Jurnal Keperawatan Indonesia, 2026, 29 (1), 59–70
DOI: 10.7454/jki.v29i1.1668
Received February 2025; Accepted January 2026

pISSN 1410-4490; eISSN 2354-9203

The Predictive Ability of Child Characteristics and Parenting Factors on Four Developmental Domains in Toddlers

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Abstract

Stunting is a chronic condition that has a significant impact on child development. This phenomenon is primarily caused by prolonged nutritional deficiency, especially during the first 1,000 days of life. In addition, as family factors also play a crucial role in children's development, this study aims to analyze the influence of child and family characteristics, mother–child attachment, parenting practices, and the nutritional status of children (stunted/non-stunted) on children's gross motor, fine motor, language, and personal–social skills. This study used a quantitative design with an explanatory approach involving 202 mother–child pairs with children aged 12–36 months. The findings show that healthcare practices ($p = 0.016$) and male gender ($p = 0.050$) significantly affected gross motor development ($AR^2 = 0.068$), while toddler age ($p < 0.001$), stunting status ($p < 0.001$), and healthcare practices ($p = 0.042$) affected fine motor development ($AR^2 = 0.213$). Healthcare practices ($p = 0.021$) significantly affected language development ($AR^2 = 0.038$), while toddler age ($p < 0.001$), mother–child attachment ($p = 0.025$), and healthcare practices ($p = 0.010$) significantly affected personal–social development ($AR^2 = 0.138$). Thus, addressing stunting requires cooperation from various stakeholders—including the government, healthcare professionals, the community, and parents—to focus on child- and family-centered approaches.

Keywords: attachment, child development, family characteristics, parenting practices, stunting

Abstrak

Daya Prediktif Karakteristik Anak dan Faktor Pengasuhan terhadap Empat Domain Perkembangan pada Batita. Stunting *merupakan kondisi kronis yang memiliki dampak signifikan terhadap perkembangan anak. Fenomena ini utamanya disebabkan oleh defisiensi nutrisi yang berkepanjangan, khususnya selama 1.000 hari pertama kehidupan. Mengingat faktor keluarga juga memegang peranan krusial dalam perkembangan anak, penelitian ini bertujuan untuk menganalisis pengaruh karakteristik anak dan keluarga, kelekatan* (attachment) *ibu-anak, praktik pengasuhan, serta status gizi anak* (stunting/non-stunting) *terhadap kemampuan motorik kasar, motorik halus, bahasa, dan personal-sosial anak. Studi ini menggunakan desain kuantitatif dengan pendekatan eksplanatori yang melibatkan 202 pasangan ibu-anak dengan anak berusia 12–36 bulan. Temuan menunjukkan bahwa praktik pengasuhan kesehatan ($p = 0,016$) dan jenis kelamin laki-laki ($p = 0,050$) secara signifikan mempengaruhi perkembangan motorik kasar ($AR^2 = 0,068$), sementara usia batita ($p < 0,001$), status* stunting *($p < 0,001$), dan praktik pengasuhan kesehatan ($p = 0,042$) memengaruhi perkembangan motorik halus ($AR^2 = 0,213$). Praktik pengasuhan kesehatan ($p = 0,021$) secara signifikan mempengaruhi perkembangan bahasa ($AR^2 = 0,038$), sementara usia batita ($p < 0,001$), kelekatan ibu-anak ($p = 0,025$), dan praktik pengasuhan kesehatan ($p = 0,010$) secara signifikan mempengaruhi perkembangan personal-sosial ($AR^2 = 0,138$). Oleh karena itu, mengatasi* stunting *memerlukan kerja sama dari berbagai pemangku kepentingan—termasuk pemerintah, tenaga kesehatan, masyarakat, dan orang tua—untuk fokus pada pendekatan yang berpusat pada anak dan keluarga.*

Kata Kunci: *karakteristik keluarga, kelekatan, perkembangan anak, praktik pengasuhan,* stunting

Introduction

Stunting, defined as impaired linear growth resulting from chronic malnutrition and recurrent infections during the first 1,000 days of life (WHO, 2018), remains a critical global public health challenge with profound implications for human capital development. Characterized by

height-for-age below −2 standard deviations from WHO growth standards, its prevalence in Indonesia persists at 21.6%, despite recent declines (Ministry of Health, Republic of Indonesia, 2023). The consequences extend far beyond compromised physical stature, with extensive evidence linking stunting to diminished cognitive capacity, reduced educational attainment, and lower economic productivity in adulthood (Kumar & Lakhtakia, 2020; Lestari et al., 2024; Nasser et al., 2022; Sartika et al., 2021).

The neurodevelopmental impact of stunting can be severe, particularly when it occurs during early childhood, a critical period for brain and cognitive development, and may lead to potentially irreversible physical and neurocognitive impairments (Soliman et al., 2021). This results in significant impairments across key developmental domains: cognitive abilities, gross and fine motor skills, language acquisition, and personal–social competence (Mustakim et al., 2022; Supriatin et al., 2020). Stunted children face substantially higher risks of developmental delays than their non-stunted peers, with deficits potentially persisting into adulthood as reduced cognitive and numerical abilities (Mutapi et al., 2021; Lestari et al., 2024). This burden is especially acute in low- and middle-income countries, where stunting contributes to the loss of developmental potential in nearly 40% of children under five years of age (Perkins et al., 2017; Black et al., 2017).

The etiology is complex and involves multilevel determinants. Child characteristics (age, sex, birth weight) and family/household factors (maternal education, socioeconomic status, sanitation) are established correlates (Sk et al., 2021; Wake & Zewotir, 2022). Crucially, proximal caregiving environment factors significantly influence outcomes. Mother-child attachment predicts emotion regulation abilities and cognitive development (Deneault et al., 2023; Ferreira et al., 2024), while parenting practices (healthcare behaviors, nurturing interactions) shape cognitive, motor, and social development (Sukumaran & Balakrishna, 2021; Fadlillah & Pangastuti, 2022). Positive parenting may buffer against stunting-related risks (Latifah et al., 2025), aligning with frameworks emphasizing integrated health–nutrition–caregiving interventions (Black et al., 2017).

While independent associations are documented, significant limitations persist in understanding these factors' relative and combined contributions across multiple developmental domains within the same population. Most studies have examined isolated domains (e.g., cognition or motor skills) or limited predictor combinations (e.g., stunting and parenting without attachment) (Ekholuenetale et al., 2020; Hastuti et al., 2025; Rambe et al., 2023; Syandri & Latifah, 2024). This fragmentation obscures synergistic effects and unique predictive power—for instance, whether secure attachment moderates stunting's impact on language or how child age interacts with parenting quality to influence motor skills. Comprehensive analysis is essential for effective interventions (Black et al., 2017).

This study addresses this gap through an integrated analysis of child characteristics (age, sex), family factors, mother–child attachment, parenting practices, and stunting status in four domains: gross motor, fine motor, language, and personal–social skills in Indonesian toddlers (12–36 months). Examining these predictors across domains provides novel insights into their interplay (Black et al., 2017), identifying key intervention levers for optimizing development in high-stunting contexts.

Methods

Study Design, Participants, and Sampling. This study employed a quantitative design with an explanatory approach to examine the relationships among the variables under study. The research was conducted in Bogor Regency and involved three selected villages drawn from one subdistrict with a high prevalence of stunting. From this subdistrict, two villages with the highest stunting rates were selected from which to obtain samples of stunted children, while a villa-

ge with the lowest stunting rate was selected from which to obtain samples of non-stunted children.

A total of 12 Integrated Health Posts for Child Health (Posyandu) across these three villages were included. From these Posyandu, data on stunted and non-stunted children were collected and subsequently subjected to random sampling, yielding an initial total of 204 data points. Two samples were excluded because the children were classified as over-nourished and did not meet the study criteria. Consequently, 202 respondents (69 stunted children and 133 non-stunted children), consisting of mothers and their children, were included in the final analysis.

The inclusion criteria were mothers with biological children aged 12–36 months who were registered at the Integrated Health Post for Child Health and who provided consent for themselves and their children to participate. Children were required to have either stunted or normal nutritional status and to be free from congenital diseases.

Variables and Instruments. The variables studied in this research included child characteristics (age, sex, birth weight, birth length, number of siblings), family characteristics (father's age, mother's age, father's education, mother's education, father's occupation, mother's occupation, per capita income, family size), and socio-cultural practices encompassing mother–child attachment, feeding practices, and health care practices. The child development variables included gross motor, fine motor-adaptive, language, and personal–social development. Data on child characteristics, family characteristics, and socio-cultural practices were collected through structured questionnaire interviews with the mothers. Meanwhile, data regarding child development were collected through measurements taken by enumerators of toddlers' subjects. All instruments were pilot tested and underwent a readability check by the researchers before the main data collection.

Mother–child attachment is the emotional bond formed between a child and the mother. In this study, attachment was measured using an instrument developed by Robinson (1994). The reliability of the instrument in this study was 0.607 (Cronbach's alpha). The questionnaire consisted of 12 questions answered on a Likert scale. The original questions had a 9-point scale (1 = very unlike my child; 9 = most like my child). For ease of response for the Indonesian community, the options were modified to five choices: 1 = very unlike my child, 2 = unlike my child, 3 = neither like nor unlike, 4 = like my child, and 5 = most like my child. The total possible score ranged from 12 to 60, with higher scores indicating a greater level of attachment between the mother and her child. An example question is, "My child readily lets new adults hold or share things he/she has if they ask to."

Feeding practices refers to the eating habits established by the mother and her child. In this study, feeding practices were measured using an instrument that was tested for validity and reliability by Nurdiani et al. (2019) with a Cronbach's alpha of 0.657. This variable consisted of 11 questions created by the researcher, an example of which is, "Does your child receive complementary foods such as tempeh/tofu/legumes?" with answer choices being 0 = never, 1 = rarely/sometimes, and 2 = often/always. Healthcare practices refer to the ways in which a mother supports and enhances her child's physical well-being. In this study, healthcare practices were measured using an instrument that was tested for validity and reliability by Nurdiani et al. (2019) with a Cronbach's alpha of 0.689. The researcher devised 11 questions to measure this variable, an example being, "Does the mother always teach the child to bathe regularly?" The answer choices were 0 = no and 1 = yes, resulting in a total possible score ranging from 0 to 11 for both feeding practices and healthcare practices.

Child development was assessed using the Denver Developmental Screening Test (Denver II) (Suwariyah, 2021), a widely used tool designed to identify developmental delays in chil-

dren from birth to six years of age. Denver II evaluates four significant areas of development: gross motor skills, fine motor-adaptive, language, and personal-social. It includes a series of tasks and observations used to measure a child's ability to perform age-appropriate skills. Denver II was used to assess four domains of child development based on the child's age. Since the number of items administered varied depending on the child's age, the minimum and maximum possible total scores differed across individuals.

Data Collection Procedures. This study was conducted in Bogor Regency, West Java, Indonesia, and data were collected from May to June 2024. Ten trained enumerators worked in pairs to collect data from respondents through door-to-door visits.

Ethical Considerations. This study did not involve experimental procedures or interventions. The Research Ethics Commission approved the Protocol for Human Subjects Research at IPB University with number 1222/IT3.KEPMSM-IPB/SK/2024. Respondents' rights were protected, including the right to refuse or withdraw from the study at any time without risk. Data confidentiality is maintained by not including personal identities in the publication of the research results. As compensation, the respondents received a gift package (souvenir) as a token of appreciation.

Data Analysis. The obtained data were then inputted, filtered, cleaned, and processed using JASP software. The analysis included descriptive tests (minimum value, maximum value, mean, standard deviation) and inferential tests (multiple linear regressions). To enable comparison across variables with different score ranges, all total scores were rescaled to a 0–100 scale by subtracting the minimum possible score from each total score, dividing the result by the range between the maximum and mini-mum possible scores, and then multiplying by 100. This transformation was applied to the developmental outcomes, as well as the parenting-related variables, including mother–child attachment, feeding practices, and healthcare practices, to ensure consistency in interpretation and analysis.

Table 1. Range, Mean, Standard Deviation, and p-value of Child Characteristics, Family Variables, Parenting Variables, and Child Development

Variable	Range (min-max)	Mean ± SD
Child Characteristics		
Age (months)	12–36	22.658 ± 6.750
Birth length (cm)	30.00–56.00	48.109 ± 3.261
Birth weight (kg)	1.00–6.80	3.019 ± 0.591
Number of siblings (people)	0–9	1.317 ± 1.269
Family Characteristics		
Father's age (years)	31–65	35.408 ± 7.449
Mother's age (years)	19–46	30.975 ± 6.017
Father's education (years)	0–18	9.448 ± 3.072
Mother's education (years)	0–16	9.342 ± 2.812
Family size (people)	3–11	4.421 ± 1.303
Per capita income (thousand rupiah/month)	50–12,620	1,058 ± 1,471
Parenting		
Mother–child attachment (index)	47.00–93.00	74.114 ± 8.808
Feeding practices (index)	23.00–91.00	67.926 ± 12.315
Healthcare practices (index)	36.00–100.00	68.00 ± 13.806
Child Development		
Gross motor (index)	00.00–100.00	63.238 ± 23.912
Fine motor-adaptive (index)	11.00–100.00	58.569 ± 17.157
Language (index)	6.00–100.00	63.861 ± 25.543
Personal–social (index)	18.00–100.00	56.931 ± 17.676

Table 2. Distribution of Stunting by Toddler's Sex, Father's Occupation, and Mother's Occupation

Characteristic	n	%
Toddler's sex		
Male	100	49.505
Female	102	50.495
Father's occupation		
Employed	198	98.020
Unemployed	3	1.485
No father	1	0.495
Mother's occupation		
Employed	23	11.386
Unemployed/homemaker	179	88.614

Table 3. The Impact of Child Characteristics and Parenting Factors on Toddler Gross Motor Development: Coefficients from Multiple Linear Regressions

Model		Unstandardized	Standard Error	Standardized	t	p
H_0	(Intercept)	63.238	1.682		37.587	< 0.001
H_1	(Intercept)	0.511	30.167		0.017	0.986
	Toddler's sex (1 = male; 0 = female)	6.512	3.307	0.136	1.969	0.050
	Toddler's age (years)	0.362	0.257	0.102	1.412	0.160
	Birth weight (kg)	3.456	3.235	0.085	1.068	0.287
	Birth length (cm)	0.456	0.588	0.062	0.775	0.439
	Number of siblings (people)	−1.733	1.335	−0.092	−1.298	0.196
	Growth status (1= non stunted; 0 = stunted)	5.175	3.653	0.103	1.417	0.158
	Mother-child attachment (index)	0.004	0.197	0.001	0.020	0.984
	Feeding practices (index)	−0.044	0.141	−0.023	−0.312	0.755
	Healthcare practices (index)	0.302	0.124	0.174	2.436	**0.016***

Note. Analysis of Linear Regression Model for Gross Motor Development on Stunted and Non-stunted Toddler; Adjusted R^2 = 0.068; R^2 = 0.110; F-value = 2.624; p = 0.007; *p < 0.05

Results

The results, as presented in Table 1, provide a comprehensive summary of the minimum, maximum, mean, and standard deviation values. The average toddler was 22.658 months old, with a birth length of 48.109 cm and a birth weight of 3.019 kg. On average, they had 1 to 2 siblings. The average age of fathers (mean ± SD = 35.408 ± 7.44) and mothers (mean ± SD = 30.975 ± 6.017) put them in the young adult category. The average education level of fathers (mean ± SD = 9.448 ± 3.072) and mothers (mean ± SD = 9.342 ± 2.812) was equivalent to completing junior high school but not graduating from senior high school. The average family size was 4–5 members (Mean ± SD = 4.421 ± 1.303), and the average per capita income (Mean ± SD = 1,058 thousand ± 1,471 thousand) was above the poverty line for Bogor Regency, which was IDR 513,512 (Central Statistics Agency of Bogor Regency, 2024).

As shown in Table 2, there were 100 boys (49.51%) and 102 girls (50.49%). Additionally, almost all fathers in both groups were employed. As many as 198 fathers were employed (98.51%), and three were unemployed (1.49%). One child in the non-stunted group did not live with their father due to the divorce status of the family. The analysis of maternal employment revealed that 23 mothers were employed (11.39%) and 179 were unemployed or home-makers (88.61%).

Based on the average parenting score, mother–child attachment (Mean ± SD = 74.114 ± 8.808)

Table 4. The Impact of Child Characteristics and Parenting Factors on Toddler Fine Motor-Adaptive Development: Coefficients from Multiple Linear Regressions

Model		Unstandardized	Standard Error	Standardized	t	p
H_0	(Intercept)	58.569	1.207		48.519	< 0.001
H_1	(Intercept)	44.623	19.894		2.243	0.026
	Toddler's sex (1 = male; 0 = female)	3.345	2.181	0.098	1.534	0.127
	Toddler's age (years)	−0.640	0.169	−0.252	−3.780	**< 0.001*** **
	Birth weight (kg)	1.208	2.133	0.042	0.566	0.572
	Birth length (cm)	0.175	0.388	0.033	0.452	0.652
	Number of siblings (people)	−1.053	0.880	−0.078	−1.196	0.233
	Growth status (1 = non stunted; 0 = stunted)	10.048	2.409	0.278	4.171	**< 0.001*** **
	Mother–child attachment (index)	−0.081	0.130	−0.042	−0.628	0.531
	Feeding practices (index)	0.061	0.093	0.044	0.652	0.515
	Healthcare practices (index)	0.167	0.082	0.135	2.051	**0.042***

Note. Analysis of Linear Regression Model for Fine Motor-Adaptive Development on Stunted and Non-stunted Toddler; Adjusted R^2 = 0.213; R^2 = 0.248; F-value = 7.028; p = < 0.001; *p < 0.05, ***p < 0.001

Table 5. The Impact of Child Characteristics and Parenting Factors on Toddler Language Development: Coefficients from Multiple Linear Regressions

Model		Unstandardized	Standard Error	Standardized	t	p
H_0	(Intercept)	63.861	1.797		35.534	< 0.001
H_1	(Intercept)	−11.905	32.740		−0.364	0.717
	Toddler's sex (1 = male; 0 = female)	0.646	3.589	0.013	0.180	0.857
	Toddler's age (years)	0.520	0.278	0.137	1.868	0.063
	Birth weight (kg)	1.659	3.511	0.038	0.472	0.637
	Birth length (cm)	0.056	0.638	0.007	0.087	0.931
	Number of siblings (people)	−0.749	1.449	−0.037	−0.517	0.606
	Growth status (1 = non stunted; 0 = stunted)	2.662	3.965	0.050	0.672	0.503
	Mother–child attachment (index)	0.307	0.214	0.106	1.438	0.152
	Feeding practices (index)	0.166	0.153	0.080	1.081	0.281
	Healthcare practices (index)	0.312	0.134	0.169	2.322	**0.021***

Note. Analysis of Linear Regression Model for Language Development on Stunted and Non-stunted Toddlers; Adjusted R^2 = 0.038; R^2 = 0.081; F-value = 1.875; p = 0.058

had a better score than feeding practices (Mean ± SD = 67.926 ± 12.315) and healthcare practices (Mean ± SD = 68.00 ± 13.806) (Table 1). This indicates that, while the emotional bond was adequately developed, there was room to strengthen practical caregiving behaviors.

In terms of child development, language skills (mean ± SD = 63.861 ± 25.543) and gross motor skills (mean ± SD = 63.238 ± 23.912) had the highest average development. In contrast, social and personal development had the lowest average development (mean ± SD = 56.931 ± 17.676), indicating a potential developmental lag in social adaptability (Table 1).

As shown in Table 3, the regression models demonstrated that healthcare practices (p = 0.016) significantly impacted gross motor development, indicating that better healthcare practices are associated with improved gross motor skills in toddlers. The adjusted R^2 value of 0.068 indicates that this model explained 6.8% of the variance in gross motor development.

Table 6. The Impact of Child Characteristics and Parenting Factors on Toddler Social Personal Development: Coefficients from Multiple Linear Regressions

Model		Unstandardized	Standard Error	Standardized	t	p
H_0	(Intercept)	56.931	1.244		45.775	< 0.001
H_1	(Intercept)	0.116	21.446		0.005	0.996
	Toddler's sex (1 = male; 0 = female)	−0.902	2.351	−0.026	−0.384	0.702
	Toddler's age (years)	−0.660	0.182	−0.252	−3.616	**< 0.001*** **
	Birth weight (kg)	−2.767	2.300	−0.092	−1.203	0.230
	Birth length (cm)	0.758	0.418	0.140	1.813	0.071
	Number of siblings (people)	−0.691	0.949	−0.050	−0.728	0.467
	Growth status (1 = non stunted; 0 = stunted)	−0.349	2.597	−0.009	−0.135	0.893
	Mother–child attachment (index)	0.316	0.140	0.158	2.262	**0.025***
	Feeding practices (index)	0.091	0.100	0.063	0.904	0.367
	Healthcare practices (index)	0.229	0.088	0.179	2.607	**0.010****

Note. Analysis of Linear Regression Model for Social Personal Development on Stunted and Non-stunted Toddlers; Adjusted R^2 = 0.138; R^2 = 0.176; F-value = 4.570; p = < 0.001; *p < 0.05, **p < 0.01, ***p < 0.001

The model in Table 4 shows that toddler age (p < 0.001), growth status (p < 0.001), and healthcare practices (p = 0.042) significantly affected fine motor development. These findings suggest that older age, non-stunted growth, and better healthcare practices positively influence fine motor skills. The adjusted R^2 value of 0.213 indicates that the model explained 21.3% of the variance in fine motor development.

Table 5 reveals that although the overall model was insignificant (p = 0.058), language development significantly affected healthcare practices (p = 0.021). This suggests that better healthcare practices contribute to improved language development. The adjusted R^2 value of 0.038 indicates that the model explained only 3.8% of the variance in language development. This indicates that the current model provided a limited explanation of the factors affecting language development and that additional variables may be needed to strengthen and better clarify the model.

Table 6 shows that toddler age (p < 0.001), mother–child attachment (p = 0.025), and healthcare practices (p = 0.010) significantly affected personal–social development. This suggests that younger age, stronger mother–child attachment, and better healthcare practices are associated with better personal–social development. The adjusted R^2 value of 0.138 indicates that the presented model explained 13.8% of the variance in personal–social development.

Discussion

This study reveals that healthcare practices have a significant influence on toddler development, particularly in the domains of gross motor, fine motor, language, and personal–social development. The regression analysis demonstrated a clear association between the quality of healthcare received and the developmental outcomes of young children. These findings highlight the crucial role of parents, particularly maternal engagement, in health-related parenting practices. These results are consistent with existing evidence that nurturing and stimulation interventions have significant effects on child development (Prado et al., 2019). Meylia et al. (2022) emphasized that healthy parenting contributes significantly to toddlers' motor development, highlighting that toddlers who receive consistent and high-quality health care tend to achieve better mobility and gross motor mile-stones.

Our findings show that healthcare practices were the only variable significantly associated with both gross motor and language develop-

ment. In the gross motor domain, this reflects a strong relationship between routine health maintenance and physical capability. In the language domain, while the overall model was not statistically significant (p = 0.058), healthcare practices alone still showed a significant association (p = 0.021). These health routines indirectly support language acquisition by enhancing overall vitality and facilitating more frequent social interactions. Muhoozi et al. (2018) found that providing mothers with education on nutrition, hygiene, and stimulation improved children's motor and language development, suggesting that the direct implementation of these practices, as in our study, may offer similarly beneficial effects.

Furthermore, the study indicates that age and nutritional status, specifically whether toddlers are stunted, also contribute to fine motor development. This finding aligns with research showing that undernutrition, particularly stunting and underweight, during early childhood is associated with delays in overall child development, including motor skill acquisition (Oumer et al., 2022). Ensuring access to appropriate healthcare can mitigate these developmental risks, highlighting the essential role of parental involvement, particularly maternal caregiving, in shaping developmental trajectories. This finding also supports the notion that combining biological and environmental factors, including responsive health-care practices, creates a foundation for physical and cognitive growth. Parental involvement, particularly mothers' attentiveness to their children's daily health routines, is vital in facilitating this development (Berkes et al., 2019).

Personal–social development is also influenced by mother attachment. The results highlight the importance of maternal–child emotional attachment as a predictor of healthy social behavior. The results of this study are also corroborated by previous findings showing that secure maternal–child attachments are associated with improved communication skills and social behaviors (Bowlby, 1988; Jeong et al., 2021). This finding suggests that a holistic approach to healthcare, including psychosocial support, has far-reaching developmental impacts.

Our findings demonstrate that healthcare practices consistently influence all four developmental domains—gross motor, fine motor, language, and personal–social. While previous research has often emphasized the importance of nutritional interventions and dietary intake in early child development (Roberts at al., 2022; Vaivada et al., 2017), our study highlights that routine healthcare practices—such as regular bathing, proper tooth brushing, complete immunization, encouraging physical movement, and monitoring a child's growth—play a significant role in supporting toddler development. This suggests that parents and caregivers should not only focus on nutritional intake but also ensure regular and preventive healthcare practices to support optimal child development.

Despite the study's strengths, several limitations must be acknowledged. First, the study was based on cross-sectional data, which limits its ability to establish causal relationships. Longitudinal research is recommended to better understand how healthcare practices influence developmental trajectories. Second, the study relied primarily on caregiver self-reports, which may have introduced reporting bias. Future research could integrate clinical assessments and objective developmental screening tools to enhance the validity of the data. Third, the model for language development did not reach overall statistical significance (p = 0.058), suggesting the need to identify and include other relevant factors in future models to better capture language-related outcomes. Fourth, this study did not deeply explore cultural and socioeconomic factors, although they may moderate the relationship between healthcare practices and child development. Expanding the model to include these variables could offer a more comprehensive analysis. Future studies, especially in low-resource settings, may examine healthcare practices as a practical and cost-effective intervention to support early child development. Its effectiveness can also be assessed in combination with nutri-

tion and parenting programs to improve developmental outcomes.

This research has significant practical implications for public health practitioners, early childhood educators, and policymakers. Interventions that promote parental education in healthcare practices should be prioritized. Programs that support mothers in providing regular nutrition, immunization, and hygiene care can substantially improve early childhood development outcomes. Moreover, community-based healthcare models that integrate parental involvement can help bridge gaps in early childhood services in underserved areas. Policymakers should consider developing family-centered health programs that empower caregivers with the knowledge and resources necessary to foster holistic child development.

Conclusion

Our findings indicate that healthcare practices consistently and positively influence all domains of child development: gross motor, fine motor, language, and personal–social. However, the overall regression model for language development only reached marginal significance. This highlights the importance of parents or caregivers implementing good healthcare practices to support child growth and development. In addition, male toddlers tend to show higher gross motor development. Toddler age positively influences fine motor development. Growth status (non-stunted children) is associated with higher fine motor development. Older toddlers and better mother–child attachment affect toddlers' personal–social development. It also indicates that, besides healthcare practices, another factor must be taken into account.

A key limitation is that this cross-sectional design cannot confirm causality. It also depended on caregiver self-reports, which may have biased the results. Notably, the regression model for language development did not reach overall significance, suggesting that additional or alternative factors may better explain language outcomes. Future research should use objective measures, apply longitudinal designs, and include cultural and socioeconomic contexts to enrich understanding and guide better practices.

Acknowledgments

We would like to express our gratitude for the research funding provided by the Indonesian Endowment Fund for Education (LPDP) through the Equity Program (DAPT), specifically under the fundamental research scheme/Riset Fundamental (Ri-Fund) (Grant No.: 430/IT3.D10/PT.01.03/P/B/2024).

We also wish to acknowledge the Bogor Health Office, the Subdistrict, the Village, Community Health Workers, Public Health Centers (Puskesmas), Integrated Service Posts (Posyandu), and enumerators for their invaluable support and collaboration. Additionally, we express our deep appreciation to all contributors and participants who graciously dedicated their time and effort to this study.

The authors used AI tools for language editing and grammar checking. All content has been reviewed and approved by the authors.

References

Berkes, J., Raikes, A., Bouguen, A., & Filmer, D. (2019). Joint roles of parenting and nutritional status for child development: Evidence from rural Cambodia. *Developmental Science, 22* (5), e12874. doi: 10.1111/desc.12874h.

Black, M.M., Walker, S.P., Fernald, L.C., Andersen, C.T., DiGirolamo, A.M., Lu, C., ... & Grantham-McGregor, S. (2017). Early childhood development coming of age: science through the life course. *The Lancet, 389* (10064), 77-90. doi: 10.1016/S0140-6736(16)31389-7.

Bowlby, J. (1988). *A secure base: Clinical applications of attachment theory*. Routledge.

Central Statistics Agency of Bogor Regency. (2024). *Garis kemiskinan (Rupiah), 2022-2024 [Poverty line (Rupiah) 2022-2024]*. Badan Pusat Statistik Kabupaten Bogor. Retrieved from: https://bogorkab.bps.go.id/id/statistics-table/2/NjMjMg==/garis-kemiskinan.html.

Deneault, A.A., Duschinsky, R., van Ijzendoorn, M.H., Roisman, G.I., Ly, A., Fearon, R.P., & Madigan, S. (2023). Does child-mother attachment predict and mediate language and cognitive outcomes? A series of meta-analyses. *Developmental Review, 70*, 101093. doi: 10.1016/j.dr.2023.101093.

Ekholuenetale, M., Barrow, A., Ekholuenetale, C.E., & Tudeme, G. (2020). Impact of stunting on early childhood cognitive development in Benin: Evidence from Demographic and Health Survey. *Egyptian Pediatric Association Gazette, 68*, 31. doi: 10.1186/s43054-020-00043-x.

Fadlillah, M., & Pangastuti, R. (2022). Parenting style to support the cognitive development of early childhood. *Jurnal Iqra*, *7* (1), 156–163. doi: 10.25217/ji.v7i1.1614.

Ferreira, T., Matias, M., Carvalho, H., & Matos, P.M. (2024). Parent-partner and parent-child attachment: Links to children's emotion regulation. Journal of Applied Developmental Psychology, 91, 101617. doi: 10.1016/j.appdev.2023.101617.

Hastuti, D., Latifah, M., & Hasanah, R.A. (2025). Mother's knowledge and parenting practices for stunted and non-stunted children under three in Bogor City. *Malaysian Journal of Medicine & Health Sciences, 21* (Supp 1), 45–46. doi: 10.47836/mjmhs.21.s1.1.

Jeong, J., Franchett, E.E., Ramos de Oliveira, C.V., Rehmani, K., & Yousafzai, A.K. (2021). Parenting interventions to promote early child development in the first three years of life: A global systematic review and meta-analysis. *PLoS Medicine*, *18* (5), e1003602. doi: 10.1371/journal.pmed.1003602.

Kumar, R., & Lakhtakia, S. (2020). Women's empowerment and child stunting in India: An investigation. *Journal of Population and Social Studies*, *29*, 47–66. doi: 10.25133/jpssv292021.004.

Latifah, M., Hernawati, N., Riany, Y.E., & Hasanah, R.A. (2025). Maternal parenting efficacy, mother-child attachment, home parenting environment, and child development: An analysis of stunted and non-stunted children in Bogor City. *Malaysian Journal of Medicine & Health Sciences*, *21* (Supp 1), 47–48. doi: 10.47836/mjmhs.21.s1.1.

Lestari, E., Siregar, A., Hidayat, A.K., & Yusuf, A.A. (2024). Stunting and its association with education and cognitive outcomes in adulthood: A longitudinal study in Indonesia. *PLoS One*, *19* (5), e0295380. doi: 10.1371/journal.pone.0295380.

Meylia, K.N., Siswati, T., Paramashanti, B.A., & Hati, F.S. (2022). Fine motor, gross motor, and social independence skills among stunted and non-stunted children. *Early Child Development and Care*, *192* (1), 95–102. doi: 10.1080/03004430.2020.1739028.

Ministry of Health Republic Indonesia. (2023). *Buku saku hasil Survei Status Gizi Indonesia (SSGI) Tahun 2022 [Pocketbook of the 2022 Indonesian Nutrition Status Survey (SSGI)]*. Retrieved from: https://repository.badankebijakan.kemkes.go.id/id/eprint/4855/

Muhoozi, G.K., Atukunda, P., Diep, L.M., Mwadime, R., Kaaya, A.N., Skaare, A.B., Willumsen, T., Westerberg, A.C., & Iversen, P.O. (2018). Nutrition, hygiene, and stimulation education to improve growth, cognitive, language, and motor development among infants in Uganda: A cluster-randomized trial. *Maternal & Child Nutrition*, *14* (2), e12527. doi: 10.1111/mcn.12527.

Mustakim, M.R.D., Irwanto, I., Irawan, R., Irmawati, M., & Setyoboedi, B. (2022). Impact of stunting on development of children between 1–3 years of age. *Ethiopian Journal of Health Sciences, 32* (3), 569–578. doi: 10.4314/ejhs.v32i3.13.

Mutapi, F., Pfavayi, L., Osakunor, D., Lim, R., Kasambala, M., Mutemeri, A., Rusakaniko, S., Chibanda, D., & Mduluza, T. (2021). Assessing early child development and its

association with stunting and schistosome infections in rural Zimbabwean children using the Griffiths scales of child development. *PLOS Neglected Tropical Diseases, 15* (8), e0009660. doi: 10.1371/journal.pntd.0009660.

Nasser, M.S., Akhlaq, A., Ali, H., & Nasser, D. (2022). Evidence linking stunting to economic outcomes in the SAARC region: A systematic review. *Pakistan Journal of Public Health, 12* (2), 88–101. doi: 10.32413/pjph.v12i2.978.

Nurdiani, R., Herawati, T., Rizkillah, R., Pujihasvuty, R., & Amrullah, H. (2019). Association between parental feeding practice and clean and healthy lifestyle behaviour with stunting status among toddlers in West Bandung, Indonesia. *Annals of Nutrition and Metabolism, 75* (Suppl. 3), 296. doi: 10.1159/000501751.

Oumer, A., Fikre, Z., Girum, T., Bedewi, J., Nuriye, K., & Assefa, K. (2022). Stunting and Underweight, but not Wasting are Associated with Delay in Child Development in Southwest Ethiopia. Pediatric Health, Medicine and Therapeutics, 13, 1–12. doi: 10.2147/PHMT.S344715

Perkins, J.M., Kim, R., Krishna, A., McGovern, M., Aguayo, V.M., & Subramanian, S. (2017). Understanding the association between stunting and child development in low- and middle-income countries: Next steps for research and intervention. *Social Science and Medicine, 193*, 101–109. doi: 10.1016/j.socscimed.2017.09.039.

Prado, E. L., Larson, L. M., Cox, K., Bettencourt, K., Kubes, J. N., & Shankar, A. H. (2019). Do effects of early life interventions on linear growth correspond to effects on neuro-behavioural development? A systematic review and meta-analysis. *The Lancet Global Health, 7* (10), e1398-e1413. doi: 10.1016/S2214-109X(19)30361-4.

Rambe, N.L., Hutabarat, E.N., & Hafifah, R. (2023). The effect of stunting on children's cognitive development: Systematic review. *Contagion: Scientific Periodical Journal of Public Health and Coastal Health, 5* (2), 360–372. doi: 10.30829/contagion.v5i2.14807.

Roberts, M., Tolar-Peterson, T., Reynolds, A., Wall, C., Reeder, N., & Rico Mendez, G. (2022). The effects of nutritional interventions on the cognitive development of preschool-age children: a systematic review. *Nutrients, 14* (3), 532. doi: 10.3390/nu14030532.

Robinson, J.R. (1994). *Quality of attachment as a predictor of parental visitation when a young child or infant is hospitalized* [Doctoral dissertation, Drake University]. https://escholarshare.drake.edu/server/api/core/bitstreams/686fb1af-7f6c-4973-8003-cc73d3770d8d/content

Sartika, A.N., Khoirunnisa, M., Meiyetriani, E., Ermayani, E., Pramesthi, I.L., & Ananda, A.J.N. (2021). Prenatal and postnatal determinants of stunting at age 0–11 months: A cross-sectional study in Indonesia. *PLOS One, 16* (7), e0254662. doi: 10.1371/journal.pone.0254662.

Sk, R., Banerjee, A., & Rana, M.J. (2021). Nutritional status and concomitant factors of stunting among pre-school children in Malda, India: A micro-level study using a multilevel approach. *BMC Public Health, 21* (1), 1690. doi: 10.1186/s12889-021-11704-w.

Soliman, A., De Sanctis, V., Alaaraj, N., Ahmed, S., Alyafei, F., Hamed, N., & Soliman, N. (2021). Early and long-term consequences of nutritional stunting: From childhood to adulthood. *Acta Bio Medica: Atenei Parmensis, 92* (1), e2021168. doi: 10.23750/abm.v92i1.11346.

Sukumaran, P., & Balakrishna, B. (2021). Parenting styles and social–emotional development of preschool children. *International Journal of Contemporary Pediatrics, 8* (12), 1952–1957. doi: 10.18203/2349-3291.ijcp20214534.

Supriatin, E., Sudrajat, D.A., & Lindayani, L. (2020). The effect of stunting on cognitive and motor development in toddler children: Literature review. *Jurnal Ilmu Keperawatan Anak, 3* (2), 31–41. doi: 10.32584/jika.v3i2.782.

Suwariyah, P. (2021). *Test Perkembangan bayi/ anak menggunakan Denver Developmental Screening Test (DDST) [Baby/child development test using the Denver Developmental Screening Test (DDST)]*. Trans Info Media.

Syandri, F., & Latifah, M. (2024). Mother's knowledge, parenting style, and motor development in stunting and non-stunting toddler. *Journal of Child, Family, and Consumer Studies*, *3* (2), 107–116. doi: 10.29244/jcfcs.3.2.107-116.

Vaivada, T., Gaffey, M.F., & Bhutta, Z.A. (2017). Promoting early child development with interventions in health and nutrition: a systematic review. *Pediatrics*, *140* (2), e20164308. doi: 10.1542/peds.2016-4308.

Wake, S.K., & Zewotir, T. (2022). *Patterns, prevalence and determinants of stunting among children aged 1–15 years*. Research Square. doi: 10.21203/rs.3.rs-2140794/v1

World Health Organization. (2018). Reducing stunting in children: equity considerations for achieving the Global Nutrition Targets 2025. Retrieved from https://iris.who.int/server/api/core/bitstreams/a9f21ba5-4fc7-4404-96eb-eeaa8b1b22ff/content