JURNAL KESEHATAN LINGKUNGAN
JURNAL DAN APLIKASI TEKNIK KESEHATAN LINGKUNGAN

ISSN 1829-9407 (Print)
ISSN 2581-0898 (Online)

Volume 23, No.1, January 2026 ; Page: 1-12; *DOI: https://doi.org/10.31964/jkl.v23i1.1090*

Original Research

SILENT CRISIS: WATER SANITATION AND FOOD HYGIENE AS DETERMINANTS OF STUNTING (A CASE-CONTROL STUDY IN BANJAR REGENCY INDONESIA)

Ani Kipatul Hidayah[1], Laily Khairiyati[1], Lenie Marlinae[1], Husaini[1], Syamsul Arifin[2], Agung Waskito[1], Muhammad Rasyid Ridha[3], Anugrah Nur Rahmat[1], Anis Kamila Saleha[1]

[1]Department of Environmental Health, Public Health Program, Faculty of Medicine and Health Sciences, Lambung Mangkurat University

[2]Undergraduate Medical Program, Department of Pharmacology, Faculty of Medicine and Health Sciences, Lambung Mangkurat University

[3]Department of Epidemiology, Public Health Program, Faculty of Medicine and Health Sciences, Lambung Mangkurat University

Address: Jl. A. Yani Km. 36, Banjarbaru, South Kalimantan 70714, Indonesia

E-mail: anikipatulhidayah@ulm.ac.id

Article Info

Article history:

Received October 17, 2025
Revised January 23, 2025
Accepted January 23, 2025

Keywords:

Stunting
Clean water
Drinking water
Water quality
Food hygiene

ABSTRACT

Silent Crisis: Water Sanitation And Food Hygiene As Determinants of Stunting (A Case-Control Study In Banjar Regency, Indonesia). *Data from the Indonesian Nutrition Status Survey (SSGI) show that the prevalence of stunting in Banjar Regency increased from 17.68% (2021) to 26.4% (2022), and further rose to 30.6% (2023). Limited access to safe drinking water and food increases the risk of stunting through infectious diseases that disrupt nutrient absorption. This study aimed to analyze the relationship between water quality, food hygiene, and stunting among children under five in Banjar Regency. This research used case control study design. The case and control groups each received 30 samples. Independent variables included the source and quality of clean water (physical, chemical, microbiological), the source and quality of drinking water, drinking water management, and food hygiene practices (processing, serving, storage). Data were collected through household water sampling tested for physical (turbidity), chemical (pH, Fe), and microbiological (E. coli) parameters, as well as questionnaires and structured interviews with parents or caregivers. Data analysis was conducted using binary and multivariate logistic regression tests. The results showed that clean water sources, drinking water sources, microbiological quality of drinking water, drinking water management, and food management were significantly associated with stunting (p < 0.05). Multivariate analysis identified drinking water sources and food management as the primary determinants, jointly accounting for 18.4% of stunting occurrence. These findings underscore that stunting prevention interventions should be prioritized toward improving the safety of household drinking water and strengthening food hygiene practices.*

INTRODUCTION

Stunting is a global public health problem and a chronic nutritional condition that poses serious consequences for human capital development. Beyond impaired linear growth, stunting adversely affects cognitive development, immune function, and future productivity.

In 2020, UNICEF reported that approximately 21.9%, or 149 million, children under five worldwide were stunted, with a substantial proportion occurring in Southeast Asia [1].

In Indonesia, stunting reduction has been prioritized as a national development agenda, with a target prevalence of 14% by 2024. Nevertheless, data from the Indonesian Nutrition Status Survey (Survei Status Gizi Indonesia—SSGI) indicate that stunting prevalence remained high at 21.5% in 2023, despite a gradual decline from previous years, highlighting persistent regional disparities [2].

Contrary to the national trend, Banjar Regency in South Kalimantan has experienced a marked increase in stunting prevalence, rising from 17.68% in 2021 to 30.6% in 2023 [3]. This figure substantially exceeds the national average and underscores an urgent need for context-specific, evidence-based investigations to identify dominant local risk factors.

Environmental determinants, particularly water, sanitation, and hygiene, have been widely recognized as key contributors to stunting. Globally, environmental risk factors are estimated to contribute to approximately 7.2 million stunting cases annually [4]. Previous studies have demonstrated significant associations between inadequate Water, Sanitation, and Hygiene (WASH) practices and stunting [5]. However, many of these studies have focused primarily on access indicators and have not comprehensively assessed water quality parameters or household food hygiene practices, especially in wetland settings such as Banjar Regency [6].

Limited access to safe drinking water and reliance on unsafe water sources increase the risk of repeated infections that impair nutrient absorption. Exposure to microbiologically contaminated water, particularly Escherichia coli, can lead to subclinical intestinal inflammation known as Environmental Enteric Dysfunction (EED), which disrupts nutrient absorption and contributes to growth faltering [7–11]. In addition, inadequate household drinking water management and poor food hygiene practices further elevate the risk of fecal–oral pathogen transmission among young children [12–16].

Despite growing evidence linking environmental sanitation to stunting, there remains a research gap regarding the combined influence of water source, water quality (physical, chemical, and microbiological), household water management, and food hygiene practices in areas with persistently high stunting prevalence, such as Banjar Regency.

This study aims to examine the relationship between water sanitation, food hygiene practices, and stunting among children under five in Banjar Regency using a case–control approach.

MATERIALS AND RESEARCH METHODS

This study employed an analytical observational design with a case–control approach and was conducted in Astambul Subdistrict, Banjar Regency, from July to August 2025. The study sample comprised 30 stunted children under five years of age (cases) and 30 non-stunted children (controls), selected using purposive sampling based on predefined inclusion criteria and matching characteristics. The sample size was determined by considering study feasibility, the availability of eligible participants within the study period, and the minimum requirements for exploratory field-based case–control analyses.

Data were collected through structured interviews using standardized questionnaires covering respondent characteristics, water sources, household drinking water management, and food hygiene practices. These primary data were complemented by laboratory analyses of clean water and household drinking water quality, which included physical, chemical, and microbiological parameters. Data analysis consisted of univariate analysis, bivariate logistic regression, and multivariate logistic regression to identify factors significantly associated with stunting.

Water quality assessment encompassed microbiological, chemical, and physical parameters. Microbiological quality of drinking water was examined using the Most Probable Number (MPN) method to detect *Escherichia coli*. Iron (Fe) concentration was measured using atomic absorption spectrophotometry (AAS), turbidity was assessed using a turbidimeter, and pH was measured with a calibrated pH meter. Water quality was classified as meeting or not meeting health standards in accordance with Indonesian Ministry of Health Regulation No. 2/MENKES/PER/I/2023.

Purposive sampling was applied to ensure comparability between cases and controls; however, as a non-probability sampling technique, it may limit the generalizability of the findings beyond the study population. Consequently, the results should be interpreted as context-specific evidence reflecting local conditions rather than being extrapolated to a broader population.

Ethical approval for this study was obtained from the relevant institutional research ethics committee. All respondents received detailed information about the study and provided written informed consent prior to participation. Confidentiality and anonymity of participants were strictly maintained throughout the research process.

RESEARCH RESULTS AND DISCUSSION

The Characteristics of Respondents

Table 1. The Characteristics of Respondents

Characteristics of Respondents	*Frekuensi*	*%*
Stunting		
Yes	*30*	*50*
No	*30*	*50*
Child's Age		
6 – 23 Months	*14*	76.67
24 – 59 Months	*46*	*23.33*
Gender		
Male	36	60.0
Female	24	40.0
Mother's/Caregiver's Age		
21-30	24	40.0
31-40	28	46.7
41-50	6	10.0
51-60	2	3.3
Type of Clean Water Source		
Piped water (PDAM)	18	30.0
Borehole/pump well	6	10.0
Dug well	26	43.3
River water	10	16.7
Type of Drinking Water Source		
Refilled water	20	33.3
Branded bottled water	2	3.3
Piped water (PDAM)	12	20.0
Borehole/dug well	18	30.0
River water	8	13.3

Table 1 shows that a total of 60 respondents participated in this study, consisting of 30 stunted children and 30 non-stunted children. The majority of children were in the 24–59 months age group (76.7%) and were predominantly male (60.0%). Most mothers or caregivers were within the productive age range, with the largest proportion in the 31–40 years group (46.7%).

In terms of water access, dug wells were the most commonly used source of clean water (43.3%), followed by piped water (PDAM) (30.0%), while river water was still utilized by 16.0% of respondents. Regarding drinking water facilities, refilled bottled water was the most frequently used (33.3%), followed by borehole/dug well water (30.0%) and piped water (20.0%). Overall, the distribution of stunting status was evenly divided, with findings indicating varied patterns of water use; however, there remains reliance on unprotected water sources.

Frequency Distribution of Water Sanitation and Food Higiene

Table 2. Frequency Distribution of Water Sanitation and Food Higiene

Variable	*Frekuensi*	*%*
Drinking Water Source		
Not fulfilling the requirement	*36*	*60*
Fufilling the requirement	*24*	*40*
Physical Quality (Turbidity) of Drinking Water		
Not fulfilling the requirement	*21*	*35*
Fufilling the requirement	*39*	*65*
Chemical Quality (pH) of Drinking Water		
Not fulfilling the requirement	*29*	*48,3*
Fufilling the requirement	*31*	*51,7*
Chemical Quality (Fe) of Drinking Water		
Not fulfilling the requirement	*6*	*10,0*
Fufilling the requirement	*54*	*90,0*
Microbiological Quality (E. coli) of Drinking Water		
Not fulfilling the requirement	*21*	*35,0*
Fufilling the requirement	*39*	*65,0*
Clean Water Source		
Not fulfilling the requirement	31	51,7
Fufilling the requirement	29	48,3
Physical Quality (Turbidity) of Clean Water		
Not fulfilling the requirement	40	66,7
Fufilling the requirement	20	33.3
Chemical Quality (pH) of Clean Water		
Not fulfilling the requirement	48	80,0
Fufilling the requirement	12	20,0
Chemical Quality (Fe) of Clean Water		
Not fulfilling the requirement	7	11,7
Fufilling the requirement	53	88,3
Microbiological Quality (E. coli) of Clean Water		
Not fulfilling the requirement	49	81,7
Fufilling the requirement	11	18,3
Access to Clean Water		
Not easy	15	25,5
Easy	45	56,7
Drinking Water Management		
Poor	26	43,3
Good	34	56,7
Food Management		
Poor	38	63,4
Good	22	36,6
Food Serving		
Poor	60	100
Good	0	0
Food Storage		
Poor	49	81,67
Good	11	18,3

The findings of this study indicate substantial household-level environmental exposures related to unsafe water and inadequate food hygiene practices, which play an important role in shaping child health and nutritional outcomes. The widespread presence of *Escherichia coli* contamination in household water sources reflects persistent fecal pollution and highlights a critical pathway through which environmental factors contribute to stunting. Previous studies have consistently demonstrated that chronic exposure to fecally contaminated drinking water is strongly associated with impaired child growth in low- and middle-income countries [17,25].

The most plausible biological mechanism underlying this association is Environmental Enteric Dysfunction (EED), a subclinical condition characterized by chronic intestinal inflammation resulting from repeated exposure to enteric pathogens. EED disrupts intestinal integrity, reduces nutrient absorption, and ultimately impairs linear growth, even in the absence of overt diarrheal disease [18]. The observation that households often report adequate access to water while still experiencing poor microbiological quality reinforces the notion that water availability alone is insufficient. Instead, ensuring microbiological safety at the point of use should be a central focus of water sanitation interventions, in line with current global Water, Sanitation, and Hygiene (WASH) priorities [19].

Beyond microbiological contamination, deficiencies in the physical and chemical quality of water further exacerbate health risks. High turbidity and unsuitable pH levels may reduce the effectiveness of household water treatment and facilitate the persistence of pathogenic microorganisms [20]. These conditions indicate broader systemic challenges related to unprotected water sources and suboptimal water handling practices, which collectively increase children's exposure to waterborne pathogens [21].

Household food hygiene practices also emerged as a critical determinant of stunting. Inadequate food preparation, serving, and storage practices create favorable conditions for bacterial contamination and proliferation, thereby increasing the risk of foodborne infections. Such infections contribute to recurrent illness, reduced appetite, and nutrient losses, reinforcing the cycle of undernutrition and growth faltering. The World Health Organization has emphasized that young children bear a disproportionate burden of foodborne diseases, underscoring their vulnerability to unsafe food environments [22]. The consistency of these findings with evidence from other low-resource settings suggests that poor household food hygiene remains a widespread yet preventable risk factor for stunting [23,24].

Taken together, these results indicate that children in Banjar Regency are simultaneously exposed to unsafe drinking water and inadequate food hygiene practices, creating a compounded environmental risk that heightens susceptibility to stunting. These findings underscore the need for integrated interventions that extend beyond infrastructure provision to address behavioral and household-level practices. Policy efforts should prioritize improving microbiological water safety, promoting effective household water treatment and safe storage, and strengthening food hygiene education as integral components of comprehensive stunting prevention strategies.

The Influence of Water Sanitation and Food Higiene on Stunting Occurrence

Bivariate analysis was subsequently conducted using the appropriate statistical test, namely logistic regression analysis. This approach was employed to determine which variables demonstrated a significant association with the incidence of stunting, accompanied by p-values and odds ratios (ORs) to strengthen the interpretation of these associations.

Table 3. The Influence of Water Sanitation and Food Higiene on Stunting Occurrence

Variable		Stunting		Not Stunting		*P Vaule*	OR
		n	%	n	%		
Clean Water Source	*Not fulfilling the requirement*	24	40	7	11,7	0,001	13,143 (3,837-45,023)
	Fufilling the requirement	6	10	23	38,3		
Physical Quality (Turbidity) of Clean Water	*Not fulfilling the requirement*	22	36,7	18	30,0	0,276	1,833 (0,616-5453)
	Fufilling the requirement	8	13,3	12	20,0		
Chemical Quality (pH) of Clean Water	*Not fulfilling the requirement*	24	40,0	24	40,0	1,000	1,000 (0,282-3,544)
	Fufilling the requirement	6	10,0	6	10,0		
Chemical Quality (Fe) of Clean Water	*Not fulfilling the requirement*	4	6,7	3	5,0	0,688	1,385 (0,282-6,796)
	Fufilling the requirement	26	43,3	27	45,0		
Microbiological Quality (E. coli) of Clean Water	*Not fulfilling the requirement*	26	43,3	23	38,3	0,322	1,978 (0,513-7,653)
	Fufilling the requirement	4	6,7	7	11,7		
Drinking Water Source	*Not fulfilling the requirement*	27	45,0	9	15,0	0,001	21,000 (5,047-87,373)
	Fufilling the requirement	3	5,0	21	35,0		
Physical Quality (Turbidity) of Drinking Water	*Not fulfilling the requirement*	12	20,0	9	15,0	0,418	1556 (0,534-4532)
	Fufilling the requirement	18	30,0	21	35,0		
Chemical Quality (pH) of Drinking Water	*Not fulfilling the requirement*	14	23,3	15	25,0	0,796	0,875 (0,318-2.410)
	Fufilling the requirement	16	26,7	15	25,0		
Chemical Quality (Fe) of Drinking Water	*Not fulfilling the requirement*	3	5,0	3	5,0	1,000	1,000 (0,185-5,403)
	Fufilling the requirement	27	45,0	27	45,0		
Microbiological Quality (E. coli) of Drinking Water	*Not fulfilling the requirement*	17	28,3	4	6,7	0,001	8,500 (2,371-30,466)
	Fufilling the requirement	13	21,7	26	43,3		
Access to Clean Water	Not Easy	9	15,0	6	10,0	0,374	1,714 (0,523-5,621)
	Easy	21	35,0	24	40		
Drinking Water Management	Poor	18	30	8	13,3	0,011	4,125 (1,387-12,270)
	Good	12	20	22	36,7		
Food Management	Poor	25	41,7	13	21,7	0,002	6,538 (1,967-21,739)
	Good	5	8,3	17	28,3		
Food Serving	Poor	30	50	30	50	1,000	1,000 (0,302-3,308)
	Good	0	0	0	0		
Food Storage	Poor	26	53	23	47	1,000	0,505 (0,131-1951)
	Good	4	36	7	63		

The bivariate analysis identified water sanitation and household hygiene practices as the principal determinants of stunting in the study population, underscoring the critical role of environmental and behavioral factors in growth faltering. Overall, the findings indicate that unsafe drinking water and poor household food hygiene constitute dominant exposure pathways for enteric infections associated with stunting.

The strongest associations were observed for unsafe drinking water sources (OR = 21.000) and microbiological contamination of drinking water (OR = 8.500). These findings highlight that the primary risk does not merely stem from limited access to water, but rather from exposure to microbiologically unsafe water at the point of consumption. This reinforces the current Water, Sanitation, and Hygiene (WASH) paradigm, which emphasizes water safety and quality rather than physical access alone. Repeated consumption of fecally contaminated water facilitates chronic enteric infections, particularly Environmental Enteric Dysfunction (EED), characterized by persistent intestinal inflammation and impaired nutrient absorption, ultimately leading to linear growth failure in young children [25].

Similarly, unsafe clean water sources used for domestic activities were significantly associated with stunting (OR = 13.143). Although this water is not directly consumed, it plays a crucial role in shaping the household contamination environment. Poor-quality water used for bathing, washing utensils, and cleaning food increases the risk of fecal–oral transmission through contaminated hands, surfaces, and cooking equipment, thereby indirectly affecting child nutritional status [23]. These findings emphasize that water safety interventions should encompass both drinking and non-drinking water sources within households.

Household water management practices also emerged as an important determinant of stunting (OR = 4.125). Inadequate handling, storage, and serving of drinking water increase the likelihood of recontamination, even when the initial source is relatively safe. This finding highlights a critical gap in conventional WASH interventions that primarily focus on infrastructure while underemphasizing behavioral practices at the household level [23,25].

Poor food hygiene practices were another key determinant of stunting (OR = 6.538). Unhygienic food preparation and serving facilitate cross-contamination from contaminated water, hands, and the domestic environment into children's food. Recurrent exposure to foodborne pathogens contributes to repeated gastrointestinal infections, nutrient malabsorption, and subsequent growth faltering [23,26]. The widespread inadequacy of food-serving practices observed in this study suggests that food hygiene represents a pervasive and underaddressed risk factor in the study area.

In contrast, physical and chemical parameters of water quality, including turbidity, pH, and iron (Fe) concentration, were not significantly associated with stunting. This finding suggests that microbiological contamination plays a more decisive role in determining child health outcomes than physical or chemical characteristics. These results are consistent with existing evidence indicating that microbiological safety is the most critical dimension of water quality in relation to child growth outcomes [19,20].

The non-significant statistical results for certain food storage and food serving variables should be interpreted with caution. The absence of observed associations likely reflects minimal variability in these practices, as poor food handling was nearly universal among respondents. Rather than indicating a lack of risk, this finding suggests uniformly high exposure levels, which limited the ability to detect statistically significant differences.

From a policy perspective, these findings underscore the need to shift stunting prevention strategies beyond nutrition-specific interventions toward integrated environmental health approaches. Priority actions should focus on ensuring microbiologically safe drinking water through effective household water treatment and safe storage, as well as strengthening food hygiene practices, particularly during food preparation and serving. Addressing these environmental determinants is essential for achieving sustainable reductions in stunting prevalence in high-risk settings.

Simultaneous Effects of Water Sanitation and Food Hygiene on Stunting Occurrence

Based on the results of the bivariate analysis, five variables with p-values < 0.25 were included in the multivariate logistic regression model. These variables comprised source of clean water, source of drinking water, microbiological quality (*Escherichia coli*) of clean water, household drinking water management, and food hygiene practices. Multivariate logistic regression analysis was conducted to identify risk factors that simultaneously and independently influenced the occurrence of stunting among children under five.

Table 4. The Initial Model of Simultaneous Influence of Water Sanitation and Food Higiene Toward Stunting

Variabel	B	P. Value	OR	95% CI
Clean Water Source	1.357	0.123	3.886	0.692 – 21.818
Drinking Water Source	1.880	0.056	6.552	0.955 – 44.953
Microbiological Quality (E. coli) of Drinking Water	-0.525	0.608	0.591	0.080 – 4.393
Drinking Water Management	0.478	0.539	1.613	0.350 – 7.431
Food Management	1.283	0.094	3.607	0.804 – 16.184
Constant	-6.385	0.001	0.002	

The initial multivariate model (Table 4), which included all five predictor variables, indicated that none of the variables reached statistical significance at $\alpha = 0.05$. However, source of drinking water ($p = 0.056$) and food management practices ($p = 0.094$) demonstrated borderline statistical significance. Households using unsafe drinking water had a 6.552-fold higher risk of stunting, while inadequate food management practices increased the risk by 3.607 times.

In contrast, other variables—including source of clean water ($p = 0.123$), household drinking water management ($p = 0.539$), and microbiological quality (*Escherichia coli*) of clean water ($p = 0.608$)—did not exhibit statistically significant associations with stunting in the initial model.

Through stepwise elimination of non-significant variables using the backward likelihood ratio method, a more parsimonious final model (Table 5) was obtained. This final model identified two key independent risk factors for stunting among children under five.

Table 5. The Initial Model of Simultaneous Influence of Water Sanitation and Food Higiene Toward Stunting Occurance

Variabel	B	P. Value	OR	95% CI
Drinking Water Source	2.794	0.001	16.352	3.757 – 71.176
Food Management	1.423	0.050	4.150	1.001 – 17.209
Constant	-5.710	0.001	0.003	

The final multivariate model identified unsafe drinking water as the strongest and most statistically significant predictor of stunting (OR = 16.352). This magnitude of risk substantially exceeds those reported in previous studies examining unsafe or microbiologically contaminated drinking water [17,25]. The markedly elevated odds ratio observed in this study suggests intense and continuous exposure to enteric pathogens in the study area, likely driven by persistent fecal contamination of drinking water sources. Such exposure is strongly associated with Environmental Enteric Dysfunction (EED), a chronic subclinical condition characterized by intestinal inflammation, impaired nutrient absorption, and systemic immune activation, all of which contribute directly to linear growth failure regardless of food availability [25].

This finding aligns with the growing global consensus that water safety at the point of consumption is more critical than access alone. Drinking water classified as unsafe typically reflects failures in sanitation barriers and is commonly indicated by microbiological contamination, particularly *Escherichia coli* [19]. From a public health perspective, the magnitude of this association underscores the urgent need to prioritize household-level drinking water quality improvement—including routine water quality testing, effective household water treatment, and safe storage practices—as core components of stunting prevention programs.

Inadequate food management emerged as an additional independent determinant, increasing the risk of stunting more than fourfold (OR = 4.150). Although the confidence interval was wide, the statistical significance observed in the multivariate model confirms the substantive role of unsafe food handling practices in shaping child growth outcomes. Poor food hygiene, including improper food preparation, storage, and serving practices, facilitates foodborne pathogen transmission and contributes to recurrent infections that exacerbate nutrient loss and growth faltering [23,26]. These findings reinforce the growing body of evidence indicating that unsafe water and unsafe food act synergistically, amplifying children's cumulative exposure to enteric pathogens.

The final logistic regression model was expressed as:

Y = -5,719 + 2,794 (Drinking Water Source) + 1,423 (Food Management)
Y = -1,493

$$\rho = \frac{1}{1 + e^{-y}}$$

$$\rho = \frac{1}{1 + 2{,}72^{-(-1{,}493)}}$$

$$\rho = 0{,}1835 = 18{,}4\%$$

The multivariate logistic regression model demonstrated that the combined effects of unsafe drinking water sources and poor household food management accounted for approximately 18.4% of stunting occurrence in the study population. Although this proportion may appear moderate, it is epidemiologically meaningful because it represents a share of stunting risk that is directly attributable to modifiable environmental exposures. From a public health perspective, this finding suggests that nearly one in five stunting cases in the study area could potentially be prevented through effective improvements in drinking water safety and household food hygiene alone.

The estimated probability of stunting attributable to these combined environmental determinants (ρ = 0.184) highlights the importance of targeting upstream risk factors operating through fecal–oral transmission pathways. Unsafe drinking water and inadequate food hygiene practices contribute to repeated exposure to enteric pathogens, thereby increasing the likelihood of subclinical infections and Environmental Enteric Dysfunction (EED), which impair nutrient absorption and hinder linear growth. Unlike non-modifiable determinants, such as genetic factors, these environmental risks are amenable to intervention through relatively low-cost, scalable, and sustainable public health measures.

It is important to note that the remaining proportion of stunting risk (81.6%) is likely influenced by a complex interplay of factors, including maternal nutritional status, infant and young child feeding practices, dietary diversity, socioeconomic conditions, and household poverty. Nevertheless, environmental determinants—particularly drinking water safety and food hygiene—represent some of the most feasible and actionable entry points for intervention, especially in resource-limited settings where infrastructure and healthcare access may be constrained.

From a policy and programmatic perspective, even partial reductions in exposure to unsafe water and unhygienic food practices could yield substantial population-level benefits for child growth outcomes. Community-based behavior change interventions, household water treatment and safe storage, routine water quality monitoring, and strengthened local sanitation regulations are practical strategies that can be implemented alongside nutrition-specific programs. Accordingly, the findings of this study provide strong empirical support for integrating drinking water quality assurance and food hygiene interventions as core components of comprehensive stunting prevention strategies, particularly in high-risk areas such as Banjar Regency.

CONCLUSIONS AND RECOMMENDATIONS

This study confirms that unsafe drinking water, particularly Escherichia coli contamination, and poor household food management are key determinants of stunting among children under five in Banjar Regency. These environmental factors contribute to stunting through fecal–oral transmission pathways and Environmental Enteric Dysfunction (EED), which impair nutrient absorption and linear growth. However, the use of purposive sampling and a limited sample size may restrict the generalizability of the findings, and causal inference should be interpreted with caution.

Stunting prevention efforts should prioritize household-level drinking water safety through appropriate treatment methods, safe storage, and regular quality monitoring. In addition, targeted food hygiene education focusing on safe food preparation, serving, and storage practices should be strengthened through community-based platforms and integrated with existing WASH and nutrition programs.

REFERENCES

1. UNICEF, WHO WB. Levels and trends in child malnutrition: Key findings of the 2020 edition of the Joint Child Malnutrition Estimates. Geneva: World Health Organization; 2020.
2. Kementerian Kesehatan RI. Survei Kesehatan Indonesia (SKI) Tahun 2023. Jakarta: Kemenkes RI; 2023.
3. USAID. USAID Ethiopia Fact Sheet - WASH. Washington DC: USAID; 2020.
4. Yurizal & Fajar NA. Analysis of environmental factors with the incidence of stunting in toddlers (literature review). Ris Inf Kesehat. 2023;12(1):88–97.
5. Marlinae L et al. The relationship between drinking water treatment and clean water sources on the incidence of stunting. River Study. 2024;2(2):232–42.
6. Rizaldy MA et al. Water, sanitation and higiene (WASH) and its association with stunting in developing countries in Asia: a systematic review. Svasthya [Internet]. 2025;2(2):e81. Available from: https://doi.org/10.70347/svsthya.v2i2.81
7. Yuswita T et al. The influence of clean water sources on stunting incidents. Int J Glob Heal Res [Internet]. 2024;6(4):2197–204. Available from: https://jurnal.globalhealthsciencegroup.com/index.php/IJGHR/article/view/3447
8. Lestari PP RA& MS. Analisis Determinan Masalah Stunting di Kabupaten Banjar. INVOLUSI J Ilmu Kebidanan. 2025;15(1):12–8.
9. Nasidah M FN& N. A review of water and sanitation factors with child stunting incidence. J Kesehat Komunitas [Internet]. 2022;8(3):597–606. Available from: https://doi.org/10.25311/keskom.Vol8.Iss3.1338
10. Munthe SN dkk. Kajian literatur: pengaruh konsumsi air bersih terhadap stunting pada anak yang berasal dari keluarga berpendapatan rendah. MAHESA Malahayati Heal Student J. 2024;4(2):566–80.
11. Sefdiyanto R D. Kualitas Air Minum Rumah Tangga Dan Stunting Pada Balita Di Kecamatan Kerkap Kabupaten Bengkulu Utara. J Ilmu Kesehat Masy. 2024;20(1):1–8.
12. Wahid NK MI& HH. Relationship Between Drinking Water Sources, Drinking Water Treatment And Sewage Management With Stunting In Two-Years-Old Children In Mamuju Regency. EAS J Nutr Food Sci [Internet]. 2020;2(4):204–9. Available from: https://10.0.141.253/easjnfs.2020.v02i04.005
13. Abidin K A& T IL. Faktor Air, Sanitasi, Dan Higiene Terhadap Kejadian Diare Pada Balita Di Permukiman Kumuh Kota Makassar. Hasanuddin J Public Heal. 2022;3(3):301–11.
14. Khairiyah D & Fayasari A. Perilaku higiene dan sanitasi meningkatkan risiko kejadian stunting balita usia 12-59 bulan di Banten. Ilmu Gizi Indones. 2020;3(2):123–34.

15. Ainy FN ST& S LA. The relationship between environmental sanitation of family and stunting among under-five children: A cross-sectional study in the public health center of Jember, Indonesia. Nurs Pract Today [Internet]. 2021;8(3):1–6. Available from: http://npt.tums.ac.ir
16. Pradana VN SS& RR. Personal higiene, ketersediaan air, dan sanitasi lingkungan dengan kejadian stunting pada balita usia 6–59 bulan di wilayah kerja Puskesmas Singorojo. Amerta Nutr. 2023;7(3):421–6.
17. Zaerozi A dkk. Drinking Water Quality As A Risk Factor of Stunting: Systematic Reviews. . J Community Med Public Heal Res [Internet]. 2023;4(2):148–54. Available from: https://e-journal.unair.ac.id/JCMPHR/article/download/45961/26741
18. Lauer JM, Duggan CP, Ausman LM, Griffiths JK, Webb P, Bashaasha B, Agaba E, Turyashemererwa FM GS. Unsafe Drinking Water Is Associated with Environmental Enteric Dysfunction and Poor Growth Outcomes in Young Children in Rural Southwestern Uganda. Am J Trop Med Hyg [Internet]. 2018;99(6):1606–12. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC6283503/
19. Kamei A & Soori BS. Water Treatment and E. Coli in Drinking Water: Household Responses to (Invisible) Water Quality Risks. medRxiv [Internet]. 2025; Available from: https://www.medrxiv.org/content/10.1101/2025.08.14.25333747v1.full.pdf
20. Assefa E, Jabasingh A, Mulugeta E, Dessalegne M TE. Impact of source water quality on total organic carbon and trihalomethane removal efficiency in a water treatment plant: A case study of Upper Awash, Ethiopia. J Water Health [Internet]. 2024;22(2):337–49. Available from: https://iwaponline.com/jwh/article/22/2/337/99829/Impact-of-source-water-quality-on-total-organic
21. Abdi EA & Gebremedhin S. Review of the Effects of Water Characteristics and Quality on Human Health. J Contemp Sci Res [Internet]. 2025;1(2):673–85. Available from: https://www.researchgate.net/publication/361683198
22. (WHO) WHO. Food safety (Fact Sheet) [Internet]. 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/food-safety
23. Teym A, Adane B AB and ZT. Food safety practice and associated factors among food handlers working in food and drinking establishments in Finote Selam, in resource-limited settings. Front Sustain Food Syst. 2025;
24. Osman WA, Saeed SM, Ahmed HM, Nageye QA, Malin MA HA. Factors Affecting Food Handling Practices Among Food Handlers at Food Establishments in Mogadishu, Somalia: A Cross-Sectional Study. Heal Sci Rep [Internet]. 2025;8(7). Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC12235575/
25. Lee DD & Giang LT. Water quality and child undernutrition: evidence from 29 low- and middle-income countries. Bull World Health Organ [Internet]. 2023;101(11):724–33. Available from: https://cdn.who.int/media/docs/default-source/bulletin/online-first/blt.24.292682.pdf?sfvrsn=bed9ce08_
26. Aleru EO, Bodunde IO, Deniran IA, Ajani ON, Aleru OO FA. WASH practices increased the prevalence of malnutrition among under-five children (6–59 months) in an urban slum area in Ibadan, Nigeria. J Water, Sanit Hyg Dev [Internet]. 2023;13(11):910–921. Available from: https://iwaponline.com/washdev/article/13/11/910/98627/WASH-practices-increased-the-prevalence-of