introduction

Stunting remains a major public health and nutrition challenge for children under five years of age in Indonesia. It reflects chronic linear growth failure resulting from prolonged nutritional deprivation and is defined as a height-for-age z-score (HAZ) below −2 standard deviations, according to the World Health Organization growth standards. Children affected by stunting are at an increased risk of infectious diseases, impaired cognitive development, poor educational attainment, and reduced productivity in adulthood (de Onis & Branca, 2016; UNICEF et al., 2023; Vaivada et al., 2020; WHO & UNICEF, 2025). Beyond its biological consequences, stunting contributes to intergenerational cycles of poverty, diminished human capital, and long-term socioeconomic inequality in developing countries.

Stunting is a multifactorial condition shaped by direct and indirect determinants across biological, behavioral, environmental, and socioeconomic dimensions. The direct causes of wasting include inadequate nutrient intake and recurrent infections, whereas indirect determinants encompass household food security, childcare and feeding practices, parental education, access to health services, and environmental conditions, including water, sanitation, and hygiene (WASH) (Ariyanti et al., 2025; Beal et al., 2018; Maqfira et al., 2024; Vaivada et al., 2020). Poor sanitation and inadequate access to clean water increase children's exposure to infectious diseases, which may impair nutrient absorption and growth processes, thereby increasing the risk of chronic growth failure (Beal et al., 2018; Gaffan et al., 2023).

The Indonesian Nutritional Status Survey (INSS) indicates that the prevalence of stunting in Indonesia remains above the threshold for public health concerns and varies substantially across regions and socioeconomic groups. Children from socioeconomically vulnerable families are more likely to experience chronic growth faltering because limited household resources may compromise dietary quality, caregiving capacity, environmental conditions, and the utilization of health services (Beal et al., 2018; Ministry of Health Republic of Indonesia, 2025; UNICEF et al., 2023). These disparities suggest that stunting prevention requires not only nutrition-specific interventions but also broader family- and environment-based approaches that target vulnerable populations.

A family ecological approach provides a comprehensive framework for understanding stunting as an outcome of interactions among children, families, and broader environmental systems. From this perspective, the family functions as the primary microsystem influencing a child's nutritional status through economic conditions, caregiving practices, feeding behaviors, and access to supportive resources. Family economic pressure, particularly low income and limited household resources, may reduce the capacity to provide nutritious food, adequate sanitation, and appropriate health services. Chronic economic hardship may also affect parental stress, caregiving quality, and family functioning, thereby increasing children's nutritional vulnerability (Kurniawan et al., 2025; Muluye et al., 2020; Mustikaningrum et al., 2016; Story & Carpiano, 2017; Sugiharto & Riany, 2024). Within Bronfenbrenner's ecological perspective, these structural constraints may indirectly influence nutritional outcomes through caregiving and feeding pathways at the household level.

Access to health services also plays a critical role in preventing stunting, particularly during the first 1,000 days of life. Utilization of antenatal care, growth monitoring, immunization, nutrition counseling, and integrated health services can improve parental knowledge and support healthy feeding

practices. However, geographical barriers, economic limitations, transportation constraints, and low utilization of preventive services remain important obstacles for vulnerable families (Darmawan et al., 2022). Therefore, feeding practices represent an important behavioral pathway linking family socioeconomic conditions to child nutritional outcomes within the broader ecological environment.

Although many studies have examined the determinants of stunting, most have analyzed these variables separately using conventional statistical approaches and have rarely explored the structural interrelationships among family, environmental, and health-related factors. Existing studies using structural equation modeling have also predominantly focused on direct effects and have provided limited analysis of complex pathways involving economic pressure, access to health services, feeding practices, and nutritional status among families at risk of stunting. Consequently, a more comprehensive analytical approach is needed to explain the multidimensional pathways influencing nutritional outcomes in children (Kurniawan et al., 2025; Sugiharto & Riany, 2024; Sugiharto et al., 2026; Victora et al., 2021).

Partial Least Squares Structural Equation Modeling (PLS-SEM) was considered appropriate for this study because it enables the simultaneous analysis of multiple latent constructs, mediating relationships, and complex structural pathways within an exploratory family ecological framework. This approach allows for the examination of how family economic pressure and access to health services interact through feeding practices to influence the nutritional status of children under five years of age.

Therefore, this study aimed to analyze the structural relationships among family economic pressure, access to health services, feeding practices, and nutritional status among children aged 0–59 months from families at risk of stunting in the Sumur District, Pandeglang Regency, Banten Province, Indonesia. These findings are expected to contribute to the development of more integrated family based strategies for stunting prevention among vulnerable populations.

Methods

This study used a cross-sectional design to examine the relationship between family characteristics and the nutritional status of children under five years of age from families at risk of developing stunting. This study was approved by the Research Ethics Committee Involving Human Subjects of Bogor Agricultural University (certificate number: 1803/IT3.KEPMSM-IPB/SK/2025), dated July 1, 2025. Permission to conduct the study was obtained from the Investment and One-Stop Integrated Service Office of Pandeglang Regency (number 070/197-SKP/DPMPTSP/VIII/2025) dated August 14, 2025. All participants provided informed consent and had the right to refuse or withdraw from the study at any time without consequences.

The study was conducted in Sumur District, Pandeglang Regency, Banten Province, Indonesia, which was identified as having a predominance of families at risk of stunting. In this study, a family at risk of stunting was defined as a family in which one or both of the following conditions were present: the mother was married before the age of 18 years, or the family had at least three children. Sumur District is located at an altitude of approximately 11–15 m above sea level. The study will be conducted from July 1 to September 15, 2025. Sumur District is bordered by the Indian Ocean to the north, west, and south, and by Cimanggu District to the east.

This study included families with children aged 0–59 months who were at risk of stunting. The sample size was determined based on eligibility criteria. The inclusion criteria were families recorded as having complete data on family characteristics and a fully recallable history of child feeding practices, as well as children whose physical conditions permitted anthropometric measurements.

The dependent variable in this study was the nutritional status of children under five years of age, measured using height-for-age z-scores (HAZ), and categorized as stunted or non-stunted based on the WHO growth standards (2006). The independent variables included parental education level, family economic pressure, access to health facilities, parental occupation, and income. The control variables included the child's age, sex, birth weight, and other relevant characteristics. A schematic model is presented in Figure 1 to illustrate the relationships and effects of the variables examined in this study.

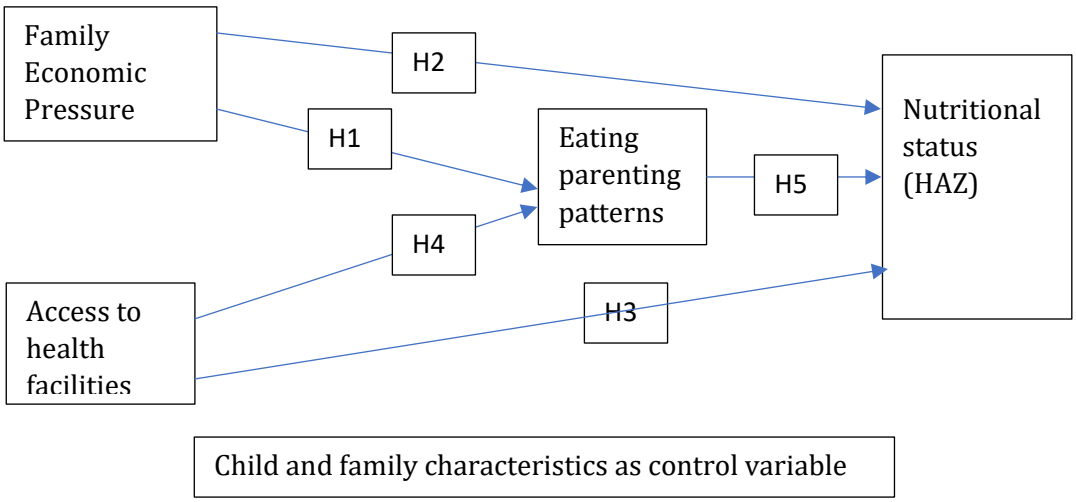

Figure 1. Test of the relationship and influence of independent, mediator and dependent variables

Data were collected using questionnaires that were administered through structured interviews. Family economic pressure was measured using 11 items that had been tested for reliability, with a Cronbach's alpha of 0.930. Accessibility to health facilities was measured using four items with a Cronbach's alpha value of 0.607. Data on child feeding practices were collected using the extended version of the Feeding Practices and Structure Questionnaire (FPSQ-S), consisting of 36 items that had been tested for reliability, with a Cronbach's alpha of 0.906. In this study, weight-for-age z-score (WAZ) and height-for-age z-score (HAZ) indices below −2 SD were used to determine the nutritional status of the children, including stunting status. Data were analyzed using descriptive statistics and Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 3.0 software as the primary analytical framework. PLS-SEM was used to examine the structural relationships among latent variables, including economic pressure of the family, access to health services, feeding practices, and nutritional status of the child. Preliminary correlation analyses using Pearson, Spearman, and Kendall's tau-b tests were conducted only as exploratory screening procedures according to the data characteristics and measurement scales. Statistical significance was set at $p < 0.05$. During data collection, trained enumerators assisted the respondents in addressing any difficulties encountered in completing the questionnaire. The questionnaire also captured the family and environmental conditions of infants and toddlers, as well as one-time measurements of body length and weight using calibrated anthropometric instruments.

Descriptive analyses were performed to summarize the respondent characteristics and variable distributions. The primary inferential analysis used PLS-SEM to evaluate both direct and indirect structural pathways among exogenous, mediating, and endogenous constructs within the framework. The measurement model evaluation included assessments of convergent validity, discriminant validity, composite reliability, and Cronbach's alpha. Structural model evaluation included path coefficient estimation and significance testing using the bootstrapping procedure.

Result and Discussion

The characteristics of the research subjects included child age, with the youngest children aged less than 1 year and the oldest aged 49 months; all were categorized as children under five years of age. The characteristics of the study participants were further described according to sex, birth weight, birth length, history of comorbidities, and birth order. The complete data are presented in Table 1.

The results showed that the mean age of the children was 1.9 ± 0.7 years, and 44.8% were underweight. Birth weight significantly influenced the nutritional status of children based on WAZ ($p = 0.042$); however, its association with HAZ was not statistically significant ($p = 0.052$). Family economic pressure significantly affected the feeding practices ($p < 0.001$). Access to health facilities significantly influenced feeding practices ($p < 0.001$) but showed no direct relationship with the child's nutritional status.

Table 1. Distribution of child and parent characteristics

Variables	Category	Child; n (%)	Father; n (%)	Mother; n (%)
Child Age	<1 year	136 (33.8)	-	-
	2–3 years	145 (36.1)	-	-
	3–4 years	121 (30.1)	-	-
Sex	Male	197 (49.0)	-	-
	Female	205 (51.0)	-	-
Birth Weight	<2.5 kg	339 (84.3)	-	-
	2.5–4 kg	54 (13.4)	-	-
	>4 kg	9 (2.2)	-	-
Birth Length	≤48 cm	254 (63.2)	-	-
	49–52 cm	136 (33.8)	-	-
	>53 cm	12 (3.0)	-	-
History of Illness	None	367 (91.3)	-	-
	Acute respiratory infection	27 (6.7)	-	-
	Heart disorder	1 (0.2)	-	-
	Hydrocephalus	1 (0.2)	-	-
	Others	6 (1.5)	-	-
Birth Order	1st–3rd child	343 (85.3)	-	-
	4th–5th child	56 (13.9)	-	-
	>6th child	3 (0.7)	-	-
Nutritional Status (WAZ)	Severely underweight (< -3 SD)	144 (35.8)	-	-
	Underweight (-3 SD sampai < -2 SD)	36 (9.0)	-	-
	Normal (-2 SD sampai +2 SD)	173 (43.0)	-	-
	Overweight (> +2 SD)	49 (12.2)	-	-
Nutritional Status (HAZ)	Severely stunted (< -3 SD)	74(18.4)	-	-
	Stunted (-3 SD to < -2 SD)	82(20.4)	-	-
	Normal (-2 SD to +3 SD)	236(58.7)	-	-
	Tall (> +3 SD)	10(2.5)	-	-
Current Age	Adolescents (<18 years)	-	2 (0.5)	4 (1.0)
	Early adulthood (19–40 years)	-	260 (64.7)	358 (89.1)
	Middle adulthood (41–60 years)	-	137 (34.1)	40 (10.0)
	RIP	-	3 (0.7)	0 (0.0)
Age at First Marriage	Adolescents (<18 years)	-	88 (21.9)	263 (65.4)
	Early adulthood (19–40 years)	-	307 (76.4)	139 (34.6)
	Middle adulthood (41–60 years)	-	7 (1.7)	0 (0.0)
Number of Marriages	1	-	336 (83.6)	321 (79.9)
	2–3	-	59 (14.6)	75 (18.6)
	4–5	-	1 (0.2)	4 (1.0)
Education	Did not complete primary school	-	12 (3.0)	10 (2.5)
	Primary school	-	226 (56.2)	208 (51.7)
	Junior high school	-	79 (19.7)	117 (29.1)
	Senior high school	-	79 (19.7)	61 (15.2)
	Diploma	-	1 (0.2)	2 (0.5)
	Bachelor's degree	-	5 (1.2)	4 (1.0)
Occupation	Unemployed	-	4 (1.0)	0 (0.0)
	Civil servant / Police / Military	-	1 (0.2)	5 (1.2)
	Entrepreneur	-	14 (3.5)	0 (0.0)
	Farmer	-	125 (31.1)	1 (0.2)
	Fisherman	-	159 (39.6)	19 (4.7)
	Trader	-	35 (8.7)	35 (8.7)
	Laborer / Self-employed	-	40 (10.0)	0 (0.0)
	Private employee	-	12 (3.0)	0 (0.0)
	Housewife	-	0 (0.0)	342 (85.1)
	Others	-	12 (3.0)	0 (0.0)
Income (IDR)	≤1,000,000	-	213 (53.0)	380 (94.5)
	1,000,001–2,000,000	-	137 (34.1)	15 (3.7)
	2,000,001–3,000,000	-	41 (10.2)	5 (1.2)
	>3,000,000	-	11 (2.7)	2 (0.5)

Table 2. Relationship between microsystem factors, feeding practices, and nutritional status

Variable	Category	Distribution, n (%)	Mean ± SD	p-value		
				Feeding Practices	WAZ	HAZ
Sex	Male	197 (49.0)	–	0.646	0.782	0.761
	Female	205 (51.0)	–			
Child age (years)	<1 year	136 (33.8)	1.9 ± 0.7	0.053*	<0.001*	<0.001*
	2–3 years	145 (36.1)				
	3–4 years	121 (30.1)				
Birth weight (kg)	<2.5	339 (84.3)	2.9 ± 0.58	0.732	0.042*	0.052
	2.5–4.0	54 (13.4)				
	>4.0	9 (2.2)				
Birth length (cm)	≤48	254 (63.2)	45.0 ± 7.2	0.105	<0.001*	<0.001*
	49–52	136 (33.8)				
	>53	12 (3.0)				
History of comorbidities	None	367 (91.3)	–	0.023*	0.352	0.142
	Acute respiratory infection	27 (6.7)				
	Heart disorder	1 (0.2)				
	Hydrocephalus	1 (0.2)				
	Others	6 (1.5)				
Father's age at first marriage	Adolescence	88 (21.9)	–	0.115	0.491	0.353
	Early adulthood	307 (76.4)				
	Middle adulthood	7 (1.7)				
Father's current age	Adolescence	2 (0.5)	35.30 ± 8.73	0.384	0.504	0.575
	Early adulthood	260 (64.7)				
	Middle adulthood	137 (34.1)				
	Deceased	3 (0.7)				
Father's education	Did not complete primary school	12 (3.0)	–	0.196	0.101	0.874
	Primary school	226 (56.2)				
	Junior high school	79 (19.7)				
	Senior high school	79 (19.7)				
	Diploma	1 (0.2)				
	Bachelor's degree	5 (1.2)				
Mother's age at first marriage (years)	Adolescence	263 (65.4)	18.42 ± 3.72	0.664	0.072	0.212
	Early adulthood	139 (34.6)				
Mother's current age (years)	Adolescence	4 (1.0)	31.05 ± 7.68	0.972	0.923	0.763
	Early adulthood	358 (89.1)				
	Middle adulthood	40 (10.0)				
Mother's education	Did not complete primary school	10 (2.5)	–	0.131	0.018*	0.102
	Primary school	208 (51.7)				
	Junior high school	117 (29.1)				
	Senior high school	61 (15.2)				
	Diploma	2 (0.5)				
	Bachelor's degree	4 (1.0)				
Number of children	1–2 children	237 (59.0)	1.41 ± 0.49	0.693	0.656	0.996
	≥3 children	165 (41.0)				
Per capita income (IDR/capita/month)	–	–	420,24± 41,2	0.404	0.040*	0.37
Monthly household income	Poor	331 (82.3)	–	0.171	0.889	0.399
	Non-poor	71 (17.7)				
Objective economic pressure	Moderate	237 (58.9)	3.5 ± 0.46	<0.001*	0.261	0.020*
	High	165 (41.0)				
Subjective economic pressure	Low	236 (58.7)	54.4 ± 21.7	0.443	0.834	0.196
	Moderate	120 (29.9)				
	High	46 (11.4)				

Nutritional Status WAZ and HAZ. *Note: Significant at $p < 0.05$

As shown in Table 1, most of the children were female (51.0%). Most respondents were first- to third-born children (85.3%), and the majority had no history of comorbidities (91.3%). Most children had a birth length of ≤48 cm (63.2%) and a birth weight of <2.5 kg (84.3%), indicating a substantial burden of low birth weight among families at risk of stunting in the study area. This unusually high proportion may reflect the specific vulnerability profile of the sampled population, which consisted exclusively of families at risk of stunting, characterized by early marriage, high parity, chronic socioeconomic hardship, and limited access to maternal and child health services in rural coastal communities. This finding may also reflect chronic socioeconomic vulnerability, maternal nutritional problems, early marriage, and limited access to maternal health services in the community. The high proportion of low birth weight observed in this study highlights the persistence of prenatal nutritional vulnerability among families at risk of stunting in rural coastal area. The distribution of child age was relatively balanced, with 33.8% aged <1 year, 36.1% aged 2–3 years, and 30.1% aged 3–4.

Child nutritional status is commonly evaluated using anthropometric indicators in public health nutrition studies, including height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ), and weight-for-height z-scores (WHZ), which reflect both chronic and acute nutritional conditions in children (Sachdev & Borghi, 2024). Nutritional status is a health condition influenced by nutrient intake, absorption, and utilization, and is reflected in children's physical growth and development. It is generally assessed using anthropometric measurements, including WAZ, HAZ, WHZ, and body mass index-for-age (BMI-for-age) (Ferreira 2020).

Based on the WAZ classification presented in Table 1, nearly half of the children were in the normal category (43.0%), indicating that almost half of the respondents had body weight appropriate to the standard. However, 35.8% of the children were categorized as severely underweight and 9.0% as underweight, indicating that approximately 44.8% of the children experienced undernutrition. In contrast, 12.2% of the children were classified as overweight. These findings indicate that although many children had a normal nutritional status, a considerable proportion experienced both undernutrition and overnutrition; therefore, continued attention to feeding practices and nutritional adequacy remains necessary.

Based on the parental characteristics presented in Table 2, most fathers and mothers were in the early adulthood age group (19–40 years old). Fathers' age at first marriage was predominantly early adulthood (76.4%), whereas most mothers married during adolescence (<18 years), accounting for 65.4% of the sample. This finding indicates that most mothers were married before the age of 18 years. Regarding marital status, most fathers and mothers were in their first marriages (83.6% and 79.9%, respectively). In terms of education, more than half of the fathers and mothers had low educational attainment, with primary school as the highest completed education level (56.2% and 51.7%, respectively). The fathers had diverse occupational backgrounds, although most worked as fishermen (39.6%) or farmers (31.1%). Most mothers were housewives (85.1%). Regarding income, both household heads and mothers generally had low incomes, with monthly earnings of less than IDR 1,000,000 reported by 53.0% of fathers and 94.5% of mothers, respectively.

Factors Related to Feeding Practices

Based on the analysis presented in Table 3, several characteristics showed significant relationships with child feeding practices. History of comorbidities ($p = 0.023$) and objective economic pressure ($p < 0.001$) were significantly associated with feeding practices, whereas child age showed a marginal association ($p = 0.053$). These findings indicate that feeding practices and the variety of foods provided to children may change as children grow older.

Similarly, when children have a history of illness since birth, feeding practices may differ from those of children born without any health problems. Children from families with sufficient economic capacity are less likely to face barriers to obtaining nutritious food. These findings are consistent with those of Nasrul et al. (2022) in Subulussalam City, which showed that family socioeconomic characteristics, including parental occupation as an indicator of unstable income, were significantly associated with stunting. Children from families with unstable paternal occupations, such as laborers, have a higher risk of stunting than those from families with more

stable occupational backgrounds. These findings suggest that low economic capacity may contribute to nutritional vulnerability in children through limited food access and caregiving resources. Moreover, better economic conditions may support the provision of nutritious foods. A clean environment and adequate sanitation support nutrient absorption by preventing infectious diseases.

Nutritional status based on WAZ was significantly associated with birth weight (p = 0.042). This result indicates that children with a history of low birth weight tend to have a higher risk of nutritional problems later in life. This finding is consistent with Nasrul et al. (2022), who found that low birth weight was significantly associated with stunting among school-age children (p = 0.047; OR = 0.78), indicating that growth disturbances may begin during the prenatal period and continue into later-life stages. However, Ahmad et al. (2024) reported that although low birth weight is an early risk factor for stunting, its effect may be mediated or weakened by caregiving practices, environmental conditions, and access to health services during the first 1,000 days of life. These results also indicate that as children grow older, their weight tends to increase in accordance with the growth phase. Children with normal birth weights and lengths tend to have better nutritional statuses. Nutrition education and structured supplementary feeding interventions have been shown to improve the nutritional status of stunted children (Heryanda & Khoiriyah, 2024).

Factors significantly associated with nutritional status based on HAZ included child age (p = 0.000), birth length (p = 0.000), and economic pressure (p = 0.020). Birth weight also showed a borderline association with HAZ (p = 0.052). These findings indicate that linear growth is related to birth conditions, including birth weight and length. In addition, objective economic pressure negatively affects children's nutritional status because it influences the family's ability to provide adequate, diverse, and timely food intake for children, which may contribute to the impaired linear growth. The bivariate relationships between access to health facilities, feeding practices, and nutritional status are presented in Table 3. The results of the structural and measurement model assessments are presented in Table 4. Based on the PLS-SEM analysis (Table 4), access to health facilities significantly influenced feeding practices (β = 0.130; p = 0.024). These findings indicate that better access to health facilities is associated with improved feeding practices for infants. Access to health services enables parents to obtain adequate knowledge and support regarding child nutrition, thereby facilitating the implementation of healthy feeding practices at home. This finding is consistent with that of Darmawan et al. (2022), who reported that limited access to and low utilization of health services, such as antenatal care, posyandu visits, and immunization, were significantly associated with stunting. However, feeding practices did not have a significant direct effect on HAZ in the structural model (β = 0.015; p = 0.768). A multisite study in Indonesia also showed that family socioeconomic status, sanitation, and parental education are dominant determinants of stunting among two-year-old children, supporting these findings (Fitri et al., 2024).

Table 3. Relationship between health access, feeding practices, and nutritional status

Variable	Category	Distribution, n (%)	Mean ± SD	p-value Feeding Practices	Nutritional Status (WAZ)	Nutritional Status (HAZ)
Access to health facilities	Low	110 (27.4)	67.5 ± 20.59	<0.001*	0.814	0.129
	Moderate	197 (49.0)				
	High	95 (23.6)				
Feeding practices	Low	160 (39.8)	63.6 ± 20.30	1	0.040*	0.050*
	Moderate	164 (40.8)				
	High	78 (19.4)				

Notes: *Significant at p < 0.05

A measurement model evaluation was conducted to assess the validity and reliability of the constructs used. Validity testing aimed to ensure that the instrument measured the intended construct, whereas reliability testing assessed its consistency and accuracy. A

construct was considered to demonstrate convergent validity when its Average Variance Extracted (AVE) value was greater than 0.5. Discriminant validity was achieved when each indicator had a cross-loading value of greater than 0.5. Construct reliability in SEM-PLS was assessed using composite reliability (CR) >0.7 and Cronbach's alpha (CA) >0.6.

In this study, statistical values were assessed to strengthen PLS-SEM results. All variables had loading factor values greater than 0.5, indicating that all dimensions consistently formed their respective construct. To further examine the direct and indirect structural pathways among latent constructs within the family ecological framework, Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis was subsequently conducted. The PLS-SEM analysis showed that family economic pressure significantly influenced feeding practices but did not show a direct significant association with child nutritional status based on HAZ scores (β = 0.321; p < 0.001). Access to health facilities also had a significant positive effect on feeding practices (β = 0.130; p = 0.024). However, feeding practices did not significantly influence the nutritional status of children, as measured by HAZ (β = 0.015; p = 0.768). Although feeding practices showed significant bivariate associations with WAZ and a borderline association with HAZ, the multivariate PLS-SEM analysis demonstrated no significant direct structural effect on HAZ after adjusting for other variables (Table 4).

Measurement model evaluation was further conducted to assess construct reliability and convergent validity using Cronbach's alpha, composite reliability, and average variance extracted (AVE.). The results are shown in Table 4.

Table 4. Structural and measurement model assessment of PLS-SEM

Structural Model Relationship	β	Standard Deviation	t-statistics	p-value
Economic Pressure → Feeding Practices	0.321	0.056	5.727	0.000
Access to Health Facilities → Feeding Practices	0.130	0.057	2.260	0.024
Feeding Practices → HAZ	0.015	0.051	0.295	0.768
Measurement Model				
Latent Variable	Cronbach's Alpha	Composite Reliability	AVE	-
Economic Pressure	0.926	0.986	0.588	-
Access to Health Facilities	0.918	0.924	0.932	-
Feeding Practices	0.906	0.927	0.681	-

Notes: β = standardized path coefficient; AVE = Average Variance Extracted.

The structural and measurement model assessment results are presented in Table 4. As shown in Table 4, all latent constructs demonstrated acceptable reliabilities and convergent validities. Family economic pressure had a Cronbach's alpha value of 0.926, a composite reliability of 0.986, and an AVE of 0.588. Access to health facilities also demonstrated good construct reliability, with a Cronbach's alpha value of 0.918, a composite reliability of 0.924, and an AVE of 0.932. Feeding practices showed adequate reliability and validity, with Cronbach's alpha, composite reliability, and AVE values exceeding the recommended thresholds. These findings indicate that the measurement model was statistically acceptable and suitable for further structural model analysis using PLS-SEM (Aleru et al., 2023; Gaffan et al., 2023; Makasi & Humphrey, 2020).

Previous research by Gaffan et al. (2023) reported that access to health facilities did not significantly influence feeding practices or child nutritional status. In contrast, the present PLS-SEM analysis demonstrated that access to health facilities significantly influenced feeding practices, although no direct structural pathway to HAZ was found. These findings suggest that access to health services may indirectly contribute to child nutritional outcomes through caregiving and feeding pathways rather than through direct effects on linear growth. This indicates that the availability of health facilities is not necessarily accompanied by optimal utilization by the families. Most families tend to use health services only when their children

show symptoms of illness rather than for preventive care or routine growth monitoring. In addition, distance, transportation costs, availability of transportation, limited health personnel, and lack of comprehensive nutrition education may influence the effectiveness of access to health services in rural areas. Therefore, the presence of health facilities does not automatically guarantee improved caregiving quality or child nutritional status without active family participation and a supportive-access system. This finding is consistent with Apriliani (2025), who emphasized that family health behaviors and feeding practices play a more decisive role than the mere availability of health services.

The findings showed that economic pressure significantly influenced feeding practices ($\beta = 0.321$; $p < 0.001$) but did not demonstrate a direct significant association with nutritional status based on HAZ. These findings suggest that economic pressure may indirectly influence child nutritional status through caregiving and feeding pathways rather than through a direct structural effect on HAZ. This is consistent with Almaatani et al. (2023), who found that economic pressure and restrictive feeding practices had minimal and non-significant effects on children's feeding behavior. This phenomenon may be explained by the differences between objective economic pressure and subjective economic perception. Although some families may perceive their economic conditions as moderate or high, their objective economic pressure may not be sufficient to directly influence feeding practices. This finding is consistent with Schmiedeberg and Bozoyan's (2021) report that objective economic conditions do not always significantly influence parenting when other variables are controlled. In addition, Schneider and Schenck-Fontaine (2022) showed that subjective perceptions of economic status may differ from actual conditions and have different effects on parenting practices.

The results showed that feeding practices did not significantly influence the nutritional status of children. The nonsignificant association between feeding practices and child nutritional status may reflect the multifactorial nature of stunting and undernutrition. Nutritional status represents cumulative biological and environmental influences over time, whereas the feeding practices assessed in this study primarily reflected current caregiving behaviors. Additionally, the cross-sectional design limited our ability to establish temporal and causal pathways. Similar findings have been reported in Indonesia and India, suggesting that feeding practices alone may not sufficiently explain child nutritional outcomes without considering broader determinants such as maternal nutritional status, recurrent infections, and household food security. Nutritional status reflects cumulative influences over time, whereas feeding practices reflect current behavior. Previous studies in West Java, Indonesia, have reported similar results (Novitasari & Wanda, 2020). International studies also support this finding, including a study in India that showed no relationship between feeding practices and child nutritional status (Inbaraj et al., 2020).

These findings strengthen the family ecological perspective, which positions economic pressure as an important microsystem factor associated with child nutritional status. Children with stunting generally have lower energy and protein intakes than non-stunted children, as reported in studies conducted in Bengkulu (Kusdalinah & Suryani, 2021). Family per capita income and monthly income were significantly associated with feeding practices and nutritional status, indicating that economic limitations affect not only food availability but also daily caregiving practices of the elderly. Better economic conditions enable families to provide more diverse and nutritious food and support more responsive feeding practices. These findings are consistent with those reported by Mustikaningrum et al. (2016) and Muluye et al. (2020) and align with the findings among fishing communities in Bengkulu, which showed that dietary intake was associated with stunting (Yuliantini et al., 2022). Within Bronfenbrenner's ecological framework, chronic economic pressure can weaken family functioning, particularly economic and caregiving functions, thereby increasing the risk of stunting if not mediated by protective factors such as maternal knowledge, access to health services, and social capital (SimplyPsychology.org, 2024; Sugiharto & Riany, 2024).

This study had several limitations. First, the cross-sectional design limited the ability to establish temporal and causal relationships

between family economic pressure, feeding practices, access to health services, and child nutritional status. Second, several variables, including feeding practices and household conditions, were measured using self-reported questionnaires, which may have introduced recall and social desirability biases. Third, this study was conducted exclusively among families at risk of stunting in a rural coastal area of Banten Province; therefore, the findings may not be fully generalizable to other populations or urban settings in Indonesia. In addition, although PLS-SEM enabled the simultaneous analysis of complex structural relationships, the model did not include several biological and environmental variables that may also influence nutritional status, such as maternal nutritional status, recurrent infections, and micronutrient intake. Future longitudinal studies involving broader ecological determinants are recommended to better explain the causal pathways related to stunting among vulnerable families.

Conclusion

Based on the family ecological framework, this study indicates that family economic pressure and access to health facilities are important contextual factors associated with feeding practices among children from families at risk of developing stunting. Birth weight remained the most consistent factor associated with the nutritional status of children, whereas feeding practices did not show a significant direct relationship with HAZ in the structural model.

These findings suggest that stunting prevention strategies should not rely solely on household feeding behaviors but should also address structural family vulnerabilities, particularly economic pressure and limited access to preventive health services. PLS-SEM analysis demonstrated that family economic pressure and access to health facilities significantly influenced feeding practices, although no direct structural effect on HAZ was identified. Therefore, strengthening family economic resilience and improving the utilization of preventive health services may enhance caregiving and feeding practices among vulnerable families. Future longitudinal studies are needed to clarify the indirect and causal pathways linking family conditions, feeding practices, and nutritional outcomes in children.

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References

Ahmad, A. (2024). Factors associated with stunting among children 0–23 months in Aceh: A cross-sectional study using SSGI 2021. *AcTion: Aceh Nutrition Journal, 9*(3), 539. https://doi.org/10.30867/action.v9i3.1824

Aleru, E. O., Bodunde, I. O., Deniran, I. A., Ajani, O. N., Aleru, O. O., & Fawole, A. O. (2023). WASH practices increased the prevalence of malnutrition among under-five children (6–59 months) in an urban slum area in Ibadan, Nigeria. *Journal of Water, Sanitation and Hygiene for Development, 13*(11), 910–920. https://doi.org/10.2166/washdev.2023.186

Almaatani, D., Zurbau, A., Khoshnevisan, F., Bandsma, R. H. J., Khan, T. A., Sievenpiper, J. L., & van den Heuvel, M. (2023). The association between parents' stress and parental feeding practices and feeding styles: Systematic review and meta-analysis of observational studies. *Maternal & Child Nutrition, 19*(1), e13448. https://doi.org/10.1111/mcn.13448

Apriliani, A. (2025). Utilization of primary healthcare services and stunting among children aged 0–59 months in Indonesia: a national cross-sectional study. *Contagion: Scientific Periodical Journal of Public Health and Coastal Health*, *7*(1), 404-414. https://doi.org/http://dx.doi.org/10.30829/contagion.v7i1.25425

Ariyanti, R., Saefurrohim, M. Z., & Rahayu, E. P. (2025). Pengaruh water, sanitation, and hygiene (WASH) terhadap kejadian stunting pada balita di Indonesia: A systematic review. *Jurnal Keperawatan Malang, 10*(1), 18–30.

https://doi.org/10.36916/jkm.v10i1.357

Badan Pusat Statistik Provinsi Banten. (2024). *Provinsi Banten dalam angka 2024*. Badan Pusat Statistik Provinsi Banten.

Beal, T., Tumilowicz, A., Sutrisna, A., Izwardy, D., & Neufeld, L. M. (2018). A review of child stunting determinants in Indonesia. *Maternal & Child Nutrition, 14*(4), e12617. https://doi.org/10.1111/mcn.12617

Darmawan, A., Reski, R., & Andriani, R. (2022). Kunjungan ANC, posyandu dan imunisasi dengan kejadian stunting pada balita di Kabupaten Buton Tengah. *AcTion: Aceh Nutrition Journal, 7*(1), 33. https://doi.org/10.30867/action.v7i1.469

de Onis, M., & Branca, F. (2016). Childhood stunting: A global perspective. *Maternal & Child Nutrition, 12*(S1), 12–26. https://doi.org/10.1111/mcn.12231

Fitri, R., Khomsan, A., & Dwiriani, C. M. (2024). The dominant factors associated with stunting among two years children in five provinces in Indonesia. *AcTion: Aceh Nutrition Journal, 9*(1), 100–109. https://doi.org/10.30867/action.v9i1.1527

Gaffan, N., Kpozehouen, A., Degbey, C., Ahanhanzo, Y. G., & Paraïso, M. N. (2023). Effects of the level of household access to water, sanitation and hygiene on the nutritional status of children under five, Benin. *BMC Nutrition, 9*(1). https://doi.org/10.1186/s40795-023-00751-8

Heryanda, M. F., & Khoiriyah, N. (2024). Effects of healthy eating patterns based nutrition education and providing structured supplementary feeding on improving the nutritional status of stunted children. *AcTion: Aceh Nutrition Journal, 9*(3), 512. https://doi.org/10.30867/action.v9i3.1749

Inbaraj, L. R., Khaja, S., George, C. E., & Norman, G. (2020). Paternal involvement in feeding and its association with nutritional status of children in an urban slum in a low resource setting: A cross-sectional study. *Nutrition, 74*, 110735. https://doi.org/10.1016/j.nut.2020.110735

Kementerian Kesehatan Republik Indonesia. (2025). *Survei Status Gizi Indonesia 2024*. Kementerian Kesehatan Republik Indonesia.

Kurniawan, R., Widyastuti, L., Alimoeso, S., Fathonah, S., Diaini, M., Kodir, M., Fine, W., Prawiti, O. A., & Fadhilah, H. F. (2025). Families at risk of stunting and the prevalence of stunting in Indonesia: An ecological study. *KEMAS, 21*(1), 225–236. https://doi.org/10.15294/kemas.v21i1.20978

Kusdalinah, K., & Suryani, D. (2021). Asupan zat gizi makro dan mikro pada anak sekolah dasar yang stunting di Kota Bengkulu. *AcTion: Aceh Nutrition Journal, 6*(1), 93. https://doi.org/10.30867/action.v6i1.385

Makasi, R. R., & Humphrey, J. H. (2020). Summarizing the child growth and diarrhea findings of the Water, Sanitation, and Hygiene Benefits and Sanitation Hygiene Infant Nutrition Efficacy trials. *Nestlé Nutrition Institute Workshop Series, 93*, 153–166. https://doi.org/10.1159/000503350

Maqfira, N., Setiawan, B., & Dwiriani, C. M. (2024). Faktor determinan stunting pada balita dan positive deviance ibu di Desa Lokus Stunting Kabupaten Barru. *AcTion: Aceh Nutrition Journal, 9*(3), 433. https://doi.org/10.30867/action.v9i3.1700

Muluye, S. D., Lemma, T. B., & Diddana, T. Z. (2020). Effects of nutrition education on improving knowledge and practice of complementary feeding of mothers with 6- to 23-month-old children in daycare centers in Hawassa Town, Southern Ethiopia: An institution-based randomized control trial. *Journal of Nutrition and Metabolism, 2020*, 6571583. https://doi.org/10.1155/2020/6571583

Mustikaningrum, A. C., Subagio, H. W., & Margawati, A. (2016). Determinan kejadian stunting pada bayi usia 6 bulan di Kota Semarang. *Jurnal Gizi Indonesia, 4*(2), 82–88. https://doi.org/10.14710/jgi.4.2.82-88

Nasrul Z, N. Z., Usman, S., & Alfridsyah, A. (2022). Prevalensi dan faktor determinan kejadian stunting pada siswa sekolah dasar di Kota Subulussalam, Provinsi Aceh 2021. *AcTion: Aceh Nutrition Journal, 7*(1), 104. https://doi.org/10.30867/action.v7i1.833

Novitasari, P. D., & Wanda, D. (2020). Maternal feeding practice and its relationship with stunting in children. *Pediatric Reports, 12*(1), 1–4. https://doi.org/10.4081/pr.2020.8698

Sachdev, H. S., & Borghi, E. (2024). Should a single growth standard be used to judge the nutritional status of children under age 5 years globally? No. *The American Journal*

of Clinical Nutrition, 120(4), 759–763. https://doi.org/10.1016/j.ajcnut.2024.04.014

Schmiedeberg, C., & Bozoyan, C. (2021). Do economic hardship and pressure really influence parenting? *European Sociological Review, 37*(2), 287–304. https://doi.org/10.1093/esr/jcaa051

Schneider, W., & Schenck-Fontaine, A. (2022). Growing up unequal: Objective and subjective economic disparities and authoritarian parenting. *Child Abuse & Neglect, 130*, 105332. https://doi.org/10.1016/j.chiabu.2021.105332

Story, W. T., & Carpiano, R. M. (2017). Household social capital and socioeconomic inequalities in child undernutrition in rural India. *Social Science & Medicine, 181*, 112–121. https://doi.org/10.1016/j.socscimed.2017.03.043

Sugiharto, A., & Riany, Y. E. (2024). Comparative review of stunting prevalence rates in Banten Province, causal factors and preventive-curative measures. *Journal of Family Sciences*, 99–116. https://doi.org/10.29244/jfs.vi.50748

Sugiharto, A., & Riany, Y. E. (2024a). Family characteristics, family functions and socio-economic status among families of contributory assistance recipient in Indonesia. *Journal of Family Sciences, 9*(1). https://doi.org/10.29244/jfs.v9i1.43941

Sugiharto, A., & Riany, Y. E. (2024b). Comparative review of stunting prevalence rates in Banten Province, causal factors and preventive-curative measures. *Journal of Family Sciences*, 99–116. https://doi.org/10.29244/jfs.vi.50748

Sugiharto, A., Simanjuntak, M., Riany, Y. E., Damanik, M. R. M., & Krisnatuti, D. (2026). Exploring husband's contribution to toddler nutritional sufficiency: A socio-economic study from coastal and agromaritime communities. *BIO Web of Conferences, 234*, 04008. https://doi.org/10.1051/bioconf/202623404008

UNICEF, World Health Organization, & World Bank Group. (2023). *Levels and trends in child malnutrition: UNICEF/WHO/World Bank Group Joint Child Malnutrition Estimates: Key findings of the 2023 edition*. UNICEF, World Health Organization, & World Bank Group.

Vaivada, T., Akseer, N., Akseer, S., Somaskandan, A., Stefopulos, M., & Bhutta, Z. A. (2020). Stunting in childhood: An overview of global burden, trends, determinants, and drivers of decline. *The American Journal of Clinical Nutrition, 112*(Supplement 2), 777S–791S. https://doi.org/10.1093/ajcn/nqaa159

Victora, C. G., Christian, P., Vidaletti, L. P., Gatica-Domínguez, G., Menon, P., & Black, R. E. (2021). Revisiting maternal and child undernutrition in low-income and middle-income countries: Variable progress towards an unfinished agenda. *The Lancet, 397*(10282), 1388–1399. https://doi.org/10.1016/S0140-6736(21)00394-9

World Health Organization & United Nations Children's Fund. (2025). *Global nutrition targets 2030: Stunting brief*. World Health Organization. https://doi.org/10.2471/B09383

Yuliantini, E., Kamsiah, K., Maigoda, T. C., & Ahmad, A. (2022). Asupan makanan dengan kejadian stunting pada keluarga nelayan di Kota Bengkulu. *AcTion: Aceh Nutrition Journal, 7*(1), 79. https://doi.org/10.30867/action.v7i1.579