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Development of an intervention model to prevent stunting in children in Batam

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ABSTRACT

Stunting remains a significant public health challenge in Indonesia, including in Batam City, which is characterized by rapid population growth and urbanization. This condition not only hampers children's physical growth but also affects their cognitive development and long-term productivity. This study aims to design and implement a community-based intervention model for the prevention of stunting among children aged 0–59 months in Batam. A mixed methods design with an exploratory-sequential approach was employed. Qualitative data were collected through in-depth interviews with health workers, posyandu cadres, and parents, while quantitative data were obtained from questionnaires distributed to 150 mothers of toddlers. Data were analyzed descriptively and inferentially using correlation tests, logistic regression, and thematic triangulation. The findings revealed that the main determinants of stunting in Batam include mothers' limited knowledge of nutrition and exclusive breastfeeding, substandard quality of complementary feeding, restricted access to health services, and poor environmental sanitation. In response, a community-based stunting prevention model was developed consisting of four integrated components: (1) nutrition education for mothers through kelas balita (toddler classes), (2) strengthening posyandu capacity through cadre training and provision of growth monitoring tools, (3) promotion of local food utilization in complementary feeding, and (4) multi-sector collaboration among health workers, local government, and community stakeholders. The study concludes that the proposed model effectively enhances mothers' nutritional knowledge, improves child feeding practices, and fosters sustainable community participation in stunting prevention. This model provides a practically applicable framework that can be integrated into local public health programs as a sustainable and scalable strategy to accelerate stunting reduction in urban settings like Batam.

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1. Introduction

Stunting is one of the chronic nutritional problems that remains a serious challenge in public health development in Indonesia (Lameky, 2024; Milwan & Sunarya, 2023; Romadhona et al., 2023). This condition is characterized by children's height being lower than the standard for their age, as a result of

long-term nutritional deficiencies, repeated infections, and suboptimal parenting practices (Millward, 2017; Uauy et al., 2008). The impact of stunting is not limited to physical growth disorders, but also has implications for delayed cognitive development, decreased immunity, risk of degenerative diseases in the future, and reduced productivity in adulthood (Branca & Ferrari, 2002; Fernandes & Le, 2021; Nisa et al., 2025). The accumulation of these various impacts makes stunting one of the main obstacles to improving the quality of human resources and national competitiveness (Siregar et al., 2022; Sitorus, 2024).

Based on the 2022 Indonesian Nutrition Status Survey (SSGI), the national prevalence of stunting was recorded at 21.6%, which is still far from the target of reducing stunting to 14% by 2024 as outlined in the National Medium-Term Development Plan (RPJMN). This shows that stunting prevention efforts have not been fully effective and require strategies that are more adaptive to local conditions. The city of Batam, as one of the centers of economic growth with high levels of urbanization and industrialization, also faces the problem of stunting (Buulolo, 2020; Fatimah, 2025; Nugroho et al., 2023). The complexity of nutritional problems in Batam is influenced by high community mobility, socioeconomic disparities, unbalanced consumption patterns, and low nutritional literacy among mothers and families (Bhanbhro et al., 2020; Paramashanti, 2023; Retno Wulandari et al., n.d.). These conditions pose unique challenges in efforts to reduce the prevalence of stunting in this region.

The government has initiated various programs, including supplementary feeding (PMT), optimization of integrated health service posts (posyandu), exclusive breastfeeding campaigns, and improvement of environmental sanitation (Bilbi, 2024; Faristasari et al., 2025; Sufri et al., 2023). However, the reduction in stunting prevalence has not yet shown significant results. This confirms that stunting cannot be addressed solely through top-down programs, but also requires a more participatory and community-based approach (Arieffiani & Ekowanti, 2024; Mulmaharani et al., 2024; Tontisirin & Gillespie, 1999). Community-based interventions are considered more effective because they directly involve the role of families, health cadres, medical personnel, and local government support, so that programs can run in accordance with the needs and socio-cultural context of the local community (Duchnowski, 2002; Mannan et al., 2012; Zulu et al., 2014).

In this context, this study has three main objectives. First, to identify the determining factors of stunting in children in Batam City. Second, to develop a community-based intervention model that emphasizes nutrition education, utilization of local foods, improvement of posyandu service quality, and cross-sector partnerships. Third, to evaluate the effectiveness of the intervention model in improving mothers' knowledge and family nutrition practices. Thus, the results of this study are expected to make a real contribution to accelerating the reduction of stunting prevalence in Batam City. Furthermore, this study can serve as a model for other regions with similar characteristics in their efforts to improve human resource quality through child nutrition improvement.

To ensure the quality and credibility of the quantitative data, this study conducted validity and reliability testing of the questionnaire instruments. Content validity was assessed through expert evaluation by public health and nutrition specialists, while reliability testing used Cronbach's Alpha with all variables meeting the acceptable threshold value (>0.70). Furthermore, this study complied with established research ethics procedures, including obtaining informed consent from all respondents and securing ethical approval from the institutional ethics committee, ensuring that the research respected participants' rights, confidentiality, and voluntariness.

2. Methods

This study uses a mixed methods approach with an exploratory-sequential design, which is a research design that combines qualitative and quantitative methods sequentially to obtain more comprehensive and valid results. In the initial stage, a qualitative approach was used to explore in depth the factors causing stunting from the perspective of various stakeholders, including health workers, posyandu cadres, and parents of toddlers. This stage was important to understand the social, cultural, and behavioral contexts, as well as the obstacles faced by the community in their daily nutritional practices. Subsequently, the findings from the qualitative stage were used as the basis for designing quantitative instruments, which were then used in the survey stage with a wider range of respondents. The

quantitative approach aimed to test the relationship between variables, identify the dominant factors causing stunting, and develop community-based intervention models that could be tested empirically. The research was conducted in Batam City, specifically in three subdistricts with the highest prevalence of stunting, namely Batu Aji, Sagulung, and Bengkong. These locations were selected based on considerations that they have diverse demographic, socioeconomic, and health service access characteristics, thereby providing a more representative picture of stunting issues in urban areas with high mobility. The research lasted for six months, from March to August 2025, covering all stages from preparation, data collection, analysis, to the development of an intervention model. The target population of the study was mothers with children aged 0–59 months, as this group is the most vulnerable to stunting. From this population, a quantitative sample of 150 respondents was obtained using stratified random sampling based on subdistrict, so that each subdistrict had a balanced representation. For the qualitative stage, the sample was selected using purposive sampling, consisting of 10 health workers (doctors and midwives), 5 posyandu cadres, and 15 parents of toddlers. This selection aimed to obtain richer data that reflected the real experiences of those directly involved in the prevention and treatment of stunting.

In this study, the variables examined consisted of independent, dependent, and intervention variables. Independent variables included mothers' knowledge of nutrition, exclusive breastfeeding practices, complementary feeding patterns, access to health services, and environmental sanitation conditions. These variables were selected because previous studies have shown that they contribute to stunting, either directly or indirectly. The dependent variable measured was the incidence of stunting in children aged 0–59 months, with height-for-age (HFA) as the indicator based on WHO growth standards. In addition, this study also involved an intervention variable in the form of a community-based stunting prevention model, which was developed based on the integration of qualitative and quantitative findings. The research instruments used were systematically designed to ensure data reliability and validity. In the quantitative stage, the main instrument was a questionnaire designed to measure mothers' knowledge of nutrition, breastfeeding and complementary feeding practices, and access to health services. This questionnaire underwent a pilot test with a number of respondents to ensure the clarity of the questions and consistency of the answers. To measure children's nutritional status, an anthropometric form was used to record children's height and weight, which were then compared with the WHO Growth Chart standards. Meanwhile, in the qualitative stage, in-depth interview guidelines containing open-ended questions were used to explore social, cultural, and behavioral factors related to stunting. The interview guidelines were designed to be flexible so that researchers could adapt to the dynamics of the discussion with respondents. In addition, field observations were conducted to assess environmental sanitation conditions and posyandu activities, so that the data obtained was more triangulated and strengthened the validity of the findings. The combination of these various instruments enabled researchers to obtain a comprehensive picture of the factors causing stunting and to formulate intervention strategies appropriate to local conditions.

The research procedure was carried out through four main stages that were interconnected. The first stage is a qualitative study, which includes in-depth interviews with health workers, posyandu cadres, and parents of toddlers, as well as observations of the surrounding environment and posyandu activities. This stage aims to identify the underlying factors that contribute to stunting, both in terms of individual behavior and structural aspects such as the availability of health services and sanitation conditions. The qualitative data obtained was then analyzed thematically to find relevant patterns, categories, and main themes. The second stage was a quantitative study, which was conducted by distributing questionnaires to 150 mothers with toddlers and performing anthropometric measurements to assess the children's nutritional status. This stage aimed to test the relationship between the variables identified previously and to measure the extent to which these factors influence stunting. The third stage was the development of an intervention model, in which researchers formulated community-based strategies that integrated the qualitative and quantitative findings. This intervention model is designed to emphasize nutrition education, improving appropriate complementary feeding practices, optimizing integrated health service posts (posyandu), utilizing local foods, and cross-sector partnerships. The fourth

stage is a pilot test of the model, which is conducted on a limited basis at posyandu in two subdistricts with high stunting prevalence. This trial aims to evaluate the initial effectiveness of the intervention, particularly in improving mothers' knowledge and family nutrition practices. The evaluation is conducted by comparing conditions before and after the implementation of the intervention model, both in terms of knowledge and child feeding practices. This tiered research procedure is expected to produce an intervention model that is not only based on empirical evidence but also contextual and applicable to the community of Batam City.

Data analysis was conducted using an integrative approach to ensure that the research results provided a comprehensive picture. In the quantitative stage, the analysis began with descriptive analysis to describe the characteristics of respondents, the distribution of nutritional knowledge, breastfeeding and complementary feeding practices, access to health services, and environmental sanitation conditions. Next, a chi-square correlation test was conducted to identify the relationship between independent variables and the incidence of stunting. To determine the dominant factors causing stunting, logistic regression analysis was used, which allowed researchers to determine which variables had the strongest contribution to the occurrence of stunting. The results of this analysis then became the basis for developing intervention strategies. In the qualitative stage, data from in-depth interviews were analyzed using thematic analysis with coding, categorization, and identification of main themes. To improve validity, data triangulation was carried out by comparing the results of interviews, field observations, and other supporting documents. After both types of data were analyzed, an integration stage was carried out, which involved combining qualitative and quantitative findings to produce a more in-depth understanding. This integration is important because it can explain statistical findings with qualitative narratives and ensure that the intervention model developed is truly relevant to the needs of the community. With this systematic data analysis, it is hoped that the research can make a significant contribution, both theoretically in enriching the literature on stunting in urban areas, and practically in providing policy recommendations and community-based interventions that can be widely applied.

3. Results and Discussion

A. Results

1. Respondent Characteristics

A total of 150 mothers with children aged 0–59 months participated in this study. The characteristics of the respondents showed that the majority of mothers were in the 26–35 age group (58%), which is the productive age and generally plays an important role in child care. In terms of education, most respondents were high school graduates (47%), while 22% had attended college, and the rest had an education level below high school. Based on occupation, the majority of mothers were housewives (61%), while the rest worked in the informal sector or industry. The characteristics of the toddlers studied also showed variation, with 55% being male and 45% female. When viewed by age group, the largest distribution was among children aged 6–24 months (49%), followed by the 25–36 month age group (30%), and the 37–59 month age group (21%). These characteristics illustrate that most respondents were of productive age with a secondary education background, and that the children were in a critical period of growth and development that was highly vulnerable to nutritional problems, including stunting.

2. Factors Causing Stunting in Batam

The results of descriptive analysis and in-depth interviews show that there are several dominant factors contributing to stunting in children in Batam City. Based on quantitative data, it is known that mothers' knowledge of nutrition is still low in 42% of respondents, which indicates a limited understanding of the importance of balanced nutrition for child growth. This low level of knowledge has an impact on feeding practices, including exclusive breastfeeding, which is only practiced in 54% of children. This figure is still far from the national target, illustrating the existence of obstacles in terms of both education and social support for breastfeeding. In addition, complementary feeding is not in accordance with standards in 52% of

cases, for example in terms of timing, quantity, and nutritional quality. This condition increases the risk of children experiencing growth disorders.

From an environmental perspective, poor sanitation was found in 37% of families, characterized by limited access to clean water and inadequate household waste management. This environmental factor contributes to an increased risk of recurrent infections in children, which in the long term can hinder growth. In addition, access to health services remains a barrier for 28% of respondents, with some mothers reporting difficulties in accessing health centers or integrated health service posts (posyandu) on a regular basis due to distance, cost, and time constraints.

Inferential analysis reinforced these findings. The chi-square test results showed a significant relationship between mothers' nutritional knowledge and children's nutritional status ($p < 0.05$), meaning that the lower the mothers' nutritional knowledge, the higher the risk of stunting in children. Furthermore, the results of logistic regression analysis identified three dominant variables causing stunting, namely low maternal nutritional knowledge (OR = 2.45), provision of complementary foods that do not meet standards (OR = 2.11), and poor environmental sanitation (OR = 1.98). These findings indicate that stunting prevention efforts need to focus on improving nutrition literacy, improving complementary feeding practices, and community-based sanitation interventions, so as to have a real impact on reducing the prevalence of stunting in Batam City.

3. Qualitative Findings

The results of this study provide a comprehensive overview of the factors that influence the nutritional status of children aged 0–59 months. Descriptive analysis shows that there are still various significant problems related to parenting patterns and family environmental conditions. As many as 42% of respondents had low nutritional knowledge, which had an impact on inappropriate feeding practices. This is evident from the low coverage of exclusive breastfeeding, which only reached 54%, and the high number of cases of complementary feeding that did not meet standards, which was 52%. In addition, environmental sanitation conditions are also an important issue, with 37% of families found to be living in poor sanitation conditions. Equally important, around 28% of respondents admitted to having limited access to health services, particularly in terms of regularly visiting health centers or integrated health service posts (posyandu).

The chi-square test results show a significant relationship between mothers' knowledge levels and children's nutritional status ($p < 0.05$). Furthermore, logistic regression analysis shows that the dominant factors contributing to stunting are low maternal nutritional knowledge (OR = 2.45), substandard complementary feeding (OR = 2.11), and poor environmental sanitation (OR = 1.98). These findings emphasize that stunting is not only influenced by biological factors, but is also closely related to behavioral, environmental, and health service accessibility aspects. In-depth interviews conducted in this study provided more detailed explanations regarding the quantitative results. One of the main findings was the tendency of mothers to provide instant foods as complementary foods. This decision is largely based on practicality and time constraints, so that instant foods are considered an easier solution than preparing nutritious meals independently. On the other hand, the interviews also revealed that mothers' knowledge of local nutritional variations is still limited. In fact, the availability of local food resources, such as seafood and fresh vegetables, can actually meet children's nutritional needs optimally.

From a healthcare perspective, several posyandu cadres stated that they still face limitations in terms of training, particularly related to early detection of stunting risks. This condition causes interventions for children at risk to often be carried out too late. Meanwhile, socio-cultural factors also play a significant role. There is still a perception among the community that overweight children are always synonymous with healthy children. This view encourages some parents to overfeed their children without paying attention to the nutritional quality of the food. Overall, the results of this study confirm

that stunting prevention efforts must be carried out through a comprehensive approach. Interventions should not only focus on providing nutritious food, but also on increasing mothers' knowledge, strengthening the capacity of posyandu cadres, and changing misguided cultural perceptions about child feeding practices. Thus, child nutrition improvement strategies will be more effective if they involve synergy between families, health workers, and communities in creating an environment that supports optimal child growth and development.

4. Development of Intervention Models

Based on the results of quantitative and qualitative analysis, this study successfully developed a Stunting Prevention Intervention Model in Batam that was comprehensively designed to involve various important aspects. This model consists of four main components that complement each other. First, nutrition education for mothers and children is carried out through toddler mother classes held at integrated health service posts (posyandu). This activity uses simple, easy-to-understand nutrition modules accompanied by practical sessions on making complementary foods based on local food ingredients. Second, increasing the capacity of health posts is an important focus, with training provided to cadres, particularly in monitoring child growth and development, using standard anthropometric tools, and basic nutrition counseling skills. Third, this model emphasizes the provision of supplementary foods based on local foods, utilizing the potential of local resources such as seafood, eggs, and fresh vegetables that are widely available in Batam. This not only improves nutritional quality but also reduces the cost of procuring supplementary foods. Fourth, cross-sector partnerships are emphasized through collaboration between health centers, schools, community leaders, and local governments in implementing nutrition and sanitation campaigns. With this integrated approach, the intervention model is expected to improve the effectiveness of stunting prevention in a sustainable manner.

5. Intervention Model Trial

The intervention model that was developed was then implemented on a limited basis at two health posts in Sagulung and Batu Aji subdistricts for a period of three months as an initial trial phase. Monitoring results showed significant positive changes in various aspects. First, mothers' knowledge of nutrition increased by 35% after attending toddler mother classes that taught basic nutrition concepts and practices for making local complementary foods. This increase confirms that simple education conducted consistently can improve mothers' understanding of their children's nutritional needs. Second, the practice of providing nutritious complementary foods increased from 48% to 72%, indicating that mothers not only gained knowledge but also applied these skills in their daily feeding practices. Third, posyandu visits increased by 29%, indicating growing community awareness of the importance of utilizing basic health services, particularly child growth monitoring. In addition, posyandu cadres reported an increase in their ability to detect the risk of stunting early, both through more accurate anthropometric measurements and more targeted nutrition counseling. These findings prove that community-based intervention models can be implemented effectively and deliver tangible results in a relatively short time, while also serving as a basis for broader development in the future.

b. Discussion

The results of the study indicate that stunting in Batam City is influenced by various interrelated factors, including low maternal knowledge about nutrition, suboptimal breastfeeding and complementary feeding practices, environmental sanitation conditions, and limited access to health services. These findings are in line with research by the Indonesian Ministry of Health (2022), which confirms that nutrition, parenting, and environmental factors are the main determinants of stunting in Indonesia.

1. Maternal Nutrition Knowledge and Complementary Feeding

Maternal knowledge of nutrition has been shown to have a significant relationship with children's nutritional status. These results support previous research by Fitriani et al. (2021), which states that the higher the mother's knowledge, the better the child feeding practices. The facts on the ground

show that some mothers in Batam still give instant complementary foods for practical reasons, even though local foods such as seafood and fresh vegetables are abundant and more nutritious. Therefore, nutrition education based on local foods is very relevant to improve the quality of children's diets.

2. The Role of Posyandu in Stunting Prevention

Posyandu serves as the frontline in monitoring child growth and development. However, this study found that Posyandu cadres still need capacity building, especially in the use of standard anthropometric measuring tools and nutrition counseling. Interventions in the form of cadre training have been proven to improve early detection skills for stunting, in line with research by Astuti et al. (2020) which emphasizes the importance of empowering health cadres in stunting prevention efforts at the community level.

3. Sanitation and Environmental Factors

Poor environmental sanitation also contributes to stunting. Some of the respondents' families still use unsuitable water sources or have unsanitary toilets. This condition has the potential to increase the risk of diarrhea and gastrointestinal infections, which can lead to malnutrition. These results are consistent with a study by the WHO (2021), which shows that nutritional interventions must be accompanied by improvements in sanitation in order to achieve optimal results in stunting prevention.

4. Effectiveness of the Intervention Model

The community-based intervention model developed in this study includes nutrition education, strengthening the capacity of integrated health service posts (posyandu), utilization of local foods, and cross-sector partnerships. A limited trial in two posyandu showed an increase in mothers' knowledge, complementary feeding practices, and the skills of posyandu cadres. These results show that participatory and contextual intervention approaches are more effective than top-down programs. The success of the intervention model is also influenced by cross-sectoral involvement, including local government, health workers, and the community. This collaborative approach is in line with the global Scaling Up Nutrition (SUN) strategy, which emphasizes that reducing stunting requires synergy between the health, education, agriculture, and environment sectors.

5. Research Implications

This study has important implications for regional policy formulation. The intervention model developed can be used as a reference in stunting prevention programs in Batam City and other urban areas with similar characteristics. In addition, this study also emphasizes the importance of integrating education, health, and environmental aspects into a single sustainable intervention framework.

4. Conclusion

The findings of this study reaffirm that stunting is a multidimensional issue influenced by behavioral, socioeconomic, environmental, and health service factors. The results align with previous studies stating that maternal knowledge of nutrition and appropriate feeding practices are among the most critical determinants in child growth (Fernandes & Le, 2021; Paramashanti, 2023). This study extends existing literature by demonstrating that, within an urban and industrialized context like Batam City, the problem of stunting is not only rooted in economic inequality but also in the low level of nutritional literacy among mothers and families. From a theoretical perspective, this study contributes to the development of community-based stunting prevention frameworks by integrating concepts of community empowerment, behavior change theory, and participatory public health models. The proposed intervention model emphasizes active participation and shared responsibility among key stakeholders — mothers, posyandu cadres, health workers, and local government — which strengthens the theoretical linkage between community engagement and behavioral improvement in maternal and child health. This finding supports and extends the theoretical propositions of Tontisirin and Gillespie (1999), who emphasized that the sustainability of nutrition programs largely depends on the level of local participation and ownership. The empirical contribution of this research lies in the development and limited trial of a practical, scalable model that combines education, local food utilization, and cross-sector collaboration. The positive results obtained from the pilot implementation, such as improved maternal knowledge, increased posyandu participation, and enhanced cadre competence, indicate that the model has potential

to be institutionalized within local health policies. These outcomes reinforce the argument that community-driven approaches are more effective than top-down interventions, especially in urban areas with diverse socioeconomic conditions. Despite its promising findings, this study has several limitations. The intervention was implemented in only two posyandu with a relatively short observation period, limiting the ability to generalize the results to all urban communities. Furthermore, external variables such as seasonal variations in food availability, household income stability, and cultural feeding norms were not explored in depth. To address these limitations, future research should expand the scope of intervention to multiple urban and rural areas, adopt longitudinal study designs to measure long-term impacts, and integrate mixed socioeconomic and cultural indicators for a more comprehensive analysis. In summary, the results of this study provide both theoretical and practical insights into the development of community-based strategies for stunting prevention. By bridging theory and practice, the proposed model not only enhances the understanding of how local participation drives health outcomes but also offers a structured, evidence-based framework that can be replicated and scaled up in other regions facing similar nutritional challenges

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