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Families at Risk of Stunting and the Prevalence of Stunting in Indonesia: An Ecological Study

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Abstract

Abstract: Stunting remains a critical public health challenge in Indonesia, impacting child growth, cognitive development, and long-term productivity. The government has prioritized interventions targeting families at risk of stunting to reduce its prevalence. This study examines the relationship between families at risk of stunting and stunting prevalence in Indonesia by an ecological study design. Data were analyzed at the district/city level using correlation analysis to assess key risk factors. The findings indicate that inadequate access to safe drinking water, poor sanitation, substandard housing, and reproductive health risks among women of reproductive age are significantly correlated with higher stunting prevalence ($p<0.05$). The correlation coefficients for these factors are 0.14, 0.19, 0.17, and 0.33, respectively. Furthermore, a one percent reduction in families at risk of stunting is associated with a 0.19 percent decrease in stunting prevalence (R^2 = 16%). These results highlight the need for comprehensive interventions addressing environmental, socio-economic, and maternal health factors. Strengthening policies that improve access to clean water, sanitation, and maternal health services is crucial to accelerating stunting reduction efforts in Indonesia. Prioritizing families at risk can enhance the effectiveness of government strategies in achieving national stunting decrease targets.

Introduction

Stunting remains a significant public health concern in Indonesia, marked by chronic malnutrition affecting children's growth and development. In 2023, the stunting prevalence was 21.5%, showing only a slight decrease from 21.6% in 2022, highlighting persistent challenges and the need for effective interventions (Ministry of Health the Republic of Indonesia, 2024). Stunting impairs not only physical growth but also has lasting impacts on cognitive development, educational outcomes, and economic productivity. Stunting is driven by various factors, including child-specific factors like low birth weight, frequent diarrhea, and poor dietary diversity (Berhe *et al.*, 2019; Woldeamanuel & Tesfaye, 2019). Family factors, such as maternal education, height, BMI, household wealth, and family size, also play a role (Berhe *et al.*, 2019; Mulyaningsih *et al.*, 2021). Environmental factors, including limited access to clean water, sanitation, and electricity, further contribute to the issue(Mulyaningsih *et al.*, 2021; Yani *et al.*, 2023). Nutrition-specific and -sensitive interventions, such as poverty reduction, improved food access, sanitation,

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and education, are crucial for reducing stunting (Siswati *et al*., 2022). In India, enhanced health services, household assets, and sanitation led to a 47% reduction in stunting, supported by political stability and community engagement (Kohli *et al*., 2020). In Sub-Saharan Africa, stunting decreased significantly over the last decade, with faster reductions among disadvantaged groups, although disparities in diet quality and healthcare access remain (Baye *et al*., 2020).

Effective interventions should improve maternal education and nutrition, increase dietary diversity, reduce diarrheal infections, and strengthen community infrastructure (Eshete *et al*., 2020; Herawati & Sunjaya, 2022). The Indonesian government has prioritized preventive strategies for families at risk of stunting. Such families, often characterized by low socioeconomic status, insufficient parental education, limited access to healthcare, and poor dietary practices, are considered key contributors to the high prevalence of stunting in the country (Ahmad *et al*., 2023; Headey *et al*., 2020; Kwami *et al*., 2019). This study aims to evaluate the relationship between families at risk of stunting and the prevalence of stunting in Indonesia. The findings of this study will provide insights into the most effective interventions and policy measures needed to address stunting, thereby contributing to the ongoing efforts to reduce stunting prevalence in Indonesia.

Method

This research is an observational study with an ecological approach aimed at examining the relationship between families at risk of stunting and the prevalence of stunting at the district/city level. The dependent variable in this study is the prevalence of stunting at the district/city level, derived from the Indonesian Health Survey (Survei Kesehatan Indonesia - SKI) conducted in 2023. The independent variable in this study is families at risk of stunting, measured based on aggregated data from the 2023 update of Indonesian family data. According to Indonesia's National Action Plan for Accelerating Stunting Reduction (RAN PASTI), families at risk of stunting are those that possess one or more risk factors associated with stunting. These factors include having family members who are adolescent girls, brides-to-be, pregnant women, or children aged 0–23 months and 24–59 months, belonging to poor households, having parents with low educational attainment, living in environments with inadequate sanitation, and lacking access to safe drinking water. The measurement of this variable involves aggregating the total number of families meeting these risk criteria at the district/city level, providing a comprehensive overview of the distribution of at-risk families across Indonesia's 514 districts/cities. This approach allows for the analysis of the relationship between the prevalence of stunting and the concentration of at-risk families in each area.

To explore the relationships between these variables, a correlation analysis approach was employed. This method will help determine the strength and direction of the association between family risk factors and stunting prevalence across various regions. By identifying the key risk factors and their impact on stunting, the findings of this study aim to provide valuable insights for more effective interventions and policies to address stunting, thereby contributing to ongoing efforts to reduce stunting prevalence in Indonesia. This study has obtained ethical approval from the Faculty of Public Health, Universitas Indonesia, with the ethical approval number Ket-678/UN2.F10.D11/PPM.00.02/2024.

Result and Discussion

According to the 2023 Indonesian Health Survey, the national average stunting prevalence stands at 21.5%. However, this progress has yet to meet the target set in the National Medium-Term Development Plan 2020-2024, which aims to reduce it to 14% by 2024. Among Indonesia's 38 provinces, 15 provinces have a stunting prevalence below the national average. The three provinces with the highest stunting rates are Papua Tengah (39.4%), Nusa Tenggara Timur (37.9%), and Papua Pegunungan (37.3%). An in-depth analysis of stunting prevalence across the country's 514 districts and cities reveals considerable variation. In 277 districts/cities, the prevalence exceeds the national average of 21.5%, signaling the need

for focused interventions in these areas. On the other hand, 222 districts/cities have managed to keep stunting prevalence below the national average, suggesting the effectiveness of local health initiatives or differing socio-economic conditions. Data collection gaps in 15 districts/cities, due to low response rates, hinder an accurate assessment, highlighting the need for more robust data gathering efforts. Notably, 65 districts/cities have already achieved a stunting prevalence of less than 14%, meeting the 2024 target set by the Presidential Regulation. These regions offer valuable insights into successful strategies that could potentially be applied to other areas. These findings underscore the importance of region-specific approaches in reducing stunting and achieving broader public health goals across Indonesia.

The identification of families at risk of stunting is based on screening specific target families, including families with women of reproductive age (15-49 years), pregnant women, infants aged 0-23 months (baduta), and toddlers aged 24-59 months (balita). These families are assessed for risk factors such as lacking access to safe drinking water, inadequate sanitation, and the "4 Too" conditions: having children too young (under 20 years), being too old to have children (over 35 years), having closely spaced children (less than 2 years apart), or having more than two children. Families not using modern contraception are also flagged as at risk. If a family meets even one criterion, they are categorized as being at risk of stunting. Environmental factors significantly contribute to stunting, particularly access to safe drinking water. Unsafe water and inadequate sanitation heighten the risk of infections-like diarrhea, a key cause of malnutrition, especially during the first 1,000 days of a child's life (Ahmad *et al*., 2023). The highest proportion of target families without access to safe drinking water is in Papua Pegunungan Province, where 68.71% (70,797 out of 103,032 households) lack access. Conversely, DKI Jakarta has the lowest proportion, with only 0.30% (3,004 out of 995,792 households) lacking safe water access.

Adequate sanitation is also crucial for stunting prevention. Poor sanitation promotes infectious diseases. Further, increasing stunting risks (Kwami *et al*., 2019). Across Indonesia, many target families lack proper sanitation, with Papua Pegunungan Province again having the highest proportion—72.12% (74,308 out of 103,032 households) without adequate facilities. DI Yogyakarta has the lowest, with just 5.92% (30,696 out of 518,449 households) lacking sanitation. This geographic variation emphasizes the need to address both water and sanitation to reduce stunting. Reproductive health is another key factor, specifically the "4 Too" conditions: having children too young, too old, too closely spaced, or too many. In the second semester of 2023, approximately 43% of target families were identified as meeting one or more of these criteria. Addressing these conditions through targeted interventions is critical to reducing stunting prevalence.

Table I. Stunting Prevalence and Risk Factors for Families at Risk of Stunting Across Indonesian Provinces 2023

Province	Prev.	Target Families	%Poor Drinking Water	% Poor Sani-tation	% Families with High-Risk WRA	% Risk of Stunting
Aceh	29.4	802,499	5.6	16.3	51.4	34.3
Sumatera Utara	18.9	1,862,441	8.3	16.4	54.3	36.3
Sumatera Barat	23.6	738,445	5.9	24.2	52.7	38.9
Riau	13.6	958,885	14.7	14.3	50.3	35.4
Jambi	13.5	621,290	12.3	15.5	44.2	30.9
Sumatera Selatan	20.3	1,329,298	11.0	17.3	46.2	32.4
Bengkulu	20.2	335,560	7.5	12.4	44.8	25.1
Lampung	14.9	1,335,818	6.6	10.4	42.7	24.0
Kep. Bangka Belitung	20.6	250,470	2.5	7.2	43.4	16.9
Kepulauan Riau	16.8	308,936	3.2	13.5	48.5	35.3
Dki Jakarta	17.6	995,792	0.3	9.1	45.8	32.9
Jawa Barat	21.7	7,811,477	4.0	18.5	41.7	29.7
Jawa Tengah	20.7	5,777,687	4.7	11.7	38.6	23.8
DI Yogyakarta	18	518,449	5.0	5.9	36.1	20.6
Jawa Timur	17.7	6,154,287	3.6	14.9	36.1	24.6
Banten	24	1,879,648	2.6	10.6	42.8	21.9
Bali	7.2	587,840	4.6	11.7	40.9	24.6
Nusa Tenggara Barat	24.6	945,553	3.7	17.8	43.4	30.4
Nusa Tenggara Timur	37.9	638,837	20.1	36.3	56.4	60.3
Kalimantan Barat	24.5	706,347	44.4	22.5	46.1	59.8
Kalimantan Tengah	23.5	382,085	16.9	21.3	43.3	36.5
Kalimantan Selatan	24.7	639,992	10.1	18.1	41.5	29.8
Kalimantan Timur	22.9	523,012	3.9	9.1	47.9	25.9
Kalimantan Utara	17.4	85,887	10.8	16.6	52.3	40.5
Sulawesi Utara	21.3	326,325	4.2	17.2	40.2	29.6
Sulawesi Tengah	27.2	454,224	7.1	24.0	48.3	39.0
Sulawesi Selatan	27.4	1,214,817	3.9	11.2	49.0	26.1
Sulawesi Tenggara	30	389,763	5.9	15.9	53.5	35.8
Gorontalo	26.9	201,670	2.7	26.7	42.4	35.7
Sulawesi Barat	30.3	205,011	12.1	23.2	51.6	44.8
Maluku	28.4	204,077	8.3	23.0	55.9	48.4
Maluku Utara	23.7	160,544	6.5	19.4	50.8	36.4
Papua	28.6	91,301	18.4	23.7	49.7	54.9
Papua Barat	24.8	93,683	22.9	24.1	52.4	55.6
Papua Selatan	25	51,406	26.4	39.3	50.9	61.9
Papua Tengah	39.4	87,298	37.2	56.4	38.8	74.9
Papua Pegunungan	37.3	103,032	68.7	72.1	32.1	92.4

WRA=women of reproductive age

Table I below provides detailed information on stunting prevalence and families at risk of stunting at the provincial level.

Stunting prevalence is influenced by a complex mix of socio-economic and environmental factors. Access to safe drinking water and sanitation is critical, as poor water quality and inadequate facilities increase the risk of diseases like diarrhea, leading to chronic malnutrition and stunting (Astuti *et al.*, 2025; Najib *et al.*, 2024). Families lacking these services face higher risks due to repeated infections and poor nutrient absorption in children. Socio-economic conditions, such as income, education, and healthcare access, also play a significant role, with lower-income families often unable to provide adequate nutrition for proper child growth. Reproductive health practices, particularly closely spaced pregnancies (as seen in WRA 4T), further raise stunting risks. Mothers with little recovery time between pregnancies may experience nutritional depletion, impacting both their health and that of their children. These factors collectively make children more vulnerable to stunting, highlighting the need for comprehensive interventions that address both nutritional needs and the wider socio-economic and environmental conditions.

Access to safe drinking water is a critical factor in stunting. Unsafe water increases the risk of diseases like diarrhea, which contributes to malnutrition in children, particularly within the first 1,000 days of life—a key period for growth (Najib *et al.*, 2024). Figure 1 shows a positive correlation between stunting prevalence and the percentage of families

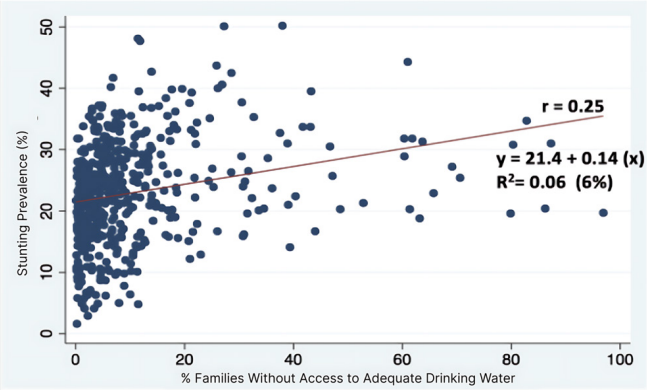

Figure 1. Correlation of Stunting Prevalence and the Percentage of Families with Inadequate Access to Safe Drinking Water

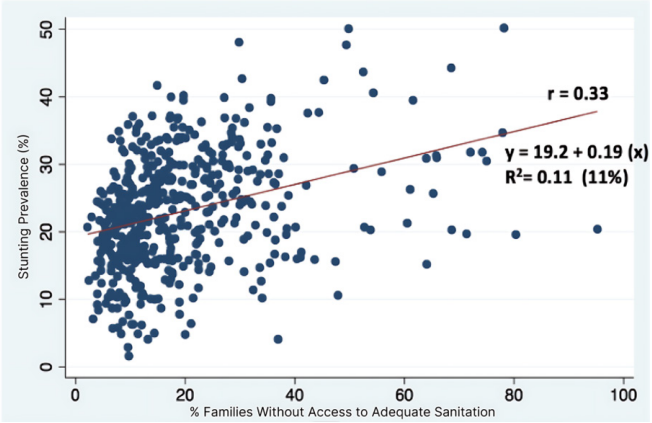

Figure 2. Correlation of Stunting Prevalence and the Percentage of Families with Inadequate Sanitation

without access to safe water. The regression line indicates that as the percentage of families lacking safe water rises, so does the prevalence of stunting.

Figure 1 illustrates a positive relationship between the percentage of families without access to safe drinking water and the prevalence of stunting in Indonesia. This relationship is depicted by the regression line with a positive slope, indicating that as the percentage of families without access to safe drinking water increases, the stunting prevalence tends to rise as well. However, this relationship is relatively weak, with a correlation coefficient (r) of 0.25. The R^2 value of 0.06 suggests that only 6% of the variation in stunting prevalence is explained by access to safe drinking water, implying that other factors play a more significant role. Therefore, while improving access to safe water is important, broader efforts are needed to address various other determinants of stunting. The condition of adequate sanitation in Indonesia is a crucial factor in preventing stunting in children. Adequate sanitation encompasses access to clean water, proper toilet facilities, and good hygiene practices. In many parts of Indonesia, particularly rural areas, access to such sanitation remains a challenge. This lack of adequate facilities contributes to the spread of diseases like diarrhea, which significantly affects children's nutritional status and overall health. Therefore, improving sanitation infrastructure is vital for reducing stunting and promoting better health outcomes for children across the country.

Figure 2 shows the correlation between the percentage of families without access to adequate sanitation and the prevalence of stunting in Indonesia. A positive relationship is evident, as stunting prevalence tends to rise with an increase in families lacking proper sanitation. The regression line's positive slope confirms this association. The correlation coefficient (r) of 0.33 indicates a moderately strong relationship, stronger than the one observed between stunting and lack of safe drinking water. The R^2 value of 0.11 reveals that 11% of the variation in stunting prevalence can be explained by access to adequate sanitation, highlighting that while sanitation plays a role, other significant factors also contribute to stunting.

Stunting, a chronic condition affecting children's physical and cognitive development, is influenced by multiple factors, including maternal health and reproductive patterns. One significant indicator associated with stunting risk is the presence of women of reproductive age with four high-risk factors, commonly referred to as 4T: women who are too young, too old, have closely spaced pregnancies, or have too many children (Najib *et al.*, 2024). These high-risk reproductive factors contribute to stunting risk in children and highlight the importance of maternal health in addressing stunting prevalence. The figure below will

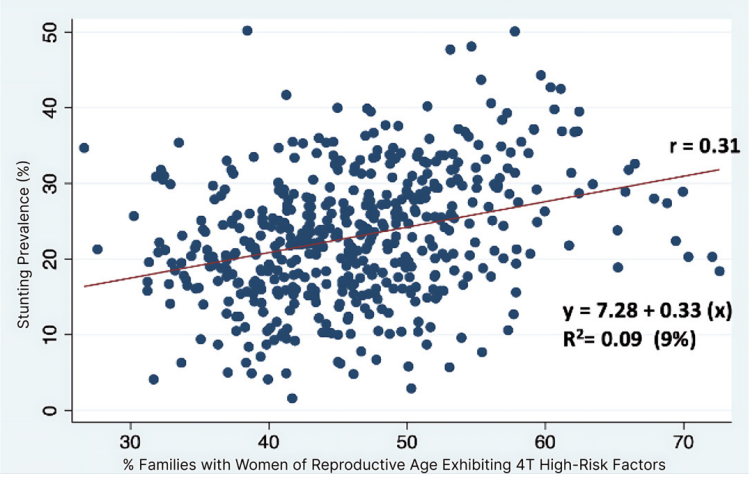

Figure 3. Correlation of Stunting Prevalence and Families with Women of Reproductive Age with High-Risk Factors

further explain the relationship between stunting prevalence and the percentage of women of reproductive age with these high-risk factors.

Figure 3 presents a linear regression analysis examining the relationship between stunting prevalence and the percentage of women of reproductive age (WRA) experiencing 4T, and the figure below illustrates this relationship. A positive correlation was found, with a regression coefficient of 0.336, indicating that for every one-unit increase in WRA with 4T, the stunting prevalence rises by 0.33 units. This finding is statistically significant, as evidenced by a very low p-value (0.000), underscoring the strong likelihood that this relationship is not due to chance. The model's R^2 value of 0.0977 and adjusted R^2 of 0.0959 suggest that around 9.59% of the variability in stunting prevalence can be explained by the percentage of WRA experiencing 4T. While this indicates a notable influence, the majority of variability in stunting prevalence remains unexplained, pointing to the presence of other contributing factors.

Families identified as "at risk of stunting" are characterized by specific risk factors, such as inadequate access to safe drinking water, poor sanitation, and the presence of high-risk reproductive behaviors among women of reproductive age, known as WRA 4T (too young, too old, closely spaced pregnancies, or having too many children). These risk factors not only affect maternal health but also create conditions that increase the likelihood of stunting in children. Understanding the relationship between at-risk families and stunting prevalence is crucial for developing targeted interventions to lower stunting rates. The following analysis explores how these risk factors contribute to stunting prevalence, emphasizing the need for comprehensive strategies to address this issue.

Figure 4 illustrates the correlation between stunting prevalence and the percentage of families at risk of stunting in Indonesia for 2023. Regression analysis reveals a significant relationship, with a regression coefficient of 0.1969 ($p < 0.0001$), indicating that for every 1% increase in families at risk, the stunting prevalence rises by 0.1969 units. The model's intercept is 15.84 ($p < 0.001$), representing the baseline stunting prevalence when no families are at risk. The R-squared value of 0.1644 implies that 16.44% of the variability in stunting prevalence is explained by this model, while the adjusted R-squared value of 0.1627 confirms model consistency. Despite the significant positive relationship, the low R-squared suggests that most variations in stunting prevalence are influenced by other factors not captured in this model.

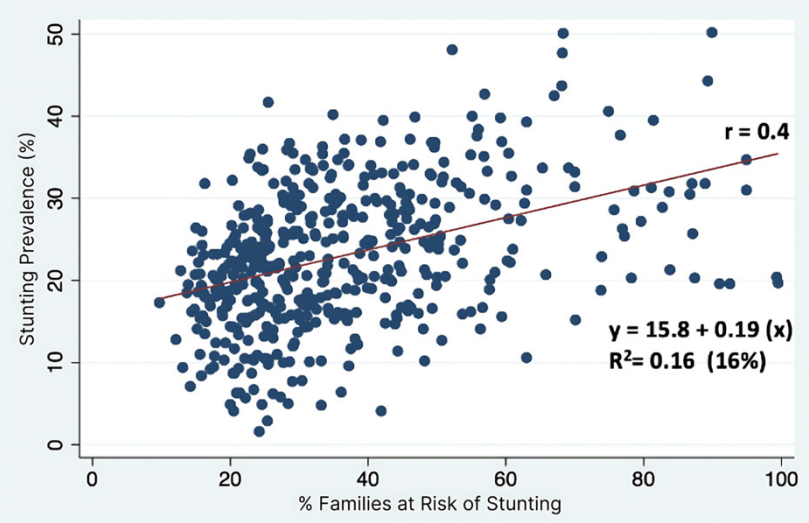

Figure 4. Correlation of Stunting Prevalence and Families at Risk of Stunting in Indonesia

Preventing stunting in children is far more effective than attempting to treat stunted growth after it has occurred. Stunting has long-term implications for a child's health, cognitive abilities, and future productivity. If not addressed early, it can lead to lower economic productivity in adulthood and place a greater burden on healthcare systems. Thus, focusing on prevention can not only improve individual well-being but also produce wider social and economic benefits, including creating a healthier, more productive workforce (Robinson & Dinh, 2023). Preventive interventions are particularly crucial during the first 1,000 days of a child's life—a critical period for growth and development. Research indicates that interventions targeting nutrition during this time frame significantly improve child linear growth and can reduce stunting by as much as 10.2% by 24 months of age. These early interventions establish a strong foundation for lifelong health and development, underlining the importance of timely action in combating stunting (Soofi *et al*., 2022).

A multisectoral approach has been proven to be more effective in preventing stunting than isolated interventions. By involving various sectors, such as health, education, sanitation, and social protection, comprehensive programs can provide a supportive environment for child growth and development. Addressing multiple factors that contribute to stunting through a collaborative approach ensures that children receive holistic care, leading to improved immediate health outcomes and enhanced long-term well-being. These integrated efforts maximize the effectiveness of interventions and are crucial for sustainable stunting reduction (Kim *et al*., 2020). Key areas such as improved sanitation, access to clean water, and health education are crucial components of these programs, as they collectively reduce the risk factors associated with stunting. Additionally, investments in stunting prevention generate substantial economic benefits. Economic analyses describe that every dollar spent on stunting prevention yields an average return of 18 dollars, as children who are not stunted tend to perform better academically, are more productive in their future careers, and have higher lifetime earnings. This highlights the long-term societal and economic gains from investing in preventive measures, going beyond individual health improvements to create broader benefits for communities and economies (Aguilera & Daher, 2019; Galasso & Wagstaff, 2018; Nasser *et al*., 2022).

To effectively address stunting, it is essential to identify families at high risk of this condition. Stunting, a consequence of chronic malnutrition, can severely impair a child's growth, cognitive development, and future productivity. By leveraging data on families at risk, governments and health organizations can develop targeted interventions to mitigate these risk factors. Such data often encompasses nutritional status, dietary habits, access to healthcare, and socio-economic conditions, enabling more precise strategies to tackle the underlying causes of stunting (Victora *et al*., 2021). Immediate interventions informed by this data can deliver nutritional support, health education, and improved access to medical services to the most vulnerable populations. For example, food and vitamin supplementation programs can be specifically directed at pregnant women and young children in high-risk families. Additionally, educating caregivers on proper feeding practices and hygiene can significantly reduce the risk of infections contributing to stunting. These targeted, data-driven approaches ensure that resources are efficiently allocated and interventions are more likely to decrease stunting prevalence (Suratri *et al*., 2023).

The role of the family is critical in preventing stunting, as it is the primary unit influencing a child's growth and development. Families play a vital role in providing adequate nutrition, balanced diets, and a supportive environment for optimal growth. Research has shown that family-centered interventions, such as education on proper feeding practices, can significantly decrease the risk of stunting. Engaging families in prevention efforts helps foster healthier habits that support children's well-being and growth (Yani *et al*., 2023). Mothers, in particular, play a crucial role in ensuring proper nutrition during the first 1,000 days of life—a period critical for both physical and cognitive development. Adequate nutrition during this window supports brain

development and establishes the groundwork for future health outcomes (Brar *et al*., 2020; Kwami *et al*., 2019).

Environmental factors like inadequate sanitation, unsafe water, and hygiene practices significantly contribute to stunting. A study by Torlesse *et al*. identified a strong relationship between household sanitary facilities, water treatment methods, and child stunting (Torlesse *et al*., 2016). The risk of stunting was over three times higher in households using unimproved latrines and consuming untreated water, emphasizing the importance of access to safe water and sanitation. Stewart *et al*. demonstrated that environmental factors like infection, inflammation, and undernutrition are critical in determining child growth and development (Stewart *et al*., 2013). Globally, contaminated water and poor sanitation account for approximately 5.4 billion diarrhea cases and 1.6 million deaths annually (Hutton & Haller, 1994). Addressing these challenges requires comprehensive interventions that focus on improving access to clean water, sanitation, and hygiene practices.

The impact of inadequate water, sanitation, and hygiene (WASH) practices remains substantial, contributing to over 1,000 child deaths daily worldwide. While strides have been made in reducing mortality rates, diarrheal diseases continue to pose a significant burden, with around 1.7 billion cases annually. Chronic diarrheal episodes can lead to undernutrition, stunted growth, and cognitive deficits in children. In addition, inadequate WASH conditions contribute to environmental enteropathy, a chronic form of intestinal inflammation that exacerbates malnutrition and developmental issues in children (Prüss-Ustün *et al*., 2019; Waddington *et al*., 2023). These conditions represent significant health risks and underscore the importance of global efforts to improve WASH practices as a preventive measure against stunting. Inadequate access to safe water, poor sanitation, and hygiene practices are dominant global health risks contributing to diarrhea and stunting. These factors are especially critical in low-income settings, where diarrheal diseases significantly add to disability-adjusted life years (DALYs) and are closely linked to stunted growth (Karambizi *et al*., 2021). Practices like using unprotected water sources and poor sanitation facilities facilitate the faecal-oral transmission of pathogens, leading to diarrhea, which can result in undernutrition and stunted growth. These health issues are associated with impaired cognitive development and reduced intellectual capacity, leading to long-term physical and cognitive deficits in children (Girma *et al*., 2024; Stürchler, 2023).

Stunting is closely related to the "4 Too" conditions among reproductive-age individuals. Young mothers, especially under 20, face a higher risk of giving birth to stunted children due to biological immaturity, often resulting in complications like low birth weight (Adugna, 2022; Qi *et al*., 2022). Older maternal age (above 35) is also associated with adverse pregnancy outcomes, increasing the risk in offspring (Jacobson *et al*., 2023; Scime *et al*., 2020). Short interpregnancy intervals deplete maternal nutrition, affecting child growth, while having more than two children can strain family resources, impacting adequate nutrition and care (Petersen *et al*., 2021; Wang *et al*., 2022). Targeted public health interventions, including family planning and maternal health education, are essential to address these "4 Too" conditions and reduce stunting prevalence (Mengesha *et al*., 2021). Socioeconomic status is a significant determinant of stunting. Low-income families often struggle to provide nutritious food and access to healthcare services essential for child growth and development. Poor economic conditions also lead to inadequate access to clean water and sanitation, key factors in preventing stunting. Children from economically disadvantaged backgrounds face a higher risk of chronic malnutrition and recurrent infections, which contribute to stunted growth (Shibre *et al*., 2021; Soekatri *et al*., 2020; Widyaningsih *et al*., 2022).

Conclusion

In conclusion, preventing stunting is a multifaceted challenge that requires timely, data-driven interventions and a multisectoral approach involving health, education, sanitation, and social protection. The critical role of families, especially mothers, in ensuring proper nutrition and care during

the first 1,000 days of a child's life cannot be overstated. Targeted programs that address high-risk families, improve access to clean water, sanitation, and healthcare, and promote health education are essential in reducing stunting rates. Furthermore, the economic benefits of stunting prevention—both in terms of individual well-being and broader societal gains—underscore the importance of continued investment in these efforts. By addressing the root causes of stunting and adopting a holistic approach, it is possible to foster a healthier, more productive generation and significantly reduce the long-term impacts of stunting.

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