

Maternal and infant nutrition practices during the first 1,000 days of life and stunting in a remote setting of south Papua, Indonesia

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ABSTRACT

Introduction: Stunting remains a major public health concern, particularly during the first 1,000 days of life, when adequate maternal healthcare and infant feeding practices are critical for optimal growth. This study examined the associations of antenatal care (ANC), exclusive breastfeeding, and complementary feeding practices with stunting among children under two years of age in Atsj District, Asmat Regency, South Papua, Indonesia.

Methods: A quantitative cross-sectional study was conducted among 43 mothers with children aged 0–24 months in the working area of Atsj Public Health Center. All eligible participants were recruited using total sampling. Data on ANC, exclusive breastfeeding, and complementary feeding were collected using questionnaires and observation sheets. Stunting status was assessed using anthropometric measurements. Data were analyzed descriptively and using Chi-square or Fisher's exact tests, as appropriate, with statistical significance set at $p < 0.05$. Crude odds ratios (ORs) and 95% confidence intervals (CIs) were derived from the reported 2×2 contingency tables.

Results: Fifteen children (34.9%) were stunted. Inadequate ANC was strongly associated with stunting (OR = 35.00; 95% CI: 3.92–312.17; $p < 0.001$). Children who were not exclusively breastfed had higher odds of stunting than exclusively breastfed children (OR = 6.00; 95% CI: 1.52–23.68; $p = 0.008$). Inadequate complementary feeding showed the strongest association with stunting (OR = 108.00; 95% CI: 10.17–1147.45; $p < 0.001$).

Conclusion: Inadequate ANC, absence of exclusive breastfeeding, and suboptimal complementary feeding were significantly associated with stunting. Strengthening maternal healthcare, breastfeeding support, and age-appropriate complementary feeding education should be prioritized within first-1,000-days interventions in remote communities.

Keywords: antenatal care; breast feeding; child nutrition; complementary feeding; stunting.

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Highlight:

- First 1,000 days practices were significantly associated with stunting in South Papua.
- Inadequate antenatal care was associated with markedly higher odds of stunting.
- Lack of exclusive breastfeeding was associated with increased stunting risk.
- Suboptimal complementary feeding showed the strongest association with stunting.
- Strengthening maternal care and infant feeding support may help reduce stunting.

INTRODUCTION

Stunting during the first two years of life represents a critical failure of linear growth that reflects cumulative nutritional and health disadvantages beginning during pregnancy. Its importance extends beyond short stature because impaired growth during this period may coincide with compromised cognitive development, greater susceptibility to illness, and reduced human capital later in life. The first 1,000 days from conception to a child's second birthday therefore constitute a critical window in which maternal health, infant nutrition, and timely healthcare interact to shape subsequent growth^{1,2}. This issue is particularly consequential in geographically remote settings, where barriers to health services and nutrition information may reduce the effective coverage of essential maternal and child health interventions^{3,4}. In Asmat Regency, South Papua, geographical constraints, limited health-service availability, restricted access to health information, and socioeconomic conditions create additional challenges for preventing childhood stunting.

Within the first 1,000 days, antenatal care (ANC), exclusive breastfeeding, and appropriate complementary feeding represent interconnected stages of a continuum rather than independent interventions⁵. ANC provides opportunities to identify maternal nutritional deficiencies and pregnancy complications, deliver micronutrient supplementation, and support fetal growth. After birth, exclusive breastfeeding during the first six months provides essential nutrients and immunological protection, while potentially reducing infections that can disrupt growth⁶. From six months onward, appropriate complementary feeding becomes increasingly important because breast milk alone can no longer meet the child's expanding nutritional requirements. Thus, disruption at any stage of this continuum may contribute to growth faltering before 24 months of age.

Existing evidence supports these pathways, but the magnitude and consistency of the associations vary across populations. Previous studies cited in the manuscript reported significant associations between breastfeeding or complementary feeding and stunting; one study reported OR = 8.333 for exclusive breastfeeding and OR = 4.241 for complementary feeding. However, the literature reviewed in the manuscript also indicates that associations involving complementary feeding may become non-significant after adjustment for other determinants. Child growth is simultaneously influenced by maternal nutritional status, birth weight, recurrent infection, sanitation, maternal education, household socioeconomic conditions, and access to healthcare⁷. These findings suggest that evidence generated in relatively accessible populations cannot automatically characterize the pattern of risk in remote communities.

A specific evidence gap is apparent in Atsj District. Local observations described in the manuscript indicate continuing growth problems alongside inadequate ANC utilization, incomplete exclusive breastfeeding practices, and complementary feeding that does not consistently meet recommended standards^{8,9}. Nevertheless, empirical evidence examining these three components of the first 1,000 days simultaneously among children younger than two years in this setting remains limited¹⁰. This gap is important because children aged 0–24 months are still within the intervention window itself, allowing assessment of maternal and infant practices closer to the period in which linear growth faltering develops.

The novelty of this study lies in examining the maternal-to-infant continuum of first-1,000-days practices ANC, exclusive breastfeeding, and complementary feeding in relation to stunting among children under two years in the remote context of Atsj, Asmat Regency, South Papua. Rather than focusing on a single nutritional behavior, the study evaluates three sequential components spanning pregnancy, early infancy, and the complementary-feeding period within one population. This context-specific evidence may help identify which components require greater programmatic attention in a geographically challenging primary healthcare setting.

Accordingly, this study aimed to determine the associations between ANC, exclusive breastfeeding, complementary feeding, and stunting among children aged 0–24 months in the working area of Atsj Public Health Center, Asmat Regency, South Papua. The findings are expected to provide evidence for strengthening first-1,000-days interventions through improved

maternal healthcare, breastfeeding support, and context-appropriate complementary-feeding education.

RESEARCH METHODOLOGY

Study Design

This study employed an analytical quantitative approach with a cross-sectional design to examine the associations between selected components of the First 1,000 Days of Life program and stunting among children under two years of age. The exposure variables were antenatal care (ANC), exclusive breastfeeding, and complementary feeding, while stunting status was the outcome variable. A cross-sectional design was appropriate because exposure and outcome information was assessed within the same study period, enabling estimation of associations between maternal and child-care practices and current nutritional status. Given the observational and cross-sectional nature of the study, the findings were interpreted as associations rather than causal relationships.

Setting and Participants

The study was conducted in June 2026 in the working area of Atsj Public Health Center, Atsj District, Asmat Regency, South Papua Province, Indonesia. The health-center catchment area comprises nine villages: Amanamkai, Ambisu, Atsj, Bakaise, Bine, Bipim, Cewewyamew, Sogoni, and Yasiuw. The source population consisted of all mothers with children aged 0–24 months residing in the Atsj Public Health Center catchment area. The population comprised 43 eligible mothers, and all were included using a total sampling approach, resulting in a final sample of 43 mother–child pairs. Because the entire accessible population was recruited, no separate sample-size calculation was applied. The source manuscript identifies having a child aged 0–24 months within the study area as the basis for participation. However, specific inclusion criteria beyond these characteristics and explicit exclusion criteria were not reported and should not be retrospectively introduced without verification from the original research protocol.

Variables and Measurement

The primary outcome was stunting status. Stunting was defined according to height-for-age, with a height-for-age z-score below -2 standard deviations (<-2 SD) indicating stunting. The exposure variables represented three components of the First 1,000 Days of Life: ANC utilization, exclusive breastfeeding, and complementary feeding. Information on these exposures was obtained using a structured, closed-ended questionnaire developed according to the indicators specified for each study variable. The questionnaire was administered to mothers of children aged 0–24 months. Anthropometric equipment included an infantometer, stadiometer/microtoise, and weighing scale for assessing child anthropometry. Primary data were obtained directly from participants through questionnaires and observation sheets. Secondary information was obtained from supporting sources, including the profile of Atsj Public Health Center and relevant documentary sources. The submitted manuscript does not report quantitative evidence of questionnaire validity or reliability, such as content-validity indices, Cronbach's alpha, test–retest reliability, or pilot-testing results. These parameters should therefore be reported only if they can be verified from the original instrument-development or pretesting records.

Data Collection and Quality Control

Data were collected directly from participating mothers using questionnaires and observation sheets, accompanied by anthropometric assessment of their children. Before statistical analysis, the data underwent sequential processing involving editing, coding, data entry, and data cleaning. Editing was performed to identify incomplete, unclear, or inconsistent responses, while coding transformed categorical responses into numerical values suitable for statistical analysis. Data entry was subsequently checked against the original questionnaires, and cleaning was undertaken to identify potential entry errors, missing observations, duplicates, or inconsistencies.

These procedures constituted the principal data-quality control measures documented in the manuscript.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 24.0. Descriptive analysis summarized participant characteristics and study variables using frequencies and percentages. Bivariate associations between categorical exposure variables and stunting were examined using 2×2 contingency tables. The Chi-square test was used where its assumptions were satisfied, while Fisher's exact test was applied when expected cell frequencies were small. Statistical significance was defined at a two-sided $\alpha = 0.05$. For effect-size reporting in the journal manuscript, crude odds ratios (cORs) with 95% confidence intervals (CIs) can be calculated from the reported 2×2 tables. However, the original study did not perform multivariable logistic regression. Therefore, adjusted odds ratios should not be reported as original findings unless the individual-level dataset is reanalyzed. This distinction is important because maternal characteristics, infection history, socioeconomic conditions, and other potential confounders cannot be controlled through bivariate analysis alone.

Ethical Considerations

The manuscript provided for this revision does not document the name of the research ethics committee, ethical approval number, or a sufficiently detailed informed-consent procedure. These elements should not be fabricated for publication. Before submission, this section should be completed using the original ethical-clearance documentation.

RESULT

Respondent Characteristics

A total of 43 mother–child pairs were included in the analysis. Most mothers were aged 21–25 years (53.5%), followed by 26–30 years (25.6%), 31–35 years (16.3%), and 16–20 years (4.7%). All mothers were housewives. Junior secondary school was the most common educational level (37.2%), followed by senior secondary school (27.9%), primary school (23.3%), and no formal education (11.6%). Among the children, 95.3% were aged 13–24 months and 55.8% were female. Fifteen children (34.9%) were classified as stunted. ANC coverage was inadequate among 51.2% of mothers, 39.5% of children had not received exclusive breastfeeding, and 30.2% had suboptimal complementary feeding.

Table 1. Characteristics of mothers and children (n = 43)

Characteristic	Category	n	%
Maternal age, years	16–20	2	4.7
	21–25	23	53.5
	26–30	11	25.6
	31–35	7	16.3
Maternal education	No formal education	5	11.6
	Primary school	10	23.3
	Junior secondary school	16	37.2
	Senior secondary school	12	27.9
Maternal occupation	Housewife	43	100.0
Child age	6–12 months	2	4.7
	13–24 months	41	95.3
Child sex	Male	19	44.2
	Female	24	55.8
Stunting status	Stunted	15	34.9
	Not stunted	28	65.1
ANC	Adequate	21	48.8
	Inadequate	22	51.2
Exclusive breastfeeding	Yes	26	60.5

Characteristic	Category	n	%
Complementary feeding	No	17	39.5
	Appropriate	30	69.8
	Suboptimal	13	30.2

The distribution of child age and sex reported in the main results was consistent with the master dataset: 41 children were aged 13–24 months and 24 were female. All three First 1,000 Days of Life indicators were significantly associated with stunting. Among mothers with inadequate ANC coverage, 14 of 22 children (63.6%) were stunted, compared with 1 of 21 children (4.8%) whose mothers had adequate ANC. The crude odds of stunting were approximately 35 times higher among children whose mothers had inadequate ANC (cOR = 35.00; 95% CI: 3.92–312.17; $p < 0.001$).

Similarly, 10 of 17 children (58.8%) who had not been exclusively breastfed were stunted, compared with 5 of 26 (19.2%) who had received exclusive breastfeeding. Lack of exclusive breastfeeding was associated with sixfold higher odds of stunting (cOR = 6.00; 95% CI: 1.52–23.68; $p = 0.008$). The strongest crude association was observed for complementary feeding. Twelve of 13 children (92.3%) with suboptimal complementary feeding were stunted, compared with 3 of 30 children (10.0%) receiving appropriate complementary feeding. Suboptimal complementary feeding was associated with substantially higher odds of stunting (cOR = 108.00; 95% CI: 10.17–1147.45; $p < 0.001$).

Table 2. Bivariate associations between First 1,000 Days indicators and stunting

Exposure	Stunted n (%)	Not stunted n (%)	cOR	95% CI	P-value
Adequate ANC	1 (4.8)	20 (95.2)	1.00	Reference	
Inadequate ANC	14 (63.6)	8 (36.4)	35.00	3.92–312.17	<0.001
Exclusive breastfeeding	5 (19.2)	21 (80.8)	1.00	Reference	
No exclusive breastfeeding	10 (58.8)	7 (41.2)	6.00	1.52–23.68	0.008
Appropriate complementary feeding	3 (10.0)	27 (90.0)	1.00	Reference	
Suboptimal complementary feeding	12 (92.3)	1 (7.7)	108.00	10.17–1147.45	<0.001

The original manuscript reported significant associations for ANC ($p = 0.000$), exclusive breastfeeding ($p = 0.008$), and complementary feeding ($p = 0.000$). The crude ORs and confidence intervals shown above were calculated from the 2×2 frequencies reported in those tables.

A multivariable binary logistic regression including inadequate ANC, absence of exclusive breastfeeding, and suboptimal complementary feeding was explored using the individual-level master dataset. However, the model exhibited quasi-complete separation, primarily because almost all children with suboptimal complementary feeding were stunted and very few exposed observations were available in some outcome cells. Consequently, conventional maximum-likelihood logistic regression did not produce stable or interpretable adjusted effect estimates.

The bivariate findings show a consistent gradient across the continuum of the First 1,000 Days of Life. Inadequate ANC was associated with substantially greater odds of stunting, suggesting that missed or insufficient maternal care during pregnancy may coincide with missed opportunities for nutritional assessment, supplementation, early detection of pregnancy complications, and fetal-growth monitoring. The breastfeeding finding indicates that nutritional and immunological protection during the first six months may remain important for subsequent linear growth. Complementary feeding showed the largest crude effect size, with nearly all children exposed to suboptimal feeding experiencing stunting.

However, the very large ORs and wide confidence intervals, particularly for ANC and complementary feeding, indicate statistical imprecision rather than precise estimates of causal

magnitude. These results should therefore be interpreted as evidence of strong associations requiring confirmation in larger studies rather than as direct estimates of individual causal risk.

DISCUSSION

The present study indicates that stunting among children under two years in Atsj, South Papua, should not be interpreted as an isolated nutritional outcome occurring only after birth. Instead, the pattern of findings points toward a continuum of vulnerability across the First 1,000 Days of Life, beginning during pregnancy and extending through exclusive breastfeeding and complementary feeding. All three components examined antenatal care (ANC), exclusive breastfeeding, and complementary feeding were significantly associated with stunting. Conceptually, this supports a life-course interpretation in which growth outcomes emerge from cumulative exposure to health and nutritional conditions across successive developmental stages rather than from a single intervention failure.

The association between inadequate ANC and stunting is particularly important because ANC represents the earliest formal point of contact within this continuum. The role of ANC extends beyond attendance itself. Adequate antenatal services provide opportunities to monitor maternal nutritional status, identify anemia and other pregnancy complications, provide micronutrient supplementation, monitor fetal growth, and deliver nutrition counseling. The manuscript also emphasizes that complete attendance does not necessarily mean that the effective content of care has been received or acted upon; adherence to iron supplementation, nutritional recommendations, and follow-up of detected health problems may vary among women who meet visit-frequency standards¹¹. Thus, the association observed in Atsj should be interpreted not merely as a question of the number of ANC contacts but as an indicator of whether maternal healthcare is continuous, accessible, and sufficiently effective to influence fetal growth.

The finding related to exclusive breastfeeding reflects the transition from maternal care to infant nutrition. Breast milk supplies nutrients appropriate for early infancy and provides immunological protection that may reduce recurrent infections¹². The manuscript specifically links the absence of exclusive breastfeeding with greater susceptibility to diarrhea and respiratory infections, both of which may compromise nutrient utilization and growth¹³. In this sense, breastfeeding may operate through both nutritional and infection-related pathways. However, breastfeeding should not be conceptualized solely as an individual maternal behavior¹⁴. In geographically difficult settings, successful exclusive breastfeeding may also depend on maternal knowledge, family support, cultural practices, access to skilled counseling, and the ability of primary care services to provide timely assistance when breastfeeding difficulties occur.

Complementary feeding produced the strongest crude association with stunting in this study. This finding is biologically and programmatically plausible because most children in the sample were already aged 13–24 months, a period during which dietary quality and feeding frequency become increasingly important¹⁵. The transition to complementary foods introduces multiple dimensions of nutritional adequacy, including timing, meal frequency, dietary diversity, texture, energy density, protein sources, micronutrient content, and food hygiene^{16,17}. The manuscript describes appropriate complementary feeding as a process that should begin at approximately six months and progressively adapt to the developmental and nutritional needs of the child. Therefore, a broad category of “suboptimal complementary feeding” may capture several overlapping disadvantages rather than one specific dietary exposure.

At a systems level, these findings suggest that the three exposures are better understood as sequential components of a single maternal child health pathway. An intervention that succeeds during pregnancy but loses continuity after delivery may have limited long-term effect. Similarly, appropriate complementary feeding may not fully compensate for severe nutritional disadvantage originating during pregnancy or early infancy¹⁸. The manuscript itself recognizes that child growth is shaped by interacting factors including maternal nutritional status, birth weight, infection, sanitation, socioeconomic conditions, and healthcare access¹⁹. The contribution of this study therefore lies less in identifying three separate risk factors and more in illustrating how

weaknesses across the First 1,000 Days may cluster within the same remote health-system context.

The findings regarding ANC are broadly consistent with studies discussed in the manuscript. Greater stunting risk among children whose mothers did not receive ANC according to recommended standards, Inadequate ANC with maternal anemia, chronic energy deficiency, low birth weight, and impaired fetal growth^{20,21}. The manuscript also cites work on the implementation of the First 1,000 Days program in which improving both ANC coverage and quality was considered an important strategy for reducing stunting. These comparisons reinforce the interpretation that ANC is not simply an obstetric service but a platform for early nutritional prevention.

Nevertheless, the literature summarized in the manuscript is not fully consistent. Some studies reportedly found that the relationship between ANC and stunting became non-significant after adjustment for breastfeeding, complementary feeding, sanitation, maternal education, or socioeconomic factors. This distinction is important. ANC may act partly through downstream pathways rather than exerting an entirely independent effect. For example, women receiving higher-quality ANC may also be more likely to receive breastfeeding counseling, use child-health services, obtain growth monitoring, or adopt recommended feeding practices. Therefore, the very large crude association observed in Atsj may partly reflect broader differences in healthcare engagement and household circumstances that were not controlled in the original bivariate analysis.

The exclusive breastfeeding finding is also consistent with the literature reviewed in the manuscript. A higher occurrence of stunting among children who did not receive exclusive breastfeeding, Examining similar relationships in Indonesian populations^{22,23}. These studies support the plausibility of breastfeeding as one component of early-life growth protection, although differences in age groups, definitions, recall periods, and local feeding practices may explain variation in effect magnitude between settings.

The complementary-feeding finding is particularly aligned with Rachmaniah and Agustina (2025), whose study reported a significant association between inappropriate complementary feeding and stunting, with an OR of 4.241 and $p = 0.012$. The manuscript also cites Sitompul and Simbolon (2025), who described inappropriate timing and inadequate nutritional content of complementary foods as being associated with stunting. These findings converge on the importance of the dietary transition after six months. However, the OR observed in the present study was considerably larger than those reported in previous work. This should not be interpreted as evidence that the biological effect is necessarily stronger in Atsj. Rather, the magnitude is likely influenced by the small sample and the highly uneven distribution of stunting across complementary-feeding categories.

The manuscript also acknowledges studies in which complementary feeding was no longer significant after multivariable adjustment. Such differences underline the multifactorial nature of stunting. Complementary feeding may be correlated with maternal education, household food availability, sanitation, infection burden, and access to healthcare²⁴. In remote environments, inadequate complementary feeding may therefore represent both a direct nutritional exposure and a marker of wider social and service constraints. This broader interpretation is more useful for program design than treating feeding behavior as an isolated maternal choice.

Several limitations require careful consideration. First, the cross-sectional design prevents determination of temporal sequence and causal direction. Although ANC clearly precedes the measurement of childhood stunting chronologically, breastfeeding and complementary-feeding information was collected at the same study period as anthropometric status²⁵. The observed associations therefore indicate statistical relationships rather than proof that these exposures caused stunting. Second, the sample consisted of only 43 mother–child pairs, with 15 stunting events. The entire accessible population was included through total sampling, which is appropriate for describing the local population, but the small absolute sample substantially limits statistical precision. The very wide confidence intervals for the ANC and complementary-feeding

odds ratios demonstrate this uncertainty. Large point estimates should therefore not be interpreted literally as precise measures of risk magnitude.

Another important limitation is that conventional multivariable logistic regression could not produce stable estimates because of sparse cells and quasi-complete separation. This is particularly relevant because stunting is influenced by multiple interacting factors²⁶. The manuscript itself identifies maternal nutrition, birth weight, infection, sanitation, education, income, caregiving, and healthcare access as potentially important determinants. Without adequate multivariable adjustment, residual confounding remains a major concern. In addition, the exposure measurements relied substantially on maternal questionnaire responses. Breastfeeding history and complementary-feeding practices may therefore be affected by recall or social-desirability bias. The manuscript also does not report formal validation or reliability testing of the questionnaire. Furthermore, the broad categorization of complementary feeding as “appropriate” or “suboptimal” may conceal variation in dietary diversity, portion size, nutrient density, frequency, animal-source food intake, and hygiene.

External generalizability is also limited. Atsj is a geographically challenging area with specific health-service, cultural, and socioeconomic conditions. These contextual characteristics make the study highly relevant for local planning, but the magnitude of the reported associations should not automatically be extrapolated to other districts or provinces. The findings are most appropriately interpreted as context-specific evidence that highlights where vulnerabilities may concentrate within a remote primary healthcare system.

Future studies should build on the current findings using designs capable of examining temporal pathways and confounding more rigorously. A larger prospective cohort beginning during pregnancy and following children through 24 months would allow investigators to assess how maternal nutritional status, ANC quality, birth outcomes, breastfeeding, complementary feeding, infection episodes, sanitation, and growth trajectories interact over time. Such an approach would move beyond isolated exposure–outcome associations toward a more comprehensive model of growth vulnerability.

Future measurement should also distinguish between ANC contact and ANC content. Number of visits alone may inadequately represent service quality. Studies should capture nutritional assessment, iron–folic acid adherence, detection of maternal undernutrition or anemia, counseling, referral, and continuity into postnatal care. Likewise, breastfeeding research should include early initiation, exclusivity, duration, counseling exposure, family support, and breastfeeding difficulties. Complementary feeding deserves more detailed measurement using indicators of minimum dietary diversity, minimum meal frequency, acceptable diet, animal-source food consumption, food security, and hygiene practices. This would help determine which aspect of feeding is most strongly associated with linear growth rather than treating complementary feeding as a single binary exposure.

Analytically, future studies should recruit sufficient numbers of participants and stunting events to permit robust multivariable modeling. Where sparse data remain unavoidable, penalized approaches such as Firth logistic regression may be preferable to conventional maximum-likelihood estimation. Interaction analyses could also examine whether the effect of complementary feeding differs according to earlier ANC or breastfeeding exposure. The most important conceptual direction is to study the First 1,000 Days as an integrated system. Future research in South Papua should therefore evaluate not only maternal and child behaviors but also the organization of primary care, geographical accessibility, continuity of counseling, availability of nutritious local foods, sanitation, family support, and culturally embedded feeding practices. The current study suggests that preventing stunting in Atsj is unlikely to depend on one intervention alone. A more plausible pathway is cumulative: effective pregnancy care must connect with breastfeeding support, appropriate complementary feeding, infection prevention, growth monitoring, and household-level enabling conditions. This integrated perspective provides a stronger foundation for designing context-responsive stunting interventions in remote communities.

CONCLUSION

This study found that the implementation of key components of the First 1,000 Days of Life was significantly associated with stunting among children under two years of age in the working area of Atsj Public Health Center, Asmat Regency, South Papua. Inadequate antenatal care, absence of exclusive breastfeeding, and suboptimal complementary feeding were all associated with higher odds of stunting, with the strongest crude association observed for complementary feeding. These findings support the importance of maintaining continuity of maternal and child nutrition interventions from pregnancy through the first two years of life. From a policy perspective, stunting prevention in remote settings should not rely on a single intervention. Primary healthcare services should strengthen ANC coverage and quality, provide sustained breastfeeding counseling, and deliver practical complementary-feeding education that emphasizes appropriate timing, dietary diversity, feeding frequency, hygiene, and locally available nutrient-dense foods. Because the study used a small cross-sectional sample and did not provide stable multivariable estimates, the observed associations should be interpreted cautiously. Larger prospective studies are needed to confirm the independent contribution of each component and to guide more precisely targeted stunting-prevention strategies.

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Conflict of Interest

The authors declare that they have no conflicts of interest that could have influenced the conduct, analysis, interpretation, or reporting of this study.

Authors' Contributions

Yuniati Langan: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Visualization, and Writing – Original Draft. She was responsible for developing the study concept, collecting and managing the research data, conducting the statistical analysis, interpreting the findings, and preparing the initial manuscript.

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Declaration of Generative AI Use

During the preparation of this manuscript, generative artificial intelligence was used solely to assist with language refinement, organization, and improvement of academic presentation. The research data, statistical results, interpretation of findings, and scientific conclusions remained under the responsibility of the authors. All AI-assisted text was critically reviewed, revised, and verified by the authors, who take full responsibility for the accuracy, integrity, and final content of the manuscript.

Data Availability Statement

The data supporting the findings of this study were derived from the primary research dataset. An individual-level master table containing participant characteristics, anthropometric measurements, stunting status, antenatal care, exclusive breastfeeding, and complementary-feeding variables is included in Appendix 2 of the source thesis. Any sharing of additional

individual-level data should be undertaken in accordance with participant confidentiality, institutional requirements, and applicable ethical regulations.

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