

## Risk Factors for Stunting in Children Aged 6-36 Months Among Seaweed Farmers in Coastal Areas

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### ORIGINAL ARTICLES

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### ABSTRACT

Stunting constitutes a formidable challenge within public health development, necessitating integrated, cross-sectoral strategies for its effective mitigation. A heightened prevalence of stunting is observed in the coastal regions of Tarakan City. This study was designed to elucidate the determinants of stunting among children aged 6–36 months within seaweed farming communities in Tarakan City to inform the formulation of targeted prevention and control policies. An analytical observational study employing a cross-sectional design was conducted from July to September 2023. The target population comprised 200 mothers engaged in seaweed farming in the coastal areas of Tarakan City with children aged 6–36 months. A purposive sampling method was utilized to recruit a sample of 151 participants. Binary logistic regression analysis revealed that stunting was significantly associated ( $p < 0.05$ ) with several variables. Key maternal determinants included the level of knowledge regarding stunting, household income, and residential sanitation conditions. Child-specific determinants encompassed the history of exclusive breastfeeding, morbidity from infectious diseases, and daily protein intake. In conclusion, the prevalence of stunting among children of seaweed farmers in this coastal setting is multifactorial, with significant determinants originating from both maternal and child-related factors. Although certain variables did not yield statistical significance in this analysis, their established role in pediatric health is undeniable. Therefore, it is recommended that comprehensive public health interventions continue to address all investigated factors, given their scientific foundation for promoting optimal child growth and development.

### Key Messages:

- The prevalence of stunting among children aged 6–36 months in Tarakan's coastal seaweed farming communities is strongly associated with a combination of maternal and child-related factors, such as maternal knowledge, household income, home sanitation, exclusive breastfeeding, history of infections, and daily protein intake.
- Comprehensive stunting prevention efforts must involve cross-sectoral collaboration and be tailored to address the distinct maternal and child health determinants prevalent in vulnerable coastal populations.

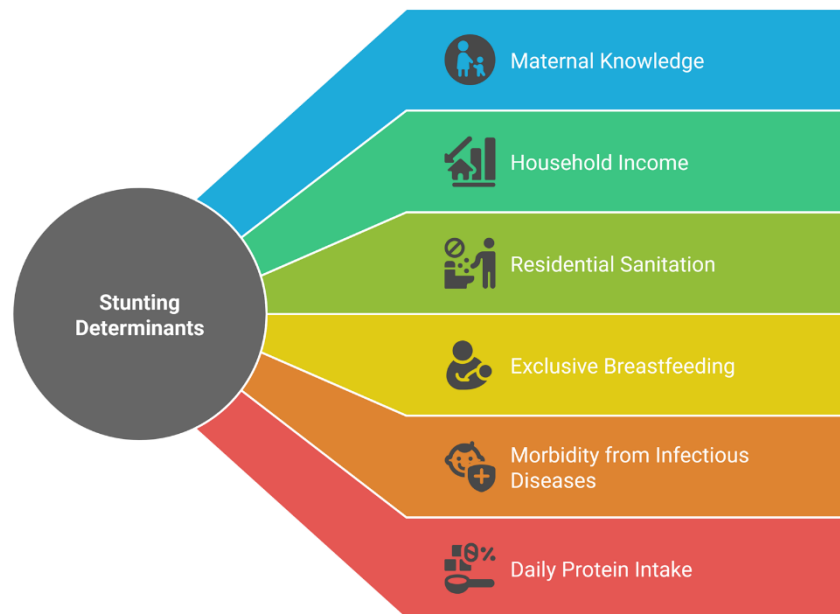
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## GRAPHICAL ABSTRACT

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## INTRODUCTION

Stunting is a serious global public health issue, particularly among children aged 6-36 months. Stunting occurs when a child's height does not reach the expected level for their age due to chronic malnutrition. A high prevalence of stunting can indicate poor nutritional and health conditions for the child and their environment. Recent data show that the global prevalence of stunting among children under five years old remains high at approximately 21.3%, with the highest rates occurring in Sub-Saharan Africa and South Asia. In Indonesia, stunting is even higher (1), at around 30.8% in 2020. This indicates that stunting remains a severe issue in Indonesia, requiring comprehensive attention and intervention. Stunting can severely impact a child's growth, cognitive development, and productivity.

According to the 2022 Indonesian Nutrition Status Survey, the stunting rate in North Kalimantan Province is 22.1%(2). This figure represents a decrease of 5.4% compared to the stunting rate in 2021, which was 27.5%. The occurrence of stunting generally correlates with extreme poverty rates. This correlation is due to the low ability of families to meet daily nutritional needs due to poverty. In 2022, the extreme poverty rate in North Kalimantan Province had nearly reached 0%, at 0.63%. This rate had decreased by 0.23% from 0.86% in 2021. Given the causal relationship between extreme poverty and stunting, addressing both issues must be done in an integrated manner. The Indonesian government has targeted reducing stunting to 14% by 2024.

The stunting rates in districts and cities across North Kalimantan Province vary, with no significant differences. With a stunting rate of 25.9%, Tarakan City is the second-highest contributor to stunting cases, following Nunukan Regency. Many sources explain that stunting is primarily associated with poverty-related issues. Although poverty is a known factor, other determinants are essential to identify and control. However, the relationship between poverty and stunting in North Kalimantan is insignificant, considering the population's relatively high average income levels, which places the province among the top five in Indonesia for the highest welfare levels. Low knowledge regarding nutritional issues is suspected to be the most critical factor(3). This is related to the potential natural resources available in abundance in the province as raw materials for nutritional needs. Fish, vegetables, and fruits are sufficiently available throughout the year.

In Tarakan City, the highest incidence of stunting is found in Pantai Amal Village, one of the coastal areas. Similar conditions with lower incidence rates are also found in other coastal areas of Tarakan City, such as Mamburungan, Juara Laut, Selumit Pantai, and Karang Anyar Pantai. This further strengthens the suspicion of low community knowledge about nutritional issues in coastal areas. Preliminary studies have identified similar characteristics of stunting incidence in children under three years old, where most of their parents work as seaweed farmers. Seaweed farming is a job that consumes much time and may lead to neglect in child-rearing. However, stunting results from an accumulation of various factors that cause chronic malnutrition in children(4).

Stunting cases in the coastal areas of Tarakan City mostly come from migrants who are attracted to the promising job opportunities as seaweed farmers. These migrants, seeking a better life, often come with low socioeconomic backgrounds and poor nutritional knowledge. The job as a seaweed farmer, although promising income, often involves harsh and unpredictable working conditions, leading to instability in meeting the nutritional needs of their families. Consequently, children from these seaweed farming families are at high risk of stunting due to inadequate nutrition and lack of parental attention due to long working hours.

The high rate of stunting in the coastal areas of Tarakan City is a multifactorial issue that requires a comprehensive approach to address. Socioeconomic, environmental, nutritional, and educational factors contribute to this problem. By implementing targeted interventions that address these factors, it is possible to significantly reduce stunting rates and improve the health and well-being of children in these communities. Ongoing research and monitoring are essential to assess these interventions' effectiveness and make necessary adjustments for continued progress.

Several studies mention that potential factors influencing stunting include socioeconomic status, family, healthcare services, diet, and health status, genetics, exclusive breastfeeding, birth weight history, appropriate age for complementary feeding, family education level, and food consumption(5,6). Poor and educated communities have the highest risk of stunting(7). This is related to their ability to correctly choose, buy, prepare, and serve food with balanced nutrition. Family knowledge, especially that of the mother, is crucial in stunting children under three. A mother's nutrition knowledge will determine her behavior when feeding her child. The mother's knowledge about nutrition, particularly regarding breastfeeding, can have long-term consequences on the child's health, such as obesity and type 2 diabetes. Good nutrition knowledge can influence the mother's feeding behavior, including breastfeeding(8).

Poor caregiving practices among seaweed farmers can be a significant risk factor for stunting in children in coastal areas. Several studies indicate that inadequate caregiving practices, such as insufficient nutritional intake, inadequate health care for children, and low parental education regarding healthy caregiving practices, can hinder optimal child growth. For instance, inadequate nutrition can lead to chronic malnutrition, which stunts physical and cognitive development. In addition, inadequate health care may result in untreated illnesses or infections that further impair growth. Furthermore, the low levels of parental education can contribute to a need for more awareness about proper childcare practices, including hygiene and stimulation, which are crucial for child development(9). These factors collectively contribute to delayed growth and development during critical age ranges, thereby exacerbating the prevalence of stunting among children of seaweed farmers in coastal areas.

Children under three years old require protein for their growth. An alternative to meet their protein needs is through animal protein sources, one of which is fish and its derivatives, as the most significant proportion of protein is expected to come from fish. If children under three years old lack animal protein, their bodies will not be able to grow and develop properly(10), which will affect their nutritional status. Stunting in children under three years old is usually only realized during puberty and adolescence, making it difficult to correct the impact of malnutrition. The work activities and characteristics of seaweed farmers in coastal communities pose a high risk of stunting for children under three years old. Therefore, this study aims to identify the main risk factors for stunting in children aged 6-36 months among seaweed farmers in the coastal areas of Tarakan City.

## METHODS

This research is an observational analytic study with a cross-sectional approach. The study was conducted in two coastal areas of Tarakan City, namely Pantai Amal and Mamburungan. The population of this study consisted of mothers with children aged 6-36 months who work as seaweed farmers in coastal areas, with an estimated population of 200 people. The sample for this study was determined based on inclusion criteria: working as seaweed farmers, having children aged 6-36 months, and being willing to participate as respondents. The sample size was calculated using the Slovin formula, resulting in 151 respondents. The samples were selected using purposive sampling techniques.

The instruments used consist of a combination of questionnaires and observation sheets. The education category was assessed based on compulsory education, with the low category defined as education at the junior high school level or below, and the high category defined as senior high school level or above. Nutritional knowledge was categorized into high, moderate, and low levels. Low Birth Weight was determined based on the history of birth weight measurement of less than 2.5 kg. Exclusive breastfeeding refers to breastfeeding the child only from birth to six months. Protein consumption was divided into four categories: often/always, sometimes, rarely, and never. Pregnancy check-ups were categorized into two groups: those who had check-ups and those who did not. Socioeconomic status refers to the family's income level, which was categorized into three groups: high, moderate, and low. Environmental sanitation was divided into two categories: good and poor. Stunting incidence was determined by measuring height and length, then compared to standard references and converted into z-scores, which were classified into two categories: normal and stunted. Data were analyzed using binary logistic regression.

## CODE OF HEALTH ETHICS

This study has met ethical eligibility based on the ethical clearance certificate issued by the Health Research Ethics Committee of the Faculty of Health Sciences, Borneo Tarakan University, Number: 015/KEPK-FIKES UBT/VI/2023

## RESULTS

Based on Table 1, it is evident that the respondents in this study are primarily of productive age, with the majority having low education levels. Most respondents are residents who have been living in the area for more than five years. The occupation of seaweed farmers has been pursued for a considerable time, lasting more than four years.

**Table 1. Respondent Characteristics**

Variable		n	%
<b>Age</b>	≤ 20 years old	6	4
	21 - 30 years old	75	49,6
	31 - 40 years old	56	37,1
	41 - 50 years old	14	9,3
<b>Education</b>	≤ Junior High School	105	69,5
	Senior High School	41	27,2
	College	5	3,3
<b>Length of Residence</b>	6 - 12 years	18	11,9
	1 - 3 years	24	15,9
	4 - 6 years	22	14,6
	7 - 10 years	20	13,2
	≥ 10 years	67	44,4
<b>Duration as Seaweed Farmer</b>	≤ 1 years	26	17,2
	1 - 3 years	46	30,5
	4 - 6 years	41	27,2
	7 - 10 years	26	17,2
	> 10 years	12	7,9

**Table 2. Statistical Analysis of Risk Factors for Stunting Derived from Maternal/Family Factors and Child Factors**

Variable	B	odds	Wald	p
<b>Maternal/Family Factors:</b>				
Educational level	0,915	-0,089	0,056	0,813
Knowledge of stunting	0,517	-0,659	5,636	0,018
Pregnancy check-up history	1,035	0,034	0,006	0,94
Socioeconomic status/income	1,19	0,174	3,114	0,007
Home environmental sanitation	0,704	-0,351	0,761	0,038
<b>Child Factors:</b>				
Low birth weight history	1,19	0,174	0,119	0,73
Exclusive breastfeeding history	1,918	0,473	1,16	0,029
Infection history	2,463	0,901	2,579	0,008
Immunization status	0,847	-0,167	1,612	0,434
Daily protein intake	1,616	0,485	2,831	0,018

Table 2 above shows that three maternal factors pose risks for stunting in children: maternal knowledge about stunting, socioeconomic status/family income, and household environmental sanitation. Meanwhile, there are also three child-related factors identified as risks for stunting, which include a history of exclusive breastfeeding, a history of infections, and daily protein intake. Meanwhile, maternal education level, history of antenatal care, low birth weight history, and immunization status did not show a clear association with the incidence of stunting in this study.

## DISCUSSION

This study identifies that almost all respondents are in their productive ages between 20-50 years old. Only a small proportion of respondents are younger. This condition can be understood because seaweed farmers are primarily breadwinners and the backbone supporting their families. Families deliberately employ younger individuals to contribute to higher household income. Most respondents have low educational levels, which may limit their knowledge about child nutrition and dietary needs. Parental education, especially for mothers, significantly influences the understanding and practice of providing nutritious food for their children(11).

Prolonged residence in coastal communities is associated with adverse health outcomes, potentially due to persistent environmental challenges such as limited access to safe water and inadequate sanitation. These conditions contribute to an increased vulnerability to infectious diseases, which in turn may compromise nutritional status and elevate the risk of stunting among children(12). Coastal communities predominantly engage in seaweed farming, a labor-intensive occupation that consumes considerable time and may detract from childcare responsibilities, including ensuring adequate nutrition. The combination of low education levels, limited knowledge about stunting, time-consuming seaweed farming occupations, and restricted access to clean water and environmental sanitation in coastal areas further heighten the risks of stunting and various other health issues.

Many cases of stunting still need to be officially recorded, complicating practical mitigation efforts. Newcomers may need to be registered in the local healthcare system, thus missing out on crucial healthcare services such as routine check-ups, nutritional supplements, and health education. This underscores the need for a more inclusive and systematic approach to registering and integrating newcomers into urban health and social systems. Community-based interventions involving population mapping of newcomers and intensive health education can help address this stunting issue(13). Additionally, policies supporting equitable and sustainable healthcare access for all residents, including newcomers, are essential to reduce stunting rates significantly.

Stunting can occur due to various factors from the mother and the child. In this study, maternal knowledge regarding stunting, household income, and the quality of environmental sanitation were identified as significant maternal determinants influencing stunting prevalence. Conversely, maternal educational attainment and prenatal care history did not statistically correlate with stunting incidence. Knowledge about stunting includes understanding its causes, risk factors, impacts, and preventive

measures, significantly influencing mothers' attitudes and behaviors in reducing stunting prevalence. In populations of seaweed farmers, mothers may need more exposure to the importance of balanced nutrition and adequate nutrient intake for their children. Mothers with good knowledge about stunting tend to be more aware of the necessity for balanced and nutritious food for their children, which is crucial in preventing stunting. This understanding leads them to be vigilant about early signs of nutritional imbalance that could lead to stunting(14), enabling them to take necessary preventive actions. Increased knowledge about stunting is crucial in reducing the risk in children(11).

The socioeconomic status of families associated with income levels significantly influences the occurrence of stunting, a finding consistent with existing literature. Socioeconomic factors significantly influence families' access to resources essential for child growth and development(15). Family income generated from seaweed farming is indeed promising. One of the most common and labor-intensive tasks is preparing seaweed cultivation media, locally referred to as "membetang." Wages are based on the quantity of seaweed planting media produced, with higher production yielding more significant income. Membetang activities are relatively easy and can be performed by anyone, including children, so many families involve their children in assisting with the work.

In terms of quantity, income from working as seaweed farmers is relatively high, averaging above the Regional Minimum Wage. However, due to behavioral factors, this high income does not lead to family prosperity. Within the local community, a detrimental tradition exists of indulging in luxuries upon receiving wages. Typically, money received is quickly spent on alcohol, luxurious food, and gambling, and some are sent to family; almost none is saved. As funds dwindle, they are willing to eat sparingly. Such behavior significantly impacts the inadequate nutritional needs of children. Children's crucial developmental period cannot be balanced with sufficient nutritional needs. This situation is similar to families with low socioeconomic status. Children from economically disadvantaged families are at higher risk of malnutrition, including stunting, due to unbalanced and poor-quality diets(16).

This study found that household environmental sanitation correlates with stunting, highlighting the importance of environmental factors in child health and development. Poor sanitation can lead to various health issues that may contribute to malnutrition and stunting. Researcher observations of respondents' home environments showed poor sanitation despite relatively unproblematic access to clean water facilities. Children also needed to be more accustomed to washing their hands properly during activities. Lack of awareness, habits, and limited time are suspected causes of poor household environmental sanitation.

Poor household environmental sanitation increases the risk of children's exposure to various disease-causing pathogens. Neglected coastal areas with abundant waste further heighten the disease risk among communities, including children. McQuade highlighted the link between unhealthy environments and stunting(17) and found that families with poor sanitation tend to have children with lower growth rates than those with good sanitation. This can be linked to an increased risk of recurrent enteric infections, which may hinder nutrient absorption and result in chronic malnutrition.

This study also successfully identified that maternal education level and history of antenatal care were not directly associated with the incidence of stunting in children. Nevertheless, it must be acknowledged that both remain important factors that require proper management. These findings are consistent with several recent studies indicating that while maternal education and the frequency of antenatal care are important, they are not the sole determinants of stunting. Danaei noted that other factors, such as the quality and quantity of nutritional intake, recurrent infections, and unhealthy household environments, play a more dominant role in influencing a child's nutritional status(18). In this context, although mothers with higher education levels may have better knowledge of nutrition and health, other factors related to economic conditions and the environment remain significant barriers to preventing stunting.

Furthermore, Kim (2019) highlighted that a history of good prenatal care does not necessarily guarantee that a child will be free from stunting if they do not receive adequate nutrition after birth and do not live in a healthy environment(19). Interventions focused solely on maternal education and prenatal care without addressing other factors contributing to poor nutrition and child health may be less effective

in addressing the issue of stunting. A more comprehensive and multifactorial approach is needed to effectively reduce stunting rates, involving improved access to quality food, better sanitation, and poverty alleviation efforts.

This study found that a history of exclusive breastfeeding, a history of infections, and daily protein intake are significant factors influencing the occurrence of stunting in children. Exclusive breastfeeding is the best source of nutrition for infants up to the first six months of life, providing all the necessary nutrients for optimal growth. Mothers working as seaweed farmers may face challenges in providing exclusive breastfeeding due to job demands and a lack of support for breastfeeding practices. Children who receive exclusive breastfeeding have a lower risk of stunting compared to those who do not receive exclusive breastfeeding(20). Exclusive breastfeeding contains all essential nutrients, enzymes, and antibodies to support the child's immune system, prevent infections, and ensure healthy growth. Exclusive breastfeeding means giving breast milk to the infant without any other food or drink such as water, glucose water, honey, etc., except medicine and vitamins, from birth to 6 months, and then continuing alongside complementary foods up to 2 years of age or beyond.

History of infections can be a contributing factor to the occurrence of stunting. In the seaweed farming population, poor environmental sanitation and limited access to health facilities exacerbate this issue, thereby increasing the incidence of stunting. Repeated infections in children, particularly respiratory tract infections and diarrhea, can significantly impair nutrient absorption and increase the body's energy requirements to fight diseases, leading to stunting. Children who frequently experience recurrent infections have a higher risk of stunting(21). These infections cause damage to the intestinal walls, reduce the ability to absorb nutrients and worsen children's nutritional status. Therefore, preventing infections through immunization, good sanitation, and healthy hygiene practices is crucial to reducing the incidence of stunting.

Adequate daily protein intake is also a critical factor in preventing stunting. Children from seaweed farming families should be able to obtain sufficient protein intake, given that fish resources are generally available in coastal areas. However, economic limitations may hinder access to animal protein sources. Protein is a crucial component in the growth and development of cells and tissues in children's bodies. Protein deficiency in daily diet can lead to delayed growth and development, ultimately stunting(22). Children who receive animal protein intake, such as from meat, fish, eggs, and milk, experience better growth than those lacking protein. Therefore, increasing access to and consumption of high-quality protein sources is crucial in preventing stunting.

On the other hand, low birth weight history and immunization status did not prove to influence the occurrence of stunting significantly. This finding may differ from some existing literature but aligns with research by Segawa, which found that although low birth weight is often considered a risk factor for stunting, its impact can be minimized with adequate nutritional interventions and optimal healthcare after birth(23). Similarly, complete immunization status should protect children from infectious diseases that can hinder growth. However, this study may indicate that other factors, such as nutrition intake and clean environments, are more crucial in preventing stunting. These factors underscore the importance of a holistic approach in addressing stunting, where nutritional interventions and environmental improvements should be prioritized to ensure optimal child growth.

Based on the findings and discussions above, extra efforts are required to control stunting among seaweed farmers in coastal areas. These efforts can generally be categorized into two main strategies: improving the nutritional status of children who are already stunted and preventing stunting among healthy children. Improving the nutrition of stunted children may include providing nutrition education for parents or caregivers, nutritional supplementation, regular health check-ups, supplementary feeding, management of comorbid conditions, and stimulation for child growth and development. On the other hand, preventing stunting in healthy children involves ensuring adequate maternal nutrition during pregnancy, promoting exclusive breastfeeding, providing reproductive health education, improving environmental sanitation, ensuring access to clean water, monitoring child growth and development, and enhancing household income and family self-reliance. Seaweed business owners should also share responsibility in controlling stunting by providing space and time for mothers to breastfeed, improving

workplace hygiene, allowing access for healthcare workers to conduct regular check-ups, and ensuring fair wages for workers. It is also important to prohibit the employment of school-aged children. Moreover, seaweed farmers and workers should be equipped with financial management education or training to ensure that family income is used wisely and not merely for consumptive purposes.

This study has several limitations, including the cross-sectional design, which restricts the ability to infer causality; the specific population of seaweed farmers, which limits the generalizability of the findings; and potential measurement biases. Therefore, future research is warranted using longitudinal study designs to explore causal pathways, intervention studies targeting the identified risk factors, or expanding the scope of research to other similar populations.

## CONCLUSION

This study successfully identified the risk factors for stunting among children aged 6-36 months among seaweed farmers in coastal areas of Tarakan City. The findings indicate that both maternal and child-related factors play a role in the incidence of stunting. This study identified an association between three maternal factors and the incidence of stunting: maternal knowledge about stunting, family income, and environmental sanitation. In addition, child-related factors such as the history of exclusive breastfeeding, frequency of infections, and daily protein intake were also associated with stunting. Meanwhile, maternal education level, prenatal care history, history of low birth weight, and immunization status did not demonstrate a direct relationship with stunting in this study. Although maternal education level, history of prenatal check-ups, low birth weight history, and immunization status did not directly correlate with stunting, these factors are believed to contribute to child health positively and, therefore, should be fulfilled.

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## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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