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Relationship between Drinking Water Quality Source, Physical Aesthetic Aspects, and Nutritional Status of Toddlers Aged 6 - 24 Months in Cijeruk and Ciembu Villages, Sumedang Regency

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Abstract Water is very important for the whole community, including children, because it is necessary for life and cleaning. However, the increasing global issues of water pollution pose a significant risk, exposing community to various waterborne diseases such as cholera, intestinal disorders, and other infectious diseases. Stunting can be promoted by poor water sanitation and hygiene practices through various mechanisms, including recurrent diarrhea, infection pathways, and gut environment dysfunction. Therefore, the objective of this study is to investigate the prevalence of stunting among toddlers aged 0-2 years using analytical observation, with a cross-sectional design and chi-square data analysis. The population was all toddlers aged 0-2 years, with a total sample size of 41 toddlers. The result showed that 17 toddlers experienced stunting due to poor water sanitation, with 28 being. malnourished, and 7 underweight. Approximately 38.1% used refillable water, 26 (61.9%) depended on pumped water for drinking purposes, and all forty-two (100%) toddlers managed water before consumption. Based on proximity, 22 (53.4%) had toilets <10 meters and 20 (47.6%) were >10 meters away. Furthermore, 14 (33.3%) experienced good sanitation and 28 (66.7%) had poor sanitation. Based on the z score, 30 (71.4%) had an average height, while 12 (28.6%) were classified as short. The results are expected to become a reference for Indonesian society, particularly in improving water sanitation to support nutritional status of toddlers under five.

Keywords Water Sanitation, Nutritional Status, Community, Toddlers

1. Introduction

Water is very important for the whole community, including children, because it is necessary for life and

cleaning [1]. As a natural resource essential for human life, the United Nations (UN) and Sustainable Development Goal 6 (SDG 6) have emphasized the provision of safe water as a fundamental human right, because access to portable water is the right of all humans [2]-[6].

Several countries still lack access to portable water. This deficiency has exposed more than 25% of the global population to various diseases. Based on estimation, there is an annual death of approximately 485,000 attributed to the consumption of water contaminated with pathogens leading to outbreak of water-borne disease. This phenomenon has caused the outbreak of waterborne diseases such as diarrhea, cholera, dysentery, and typhoid fever [2], [7]-[10].

The implementation of interventions that promote safe water and hygiene can improve environmental sanitation and prevent 10% of global diseases, including toddlers [11], [12]. Water is essential due to its importance for life and cleaning. Furthermore, water quality is critical for health, as contamination can lead to the spread of diseases such as diarrhea, cholera, dysentery, and typhoid, all of which are associated with stunting [1]. Stunting, characterized by low height for age, is a chronic obstacle to the growth potential of toddlers. This condition is specifically referred to toddlers aged 24 to 59 months who are two standard deviations below the median height for age determined by the World Health Organization (WHO) toddlers growth standards [1], [13], [14].

Several countries, including developing nations, have malnutrition problems, particularly among toddlers under five years. In Asia, data on toddlers under five who experience failure to grow and develop, namely thinness, stunting, and overweight is 49.9% [15]-[19]. Many countries especially developing countries, have malnutrition problems, especially among children under five years, in Asia is 49,9%, Stunting is a great concern, including in Indonesia, that also faces a significant challenge with stunting, despite a reported decrease from 24.4% in 2021 to 21.6% in 2022, according to the Ministry of Health [15]-[19]. To overcome this challenge, the Indonesian government has targeted to reduce stunting prevalence by 14% in 2024 [15]-[19].

The growth and development of toddlers are determined by several factors. This includes nutritional status, which affects physical growth, maturity, and academic achievement throughout their future life. Childhood nutritional disorders are globally responsible for more than 1/3 of the deaths of toddlers under five; Stunting is one of the most common nutritional disorders that causes growth and development disorders [12], [20], [21].

2. Materials and Methods

2.1. Study Design

An analytical observational method with a cross-sectional design was employed in this study, where data for both variables were collected simultaneously.

2.2. Time and Location of Study

This study was conducted from 26 January to 7 February 2020 in 10 Stunting Locus Villages, Sumedang Regency, West Java.

2.3. Population and Sample

The population used as samples were pregnant women and toddlers aged 6 - 24 months in 10 Lokus Stunting Villages, Sumedang Regency, West Java Province. The samples were collected using the purposive sampling method, based on inclusion and exclusion criteria, totaling 42 respondents.

2.4. Study Criteria

The respondents included toddlers from pregnant women who were willing to participate in interviews focusing on environmental health questionnaires. Furthermore, pregnant women attending anthropometric examinations at the Village Integrated Healthcare Center were included.

2.4.1. Inclusion Criteria and Exclusion Criteria

The respondents were toddlers from pregnant women who were interviewed regarding environmental health questionnaires, willing to participate, and attended anthropometric examination at the Village Posyandu. Meanwhile, the exclusion criteria were toddlers and pregnant women who did not participate in the interview and were absent in anthropometric examination at the Village Posyandu.

2.5. Data Collection and Measurement

Water Quality. The structured questionnaire used to assess water sanitation and hygiene, including responses from mothers, was administered through direct interviews. The questionnaire focused on evaluating the primary source of drinking water for toddlers. It was categorized based on Program JMP for Water and Sanitation to improve various water sources including protected wells, boreholes, piped water to houses, and rainwater. However, an unimproved source was defined as drinking water from an unprotected spring, well, or surface water [22], [23]. Adherence to the WHO Guideline for Drinking Water was followed to evaluate water quality. Regarding physical and aesthetic aspects, water quality was based on the absence of tastes and odors objectionable to most consumers. Based on the classification, water was categorized as having good quality when it was tasteless, odorless, or clear. Meanwhile, poor quality was assigned to water with discernable taste,

odor, cloudiness, or color [24].

In this study, a standard questionnaire was used, based on the Cohort of non-communicable diseases, foreign workers, clean and healthy living behavior, and environmental health, as provided by the Ministry of Health of the Republic of Indonesia. Specifically, this questionnaire can be accessed and used for general purposes without a license.

Nutritional Status. The anthropometric measurement using the length/height-for-age (HFA) index was carried out to assess stunted toddlers in this study. For toddlers under 2 years old or those unable to stand, length was measured using microtoise, dacin, and toddlers' scale. Nutritional status categorization was based on growth standards according to the WHO. Based on the z-score, nutritional status was categorized into severely stunted (<−3 SD), stunted (−3 SD to <−2 SD), normal (−2 SD to +3 SD), and tall (>+3 SD) [16]. Anthropometric data were compared with reference values for HFA, weight-for-height (WFH), and body mass index (BMI) defined by WHO. Malnutrition was defined according to the WHO guidelines as acute when < −2 SD of WFH or BMI for ages under five years and from five to 18 years, respectively, and chronic at < −2 SD of HFA. Severity was categorized as moderate when WFH or BMI-for-age ≤ -2 SD and ≥ -3 SD of the median, and severe at WFH or BMI-for-age < -3 SD. Meanwhile, chronic malnutrition was deemed moderate when HFA ≤ -2 SD and ≥ -3 SD, severe at HFA < -3 SD [25]. Based on this study, malnutrition refers to the presence of acute or chronic malnutrition. The z-scores for anthropometric indices were calculated using the software WHO Anthro® and WHO AnthroPlus®.

2.6. Study Instrument

The study instruments were questionnaires from the Department of Community Medicine, Faculty of Medicine, Indonesian Christian University. This questionnaire was an adaptation from the Cohort of non-communicable diseases, foreign workers, clean and healthy living behavior, and environmental health provided by the Ministry of Health of the Republic of Indonesia. Additionally, the instrument used included toddlers and dacin scales, microtoises, as well as the WHO nutritional status application (AnthroWHOplus).

2.7. Study Procedure

2.7.1. Collecting Respondent Data

Data from respondents was collected by conducting interviews with pregnant women and the results were recorded on the provided sheet. The information obtained included name, age, and water sanitation, such as;

- Water sources for drinking purposes for toddlers, including bottled, refill, tap/PDAM, retail/purchase tap, drilled wells/pumps, unprotected springs, rainwater storage, river/lake/irrigation. These sources were categorized based on Program JMP for Water and Sanitation criteria. Improved water sources included protected wells, boreholes, piped water to houses, or rainwater. Meanwhile, an unimproved water source was defined as drinking water from an unprotected spring, well or surface water [23][22].
- Quality based on the WHO Guideline for Drinking Water, emphasizes physical and aesthetic qualities. Water must be free of tastes and odors objectionable to most consumers [24].

2.7.1.1. Body Weight Measurement Using Toddlers Scale

- Place the tool on a flat surface.
- Ensure that the needle on the scale points to zero.
- Calibrate the scale by placing a weight (1.5-liter aqua bottle) and confirm a number is shown according to the weight of the bottle.
- Ensure toddlers wear little clothes by removing sandals, diapers, and hats.
- Carefully place toddlers in the center of the scale in a lying position.
- Ensure toddlers are calm and the scale needle shows a certain number.
- Record the weighing results with accuracy to one decimal place and remove toddlers from the scale.

2.7.1.2. Body Weight Measurement (Dacin tool)

- Hang the dacin on the prepared support bar.
- Check again whether the dacin is hanging firmly by pulling the stem down firmly.
- Position the sliding pendulum at zero.
- Put a safety rope on the dacin rod to prevent any harm to the measurer during weighing.
- Place the weighing trousers/cover on the dacin and ensure the sliding pendulum is at zero.
- Balance the dacin with the weighing pants installed by putting sand in a plastic bag and tying it to the dacin rod.
- Weigh toddlers with little clothing and balance the dacin by moving the sliding pendulum.
- Record the weighing results by observing the tip of the sliding pendulum.
- Adjust the sliding pendulum to zero again and lift toddlers from the weighing cover.

2.7.1.3. Height Measurement (Microtoise Tool)

- The examiner places microtoise on a flat surface.
- The microtoise is calibrated by pulling downwards to number 0 by adjusting the head position with the microtoise.
- Another examiner holds the microtoise showing the number 200 above and then tapes it across.
- The examiner stands upright in front of the microtoise.

- Respondents are invited to stand up straight under the microtoise.
- Respondents are invited to place their heels against a wall/flat surface.
- Observe the number indicated by the pointer on the micrometer.
- Record the number showed by the pointing line on the microtoise.

2.8. Data Analysis

2.8.1. Univariate

In this study, the analysis was carried out using the univariate test to determine the frequency distribution of the variables. These included the main type of water used, drinking water treatment, physical quality, and distance from the latrine to drinking water source.

2.8.2. Bivariate

The relationship between each independent and the dependent variable was analyzed using the chi-square statistical test. The specific terms and conditions of the test were fulfilled, including water sanitation and nutritional status of toddlers.

A bivariate analysis was carried out to determine the relationship between the independent variable (Fe supplementation, specifically the number of blood supplement tablets obtained and taken) and the dependent variable (the incidence of LBW). The statistical test used was the Chi-Square test with a confidence level of 95% ($\alpha = 0.05$). The Chi-Square test conditions according to Hastono and Sabri (2010) are as follows:

- The Chi-Square test is very good for tables with large degrees of freedom (df).
- When the table used is 2 x 2 and there are no cells that have an Expected Count (E) < 5, the test should be Continuity Correction.
- When a 2 x 2 table is found in cells with an E value < 5, the test used is the Fisher Exact Test. Meanwhile, when the table is more than 2 x 2, Pearson Chi-Square is used. The decisions taken from the Chi-Square results include p value > α (0.05), Ho is rejected. The Ho hypothesis states that there is no difference in events between the two groups or other variables. When Ho is rejected, and Ha is accepted, the sample data supports a significant difference and relationship between variables.

3. Result

Table 1 shows source and physical quality of water for toddlers aged 6 - 24 months in 10 stunting locus villages, Sumedang Regency 2020. The results showed that 16 (38.1%) toddlers used improved water sources for drinking water, and 26 (61.9%) used unimproved sources such as unprotected springs, wells, or surface water.

Table 2 shows the distribution of nutritional status for toddlers 6 - 24 months in 10 stunting locus villages, Sumedang Regency 2020. Based on the TB/U score (HAZ), 30 (71.4%) toddlers are normal, and 12 (28.6%) are stunted. According to BB/U (WAZ), 35 (83.3%) are normal, and 7 (16.7%) are underweight. The results of BB/TB (weight for height) showed that 33 (83.3%) toddlers were normal and 9 (16.7%) were wasted.

Table 1. Frequency Distribution of water source and physical quality of water for Toddlers 6 - 24 months in 10 Stunting Locus Villages, Sumedang Regency, 2020

Water	Frequency	Presentation
Water source	-	-
Improved water source	16	38,1
Unimproved water source	26	61,9
Physical and aesthetic aspects		
Color	20	47,6
Taste	20	47,6
Cloudy	3	7,1
Odor	11	26,2

Table 2. Frequency Distribution of nutritional status for Toddlers 6 - 24 months in 10 Stunting Locus Villages, Sumedang Regency, 2020

TB/U score (HAZ)	Frequency	Presentation
Normal	30	71,4
Stunting	12	28,6
Total	42	100,0
BB/U (WAZ)	-	-
Normal weight	35	83,3
Underweight	7	16,7
BB/TB (Weight for Height)	-	-
Normal	33	83,3
Wasted	9	16,7

Table 3. Relationship between Water Quality and Nutritional Status of Toddlers Based on TB/U Z-score measurements

Water quality category	Nutritional status				Total		P Value	P value 95% CI	OR 95%CI
	Normal		Stunting						
	N	%	N	%	N	%			
Good Water quality	13	92,8	1	7,14	14	100	0,335	0,960	8,412
Poor Water quality	17	60,7	11	39,2	28	100			
Total	30	5,7	12	93,8	42	100,0			

Table 4. Relationship between Water Quality and Nutritional Status of Toddlers Based on Z-score BB/U measurements

Water quality category	Nutritional status				Total		P Value	P value 95% CI	OR 95%CI
	Normal weight		Underweight						
	N	%	N	%	N	%			
Good Water quality	13	92,8	1	7,14	14	100	0,242	0,178	3,545
Poor water quality	22	78,5	6	21,4	28	100			
Total	30	5,7	12	93,8	42	100,0			

Table 5. Relationship between Water Quality and Nutritional Status of Toddlers Based on Z-score measurements of BB/TB

Water quality category	Nutritional status				Total		P Value	P value 95% CI	OR 95%CI
	Normal		Wasting						
	N	%	N	%	N	%			
Good Water quality	12	92,8	2	7,14	14	100	0,425	0,122	2,00
Poor Water quality	21	78,5	7	21,4	28	100			
Total	30	5,7	12	93,8	42	100,0			

Table 3 shows that among 14 toddlers with good water quality, only one was stunted. Meanwhile, out of 28 toddlers with poor water quality, only 11 were stunted and 17 were not stunted (normal). The results showed that the highest number of stunted toddlers was from poor water quality. The p-value of 0.335 was greater than the α value of 0.005, showing that Ho is rejected. Therefore, there is a significant difference between water quality and nutritional status of toddlers based on the TB/U z-score results. The OR value shown by the "estimate" value is 8.412, showing that poor water quality is 8 times more to worsen nutritional status and cause toddlers under five.

Table 4 shows that among 14 toddlers with good water quality, one was underweight and 13 were normal. Meanwhile, out of 28 toddlers with poor water quality, 28 were underweight, and 6 were normal. These results suggested that the highest number of underweight toddlers were in conditions with poor water quality. The p-value of 0.242 was greater than the α value of 0.005, showing that Ho was rejected. Consequently, there was a significant difference between water quality and nutritional status of toddlers based on the results of the z-score BB/U and TB/U. The OR value shown by the "estimate" value was 3.545, showing that poor water quality was 3 times more likely to worsen nutritional status and cause toddlers under five to be underweight.

As shown in Table 5, among 14 toddlers with good water quality, 12 were categorized as normal and 2 as wasting. Meanwhile, out of the 28 toddlers with poor water quality, 7 were wasting and 21 were normal. This showed that the highest number of wasting toddlers were in water conditions with poor water quality. The p-value of 0.425 was greater than the α value of 0.005, showing that Ho is rejected. Consequently, there was a significant relationship

between water quality and nutritional status of toddlers based on the results of the z-score BB/TB and z-score BW/TB. The OR value shown by the "estimate" value was 2.00, showing that poor water quality was twice possible to make nutritional status worse and cause wasting of toddlers.

Based on statistical tests, the value of p=0.000 was obtained, showing a relationship between water quality and nutritional status of toddlers under five according to the results of z-score TB/U, BB/U, and TB/BB, as shown in Table 3. TB/U Z-score measurement reported that among 14 toddlers with good water sanitation, only one was stunted. Meanwhile, out of the 28 toddlers with poor water quality, 11 were stunted and 17 did not experience stunting.

4. Discussion

Table 3 shows that among the 14 toddlers with good water sanitation, only one was stunted. Meanwhile, out of 28 toddlers with poor water quality, 11 were stunted and 17 did not experience stunting. This showed that the highest number of stunted toddlers was obtained in poor water conditions. Similarly, a previous investigation reported that the prevalence of malnutrition in toddlers varied significantly between access to WASH (water, sanitation, and hygiene) facilities. Toddlers from households without access to WASH facilities had the highest prevalence of malnutrition [27]-[29].

The impact of sanitation affected nutritional status of stunted toddlers [27]. Based on the type of water, those who used basic water compared to surface water were more prone to experience stunting [30]. Malnutrition and infectious diseases, including diarrhea, increased the death rate caused by inadequate access to WASH [31].

Various factors contribute to the prevalence of stunting among toddlers, including an unsupportive environment that allows for occurrence of diseases. This phenomenon leads to the disruption of the absorption of food nutrients, thereby causing malnutrition. In addition to sanitation, infectious diseases are also contributing factors leading to stunting [12], [18]-[20], [28].

Table 4 shows that among the 14 toddlers with good water quality, one was underweight and 13 were normal. Meanwhile, out of the 28 toddlers with poor water quality, 28 were underweight and 6 were normal. This showed that the highest number of underweight toddlers were in water with poor conditions. Toddlers who did not have basic sanitation facilities in the household increased the prevalence of underweight much more [27].

Water quality is essential for ensuring safe consumption, as contamination by harmful substances can lead to waterborne diseases. Access to clean water is fundamental for health, with waterborne diseases causing chronic diarrhea, malabsorption of nutrients, and malnutrition, specifically among toddlers [24]. This phenomenon creates a vicious cycle, with malnutrition weakening the immune system, and increasing vulnerability to infections, which further exacerbate malnutrition. Furthermore, poor water quality in areas lacking sanitation increases the risk of waterborne diseases and malnutrition. Disease-causing bacteria identified in feces can affect toddlers living in areas with poor sanitation facilities and water supplies. In the past, epidemiologists have mostly focused on the role that water and sanitation play in acute medical disorders such as diarrheal episodes or helminth infections spread through the soil. However, the effects of inadequate water and sanitation extend beyond communicable diseases to chronic conditions such as malnourishment, impaired intestinal function, and immunosuppression. Although these diseases may not directly cause mortality, their contribution is significant in the prevalence of stunting, affecting childhood development and cognitive function [32]. Based on these results, reducing the rate of malnutrition is significantly influenced by water access and sanitation.

Table 4 shows that among the 14 toddlers with good water quality, 2 were normal and 12 were underweight. Meanwhile, out of 28 toddlers with poor water sanitation, 7 were underweight and 21 were normal. This shows that the highest number of underweight toddlers were in poor water conditions. Factors that can cause underweight include environmental, socio-economic, and source of knowledge. Malnutrition has several classifications of causes, such as protein-energy, and anemia and so on, which may be triggered by poor sanitation [27], [33]-[36].

Many toddlers experience stunting and obesity as a result of consuming drinking water from unimproved and unsafe sources, such as unprotected springs or wells. A significant number of toddlers rely on wells for their drinking water. Moreover, ensuring safe drinking water is essential, as a fundamental requirement for sustaining life. In line with this, the United Nations adopted the SDG in 2015, aiming for equitable access to safe and affordable drinking water for all by 2030. Access to improved water and sanitation supports health, thereby reducing the prevalence of morbidity, mortality, and diarrhea among toddlers [26]. In terms of development and health, having access to clean drinking water is crucial on a local, regional, and national level. Previous investigations have shown in some areas that spending money on sanitation and water supply can result in a net economic advantage. This is because the savings on unfavorable health outcomes and medical expenses surpass the price of implementing the measures, as shown by expenditures ranging from significant water supply infrastructure to residential water treatment. Additionally, both in rural and urban settings, initiatives aimed at enhancing access to clean water benefit the impoverished and can be a useful component of policies designed to reduce poverty [24].

The maintenance of drinking water safety is crucial to prevent potential outbreaks of intestinal and other infectious diseases within community. Waterborne

diseases, capable of infecting a large segment of the population simultaneously, pose a significant threat. In addition to fecal transmission, other microbiological risks such as toxic cyanobacteria, Legionella, and guinea worms can impact public health. Although water is the main source of infectious organisms, diseases can also spread through direct contact, food ingestion, and inhalation of droplets. Changes in the appearance, taste, or odor of drinking water show flaws in treatment processes or variations in raw water quality. Water coloration due to industrial waste or metals such as iron can prompt consumers to seek alternative, potentially unsafe sources. The ideal color for drinking water is colorless. Odors in water are typically caused by organic materials, with some associated with industrial pollution or increased biological activity. Taste issues in drinking water are a combined impression of chemicals sensed by taste and smell [24].

5. Conclusions

In conclusion, this study showed the importance of understanding the impact of water quality on the development of Indonesian toddlers under the age of five. The results obtained offered valuable recommendations for community, particularly those in villages facing limited water availability and facilities. Furthermore, proper maintenance of water quality was found to be a crucial factor in reducing the growth of microorganisms capable of hindering toddlers' ability to absorb nutrition, contributing to stunting and other forms of malnutrition. The emphasis on good water quality was a key strategy to uphold health and nutrition, representing the most effective method to prevent stunting in vulnerable community. Collaborative efforts among state authorities, non-governmental organizations, and local health administrators are essential to enhance drinking water quality. These efforts should focus on high-risk groups within villages to reduce the adverse effects of relying on unimproved water sources.

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