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PUBLIC HEALTH INNOVATIONS FOR ACCELERATING STUNTING REDUCTION: EVIDENCE FROM BANGGAI LAUT, INDONESIA

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ABSTRACT

This study analyzed three innovations that successfully reduced stunting prevalence within one year. A qualitative phenomenological approach was used to explore the implementation of these innovations. Informants included health workers, Dukcapil officers, community leaders, and community members involved in the programs. Findings showed that the Dukcapil Menyapa innovation improved data availability, mapping, and continuous monitoring, enabling early and targeted interventions from pregnancy to early childhood. The Kanjoli-an Prima innovation provided specialist visits every seven days, integrated with health education, direct healthcare services, and community assistance. Meanwhile, the Coriander innovation focused on intensive monitoring and support for pregnant women from early pregnancy until childbirth. Overall, an integrated, innovation-based, and cross-sectoral approach supports accelerating stunting reduction. These innovations demonstrate strong public health relevance and scalability potential for implementation in regions with similar socio-demographic conditions, although further mixed-methods studies are needed to assess long-term effectiveness and sustainability.

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1. INTRODUCTION

Stunting is a nutritional condition based on the height-for-age index (H/A), defined as a Z-score below -2 SD, reflecting chronic malnutrition that affects children's physical growth, cognitive development, and future productivity. In Indonesia, the prevalence of stunting was recorded at 21.5% in 2023, remaining above the World Health

Organization threshold and indicating that stunting continues to be a major public health concern [1]. Beyond its health consequences, stunting also contributes to substantial economic losses through decreased educational achievement, reduced workforce productivity, and increased healthcare expenditure. To address this issue, the Indonesian government has targeted a reduction in stunting prevalence to approximately 14

The government has implemented specific and sensitive interventions through convergent and cross-sectoral approaches supported by Presidential Regulation No. 72 of 2021 and the National Action Plan for Accelerating Stunting Reduction (2021–2024) [2]. However, despite these national strategies, implementation outcomes vary considerably across districts, particularly between urban and rural areas, suggesting persistent structural and contextual challenges [3].

Previous studies have mainly focused on risk factors and general intervention evaluations, while limited qualitative evidence exists on how district-level innovations operationalize multi-sectoral stunting reduction in rural settings. In addition, studies documenting successful and replicable local innovation models remain limited, particularly those exploring innovation-based interventions grounded in local contexts and community participation [4].

Banggai Laut District, a region previously categorized as having a relatively high stunting prevalence, demonstrated a significant decline within one year through several local innovations. This achievement offers an important opportunity to examine how innovation-based and cross-sectoral interventions contribute to accelerating stunting reduction at the district level. Therefore, this study aims to analyze the implementation of local innovation-based interventions in accelerating stunting reduction in Banggai Laut District [5, 6].

2. RESEARCH METHOD

This study has obtained ethical approval from the Health Research Ethics Committee of Universitas Muslim Indonesia with approval number No.164/A.1/KEP-UMI/IV/2024 and registration number UMI012403236. All participants were informed about the purpose of the study, and their confidentiality and anonymity were strictly maintained throughout the research process.

The interview guide was developed based on the study objectives and relevant literature on stunting reduction, innovation-based interventions, and multi-sectoral collaboration. The guide consisted of semi-structured questions designed to explore participants' experiences, perceptions, implementation processes, challenges, and perceived impacts of the three innovation programs. This approach ensured that all interview questions remained aligned with the research objectives while allowing flexibility for participants to elaborate on their experiences and perspectives.

All interviews were audio-recorded and transcribed verbatim immediately after data collection to maintain data accuracy and completeness. The transcription process involved repeated listening to the recordings and cross-checking the transcripts with field notes to ensure consistency and minimize transcription errors. Participant identities were anonymized by using codes or pseudonyms during transcription and data analysis to maintain confidentiality.

To ensure rigor, triangulation was applied through multiple data sources and document review. Data validation was conducted using member checking and peer debriefing to enhance accuracy and minimize bias. Trustworthiness was ensured based on the criteria of credibility, transferability, dependability, and confirmability. Credibility was strengthened through triangulation and prolonged engagement, while an audit trail was maintained to ensure dependability and confirmability. Data analysis was conducted using thematic analysis through several stages: data familiarization, open coding, category development, theme refinement, and interpretation. The coding process was conducted manually using a structured coding matrix and thematic categorization framework to identify patterns, relationships, and key themes emerging from the interview data. Data organization and coding were performed systematically using Microsoft Excel to facilitate theme classification, comparison across informants, and interpretation of findings.

3. RESULT AND ANALYSIS

3.1 Comparative Analysis Across the Three Innovation Models

Although the three innovations Dukcapil Menyapa, Kanjoli-an Prima, and Coriander operate through different mechanisms, the findings demonstrate several important synergies, contextual dependencies, and implementation trade-offs that collectively contributed to stunting reduction in Banggai Laut.

Analytically, the three models complement one another by addressing different stages and determinants of stunting prevention. Dukcapil Menyapa primarily strengthens the governance and data-management dimensions through integrated population and health data systems, enabling accurate targeting and resource allocation. In contrast, Kanjoli-an Prima focuses on direct service delivery through outreach-based specialist healthcare and personalized nutritional interventions, particularly for children already identified as vulnerable or experiencing

growth problems. Meanwhile, Coriander emphasizes preventive maternal interventions through digital monitoring, self-management, and continuity of maternal care beginning in pregnancy. Together, these innovations form a continuum of care that links data systems, maternal health services, child nutrition interventions, and community empowerment into an integrated stunting reduction framework.

The findings further indicate that the effectiveness of each innovation is highly dependent on contextual factors. Dukcapil Menyapa relies heavily on administrative capacity, digital data quality, and intersectoral coordination. Consequently, its implementation may be less effective in regions with weak population data systems or limited institutional collaboration. Kanjoli-an Prima, while effective in improving healthcare access in remote areas, requires substantial human resources, specialist availability, and logistical support for regular outreach activities. This creates sustainability challenges, particularly in geographically isolated settings with limited healthcare personnel. In comparison, Coriander demonstrates strong potential for scalability through digital technology; however, its effectiveness depends on internet accessibility, digital literacy among pregnant women, and sustained user engagement.

Several trade-offs also emerged across the three innovation models. Dukcapil Menyapa provides strong population-level surveillance and targeting but remains relatively limited in generating individualized behavioral change. Conversely, Kanjoli-an Prima and Coriander offer more intensive interpersonal and behavioral interventions, yet these approaches require greater operational resources and continuous community engagement. This suggests that data-driven governance alone is insufficient without direct service delivery and behavioral interventions, while community-based interventions may become less sustainable without strong data integration and monitoring systems.

Another important analytical finding is that all three innovations demonstrate a shift from reactive and curative approaches toward preventive and integrated public health strategies. Dukcapil Menyapa facilitates early risk identification through integrated data systems; Kanjoli-an Prima strengthens continuous monitoring and personalized intervention for at-risk children; and Coriander intervenes earlier during pregnancy to prevent the intergenerational transmission of malnutrition. This layered intervention model contributes to stunting reduction not only through medical treatment but also through improved governance, behavioral change, family participation, and continuity of care.

However, the findings also reveal several common limitations across the three innovations. First, long-term impact evaluation remains limited, particularly regarding the sustainability of behavioral changes and child growth outcomes. Second, despite the use of digital systems and monitoring mechanisms, integration between innovation-specific data systems and broader district health information systems has not been fully optimized. Third, the success of these innovations appears strongly influenced by local leadership commitment, community participation, and cross-sectoral collaboration, indicating that replication in other regions may require contextual adaptation rather than direct duplication of the programs.

Overall, the comparative analysis demonstrates that the success of stunting reduction in Banggai Laut was not driven by a single intervention, but rather by the interaction between governance-based innovation, outreach health services, and family-centered preventive care. The synergy among these three approaches created a more comprehensive and context-responsive intervention ecosystem capable of addressing both the biomedical and social determinants of stunting.

3.2 Discussion

This study highlights how district-level innovation can contribute to stunting reduction through integrated governance, community-based services, and digital health approaches. Rather than functioning as isolated interventions, the three innovation models demonstrate the importance of integrating nutrition-specific and nutrition-sensitive strategies within a coordinated public health system. This finding is consistent with global evidence showing that stunting reduction is more effective when interventions simultaneously address healthcare access, maternal nutrition, sanitation, food security, social protection, and behavioral determinants [8]. Previous studies also indicate that fragmented interventions often produce limited improvements, whereas integrated and multisectoral approaches lead to more sustainable reductions in child undernutrition and growth failure.

The three innovation models represent different yet complementary pathways for addressing the determinants of stunting. Dukcapil Menyapa primarily strengthens governance capacity through integrated data systems, enabling more evidence-informed targeting and cross-sectoral coordination. Similar governance-oriented approaches have been implemented in several low- and middle-income countries, where integrated population and health databases improved intervention targeting, reduced duplication, and enhanced policy responsiveness [7]. Comparable district-level nutrition governance initiatives in Rwanda and Peru have also shown that integrated local data systems can improve the coordination of maternal and child health interventions and accelerate reductions in chronic malnutrition. However, unlike several Latin American models supported by stronger digital governance

infrastructure and centralized monitoring systems, the Banggai Laut innovation still faces challenges related to interoperability, data quality, and institutional capacity. This suggests that although data-driven governance is globally relevant, its effectiveness depends heavily on local administrative readiness and digital system maturity [8].

Recent studies further suggest that digital governance and real-time nutrition surveillance systems can improve program efficiency and support earlier interventions for vulnerable populations. Nevertheless, the effectiveness of these systems depends on data accuracy, interoperability, and institutional coordination. Evidence from implementation research shows that weak administrative capacity and poor data quality often reduce the effectiveness of digital health governance in rural settings, particularly where health information systems remain fragmented or inconsistently updated. These findings indicate that technological innovation alone is insufficient without simultaneous strengthening of institutional readiness and human resource capacity [9].

In contrast, Kanjoli-an Prima emphasizes outreach-based healthcare delivery and personalized nutritional interventions. This approach reflects community-based healthcare models frequently implemented in rural and geographically isolated areas. Previous studies have shown that outreach interventions can improve healthcare utilization, maternal and child health service coverage, growth monitoring, and continuity of nutritional support among vulnerable populations. Similar models in Bangladesh, Ethiopia, and Nepal have relied on community health workers and mobile maternal-child health services to overcome geographical barriers and improve nutrition outcomes in underserved communities [10, 11]. The findings of this study are consistent with those international experiences, particularly regarding the importance of direct community engagement and continuity of care. However, Kanjoli-an Prima differs from many international community-based models because it integrates specialist healthcare outreach into local services, whereas most global programs rely mainly on trained lay health workers or primary healthcare personnel. While this approach may improve the quality of clinical intervention, it also increases operational complexity, workforce dependency, and financing demands.

Personalized nutritional interventions have been associated with better improvements in child growth outcomes compared to generalized supplementation programs because they address individual clinical and nutritional conditions more specifically. Nevertheless, recent evidence suggests that outreach-based programs often face sustainability challenges, including workforce shortages, transportation barriers, high operational costs, and dependence on external funding. These findings are consistent with this study, which suggests that although outreach services strengthen intervention reach and equity, their long-term effectiveness remains vulnerable without institutional financing mechanisms and stable workforce allocation. This reflects a broader challenge identified in implementation science literature, where successful pilot interventions are often difficult to sustain when integrated into routine health systems [12].

Meanwhile, the Coriander innovation demonstrates how digital maternal-health interventions can strengthen preventive care during pregnancy. Recent systematic reviews on mobile-health (mHealth) interventions show that digital maternal-health platforms can improve antenatal attendance, nutritional awareness, treatment adherence, and maternal engagement, particularly in low-resource settings. Similar mHealth innovations have been implemented in India, Kenya, and several Southeast Asian countries through SMS reminders, telemonitoring systems, and digital maternal education platforms. The findings of this study support those global experiences by demonstrating that reminder systems, nutritional self-monitoring, and continuous communication may strengthen maternal participation during pregnancy. However, unlike digital maternal-health programs implemented in countries with broader internet penetration and stronger technological ecosystems, the effectiveness of Coriander remains constrained by unequal internet access and variations in digital literacy among rural populations. This suggests that the scalability of digital maternal-health innovation in Banggai Laut is more context-dependent compared to urban-centered or nationally integrated digital health systems observed in several higher-capacity settings

Peer-reviewed evidence also highlights that digital health interventions often produce unequal outcomes because of disparities in internet access, smartphone ownership, and digital literacy. This study similarly found that the effectiveness of Coriander depends heavily on technological accessibility and user participation. Consequently, while digital innovations offer strong scalability potential, they may unintentionally widen inequalities if implemented without adequate infrastructural and educational support. This finding aligns with recent critiques of digital public health interventions, which argue that technological scalability does not automatically guarantee equitable health outcomes

The findings further suggest that successful stunting reduction depends not only on the availability of interventions, but also on how those interventions interact within local governance and social systems. The combination of integrated data systems, outreach healthcare services, and family-centered maternal interventions created a more comprehensive prevention framework capable of addressing both biomedical and social determinants of stunting [13]. This supports implementation science perspectives emphasizing that intervention effectiveness is highly context-dependent and influenced by institutional readiness, leadership commitment, community participation, and cross-sectoral collaboration. Similar district-level innovation models in countries such as Bangladesh, Rwanda, and Peru have demonstrated that sustained reductions in stunting are more likely to occur when local

governance systems, maternal-child healthcare services, and community engagement mechanisms are strengthened simultaneously. However, compared with several internationally recognized district nutrition models that rely heavily on donor-supported financing or nationally standardized implementation frameworks, the Banggai Laut innovations appear to rely more strongly on local leadership initiatives, adaptive coordination, and contextual flexibility. This distinction suggests that the Banggai Laut model may offer important lessons regarding locally driven innovation in decentralized health systems [14, 15].

Overall, the Banggai Laut experience contributes to growing international evidence that district-level innovation can become an important driver of nutrition improvement when supported by adaptive governance and context-responsive implementation strategies. At the same time, this study demonstrates that innovation effectiveness cannot be separated from local realities, including institutional capacity, geographic conditions, digital infrastructure, and patterns of community participation [16].

Despite these contributions, several limitations should be acknowledged. First, this study was conducted within the specific socio-cultural and administrative context of Banggai Laut District; therefore, the findings should be interpreted in terms of transferability rather than broad generalizability. The applicability of these innovation models to other regions depends on similarities in governance structures, health system capacity, digital infrastructure, and community participation. Second, the study relied primarily on qualitative exploration and informant perceptions without quantitative measurement of intervention effects on stunting prevalence. Consequently, the findings provide contextual understanding of implementation processes rather than causal evidence of effectiveness. This distinction is important because previous large-scale nutrition interventions have shown that positive perceptions of program implementation do not always translate into statistically significant reductions in stunting prevalence [17, 18].

Another limitation is the absence of comparative effectiveness analysis across the three innovation models. Although each model demonstrated distinct strengths, this study could not determine which intervention was the most cost-effective, scalable, or sustainable under different resource conditions. Previous comparative effectiveness studies have shown that intervention outcomes vary depending on implementation fidelity, local adaptation, financing mechanisms, and contextual readiness. Therefore, future research should incorporate comparative evaluation frameworks, including cost-effectiveness analysis, implementation outcome assessment, and policy feasibility analysis, to better inform evidence-based scaling decisions [19, 20].

Finally, this study highlights the need for stronger quantitative validation of innovation outcomes. Mixed-methods and quasi-experimental approaches are particularly important because they enable the integration of contextual qualitative findings with measurable intervention outcomes. Longitudinal monitoring, baseline-endline comparisons, and impact evaluation designs would provide stronger evidence regarding the long-term effectiveness, sustainability, and scalability of district-level stunting innovations. In addition, future studies should examine how governance quality, community participation, and digital readiness interact to influence intervention success across different regional contexts [21].

4. CONCLUSION

This study suggests that stunting reduction efforts in Banggai Laut were supported by the interaction of governance-based innovation, outreach healthcare services, and family-centered preventive care rather than by a single intervention alone. Dukcapil Menyapa contributed to strengthening data integration and intersectoral coordination, which was perceived to support more targeted service planning and resource allocation. Kanjoli-an Prima expanded healthcare access through outreach-based specialist services and personalized nutritional interventions, while Coriander supported preventive maternal care through digital monitoring and continuous assistance during pregnancy. Collectively, these innovations appear to have created a more integrated continuum of care addressing both biomedical and social determinants of stunting.

The findings further indicate that integrated data systems, community-based outreach services, and digital maternal-health monitoring may offer important implementation contributions and potential for adaptation within district health systems. However, their sustainability and broader applicability are likely influenced by administrative capacity, digital infrastructure, workforce availability, leadership commitment, and community participation. Therefore, careful adaptation to local contexts remains essential before implementation in other regions.

This study also highlights the need for stronger empirical evidence regarding long-term outcomes and sustainability. Future research should employ mixed-methods, longitudinal, or quasi-experimental approaches to examine implementation processes, intervention outcomes, cost-effectiveness, behavioral changes, and policy impacts across different regional settings.

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