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ANALYSIS OF THE RELATIONSHIP BETWEEN ENVIRONMENTAL HEALTH FACTORS AND STUNTING INCIDENCE IN INDONESIA

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Abstract

Indonesia ranks fifth globally in stunting prevalence, with around 30.8% or 23 million children affected. Stunting hampers physical growth, brain development, metabolism, and intelligence, thereby lowering the quality of human resources. Poor nutrition, linked to limited access to safe drinking water and inadequate sanitation, is a key factor. This study analyzed the relationship between environmental health and stunting in Indonesia using secondary data from the Indonesian Health Profile (2015–2020) across 34 provinces. A descriptive-analytic approach with cross-sectional design and linear regression was applied through three models: (1) unadjusted, (2) adjusted for year and province, and (3) adjusted for year, province, poverty, and HDI. Results showed a national decline in stunting from 22.76% (2015) to 12.70% (2020), with East Nusa Tenggara reporting the highest rates. Bivariate analysis found significant associations between stunting and access to safe drinking water, sanitation, community-based sanitation (STBM), TPM compliance, poverty, housing, and HDI ($p < 0.05$). After adjustments, the strongest predictors were safe drinking water, TPM compliance, and adequate housing. Access to safe drinking water explained the largest variation (21.08%). Strengthening infrastructure and promoting clean, healthy living behavior (PHBS) remain essential to stunting prevention in Indonesia.

Keywords*: Stunting, Safe Drinking Water, Sanitation, Environmental Health, Linear Regression.*

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INTRODUCTION

Stunting is one of the most serious chronic nutritional problems faced by Indonesia and many other developing countries(Ika Indriyastuti et al., n.d.). It is a key target of the Sustainable Development Goals (SDGs), specifically Goal 2, which aims to end hunger and all forms of malnutrition by 2030 and to achieve food security(Hall et al., 2018; Usfar et al., 2010). The impacts of stunting are not only physical but also affect brain development, immune system strength, learning capacity, as well as future productivity and economic potential of the child. Children who experience stunting are at a higher risk of developing chronic diseases in adulthood and tend to have lower educational attainment and income levels(Guerrant et al., 2012; Soliman et al., 2021). The causes of stunting are highly complex, extending beyond nutritional intake, and are closely linked to environmental factors, maternal health during pregnancy, breastfeeding practices, complementary feeding, as well as the quality of sanitation and access to clean water in the household and community environment(Millward, 2017; Stewart et al., 2013).

In Indonesia, although there has been a decline in stunting prevalence in recent years, the issue remains a major public health challenge. According to the Indonesian Nutritional Status Survey (SSGI) conducted by the Ministry of Health, the prevalence of stunting among children under five decreased from 30.8% in 2018 to 24.4% in 2021, 21.6% in 2022, and slightly down to 21.5% in 2023(Schneider, 2025).

While this reduction signifies progress, disparities between regions remain substantial. The highest stunting rates are still found in provinces with limited access to basic services—such as East Nusa Tenggara, Papua, and West Sulawesi—which also typically experience high poverty rates, poor sanitation coverage, and limited maternal and child health services(Krishna et al., 2018). Globally, the latest report by UNICEF, WHO, and the World Bank (2023) stated that in 2022, around 148.1 million children under five were stunted—representing 22.3% of the global under-five population. The highest prevalence rates were observed in South Asia and Sub-Saharan Africa, while in Southeast Asia, the highest rates were found in Laos (40.1%), Timor-Leste (38.6%), and Indonesia (21.5%), highlighting the urgency of this issue across the region. On the other hand, environmental health has proven to play a crucial role in reducing stunting(da Silva et al., 2018; Said-Mohamed et al., 2015). Environmental health encompasses the quality of drinking water, sanitation, waste management, and safe, clean living conditions—all of which are essential for preventing infectious diseases that commonly impair nutrient absorption, such as diarrhea, intestinal worm infections, and upper respiratory infections(Abubakar et al., 2022; Tella et al., 2025).

According to Government Regulation No. 66 of 2014 on Environmental Health, efforts to maintain a healthy environment are part of disease prevention strategies that focus on improving the physical, chemical, biological, and social quality of the environment. Data from the Ministry of Health indicate that the number of districts/cities meeting environmental health quality standards rose from 53.89% in 2017 to 78.02% in 2019, and further increased to 83.5% in 2023.

Despite this progress, there are still areas that have not yet met minimum standards—particularly in eastern Indonesia, where geographical and logistical challenges hinder the development of basic infrastructure. Other surveys show that approximately 9.6% of Indonesians still lack access to adequate sanitation, and around 11.2% do not have access to safe drinking water. These conditions significantly increase the risk of recurring infections among children, which is one of the major contributors to stunting(Cairncross & Feachem, 2018; Zhang et al., 2010). A study by (Rah et al., 2020a)in Indonesia found that children living in areas with poor sanitation and unsafe drinking water had a significantly higher risk of stunting compared to those in healthier environments. Similarly, a review by (Rah et al., 2020b)analyzed data from 137 developing countries, concluded that environmental factors—such as access to clean water, sanitation conditions, and indoor air pollution from the use of solid fuels—were the second most significant global determinants of stunting, after nutritional intake(Gusnedi et al., 2023; Penelitian et al., 2023). However, it is important to note that not all studies have found a consistent relationship between environmental components and stunting. Therefore, accelerating the reduction of stunting in Indonesia requires a holistic and multisectoral approach that includes improving access to nutritious food, maternal and child healthcare services, adequate sanitation, safe drinking water, parenting education, promotion of hygienic behavior, and strengthening of sensitive intervention programs involving various sectors such as health, education, infrastructure, social services, and community empowerment.

METHOD

This study employs an analytical design with a cross-sectional approach to examine the relationship between environmental health factors and stunting. The research utilizes secondary data extracted from the Indonesian Health Profile Reports published between 2015 and 2020. The study covers all 34 provinces in Indonesia, with total sampling used as the sampling method. The

inclusion criteria for the sample are: (1) provinces with available data for analysis, and (2) if data for a province is missing for one specific year, the variable will be replaced with the average value. All data analyzed in this study are secondary data obtained from the Health Profile Reports and accessed via the Ministry of Health's data center website (Pusdatin). Data analysis was conducted using the STATA program. The process included recording the required variables from the Health Profile Reports into Excel spreadsheets for the years 2015 to 2020, then importing the data into STATA for further analysis. Three types of analyses were performed: univariate, bivariate, and multivariate. The univariate analysis provided descriptive insights into each variable, including the dependent variable (stunting), the independent variable (clean water coverage), and confounding variables (low birth weight and exclusive breastfeeding). The bivariate analysis used simple linear regression to assess the strength and direction of the relationship between variables. Lastly, the multivariate analysis applied multiple linear regression to identify the most dominant factors associated with stunting. Ethical considerations in this study include ensuring data integrity by refraining from manipulating or altering the data in any way.

RESULTS

General Overview

This study utilizes data from the Indonesian Health Profile, which is compiled from routine data reported by units within the Ministry of Health, as well as related institutions such as Statistics Indonesia (BPS), the Social Security Agency (BPJS), the Ministry of Home Affairs, and the National Population and Family Planning Board (BKKBN). The information presented includes both data and narrative descriptions related to demographic conditions, healthcare facilities, community-based health efforts, healthcare personnel, health financing, family health, disease control, and environmental health.

The profile provides a national overview, inter-provincial comparisons, annual trends, and other relevant contextual information. Since the available data spans from 2015 to 2019, the researcher analyzed only the data accessible within this period. Data analysis was conducted using STATA software with logistic regression testing. The study population consists of all 34 provinces in Indonesia, analyzed based on variables related to environmental health factors.

Overview of Environmental Health and Socioeconomic Indicators (2015–2020)

The following table presents the descriptive statistics of several key environmental health and socioeconomic variables across 34 provinces in Indonesia from 2015 to 2020. These variables include the percentage of access to safe drinking water, community-based total sanitation coverage, the percentage of public places meeting health standards, access to improved sanitation, the percentage of food establishments that meet hygiene requirements (TPM), poverty rates, adequate housing coverage, and the Human Development Index (HDI). For each variable, the table displays the number of provinces (n), mean values along with standard deviations (SD), and the range (minimum to maximum values) per year. These figures provide a broad overview of the progress and variation in environmental health infrastructure and socioeconomic conditions over time.

Table 1. Overview of Environmental Health and Socioeconomic Indicators (2015–2020)

Variable	Year	n	Mean (SD)	Range
Access to Safe Drinking Water (%)	2015	34	68.58 (11.04)	41–93
	2016	34	68.70 (11.01)	37–92
	2017	34	70.55 (9.66)	44–91
	2018	34	72.94 (9.31)	49–91
	2019	34	72.17 (12.71)	37–94
	2020	34	85.44 (9.58)	62–100
Community-Based Total Sanitation (%)	2015	34	32.58 (23.39)	2–94
	2016	34	41.79 (23.64)	7–96
	2017	34	49.17 (24.33)	5–99
	2018	34	60.32 (22.92)	9–96
	2019	34	71.41 (22.12)	15–100
	2020	34	74.76 (22.26)	18–100
Public Places Meeting Health Standards (%)	2015	34	58.79 (15.75)	19–83
	2016	34	63.26 (24.43)	1–89
	2017	34	49.08 (12.57)	21–79
	2018	34	57.11 (18.67)	0–83
	2019	34	59.32 (15.19)	19–83
	2020	34	52.20 (27.73)	0–95
Access to Improved Sanitation (%)	2015	34	59.00 (15.32)	24–89

	2016	34	66.14 (12.88)	31–91
	2017	34	65.73 (13.69)	33–91
	2018	34	68.41 (12.96)	34–91
	2019	34	85.38 (9.16)	54–100
	2020	34	79.79 (9.98)	40–97
Food Establishments Meeting Hygiene Standards (TPM) (%)	2015	34	10.17 (7.24)	0–28
	2016	34	14.73 (7.90)	4–34
	2017	34	19.35 (8.86)	6–35
	2018	34	27.29 (12.23)	4–53
	2019	34	38.08 (13.44)	10–66
	2020	34	44.94 (12.97)	13–70
Poverty Rate (%)	2015	34	11.73 (6.16)	4–28
	2016	34	11.29 (6.10)	4–28
	2017	34	10.88 (5.77)	4–28
	2018	34	12.88 (13.44)	4–82
	2019	34	10.52 (5.71)	3–28
	2020	34	10.82 (5.43)	4–27
Adequate Housing (%)	2015	34	89.91 (10.49)	49–99
	2016	34	91.08 (10.16)	49–100
	2017	34	92.97 (8.75)	55–100
	2018	34	93.88 (7.91)	58–99
	2019	34	54.17 (12.52)	26–82
	2020	34	57.97 (12.56)	29–86
Human Development Index (HDI)	2015	34	69.20 (4.19)	58–80
	2016	34	69.76 (4.07)	59–80
	2017	34	69.58 (2.42)	60–75
	2018	34	71.05 (3.89)	61–81
	2019	34	71.05 (3.99)	60–81
	2020	34	71.05 (3.99)	60–81

The data show a consistent improvement in several environmental health indicators from 2015 to 2020. Access to safe drinking water increased significantly from a mean of 68.58% in 2015 to 85.44% in 2020, indicating expanded efforts in water infrastructure development. Similarly, community-based sanitation coverage rose from 32.58% to 74.76%, reflecting successful implementation of national sanitation programs. The percentage of food establishments meeting hygiene standards (TPM) also saw a substantial rise from 10.17% in 2015 to 44.94% in 2020. However, public places meeting health requirements showed inconsistent progress, with fluctuations from year to year, peaking in 2016 (63.26%) and dropping again in 2020 (52.20%). Access to improved sanitation increased steadily until 2019 (85.38%), followed by a slight decline in 2020 (79.79%). In terms of poverty rates, the national average declined gradually from 11.73% in 2015 to 10.82% in 2020, though a spike was observed in 2018 (12.88%), possibly due to external economic shocks. Adequate housing coverage increased consistently until 2018 (93.88%), but saw a sharp drop in 2019 (54.17%) and remained low in 2020 (57.97%), suggesting a possible redefinition of housing standards or data inconsistency. Finally, the Human Development Index (HDI) improved modestly from 69.20 in 2015 to 71.05 in 2020, indicating steady progress in education, income, and health indicators.

Bivariate Analysis Results

Table 2 Relationship Between Environmental Health Factors and Stunting in Indonesia, 2015–2020

Variable	N	R^2	p-value
Access to Safe Drinking Water	204	0.1999	0.000
Community-Based Total Sanitation	204	0.0356	0.007
Public Places Meeting Health Standards (TTU)	204	0.0000	0.931
Access to Improved Sanitation	204	0.1464	0.000
Food Establishments Meeting Hygiene Standards (TPM)	204	0.1265	0.000
Poverty Rate	204	0.0470	0.002
Adequate Housing	204	0.0616	0.000
Human Development Index (HDI)	204	0.1442	0.000

Source: Secondary data from the Indonesian Health Profile – processed in 2021

Based on Table 2 access to safe drinking water accounts for 19.99% of the variation in stunting rates in Indonesia, with a p-value of 0.000, indicating a significant association between safe drinking water and stunting across provinces. Community-based total sanitation explains 3.56% of the variation in stunting, with a p-value of 0.007, also showing a significant relationship. In contrast, the availability of public places that meet health standards contributes 0% to the variation in stunting, with a p-value of 0.931, indicating no significant association. Improved sanitation explains 14.64% of the variation, with a p-value of 0.000, while compliant food establishments (TPM) account for 12.65% of the variation, also with a p-value of 0.000—both showing significant associations. Poverty contributes 4.70% of the variation, with a p-value of 0.002, and adequate housing explains 6.16%, with a p-value of 0.000. The Human Development Index (HDI) accounts for 14.42% of the variation in stunting, with a p-value of 0.000, indicating a strong and statistically significant relationship.

Table 3 Model Relationship Between Environmental Health Factors and Stunting, Controlled for Year and Province (2015–2020)

Variable	N	Adjusted R^2	p-value
Access to Safe Drinking Water	204	0.2757	0.000
Community-Based Total Sanitation	204	0.1473	0.376
Public Places Meeting Health Standards (TTU)	204	0.1459	0.500
Access to Improved Sanitation	204	0.1942	0.001
Food Establishments Meeting Hygiene Standards (TPM)	204	0.1946	0.000
Poverty Rate	204	0.1612	0.044
Adequate Housing	204	0.1577	0.072
Human Development Index (HDI)	204	0.2009	0.000

According to Table 3 when controlling for year and province, several environmental health variables remained significantly associated with stunting. Access to safe drinking water showed the strongest association, accounting for 27.57% of the variation in stunting (p = 0.000). Improved sanitation contributed 19.42% (p = 0.001), and compliant food establishments (TPM) contributed 19.46% (p = 0.000). Poverty remained significant, accounting for 16.12% of the variation (p = 0.044), while HDI explained 20.09% (p = 0.000). However, community-based total sanitation and public places meeting health standards were not significantly associated after controlling for year and province.

Table 4. Model 3: Relationship Between Environmental Health Factors and Stunting, Controlled for Year, Province, Poverty, and HDI (2015–2020)

Variable	N	Adjusted R^2	p-value
Access to Safe Drinking Water	204	0.2696	0.000
Community-Based Total Sanitation	204	0.2057	0.084
Public Places Meeting Health Standards (TTU)	204	0.1952	0.538
Access to Improved Sanitation	204	0.2024	0.141
Food Establishments Meeting Hygiene Standards (TPM)	204	0.2203	0.010
Adequate Housing	204	0.2478	0.000

Table shows the results after further controlling for poverty and HDI, in addition to year and province. Access to safe drinking water remained significantly associated with stunting, explaining 26.96% of the variation (p = 0.000). Food establishments meeting hygiene standards (TPM) also maintained a significant relationship, contributing 22.03% (p = 0.010). Adequate housing was strongly associated with stunting, explaining 24.78% of the variation (p = 0.000). Meanwhile, other variables—such as community-based total sanitation, improved sanitation, and public places meeting health standards—did not show significant associations in this fully adjusted model.

Discussion

Based on the analysis of data from the Indonesian Health Profile from 2015 to 2020, a comprehensive understanding was obtained regarding the relationship between environmental factors and the incidence of stunting across 34 provinces in Indonesia. This study utilized secondary data from several official institutions, including the Ministry of Health, Statistics Indonesia (BPS), BPJS (Social Security Agency), the Ministry of Home Affairs, and the National Population and Family Planning Board (BKKBN), and employed logistic regression analysis using the STATA software.

In the initial stage, descriptive analysis revealed a significant improvement in several environmental health indicators, such as access to safe drinking water, community-based total sanitation coverage, and the percentage of food establishments (TPM) meeting hygiene standards. Safe drinking water access increased from an

average of 68.58% in 2015 to 85.44% in 2020, community-based sanitation coverage rose from 32.58% to 74.76%, and TPM compliance improved markedly from only 10.17% to 44.94%. However, indicators such as the proportion of public places meeting health standards and access to improved sanitation showed fluctuations and even declined in the later years, indicating challenges in policy implementation and equitable distribution across regions.

Bivariate analysis further revealed that most environmental indicators had statistically significant relationships with stunting rates. Access to safe drinking water emerged as the strongest variable in explaining the variation in stunting incidence (R^2 = 0.1999; p = 0.000), followed by improved sanitation (R^2 = 0.1464; p = 0.000), TPM compliance (R^2 = 0.1265; p = 0.000), the Human Development Index (HDI) (R^2 = 0.1442; p = 0.000), adequate housing (R^2 = 0.0616; p = 0.000), and poverty levels (R^2 = 0.0470; p = 0.002). Meanwhile, the percentage of public places meeting health standards did not show a significant relationship (p = 0.931), suggesting that their role in stunting reduction may be less substantial compared to other variables.

In the second model, which controlled for year and province, several relationships remained significant—particularly access to safe drinking water (Adjusted R^2 = 0.2757; p = 0.000), TPM compliance (Adjusted R^2 = 0.1946; p = 0.000), improved sanitation (Adjusted R^2 = 0.1942; p = 0.001), and HDI (Adjusted R^2 = 0.2009; p = 0.000). These findings emphasize that improvements in basic infrastructure such as water and sanitation, as well as overall quality of life, play a critical role in reducing stunting prevalence. When the analysis was extended to Model 3 by additionally controlling for poverty and HDI, only a few variables remained statistically significant. Safe drinking water access remained the dominant factor (Adjusted R^2 = 0.2696; p = 0.000), followed by TPM compliance (Adjusted R^2 = 0.2203; p = 0.010) and adequate housing (Adjusted R^2 = 0.2478; p = 0.000). These results affirm that the provision of safe drinking water, food safety, and proper housing are foundational elements that have a strong correlation with stunting, even after adjusting for key socioeconomic variables such as poverty and human development. In contrast, other variables such as community-based sanitation and improved sanitation lost their significance in this model, suggesting that their influence on stunting may be more indirect or possibly overshadowed by other dominant factors. Previous studies have demonstrated that environmental and social factors significantly contribute to the prevalence of stunting in Indonesia. Access to safe drinking water, for example, is a fundamental aspect in supporting healthy child growth and development. Emphasize that children living in areas with limited access to clean water are at a higher risk of recurrent infectious diseases, particularly chronic diarrhea, which hinders nutrient absorption and ultimately leads to stunting(Rah et al., 2020a). A dditionally, studies by (Joshi et al., 2011; Smiley & Stoler, 2020) have identified that poor sanitation conditions—including the lack of adequate toilet facilities and the practice of open defecation—exacerbate children's health problems and increase their vulnerability to stunting. This situation is further worsened when public facilities and food service establishments fail to meet established hygiene standards, leading to high risks of food contamination and the spread of pathogens. According to a UNICEF report (2021), food prepared in unhygienic conditions increases microbial exposure, which contributes to infections and malnutrition(Koolwal & Van De Walle, 2013; Ngure et al., 2014)

Furthermore, socioeconomic conditions such as poverty also play a critical role. Households with low income often face limitations in meeting their children's nutritional needs, accessing clean water, and obtaining basic healthcare services(Siswanty et al., 2025). A study conducted by Bappenas and the World Bank (2020) concluded that high poverty rates are positively correlated with higher stunting rates, due to disparities in fulfilling children's basic needs. Moreover, substandard housing conditions are another important indicator that is often overlooked in discussions on stunting(Rante et al., 2025). Research by Susanti et al. (2018) found that children living in crowded, damp homes with poor ventilation are more susceptible to respiratory and skin infections, which indirectly affect their nutritional status and growth.

Finally, the Human Development Index (HDI) reflects the overall quality of life in a given area. Regions with higher HDI scores generally exhibit better education levels, higher incomes, and more efficient healthcare systems, all of which contribute to the reduction of stunting prevalence. Data from UNDP and Indonesia’s Central Bureau of Statistics (BPS) indicate a strong correlation between HDI improvement and the decline in stunting rates across various provinces in Indonesia(Joshi et al., 2011).

Therefore, efforts to combat stunting should not solely focus on nutritional interventions but must also adopt a multisectoral approach(Cunha et al., 2017). This includes improving access to clean water, sanitation, adequate housing, poverty alleviation, and enhancing the quality of education and healthcare services in a comprehensive and sustainable manner.

CONCLUSION

This study, based on the analysis of Indonesia’s Health Profile data from 2015 to 2020 across 34 provinces, provides a comprehensive understanding of how environmental factors relate to stunting. Using secondary data from multiple official agencies and logistic regression analysis via

STATA software, the study found significant progress in environmental health indicators—particularly in access to safe drinking water, sanitation coverage, and food hygiene compliance (TPM). Bivariate analysis revealed that access to safe drinking water had the strongest association with stunting reduction, followed by improved sanitation, TPM compliance, HDI, adequate housing, and poverty. However, the proportion of public places meeting health standards did not show a significant impact. Further analysis, controlling for time and province, confirmed that water access, TPM, sanitation, and HDI remained significantly linked to stunting prevalence. In the final model—after adjusting for poverty and HDI—only access to safe drinking water, TPM compliance, and adequate housing continued to show strong associations. These findings highlight that ensuring access to clean water, food safety, and livable housing are key structural interventions in reducing stunting, even when broader socioeconomic conditions are considered. Conversely, the diminishing significance of other sanitation-related variables suggests their influence may be more indirect or secondary to more dominant determinants.

REFERENCE

Abubakar, I. R., Maniruzzaman, K. M., Dano, U. L., AlShihri, F. S., AlShammari, M. S., Ahmed, S. M. S., Al-Gehlani, W. A. G., & Alrawaf, T. I. (2022). Environmental Sustainability Impacts of Solid Waste Management Practices in the Global South. *International Journal of Environmental Research and Public Health 2022, Vol. 19, Page 12717*, *19*(19), 12717. https://doi.org/10.3390/IJERPH191912717

Cairncross, S., & Feachem, R. (2018). Environmental Health Engineering in the Tropics : Water, Sanitation and Disease Control. *Environmental Health Engineering in the Tropics*. https://doi.org/10.4324/9781315883946

Cunha, M. P. L., Marques, R. C., & Dórea, J. G. (2017). Child Nutritional Status in the Changing Socioeconomic Region of the Northern Amazon, Brazil. *International Journal of Environmental Research and Public Health 2018, Vol. 15, Page 15*, *15*(1), 15. https://doi.org/10.3390/IJERPH15010015

da Silva, I. C. M., França, G. V., Barros, A. J. D., Amouzou, A., Krasevec, J., & Victora, C. G. (2018). Socioeconomic Inequalities Persist Despite Declining Stunting Prevalence in Low- and Middle-Income Countries. *The Journal of Nutrition*, *148*(2), 254–258. https://doi.org/10.1093/JN/NXX050

Guerrant, R. L., Deboer, M. D., Moore, S. R., Scharf, R. J., & Lima, A. A. M. (2012). The impoverished gut—a triple burden of diarrhoea, stunting and chronic disease. *Nature Reviews Gastroenterology & Hepatology 2012 10:4*, *10*(4), 220–229. https://doi.org/10.1038/nrgastro.2012.239

Gusnedi, G., Nindrea, R. D., Purnakarya, I., Umar, H. B., Andrafikar, Syafrawati, Asrawati, Susilowati, A., Novianti, Masrul, & Lipoeto, N. I. (2023). Risk factors associated with childhood stunting in Indonesia: A systematic review and meta-analysis. *Asia Pacific Journal of Clinical Nutrition*, *32*(2), 184–195. https://doi.org/10.6133/APJCN.202306_32(2).0001

Hall, C., Syafiq, A., Crookston, B., Bennett, C., Hasan, M. R., Linehan, M., West, J., Torres, S., & Dearden, K. (2018). Addressing Communications Campaign Development Challenges to Reduce Stunting in Indonesia. *Health*, *10*(12), 1764–1778. https://doi.org/10.4236/HEALTH.2018.101213 3

Ika Indriyastuti, H., Tri Kartono, D., Studi Doktor Penyuluhan Pembangunan Peminatan Promosi Kesehatan, P., Sebelas Maret, U., & Studi Sosiologi Fakultas iLmu Sosial Dan Politik, P. (n.d.). Implementation of the Sustainable Development Goals (SDGs) Program on the Management of Stunting Cases in Indonesia. *International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS)*, *9*, 60–65. https://doi.org/10.5281/zenodo.6631152

Joshi, D., Fawcett, B., & Mannan, F. (2011). Health, hygiene and appropriate sanitation: experiences and perceptions of the urban poor. *Environment and Urbanization*, *23*(1), 91–111. https://doi.org/10.1177/0956247811398602’

Koolwal, G., & Van De Walle, D. (2013). Access to Water, Women’s Work, and Child Outcomes. *Https://Doi.Org/10.1086/668280*, *61*(2), 369–405. https://doi.org/10.1086/668280

Krishna, A., Mejía-Guevara, I., McGovern, M., Aguayo, V. M., & Subramanian, S. V. (2018). Trends in inequalities in child stunting in South Asia. *Maternal and Child Nutrition*, *14*, e12517. https://doi.org/10.1111/MCN.12517;REQUESTEDJOURNAL:JOURNAL:17408709;PAGE:STRING:ARTICLE/CHAPTER

Millward, D. J. (2017). Nutrition, infection and stunting: the roles of deficiencies of individual nutrients and foods, and of inflammation, as determinants of reduced linear growth of children. *Nutrition Research Reviews*, *30*(1), 50–72. https://doi.org/10.1017/S0954422416000238

Ngure, F. M., Reid, B. M., Humphrey, J. H., Mbuya, M. N., Pelto, G., & Stoltzfus, R. J. (2014). Water, sanitation, and hygiene

(WASH), environmental enteropathy, nutrition, and early child development: making the links. *Annals of the New York Academy of Sciences*, *1308*(1), 118–128. https://doi.org/10.1111/NYAS.12330

Penelitian, J., Ipa, P., Raharini, H., & Yuniarti, E. (2023). The Relationship Between Water Quality and Stunting in Indonesia: Literature Review. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 664–670. https://doi.org/10.29303/JPPIPA.V9I9.4513

Rah, J. H., Sukotjo, S., Badgaiyan, N., Cronin, A. A., & Torlesse, H. (2020a). Improved sanitation is associated with reduced child stunting amongst Indonesian children under 3 years of age. *Maternal & Child Nutrition*, *16*(S2). https://doi.org/10.1111/MCN.12741'))

Rah, J. H., Sukotjo, S., Badgaiyan, N., Cronin, A. A., & Torlesse, H. (2020b). Improved sanitation is associated with reduced child stunting amongst Indonesian children under 3 years of age. *Maternal & Child Nutrition*, *16*(S2), e12741. https://doi.org/10.1111/MCN.12741

Rante, S., Bela, A., Tappy, M., Rahawarin, E., Pamean, S., Kesehatan, I., & Masyarakat, K. (2025). Faktor Risiko Stunting pada Balita Antara Kelompok Ibu yang Bekerja dan Tidak Bekerja di Wilayah Kerja Puskesmas Kotaraja Kota Jayapura. *Jurnal Ners*, *9*(3), 4492–4499. https://doi.org/10.31004/JN.V9I3.46243

Said-Mohamed, R., Micklesfield, L. K., Pettifor, J. M., & Norris, S. A. (2015). Has the prevalence of stunting in South African children changed in 40 years? A systematic review. *BMC Public Health*, *15*(1), 1–10. https://doi.org/10.1186/S12889-015-1844-9/FIGURES/4

Schneider, E. B. (2025). The determinants of child stunting and shifts in the growth pattern of children: A long-run, global review. *Journal of Economic Surveys*, *39*(2), 405–452. https://doi.org/10.1111/JOES.12591

Siswanty, D., Zulfitri, R., Magister Keperawatan, P., Keperawatan, F., Riau, U., & Keperawatan, D. (2025). Efektivitas Metode Komunikasi Antar Pribadi (KAP) dalam Meningkatkan Perubahan Perilaku Ibu dalam Penanganan Stunting pada Balita: Sebuah Tinjauan Literatur. *Jurnal Ners*, *9*(3), 5339–5347. https://doi.org/10.31004/JN.V9I3.46617

Smiley, S. L., & Stoler, J. (2020). Socio-environmental confounders of safe water interventions. *Wiley Interdisciplinary Reviews: Water*, *7*(3), e1438. https://doi.org/10.1002/WAT2.1438

Soliman, A., De Sanctis, V., Alaaraj, N., Ahmed, S., Alyafei, F., Hamed, N., & Soliman, N. (2021). Early and Long-term Consequences of Nutritional Stunting: From Childhood to Adulthood. *Acta Bio Medica : Atenei Parmensis*, *92*(1), e2021168. https://doi.org/10.23750/ABM.V92I1.11346

Stewart, C. P., Iannotti, L., Dewey, K. G., Michaelsen, K. F., & Onyango, A. W. (2013). Contextualising complementary feeding in a broader framework for stunting prevention. *Maternal and Child Nutrition*, *9*(S2), 27–45. https://doi.org/10.1111/MCN.12088;WEBSITE:WEBSITE:PERICLES;JOURNAL:JOURNAL:17408709;WGROUP:STRING:PUBLICATION

Tella, T. A., Festus, B., Olaoluwa, T. D., & Oladapo, A. S. (2025). Water and wastewater treatment in developed and developing countries: Present experience and future plans. *Smart Nanomaterials for Environmental Applications*, 351–385. https://doi.org/10.1016/B978-0-443-21794-4.00030-2

Usfar, A. A., Lebenthal, E., Atmarita, Achadi, E., Soekirman, & Hadi, H. (2010). Obesity as a poverty-related emerging nutrition problems: the case of Indonesia. *Obesity Reviews*, *11*(12), 924–928. https://doi.org/10.1111/J.1467-789X.2010.00814.X

Zhang, J., Mauzerall, D. L., Zhu, T., Liang, S., Ezzati, M., & Remais, J. V. (2010). Environmental health in China: progress towards clean air and safe water. *The Lancet*, *375*(9720), 1110–1119. https://doi.org/10.1016/S0140-6736(10)60062-1