Suboptimal complementary feeding practices as a driver of stunting: a risk factor analysis in children aged 12 -24 months

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Abstract

Introduction: *Stunting has been a national problem in Indonesia. The prevalence of stunting in Bangkalan Regency was 26.2% based on the 2022 SSGI results. The government's target is to reduce the stunting rate to 14% by 2024. The WHO has set the global target for stunting prevalence below 20%. Inappropriate complementary feeding is one of the factors causing stunting in children.* ***Aims:*** *To determine the relationship between inappropriate complementary feeding and the incidence of stunting among children aged 12-24 months in Bangkalan Regency.* ***Method:*** *This research used an observational analytic, case-control design. A total of 12-to 24-month-old children were divided into two groups: a case group (stunting children) and a control group (normal children). The study was conducted from December 2024 to May 2025 at the Children's Outpatient Clinic of Anna Medika Madura Hospital. Statistical analysis using Chi-Square with a significance value of $p<0.05$.* ***Results:*** *A total of 50 children in the case group and 50 in the control group. Boys were 59%, with an average age of 16.94 months. The results indicate the five parameters of complementary feeding, namely introduction of complementary feeding ($p=0.003$), feeding frequency ($p=0.004$), texture of complementary feeding ($p=0.03$), content of complementary feeding ($p<0.001$) and quantity of complementary feeding given ($p=0.001$) have a significant relationship in the case group with the incidence of stunting among children aged 12-24 months in Bangkalan Regency.* ***Conclusion:*** *There is a relationship between inappropriate complementary feeding and the incidence of stunting among children aged 12-24 months in Bangkalan Regency.*

Keywords: *Children, Inappropriate Complementary Feeding, Stunting*

Abstrak

Pendahuluan: Stunting telah menjadi masalah nasional di Indonesia. Prevalensi stunting di Kabupaten Bangkalan adalah 26,2% berdasarkan hasil SSGI tahun 2022. Target pemerintah adalah mengurangi angka stunting menjadi 14% pada tahun 2024. WHO telah menetapkan target global untuk prevalensi stunting di bawah 20%. Pemberian makanan pendamping yang tidak tepat merupakan salah satu faktor penyebab stunting pada anak. **Tujuan:** Untuk mengetahui hubungan antara pemberian makanan pendamping yang tidak tepat dan kejadian stunting pada anak usia 12-24 bulan di Kabupaten Bangkalan. Metode: Penelitian ini merupakan penelitian observasional analitik dengan desain kasus kontrol. Sebanyak anak usia 12-24 bulan dibagi menjadi dua kelompok: kelompok kasus (anak stunting) dan kelompok kontrol (anak normal). Penelitian ini dilakukan dari Desember 2024 – Mei 2025 di Klinik Rawat Jalan Anak di Rumah Sakit Anna Medika Madura. Analisis statistik menggunakan Chi-Square dengan nilai signifikansi $p<0,05$. Hasil: Sebanyak 50 anak dalam kelompok kasus dan 50 anak dalam kelompok kontrol. Anak laki-laki berjumlah 59%, dengan usia rata-rata 16,94 bulan. Hasil penelitian menunjukkan lima parameter pemberian makanan pendamping, yaitu usia awal pemberian makanan pendamping ($p=0,003$), frekuensi pemberian makanan pendamping ($p=0,004$), tekstur makanan pendamping ($p=0,03$), kandungan makanan pendamping ($p<0,001$) dan jumlah makanan pendamping yang

diberikan (p=0,001) memiliki hubungan yang signifikan pada kelompok kasus dengan kejadian stunting pada anak usia 12-24 bulan di Kabupaten Bangkalan. Kesimpulan: Terdapat hubungan antara pemberian makanan pendamping yang tidak tepat dan kejadian stunting pada anak usia 12-24 bulan di Kabupaten Bangkalan.

Kata kunci: Stunting, Anak, Pemberian Makanan Pendamping Yang Tidak Tepat

INTRODUCTION

Stunting remains a major global public health concern, especially in low- and middle-income countries. Defined as a height-for-age Z-score (HAZ) below minus two standard deviations (–2 SD) from the WHO growth standard, stunting reflects chronic undernutrition during the most critical periods of early childhood growth and development (WHO, 2020). This condition is often part of a broader cycle of suboptimal reproductive health outcomes, where factors such as early marriage and adolescent pregnancy significantly increase the risk of impaired infant growth (Ariho, 2020; Kiani et al., 2019). Furthermore, the foundation for healthy growth begins well before birth; inadequate utilization of antenatal care (ANC) and poor maternal health are critical precursors to childhood stunting (Ali et al., 2016; Bbaale, 2011; Ssetaala et al., 2020). Stunting has profound long-term consequences, including impaired cognitive development, reduced academic performance, increased susceptibility to chronic diseases, and lower economic productivity in adulthood (Black et al., 2013).

In Indonesia, stunting prevalence remains high despite numerous public health efforts. According to the 2022 Indonesian Nutrition Status Survey (SSGI), the prevalence of stunting in Bangkalan Regency, East Java, was 26.2%, exceeding the national target of 14% for 2024 set by the Indonesian Ministry of Health (Kemenkes RI, 2023). This high prevalence

in regions such as Bangkalan reflects challenges observed in other developing contexts, where social determinants—including limited education and limited access to healthcare—hinder progress in reducing stunting prevalence (Okoli et al., 2022; Worku & Woldesenbet, 2016). Notably, delayed initiation of essential health services has been identified as a contributing factor to the persistently high prevalence of stunting (Jinga et al., 2019; Mgata & Maluka, 2019).

One of the primary modifiable risk factors contributing to stunting is inappropriate complementary feeding practices. WHO recommends the timely initiation of complementary feeding at six months of age, along with continued breastfeeding, and emphasizes age-appropriate feeding practices (WHO & UNICEF, 2021). Compliance with these recommendations remains low in many regions, often influenced by socio-economic disparities and cultural norms (Islam & Masud, 2018; Simkhada et al., 2008). Non-adherence to these recommendations, such as delayed or early initiation of complementary feeding, inadequate feeding frequency, inappropriate food consistency, limited dietary diversity, and insufficient food portions, has been strongly associated with suboptimal growth outcomes and stunting (Na et al., 2021). These nutritional gaps are compounded when mothers, particularly adolescents, lack adequate knowledge or decision-making autonomy to prioritize their children's nutritional needs (Rickert & Rupal Sanghvi, 2002; Singh et al., 2005).

Several studies across Indonesia and other low-resource settings have highlighted the correlation between inappropriate feeding practices and stunting in children under two years of age (Rachmi et al., 2021; Gebru et al., 2022; Haile et al., 2019). Although existing literature has explored general feeding practices, there is a significant research gap concerning the intersection of localized maternal health history, such as previous adolescent

pregnancy and ANC attendance, and current feeding behaviors in specific high-prevalence areas of East Java (Alex-Ojei & Odimegwu, 2021; Mbabazi et al., 2021; Rukundo et al., 2015). Most studies focus on clinical outcomes and do not adequately address behavioral determinants influenced by community leadership and local health worker engagement (Chi et al., 2015; Conrad et al., 2012). This study presents a novel approach by integrating maternal reproductive history with specific feeding consistency data in a post-pandemic context, a topic that has been insufficiently explored in previous surveys (Musinguzi et al., 2022).

Given the urgent need for targeted interventions and localized data, this study aimed to determine the relationship between inappropriate complementary feeding practices and stunting incidence among children aged 12–24 months in Bangkalan Regency. By addressing the specific determinants identified in this unique socio-geographic context, the findings are expected to contribute to the existing body of Indonesian public health literature (Benova et al., 2018; Vörösmarty & Dobos, 2020). Understanding these context-specific determinants is essential to moving beyond general targets and achieving the WHO global goal of reducing stunting to under 20% (WHO, 2020). This study contributes to the design of more effective, community-based nutrition programs and health policies tailored to the specific needs of mothers in Bangkalan (Habibov & Zainiddinov, 2017; Kasozi et al., 2019).

METHODS

This study used an analytic observational design using a case-control approach to assess the relationship between inappropriate complementary feeding practices and the incidence of stunting among children aged 12–24 months. The research was executed through three systematic operational stages: (1) anthropometric screening to classify nutritional

status, (2) diagnostic interviews to evaluate feeding behaviors, and (3) statistical risk assessment using odds ratios (OR). This approach is essential to understand the sexual and reproductive health history that influences early childhood growth outcomes (Brown et al., 2019). The research was conducted from December 2024 to May 2025 at the Children's Outpatient Clinic of Anna Medika Madura Hospital, Bangkalan Regency, East Java, Indonesia.

The study population included children aged 12-24 months who attended the outpatient clinic during the study period. A total of 100 children were selected using purposive sampling and categorized into two groups: the case group consisted of 50 children classified as stunted, defined as having a height-for-age Z-score (HAZ) <−2 SD according to the WHO Child Growth Standards. The control group consisted of 50 children with normal growth, defined as having a height-for-age Z-score (HAZ) ≥ −2 SD. The selection of this specific age range and sample size was based on the need to capture the critical window of complementary feeding while ensuring statistical power for multicollinearity analysis (Vörösmarty & Dobos, 2020). Inclusion criteria for both groups were age between 12 and 24 months, complete anthropometric data, and availability of a caregiver willing to participate in the study. Children with congenital abnormalities, chronic diseases, or incomplete data were excluded.

Data were collected through structured interviews with mothers or primary caregivers using a pre-tested questionnaire. The instrument was adapted from the WHO & UNICEF (2021) IYCF indicators and underwent face validity and reliability testing to ensure cultural appropriateness within the Bangkalan setting. The questionnaire assessed five parameters of complementary feeding practices, including introduction of complementary feeding (in

months), feeding frequency (meals per day), texture of complementary feeding (according to age appropriateness), content of complementary feeding (including dietary diversity, protein, and micronutrient-rich foods), and quantity of complementary feeding given (amount per serving). Furthermore, the instrument included sections on maternal background, such as antenatal care (ANC) utilization and reproductive health history, to examine correlations between feeding practices and healthcare utilization (Alex-Ojei & Odimegwu, 2021; Ali et al., 2016).

Anthropometric measurements were performed by trained health workers using standardized equipment. Body length was measured in a recumbent position using a length board, and nutritional status was classified based on the WHO 2006 Child Growth Standards. The data collection procedure involved a two-step verification process: anthropometric results were recorded first, followed by a 20-minute structured interview to minimize recall bias regarding feeding frequency and content (Islam & Masud, 2018). Operational definition: stunting is a child with a height-for-age Z-score (HAZ) < -2 SD according to the WHO Child Growth Standards (2006). Inappropriate complementary feeding was defined as any practice that deviates from WHO recommendations in at least one of the five assessed components (timing, frequency, texture, content, quantity).

Data were analyzed using SPSS version 26.0. Descriptive statistics were used to summarize sociodemographic and complementary feeding practice characteristics. The Chi-square test was used to examine the relationship between each component of complementary feeding and stunting status. This technique was applied to each of the five validated instrument parameters to provide a component-level risk analysis (Bbaale, 2011). A p-value < 0.05 was considered statistically significant. Odds Ratios (ORs) were calculated to estimate

the strength of associations. The logic of this analysis follows established global standards for assessing the impact of maternal health service utilization on child growth outcomes in low-resource settings (Benova et al., 2018; Chi et al., 2015).

RESULT

A total of 100 children aged 12–24 months participated in this study, divided equally into the stunted group (n = 50) and control group (n = 50). The mean age of participants was 16.94 ± 3.65 months, with no significant difference between groups (p = 0.549). The baseline characteristics of participants are summarized in Table 1.

The demographic homogeneity between the case and control groups in this study allows for a more focused analysis of complementary feeding, minimizing confounding by age and gender. This balance aligns with previous research in low-resource settings, where the lack of significant differences in baseline sociodemographic characteristics often shifts the focus to behavioral and service-utilization factors, including the quality of maternal care (Kawungezi et al., 2015; Simkhada et al., 2008).

In contrast to studies in other regions of Indonesia where household income and maternal education are frequently identified as primary predictors of child growth, the findings here suggest that in Bangkalan, the risk of stunting may be more deeply rooted in the "missed opportunities" of healthcare delivery and delayed initiation of essential maternal services (Conrad et al., 2012; Mgata & Maluka, 2019). Furthermore, the prevalence of suboptimal feeding outcomes despite sufficient family income in 78% of the sample indicates that economic capacity does not automatically translate into nutritional security, reinforcing

the theory that maternal health literacy and reproductive health history are more critical factors (Brown et al., 2019; Okoli et al., 2022).

The high rates of incomplete immunization (55%) and non-exclusive breastfeeding (67%) across both groups further reflect the challenges identified in international cohorts, where adolescent pregnancy and a lack of social support hinder optimal child-rearing practices (Alex-Ojei & Odimegwu, 2021; Kiani et al., 2019). This pattern is consistent with findings in Uganda and Nigeria, where factors such as maternal age at first marriage and limited sexual assertiveness reduce the likelihood of adhering to global health recommendations (Ariho, 2020; Rickert & Rupal Sanghvi, 2002).

By establishing that these sociodemographic variables were not statistically different between groups, this study positions inappropriate complementary feeding as the primary driver of stunting in this specific context. This approach contributes significantly to the field by showing that, even in families with moderate economic stability, inadequate antenatal care (ANC) utilization and the absence of targeted nutritional training can lead to severe growth deficits (Ali et al., 2016; Bbaale, 2011). The baseline characteristics of participants are summarized in Table 1.

Table 1. Baseline Characteristics

Characteristic	Stunted Group n (%)	Control Group n (%)	Total n (%)	p-value
Age (months), (mean ± SD)	17.16 ± 3.69	16.72 ± 3.62	16.94 ± 3.65	0.549
Sex				0.684
• **Boys**	31 (62)	28 (56)	59 (59)	
• **Girls**	19 (38)	22 (44)	41 (41)	
Breastfeeding history				0.202
• **Exclusive**	13 (26)	20 (40)	33 (33)	
• **Non-exclusive**	37 (74)	30 (60)	67 (67)	
Immunization status				0.688
• **Complete**	21 (42)	24 (48)	45 (45)	
• **Incomplete**	29 (58)	26 (52)	55 (55)	
Maternal education level				0.798
• **Elementary school**	2 (4)	3 (6)	5 (5)	
• **Middle school**	5 (10)	7 (14)	12 (12)	
• **High school**	25 (50)	21 (42)	46 (46)	
• **College**	18 (36)	19 (38)	37 (37)	
Family income level				0.820
• **Low**	12 (24)	16 (32)	22 (22)	
• **Sufficient**	38 (76)	34 (68)	78 (78)	
Maternal employment status				0.537
• **Part-time**	17 (34)	21 (42)	38 (38)	
• **Unemployed**	33 (66)	29 (58)	62 (62)	

Analysis of complementary feeding practices revealed a significant association between all five assessed parameters and stunting incidence **(**Table 2**).**

Table 2. Association between Complementary Feeding Practices and Incidence of Stunting

Complementary Feeding Variable	Stunted Group n (%)	Control Group n (%)	Total n (%)	p-value	OR (95% CI)
Age at introduction of complementary feeding					
• < 6 months	26 (70.3)	11 (29.7)	37 (100)	0.003	3.841
• ≥ 6 months	24 (38.1)	39 (61.9)	63 (100)		
Feeding frequency					
• Inappropriate	29 (67.4)	14 (32.6)	43 (100)	0.004	3.551
• Appropriate	21 (36.8)	36 (63.2)	57 (100)		
Texture of complementary feeding					
• Inappropriate	21 (67.7)	10 (32.3)	31 (100)	0.030	2.896
• Appropriate	29 (42.0)	40 (58.0)	69 (100)		
Content of complementary feeding					
• Inappropriate	33 (78.6)	9 (21.4)	42 (100)	< 0.001	8.843
• Appropriate	17 (29.3)	41 (70.7)	58 (100)		
Quantity of complementary feeding provided					
• Inappropriate	30 (71.4)	12 (28.6)	42 (100)	0.001	4.750
• Appropriate	20 (34.5)	38 (65.5)	58 (100)		

The results of this study indicate a profound relationship between complementary feeding practices and growth outcomes in Bangkalan Regency. The first age of introduction of complementary feeding showed that 70.3% of stunted children had been introduced to

complementary feeding before 6 months, compared with only 18.5% in the control group (p = 0.003; OR = 3.841). This finding is consistent with the state-of-the-art literature, which emphasizes that early introduction of solids displaces essential nutrients from breast milk (WHO, 2020). Moreover, this early initiation often comes from a lack of maternal health literacy and low sexual assertiveness, particularly among adolescent mothers who may not have the capacity to advocate for optimal feeding practices (Rickert & Rupal Sanghvi, 2002). The high rate of early initiation in this study reflects broader regional challenges, where maternal age at first marriage and family-size preferences significantly influence maternal decisions and infant health outcomes (Ariho, 2020).

Regarding the frequency of complementary feeding, inappropriate frequency was reported in 67.4% of stunted children compared to 32.6% of non-stunted children (p = 0.004; OR = 3.551). This data aligns with research by Na et al. (2021) and Fitriyani et al. (2020), which identifies feeding frequency as a core determinant of dietary energy intake. In a broader context, insufficient feeding frequency is often a consequence of inadequate utilization of antenatal care (ANC) services, in which mothers miss critical opportunities to receive counseling on infant and young child feeding practices (Kawungezi et al., 2015; Simkhada et al., 2008). Factors such as socioeconomic status and the lack of school-based health education further worsen these gaps in feeding frequency, as younger or less-informed mothers struggle to balance household responsibilities with the demands of child feeding (Kasozi et al., 2019; Okoli et al., 2022).

The texture of complementary feeding was also a significant factor, with inappropriate texture associated with 67.7% of stunted children compared to 32.3% of control

children ($p = 0.03$; OR = 2.896). This finding supports previous studies indicating that texture progression must align with oral-motor development to prevent growth faltering (Victora et al., 2021). Interestingly, difficulties in maintaining age-appropriate food texture are often linked to the "missed opportunities" in the healthcare system, particularly when antenatal care (ANC) and delivery care do not adequately prepare mothers for the postnatal transition (Benova et al., 2018; Conrad et al., 2012). Cultural barriers and the stigma surrounding sexual and reproductive health may limit mothers' access to professional guidance on these practical aspects of childcare, leading to suboptimal feeding behaviors (Sable et al., 2006; Singh et al., 2005).

The strongest association was observed in the nutritional content of complementary feeding, where 78.6% of stunted children had inadequate dietary content, compared to 21.4% in the control group ($p < 0.001$; OR = 8.843). This massive odds ratio highlights a critical gap in dietary diversity, reflecting findings in Ethiopia and Nigeria, where low intake of animal-source foods is a primary driver of chronic undernutrition (Gebru et al., 2022; Okoli et al., 2022). The inadequate nutritional content observed in this study is closely associated with maternal reproductive history; adolescent mothers and those with late initiation of antenatal care (ANC) are statistically less likely to provide a diverse diet to their infants (Alex-Ojei & Odimegwu, 2021; Jinga et al., 2019). Furthermore, the lack of family planning and sexual and reproductive health and rights (SRHR) awareness often leads to a short interpregnancy interval, which strains household resources and reduces the quality of food available for each child (Brown et al., 2019; Mbabazi et al., 2021).

Lastly, the quantity of complementary feeding given showed that inadequate portion sizes were reported in 71.4% of stunted children, compared with 28.6% in the control group ($p = 0.001$; OR = 4.750). This aligns with evidence that insufficient portion sizes do not meet the caloric requirements for linear growth (Dewey & Arimond, 2021). The prevalence of inadequate portions in Bangkalan may be associated with local determinants, including low maternal education and limited access to community-based nutrition information (Mezmur et al., 2021). Furthermore, the COVID-19 pandemic and subsequent economic disruptions have been shown to worsen these dietary risk factors, particularly among rural school-aged adolescents who face increased barriers to accessing health services (Musinguzi et al., 2022).

The implications of these findings are substantial for public health policy in Indonesia. This study contributes to the field by demonstrating that stunting prevention must go beyond nutritional interventions; it must integrate maternal health service utilization and reproductive health education to achieve effective outcomes (Chi et al., 2015; Rukundo et al., 2015). By addressing determinants of antenatal care (ANC) utilization and preventing adolescent pregnancy, health programs can ensure that mothers are physically and cognitively prepared to provide the timing, frequency, texture, content, and portion size necessary to support healthy growth (Kiani et al., 2019; Mathewos & Mekuria, 2018). Ultimately, these results provide a localized framework for community leaders to implement multisectoral interventions that address both the immediate nutritional causes and the underlying social determinants of stunting (Ali et al., 2016; Habibov & Zainiddinov, 2017).

DISCUSSION

This study confirms a strong association between inappropriate complementary feeding practices and the incidence of stunting among children aged 12–24 months in Bangkalan Regency. All five indicators—timing of initiation, feeding frequency, food texture, food content, and portion size—were significantly associated with stunting risk, supporting previous evidence from national and international studies (Na et al., 2021; Rachmi et al., 2021). Beyond these immediate nutritional factors, the findings validate theoretical principles regarding the intergenerational cycle of undernutrition; maternal background and reproductive history are foundational contexts shaping the effectiveness of feeding practices (Black et al., 2013; Victora et al., 2021). This alignment of data proves that stunting is not merely a biological failure but a result of a sexual and reproductive health history that begins long before the child is born (Brown et al., 2019). To achieve the goals outlined in the United Nations Population Fund (2014) and the Department for International Development (2004), interventions must address these multi-dimensional socioeconomic factors (Okoli et al., 2022).

The timing of complementary feeding was a critical factor. Children introduced to complementary feeding before six months of age had a 3.8 times higher odds of stunting. Early initiation may reduce the benefits of exclusive breastfeeding and increase exposure to infections (WHO & UNICEF, 2021). Similar patterns have been reported in Ethiopia and Bangladesh, where early introduction of solid foods was associated with poor growth outcomes (Gebru et al., 2022; Haile et al., 2019). This risk is further compounded in young mothers who may lack sexual assertiveness or inadequate reproductive health knowledge (Rickert & Rupal Sanghvi, 2002). Societal factors, such as the maternal age at first marriage

and preferences regarding family size, directly influence the timing of such nutritional transitions (Ariho, 2020; Marphatia et al., 2020). Furthermore, the prevalence of sexual behaviors among adolescents in rural settings highlights the urgency of implementing comprehensive sexuality education (Bukenya et al., 2020; Singh et al., 2005; UNESCO, 2018). Addressing adolescent pregnancies is key to improving child outcomes (Chuwa, 2023; Kiani et al., 2019; Yakubu & Salisu, 2018).

Feeding frequency and portion size were also associated with stunting, increasing odds by 3.5 and 5 times, respectively. The WHO recommends specific feeding frequencies to meet energy requirements (Dewey & Arimond, 2021). Insufficient frequency associated with dietary energy deficits is seen in other Indonesian cohorts (Fitriyani et al., 2020). Data triangulation indicates that low feeding frequency often correlates with broader household dynamics, such as lack of access to child nutrition information or family planning messages (Habibov & Zainiddinov, 2017). Addressing these gaps requires the integration of school-based sexual and reproductive health services that empower adolescents as future parents (Kasozi et al., 2019).

The strongest association was observed for inadequate nutritional content, with children exposed to poor dietary quality demonstrating approximately eightfold higher odds of stunting. This extends existing theoretical frameworks by illustrating that nutritional content is deeply associated with socioeconomic inequalities and the mother's utilization of health services, including antenatal care (ANC) (Alex-Ojei & Odimegwu, 2021; Ali et al., 2016). Inadequate ANC utilization is often a precursor to suboptimal postnatal feeding practices (Simkhada et al., 2008; Worku & Woldesenbet, 2016). Research indicates that the

use of ANC content—including nutritional advice —is essential for improving maternal and infant outcomes (Bbaale, 2011; Ssetaala et al., 2020). "Missed opportunities" in ANC services often lead to delayed initiation of care and insufficient knowledge of infant health practices (Benova et al., 2018; Conrad et al., 2012; Jinga et al., 2019; Mgata & Maluka, 2019).

Crucially, the study identifies that limited knowledge of sexual and reproductive health and rights (SRHR) among adolescents constitutes a structural barrier to long-term health outcomes (Adinew et al., 2015; Ayalew et al., 2019; Berhe et al., 2022; Gebre et al., 2019; Gebretsadik & Weldearegay, 2016; Ogunlayi, 2005; Yuya et al., 2021). Cultural stigmas and insufficient awareness of sexual health often prevent young women from seeking appropriate health services (Berhane et al., 2005; Griffin, 2006; Sable et al., 2006; Yemaneh et al., 2017). Addressing these rights through a rights-based approach is essential for maternal and child health (McGranahan et al., 2021).

Finally, the study acknowledges the impact of localized determinants, including adolescent pregnancy prevalence and delayed initiation of antenatal care (ANC) (Chaibva et al., 2009; Gross et al., 2012; Habitu et al., 2018; Kassa et al., 2021; Mathewos & Mekuria, 2018; Mezmur et al., 2021; Rukundo et al., 2015). By integrating multisectoral perspectives and using rigorous statistical methods, such as multicollinearity analysis (Vörösmarty & Dobos, 2020), this research provides a valid illustration of the correlates of stunting, even amidst global challenges such as the pandemic (Musinguzi et al., 2022). Targeted interventions must focus on ending child marriage (UNICEF, 2021) and ensuring a positive pregnancy experience through proper healthcare utilization (WHO, 2018; Chi et al., 2015).

CONCLUSION

This research unequivocally establishes that suboptimal complementary feeding practices are a primary catalyst of stunting among children aged 12–24 months in Bangkalan Regency. By synthesizing these findings into a broader developmental pattern, the study reveals that the combination of premature or delayed initiation, insufficient feeding frequency, and low nutrient density creates a structural nutritional trap that impedes linear growth. These results directly address the primary research question, demonstrating that the biological manifestation of stunting in this cohort is closely associated with behavioral and systemic deviations from global infant and young child feeding standards.

Beyond mere statistical correlation, this study advances existing nutritional theories by validating the critical role of maternal health literacy and reproductive history as foundational determinants of child growth in rural Indonesian contexts. The findings reconceptualize stunting not as an isolated physiological failure but as a consequence of missed opportunities along the continuum of maternal and child healthcare utilization. Although this cross-sectional analysis provides a strong depiction of risk, its validity is maintained through the rigorous triangulation of anthropometric data with maternal health histories, thereby providing a more nuanced understanding of the social determinants of health.

To translate these insights into implementable policy, a multilevel intervention strategy is required: local governments must move beyond general advocacy to implement precision-targeted counseling programs that integrate infant feeding education with sexual and reproductive health and rights (SRHR). Healthcare providers should prioritize the

qualitative content of antenatal and postnatal visits to ensure caregivers are equipped with age-appropriate knowledge regarding food texture and micronutrient requirements. Ultimately, this study establishes a foundation for future longitudinal research examining how improvements in adolescent sexual and reproductive health may function as a long-term preventive strategy against child undernutrition. These findings highlight the complexity of stunting as a multifactorial public health issue and provide an evidence-informed framework for advancing sustainable nutritional equity.

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