

Morrin Choirunnisa Thohira

Manuscript Template_JPHTCR

 Manuscript

Document Details

Submission ID

trn:oid:::3618:144078027

Submission Date

Jun 24, 2026, 2:48 PM GMT+8

Download Date

Jun 24, 2026, 2:51 PM GMT+8

File Name

Manuscript Template_JPHTCR.docx

File Size

732.5 KB

12 Pages**4,902 Words****29,761 Characters**

14% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

- Bibliography
- Quoted Text
- Small Matches (less than 8 words)

Match Groups

-  **64 Not Cited or Quoted 14%**
Matches with neither in-text citation nor quotation marks
-  **1 Missing Quotations 0%**
Matches that are still very similar to source material
-  **0 Missing Citation 0%**
Matches that have quotation marks, but no in-text citation
-  **0 Cited and Quoted 0%**
Matches with in-text citation present, but no quotation marks

Top Sources

- 0%  Internet sources
- 14%  Publications
- 0%  Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

Match Groups

- 64 Not Cited or Quoted** 14%
Matches with neither in-text citation nor quotation marks
- 1 Missing Quotations** 0%
Matches that are still very similar to source material
- 0 Missing Citation** 0%
Matches that have quotation marks, but no in-text citation
- 0 Cited and Quoted** 0%
Matches with in-text citation present, but no quotation marks

Top Sources

- 0% Internet sources
- 14% Publications
- 0% Submitted works (Student Papers)

Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	Publication	Nora Wulandari, Rachmadiani Sukma Hanifa, Spyros Balafas, Muhamad Syaripu...	1%
2	Publication	Yoyerdy Agusmal Saputra, Mona Lisa, Nailul Hikmi, Septiria Irawati, Achmad Rizki ...	1%
3	Publication	Rabiatul Adawiah, Dewi Susanna. "Analysis of Environmental and Sociodemograp...	<1%
4	Publication	Fathurrahman Fathurrahman, Magdalena Magdalena, Siti Mas'odah, Hammad H...	<1%
5	Publication	"1st Annual Conference of Midwifery", Walter de Gruyter GmbH, 2020	<1%
6	Publication	Christiana Rialine Titaley, Dwi Hapsari Tjandrarini, Maxwell Landri Vers Malakaus...	<1%
7	Publication	Agustina, Olga Mariana Dukabain, Siprianus Singga, Wanti Wanti, Debora G. Sulu...	<1%
8	Publication	Fadhaa Aditya Kautsar Murti, Nursalam Nursalam, Christina Yeni Kustanti, Lisa M...	<1%
9	Publication	Anick Bérard, Shannon Strom, Jin-Ping Zhao, Shashi Kori, Detlef Albrecht. "Dihydr...	<1%
10	Publication	Diah Yunitawati, Marizka Khairunnisa, Donny Kristanto Mulyantoro, Hadi Ashar, ...	<1%

11	Publication	M N Hayati, I Purnamasari, S Wahyuningsih. "Analysis of spatial autocorrelation o...	<1%
12	Publication	K Chatsantiprapa. "Host and environment factors for exposure to poisons: a case-...	<1%
13	Publication	I-Hung Lin, Chia-Yi Lee, Jiann-Torng Chen, Yi-Hao Chen et al. "Predisposing Factor...	<1%
14	Publication	Xiaolong Bai, Zhijun Wang, Ziyi Cao, Junping Zhen. "Quantifying the metabolic-inf...	<1%
15	Publication	"Data Science and Emerging Technologies", Springer Science and Business Media ...	<1%
16	Publication	Maria F. De la Cerda-Vargas, Pedro Navarro-Dominguez, Elizabeth Meza-Mata, Me...	<1%
17	Publication	Atik Choirul Hidayah, Erni Astutik. "ANALYSIS OF DIARRHEA MANAGEMENT IN CHI...	<1%
18	Publication	M. Resha Febriansyah, Mona Nulanda, Widyaningrum Widyaningrum. "LITERATU...	<1%
19	Publication	Rina Nuraeni, Suharno Suharno. "Relationship Between Family Socio-Economic St...	<1%
20	Publication	Sophia Rasheeqa Ismail, Ranina Radzi, Puteri Sofia Nadira Megat Kamaruddin, Ez...	<1%
21	Publication	Ahmad Khumaidi Annaja, Martya Rahmaniati Makful, Zainul Khaqiqi Nantabah. "...	<1%
22	Publication	Bambang Murwanto, Imam Santosa, Daria Br Ginting, Sutarto Sutarto. "The Role ...	<1%
23	Publication	Claude Gaultier, Jorge Gallego. "Development of respiratory control: Evolving con...	<1%
24	Publication	Hawra Alshula, Kawther Alawami, Hawra Abdullatif, Zahra Alhamood et al. "Risk f...	<1%

25	Publication	Merita Eka Rahmuniyati, Sri Sahayati. "IMPLEMENTASI PROGRAM SANITASI TOTA...	<1%
26	Publication	Veramita Nanda Pradana, Suparmi Suparmi, Ratnawati Ratnawati. "Personal Higi...	<1%
27	Publication	"Hubungan Kelayakan Sumber Air Minum Terhadap Kejadian Diare pada Anak Ba...	<1%
28	Publication	Abiyu Abadi Tareke, Ermias Bekele Enyew, Bayley Adane Takele. "Pooled prevalen...	<1%
29	Publication	Amedetsion Abate Ali, Ewenat Geberehana, Fatimetu Mohamed, Belay Bekretsio...	<1%
30	Publication	Biniyam Sahiledengle, Pammla Petrucka, Abera Kumie, Lillian Mwanri et al. "Asso...	<1%
31	Publication	Daniel J Hoffman, Alessandra D Sommer. "Does the Lens through Which We View ...	<1%
32	Publication	Dingwen Xu, Zhihua Lu, Huishen Yan, Zhe Yang. "Rising burden of fall-induced hi...	<1%
33	Publication	Fenita Purnama Sari Indah, Tita Cardiah, Azwar Rahmat, Kuswarini Sulandjari, An...	<1%
34	Publication	Hailemariam Mekonnen Workie, Abdilahi Sharifnur Sharifabdilahi, Esubalew Muc...	<1%
35	Publication	Hasanudin, Tjitrowati Djaafar, Saharudin, Andi Bungawati. "Factors related to th...	<1%
36	Publication	Jean Baptiste NIYOMBABAZI, Viateur Hategekimana, Simeon Sibomana, Aimable ...	<1%
37	Publication	Luping Zhao, Guanjie Cao, Zhitao Shi, Jingjing Xu, Hao Yu, Zecan Weng, Sen Mao, ...	<1%
38	Publication	Mengjiao Xie, Yang Song, Jing Tao, Mengnan Jiang, Yang Liu, Io Hong Cheong, Zisi...	<1%

39	Publication	Mery Astri Yanni, D. Daniel, Anindrya Nastiti. "Environmental health risks (EHR) a...	<1%
40	Publication	Muhammad Addin Rizaldi. "Assessment of Microplastic Pollution in Surface Water...	<1%
41	Publication	Olivier Uwishema, Lydia Daniel Bisetegn, Pascaline Munezero, Courage Chandipw...	<1%
42	Publication	Ruifang Fan. "The Innovation of Multimedia Art Teaching Curriculum Design Base...	<1%
43	Publication	Taufik Anwar, Slamet Slamet, Slamet Wardoyo. "Domestic wastewater treatment ...	<1%



JOURNAL OF PUBLIC HEALTH FOR TROPICAL AND COASTAL REGION (JPHTCR)

Journal homepage: <http://ejournal2.undip.ac.id/index.php/jphtr/index>
ISSN : 2597-438

Environmental Risk Factors Associated with Diarrhea in East Kalimantan Province, Indonesia

Muhammad Aidil Fitrah^{1*}, Ayudhia Rachmawati¹, Vivi Filia Elvira¹, Morrin Choirunnisa Thohira¹, Syamsir Syamsir¹

¹Department of Environmental Health, Faculty of Public Health, Universitas Mulawarman, Samarinda City, Indonesia

*Corresponding Author: Email: aidilfitriah@fkm.unmul.ac.id

Abstract

Introduction: Diarrhea continues to be a major global public health concern, contributing substantially to morbidity and mortality. Environmental factors, including inadequate sanitation infrastructure and poor hygiene practices, play a significant role in increasing the risk of diarrhea. This study aims to analyze the relationship between environmental factors and the incidence of diarrhea in East Kalimantan Province based on big data from the 2023 Indonesian Health Survey (SKI-Survei Kesehatan Indonesia).

Methods : This study employed a cross-sectional design using secondary data from 15,854 SKI respondents. Variables included gender, education, drinking water sources, water quality and treatment, storage containers, wastewater disposal, waste management, sanitation access, and hygiene practices. Data were analyzed using Chi-square and logistic regression to determine independent environmental factors influencing diarrhea incidence.

Results: The prevalence of diarrhea was 2.1%. Bivariate analysis showed a significant association between the incidence of diarrhea and education ($p=0.001$), drinking water source ($p=0.003$), physical quality of drinking water ($p=0.000$), raw water source ($p=0.012$), waste management ($p=0.002$), and sanitation hygiene ($p=0.000$). In the models of multivariable logistic regression analysis, it was found that physical quality of drinking water ($AOR=2.058$; $p<0.001$), level of education ($AOR=2.008$; $p<0.001$), and waste management ($AOR=1.276$; $p=0.032$) were the main determinants of diarrhea incidence.

Conclusion: Poor drinking water quality, low levels of education, and inadequate waste management increase the risk of diarrhea in East Kalimantan. Efforts to improve water quality, environmental health education, and household-based waste management need to be strengthened to reduce the incidence of diarrhea.

Keywords: Diarrhea, East Kalimantan, Environmental Factors, Indonesian Health Survey, Logistic regression.

Introduction

Environmental quality in residential areas is closely related to the incidence of environmental diseases, one of which is diarrhea. Globally, diarrhea is the second leading cause of death, with approximately 75% of deaths occurring in people over the age of 5, especially in the elderly aged 70 and above¹. The number of deaths due to diarrheal diseases in children under five years of age reaches approximately 443,832 cases annually^{2,3}. In

Indonesia, diarrhea remains the leading cause of death among toddlers. Diarrhea can affect all age groups, but the elderly and toddlers are among the most vulnerable populations. This is due to the decline in physiological function in the elderly and the still suboptimal immune system in toddlers, making both groups more susceptible to diarrhea.⁴

Diarrhea is an infectious disease that has a significant impact on public health, especially among vulnerable groups such as toddlers and the elderly. In toddlers, this condition can cause drastic fluid loss and interfere with the absorption of essential nutrients, often leading to an increased risk of malnutrition and stunting⁵⁻⁸. Several studies show that recurrent diarrhea in toddlers is statistically correlated with linear growth disorders, which, in the long term, have an impact on chronic nutritional status. Meanwhile, in the elderly, severe diarrheal infections such as cholera can cause serious complications, such as severe dehydration, hypokalemia, and metabolic acidosis, which require intensive treatment. Environmental, social, and behavioral factors have been shown to play an important role in increasing the risk of diarrhea, including access to clean water, hand washing habits, and the level of public knowledge about basic sanitation practices.⁹ In addition, physical aspects of the environment such as drinking water sources and quality, water storage methods, availability of family toilets, and types of flooring in homes also influence the prevalence of diarrhea in various regions^{10,11}.

East Kalimantan Province has unique environmental characteristics that can directly or indirectly affect the health of its population. Varied topography, high rainfall, and limited access to clean water and sanitation in rural and coastal areas pose particular challenges in controlling environmental diseases such as diarrhea¹². In addition, 75.56% of the raw water supply in East Kalimantan Province still comes from rivers¹³. Human activities such as domestic and industrial waste disposal increase the potential for river pollution, which has an impact on water quality. Meanwhile, in terms of waste management in East Kalimantan Province, there are 11 landfills, with the total waste generated in 2025 reaching 2,287.97 tons/day and 835,108.87 tons/year¹⁴.

The gap in sanitation infrastructure distribution efforts and the uneven adoption of clean and healthy living behaviors are important risk factors that need to be analyzed further. The use of data from the 2023 Indonesian Health Survey (SKI) is relevant because it provides the latest and most comprehensive data on physical environmental conditions, community behaviors, and the health status of the population throughout Indonesia, including East Kalimantan Province. In addition, the large sample size in the SKI data reduces the possibility of errors in generalization. Thus, the data is able to represent the target population of the study more accurately. The 2023 SKI data enables more targeted analysis of various environmental determinants related to diarrhea cases, thereby providing an evidence-based foundation for formulating more targeted environmental health intervention policies.

Methods

Research Design

This study used secondary data derived from the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia/SKI), a nationally representative cross-sectional survey conducted by the Ministry of Health of the Republic of Indonesia. The SKI collects comprehensive data on health status, determinants, and health-related behaviors to support evidence-based policy development and program evaluation. For the present analysis, only respondents from East Kalimantan Province were included.

A total of 15,854 respondents from East Kalimantan with complete data on diarrhea incidence, environmental conditions, and hygiene practices were analyzed. The independent variables comprised drinking water source, physical quality of drinking water, water treatment practices, drinking water storage, raw water source, sanitation access, wastewater disposal, solid waste management, and sanitation hygiene behavior. The dependent variable was the incidence of diarrhea.

Variable Classification

Environmental variables were categorized based on operational definitions adopted in the Indonesian Health Survey (SKI) 2023. The classification was further aligned with national environmental health regulations and international recommendations, including WHO/UNICEF Joint Monitoring Programme (JMP) indicators for drinking water, sanitation, and hygiene. Detailed classifications are presented in Table 1.

Table 1. Variable Classification

No	Variable	Category	Criteria by SKI Instrument
1	Diarrhea	Yes	Diagnosed with diarrhea by health worker within the last 2 weeks–1 month
		No	Respondents without a reported diagnosis during the same period were classified as not having diarrhea.
2	Gender	Male Female	Based on the respondent's self-identified gender
3	Education Level	Low High	Did not complete junior high school Completed senior high school or obtained a bachelor's degree;
4	Source of Drinking Water	Unsafe	Unprotected dug wells, unprotected springs, hydrants, water terminals, retail water, surface water (rivers/lakes/irrigation), and rainwater
		Safe	Bottled water, refillable water, tap water, protected dug wells, protected springs, drilled wells/pumps
5	Physical Quality of Drinking Water	Not Qualified Standars	Cloudy, colored, tastes bad, foamy, or smells unpleasant
		Qualified Standars	Clear, colorless, tasteless, non-foamy, odorless;
6	Drinking Water Treatment	Not Treated	Water only filtered or treated with chemicals without heating
		Treated	Water boiled or treated with UV before consumption
7	Drinking Water Storage	Unsafe	Stored in uncovered containers (bucket/pot/teapot without lid)
		Safe	Stored in covered containers (bucket/gallon with lid)
8	Raw Water Source	Unsafe	Unprotected wells, rainwater, surface water, water terminals, hydrants, or retail water
		Safe	Protected wells/springs or boreholes/pumps
9	Wastewater Dumping	Unsafe	Wastewater discharged into open drains, ground, ditches, or rivers
		Safe	Wastewater channeled into closed sewers or reservoirs;
10	Waste Management	Not Proper	Waste dumped into rivers/ditches, burned, buried, or disposed of indiscriminately
		Proper	Waste disposed of properly (to TPS, recycled, composted, or to waste bank)

11	Sanitation Access	Not Viable	No toilet, shared/unusable toilet, open-top toilet, or disposal of feces in open environments (garden, field, river, etc.)
		Viable	Has private toilet with swan-neck bowl and septic tank/WWTP
12	Sanitation Hygiene	Poor	Facilities unavailable or lack clean water and soap
		Good	Handwashing facilities available with clean water and soap / detergent / antiseptic

Safe environmental health factors are classified according to the WHO/UNICEF JMP criteria and Indonesian environmental health regulations. Improved sanitation facilities are classified according to the Indonesian Community-Based Total Sanitation (CBS) framework.

Statistic Analysis

Data are presented in the form of frequencies and percentages based on the results of risk variable classification and diarrhea incidence. Only respondents with complete information on all variables included in the analysis were retained. Records with missing data on diarrhea status or environmental variables were excluded prior to statistical analysis. Bivariate analysis uses the Chi-Square test to determine the relationship between independent and dependent variables. A p-value <0.050 indicates a relationship between the variables. Furthermore, variables with a P-value <0.250 were multivariable analysis using backward stepwise conditional logistic regression. Multivariable logistic regression was performed using the backward likelihood ratio (Backward LR) method to identify the most parsimonious model and determine independent predictors of diarrhea incidence. All analyses were performed using SPSS 26.0 (IBM Corporation, NY, USA).

Result

The frequency distribution of diarrhea incidence and environmental risk factors among respondents is presented in Table 2. All variables included in the analysis had complete data after data cleaning; therefore, no missing values were present in the final analytical dataset.

Table 2. Frequency Distribution of Risk Factors for Diarrhea in East Kalimantan in 2023 (n: 15,854)

Variable		Totals	Percent (%)
Incidence of Diarrhea	Diarrhea	326	2.1
	No Diarrhea	15528	97.9
Gender	Male	7434	46.9
	Female	8420	53.1
Education	Low (No School – Junior High School)	10312	65.0
	High (Senior Hght School – Bachelor degree)	5542	35.0
Source of Drinking Water	Unsafe	1107	7.0
	Safe	14747	93.0
Physical Quality of Drinking Water	Not Qualified Standars	801	5.1
	Qualified Standars	15053	94.9
Drinking Water Treatment	Not Treated	10761	67.9
	Treated	5093	32.1

Drinking Water Storage	Unsafe	2748	17.3
	Safe	13106	82.7
Raw Water Source	Unsafe	2616	16.5
	Safe	13238	83.5
Wastewater Dumping	Unsafe	14183	89.5
	Safe	1671	10.5
Waste Management	Not Proper	6271	39.6
	Proper	9583	60.4
Sanitation Access	Not Viable	229	1.4
	Viable	15625	98.6
Sanitation Hygiene	Poor	1697	10.7
	Good	14157	89.3

Table 2 shows the frequency distribution of risk factors for diarrhea among 15,854 respondents in East Kalimantan in 2023. The prevalence of diarrhea was recorded at 2.1%, while 97.9% of respondents did not experience diarrhea. Respondents were predominantly female (53.1%) compared to male (46.9%). The majority had a low level of education (65.0%), with the remainder having a high level of education (35.0%). Most respondents used safe drinking water sources (93.0%), and 94.9% of the drinking water used met physical requirements. However, 67.9% of respondents did not treat drinking water before consumption, and only 32.1% treated drinking water.

A total of 82.7% of respondents store drinking water in closed containers, while 17.3% still use open containers. Regarding raw water sources, 16.5% of respondents rely on risky sources. Most liquid waste disposal systems are open storage (89.5%), while closed storage is only used by 10.5% of respondents. In terms of waste management, 60.4% of respondents reported proper management, while 39.6% did not manage waste properly. The majority of respondents have access to adequate sanitation (98.6%) and maintain good personal hygiene (89.3%), although 10.7% still have poor personal sanitation conditions. These findings provide an overview of the distribution of risk factors associated with diarrhea in the region. Table 3 shows the distribution of environmental risk factors related to diarrhea incidence.

Table 3. Relationship between Risk Factors for Diarrhea Incidence in East Kalimantan in 2023

Variable	Incidence of Diarrhea				OR (95% CI)	P Value
	Diarrhea		No Diarrhea			
	n	%	n	%		
Gender						
Male	147	45.1	7278	46.9	0.926 (0,745-1.158)	0.548
Female	179	54.9	8241	53.1		
Education						
Low (No School – Junior High School)	259	79.4	10053	64.7	2.105 (1.606-2.760)	0.000
High (Senior Hght School – Bachelor degree)	67	20.6	5475	35.3		
Source of Drinking Water						
Unsafe	37	11.3	1070	6.9	1.730 (1.222-2.450)	0.003
Safe	289	88.7	14458	93.1		
Physical Quality of Drinking Water						
Not Qualified Standars	33	10.1	768	4.9	2.165 (1.499-3.125)	0.000
Qualified Standars	293	89.6	14760	95.1		

Drinking Water Treatment						
Not Treated	214	65.6	10547	67.9	0.902 (0.716-1.137)	0.417
Treated	112	34.4	4981	32.1		
Drinking Water Storage						
Unsafe	66	20.2	2682	17.3	1.216 (0.925 –1.598)	0.184
Safe	260	79.8	12846	82.7		
Raw Water Source						
Unsafe	71	21.8	2545	16.4	1.420 (1.088-1.854)	0.012
Safe	255	78.2	12983	83.6		
Wastewater Dumping						
Unsafe	289	88.7	13894	89.5	0.919 (0.650-1.298)	0.697
Safe	37	11.3	1634	10.5		
Waste Management						
Not Proper	157	48.2	6114	39.4	1.430 (1.148-1.172)	0.002
Proper	169	51.8	9414	60.6		
Sanitation Access						
Not Viable	9	2.8	220	1.4	1.976 (1.005-3.883)	0.075
Viable	317	97.2	15308	98.6		
Sanitation Hygiene						
Poor	41	12.6	1656	10.7	1.236 (1.194-1.278)	0.000
Good	285	87.4	13872	89.3		

Bivariate analysis results show that several variables have a statistically significant relationship with the incidence of diarrhea, including education level (OR=2.105; 95% CI: 1.606–2.760; p=0.001), risky drinking water sources (OR=1.730; 95% CI: 1.222–2.450; p=0.003), and substandard physical quality of drinking water (OR=2.165; 95% CI: 1.499–3.125; p=0.000), use of risky raw water sources (OR=1.420; 95% CI: 1.088–1.854; p=0.012), improper waste management (OR=1.430; 95% CI: 1.148–1.172; p=0.002), and poor sanitation hygiene (OR=1.236; 95% CI: 1.194–1.278; p=0.000).

Meanwhile, variables that did not show a significant relationship with the incidence of diarrhea included gender (p=0.548), drinking water treatment (p=0.417), type of drinking water storage container (p=0.184), liquid waste disposal (p=0.697), and access to sanitation (p=0.075). All variables with p-values <0.25 will be included in the multivariate analysis to identify the most influential independent factors on the incidence of diarrhea. Table 4 presents the adjusted odds ratios (AORs) for both models.

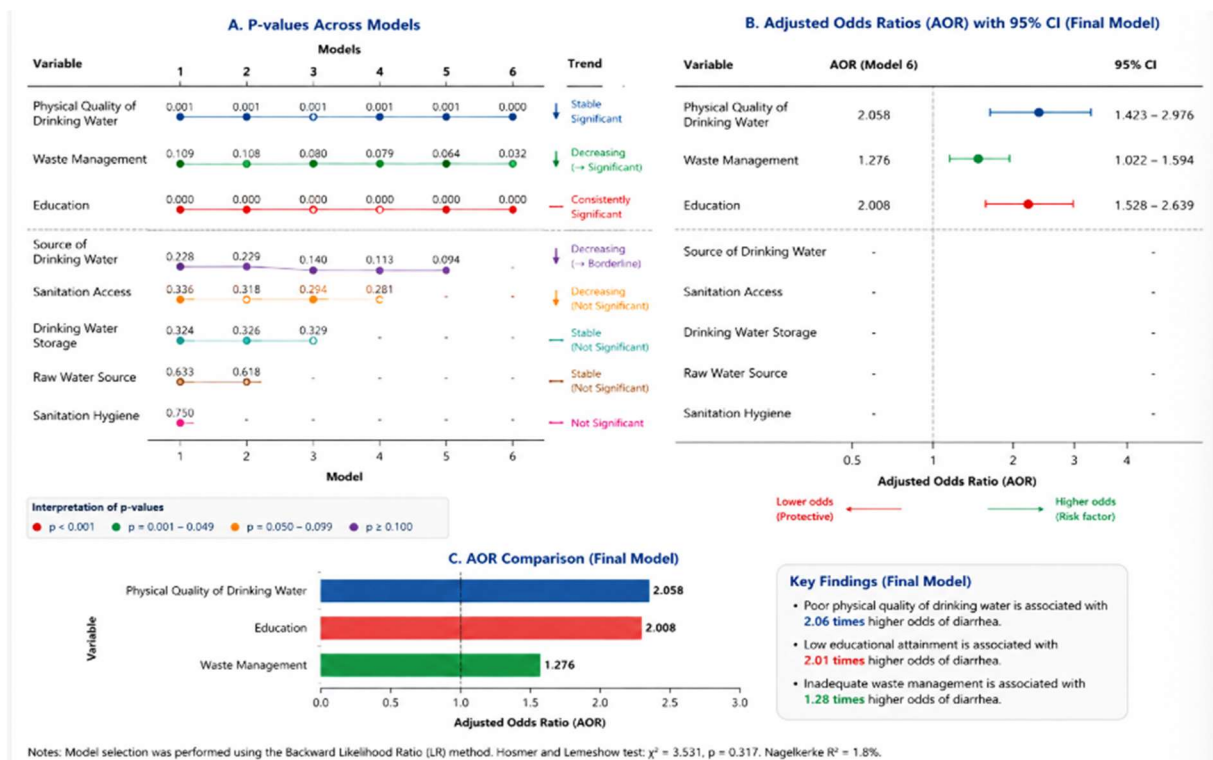


Figure 1. Logistic Regression Model of the Effect of Environmental Factors on the Incidence of Diarrhea

Picture 1 shows the results of binary logistic regression using the Odds Ratio technique to evaluate environmental factors associated with diarrhea. Three factors remained significant in the final model: physical quality of drinking water, solid waste management, and education level. Substandard physical quality of drinking water was significantly correlated with an increased risk of diarrhea (AOR = 2.058; 95% CI: 1.423–2.976; $p=0.000$). Inadequate waste management showed a significant correlation (AOR = 1.276; 95% CI: 1.022–1.594; $p=0.032$), but low education levels were associated with a twofold increase in the frequency of diarrhea (AOR = 2.008; 95% CI: 1.528–2.639; $p=0.000$). Additional factors, such as access to sanitation, water storage containers, raw water supply, and hygiene, were removed from the final model due to insufficient statistical significance. The model showed satisfactory fit with the data, as evidenced by the Hosmer and Lemeshow goodness-of-fit test ($\chi^2 = 3.531$, $p = 0.317$), but the overall variance explained was minimal (Nagelkerke $R^2 = 1.8\%$).

Discussion

The results of the study show that the prevalence of diarrhea in East Kalimantan Province in 2023 is 2.1%. This figure is relatively low compared to the national average of 4.3%, but diarrhea remains an important issue in the context of environmental health in the community. Diarrhea accounts for 21% of annual deaths among children under five in developing countries. Although most households in East Kalimantan have access to adequate sanitation and good physical quality drinking water, the analysis shows that there are environmental factors that contribute significantly to the incidence of diarrhea, namely the physical quality of drinking water, waste management, and education levels.

The physical quality of drinking water has been proven to be the most dominant factor influencing an increased risk of diarrhea (AOR = 2,058; CI 95%: 1,423–2,976). Drinking water that does not meet physical standards, such as being cloudy, smelly, or discolored, indicates the possibility of microbiological contamination that causes

diarrhea, such as *Escherichia coli* and *Vibrio cholerae* ¹⁵. This condition is in line with the characteristics of East Kalimantan, where most of the raw water sources come from rivers that are highly vulnerable to pollution from domestic and industrial activities ^{16,17}. These results also reinforce previous research by Girma et al. (2024) which showed that poor water quality is closely related to the incidence of diarrhea and the risk of stunting in toddlers. Therefore, improving household drinking water treatment systems and monitoring raw water sources should be a priority in environmental health policies.

In addition to the physical quality of drinking water, improper waste management is also significantly associated with the incidence of diarrhea (AOR = 1.276; 95% CI: 1.022–1.594). Households that do not manage waste properly have the potential to create an environment that supports the development of vectors, especially flies, which can spread bacteria that cause diarrhea to water sources. Around 39.6% of households in East Kalimantan still practice improper waste management, such as burning, hoarding, or dumping waste into rivers, while 60.4% have been managing waste properly through transportation to waste collection sites, recycling, or waste banks. Improperly managed waste becomes a breeding ground for disease vectors such as flies, which can carry bacteria that cause diarrhea (*Escherichia coli*, *Vibrio cholerae*) to water sources and food ^{11,19}. Data from the Ministry of Environment and Forestry of Indonesia in 2024 shows that more than 1,700 tons of waste are produced every day in East Kalimantan (Ministry of Environment and Forestry ²⁰. On the other hand, the limited capacity of landfills poses a major challenge to the solid waste management system. Efforts to strengthen community-based waste management, such as waste banks and recycling, need to be increased so that the risk of environment-related diseases caused by improper waste management can be minimized ²¹.

A good solid waste management system plays an important role in controlling environment-based diseases. When waste is not managed properly, for example through open dumping, uncontrolled burning, or disposal into waterways, it can become a breeding ground for vectors (including flies, mosquitoes, and rats) and a source of water and soil pollution. For example, a study in informal settlements in Tanzania found that inadequate waste collection and limited disposal facilities were significantly associated with the burden of infectious diseases such as diarrhea and cholera ²². Strengthening community-based waste management systems is important to reduce the risk of environmental contamination. Waste bank programs, household waste sorting based on the 3R concept (reduce, reuse, recycle), and optimization of landfill/transfer station facilities can support efforts to prevent environment-based diseases. Support from community leaders such as neighborhood association heads and village environmental health officers also plays an important role in the implementation of waste management in the community ²³.

Furthermore, low educational attainment was a significant social factor influencing the incidence of diarrhea (AOR = 2.008; CI 95%: 1.528–2.639). Respondents with low educational attainment were twice as likely to experience diarrhea compared to those with high educational attainment. These findings are consistent with the results of previous studies ²⁴ which states that education level is an important determinant in the distribution of diarrheal diseases, especially in families with toddlers. Education plays an important role in shaping clean and healthy living behaviors (PHBS), including hand washing, water treatment, and maintaining environmental hygiene. Low education levels imply low public awareness of basic sanitation practices, thereby increasing the risk of transmission of environment-based

diseases^{25,26}. Which states that education level is an important determinant in the distribution of diarrheal diseases, especially in families with toddlers. Education plays an important role in shaping clean and healthy living behaviors (PHBS), including hand washing, water treatment, and maintaining environmental hygiene. Low education levels imply low public awareness of basic sanitation practices, thereby increasing the risk of transmission of environment-based diseases.

Meanwhile, several other variables, such as gender, drinking water treatment, water storage containers, access to sanitation, and liquid waste disposal, did not show a statistically significant relationship with the incidence of diarrhea. This can be explained by the fact that most of the population of East Kalimantan already has access to adequate sanitation (98.6%) and good drinking water storage practices (82.7%), so these factors are no longer strong differentiators in the analysis model. However, these variables remain important to consider as part of a comprehensive environmental health control system. Based on research²⁷ Liquid waste, access to toilets, and drinking water management are related to the incidence of diarrhea, where the implementation of a good Community-Based Total Sanitation program can reduce the risk of diarrhea in the community.

An interesting finding regarding the wastewater management system is that most households in East Kalimantan still dispose of wastewater openly (89.5%), such as dumping kitchen and bathroom waste directly into gutters, soil, or water bodies such as rivers. Only a small proportion (10.5%) use closed channels or reservoirs. The results of the study show that wastewater management is not significantly related to the incidence of diarrhea ($p = 0.697$). This is likely because most households already have access to adequate sanitation (98.6%), so wastewater is not a major distinguishing factor. However, ecologically, open disposal systems still have the potential to reduce surface water quality and create an environment conducive to the growth of pathogenic microorganisms. Therefore, the development of household wastewater management systems (IPAL) and closed channels is still necessary, especially in densely populated and coastal areas^{11,28}.

Data analysis shows that the incidence of diarrhea in East Kalimantan Province is greatly influenced by drinking water quality, waste management, and community hygiene practices. Therefore, improving access to and the quality of clean water is a top priority. The equitable distribution of safe drinking water infrastructure, especially in rural and coastal areas, needs to be accompanied by education on household drinking water treatment (PAMRT), such as boiling water or using simple filters, based on data from the Indonesian Demographic and Health Survey (SDKI), household drinking water treatment (PAMRT) behavior has shown a downward trend over the past decade. In 2007, around 91% of households still practiced PAMRT, but this figure decreased to 70% in 2017²⁹. One of the factors causing this decline is the increase in consumption of bottled drinking water, which has led to the assumption that people no longer need to treat their drinking water. However, bottled drinking water cannot always be categorized as safe drinking water, especially if the distribution and storage processes do not meet hygiene standards³⁰.

Overall, diarrhea prevention in East Kalimantan needs to focus on improving clean water facilities, sustainable waste management, and public hygiene education. Further research with a longitudinal design is recommended to assess the effectiveness of interventions and the causal relationship between environmental factors and the incidence of diarrhea. However, this study has limitations in that the logistic regression model shows that these three significant factors can only explain 1.8% of the variation in diarrhea incidence (Nagelkerke $R^2 = 1.8\%$). This indicates that

there are other factors not covered in the model, such as behavioral aspects, climate, and geographical conditions that may play a role in increasing the risk of diarrhea. Therefore, diarrhea control interventions need to be carried out comprehensively through a multi-sectoral approach that combines technical environmental aspects, community behavior, and health education. Given the large sample size and the nationally standardized survey methodology, the findings are likely to be representative of the population of East Kalimantan Province.

Conclusion

This study shows that the prevalence of diarrhea in East Kalimantan in 2023 is 2.1%, lower than the national average. factors that significantly influence the incidence of diarrhea are the physical quality of drinking water, waste management, and education levels. Prevention efforts need to focus on improving the quality of safe drinking water, sustainable waste management, and education on clean and healthy living behaviors through cross-sector collaboration.

Ethics approval

This study was conducted in accordance with established ethical review standards and received approval from the Health Research Ethics Committee (KEPK) of Poltekkes Jakarta II, Indonesia, as documented in approval letter No. LB.02.01.I/KE/L/287/2023 dated May 10, 2023. The 2023 Indonesian Health Survey (IHS) dataset can be accessed through the Ministry of Health's official data service portal at <https://layanandata.kemkes.go.id/>.

Acknowledgment

The author acknowledges the Ministry of Health of the Republic of Indonesia for granting access to the 2023 Indonesian Health Survey data used in this study.

Funding

None

Author Contribution

Conceptualization: MA Fitrah. Data curation: MC Thohira, Syamsir S. Methodology: MA Fitrah, Rachmawati A, . Project administration: MA Fitrah. Visualization: VF Elvira, Rachmawati A. Writing - original draft: VF Elvira, MA Fitrah. Writing- review & editing : Syamsir S, Rachmawati A

References

1. Zhao WZ, Wang JY, Zhang MN, Wu SN, Dai WJ, Yang XZ, et al. Global burden of diarrhea disease in the older adult and its attributable risk factors from 1990 to 2021: a comprehensive analysis from the global burden of disease study 2021. *Front Public Health*. 2025;13:1–12. doi:10.3389/fpubh.2025.1541492 PubMed PMID: 40255369.
2. Xie M, Song Y, Tao J, Jiang M, Liu Y, Cheong IH, et al. Global trends, age-period-cohort analysis, and future projections of diarrhea burden: Findings from the Global Burden of Disease Study 2021. *Biosaf Health*. 2025;7:295–305. doi:10.1016/j.bsheal.2025.09.005
3. World Health Organization. Diarrhoeal disease [Internet]. 2024 [cited 2025 Oct 21]. Available from: <https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease>
4. Sumolang PP, Nurjana MA, Widjaja J. Analisis Air Minum dan Perilaku Higienis dengan Kejadian Diare pada Lansia di Indonesia. *Media Penelitian dan Pengembangan Kesehatan*. 2019;29:99–106. doi:10.22435/mpk.v29i1.123

5. Salma TT, Santik YDP. Determinan manajemen diare pada balita di Indonesia Determinants of diarrhea management among children under five in Indonesia. *SAGO: Gizi dan Kesehatan*. 2024;5:320–9. doi:10.30867/sago.v5i2.1447
6. Situmeang IRVO. DIARE PADA ANAK. *IKRAITH-HUMANIORA*. 2024;8:471–6. doi:10.37817/ikraith-humaniora.v8i2
7. Irawan A, Hastuty HSB. Kualitas Fisik Air, Kejadian Diare Dengan Stunting Pada Balita di Puskesmas Arso Kota. *Jurnal Kesehatan Komunitas*. 2022;8:130–4. doi:10.25311/keskom.vol8.iss1.1119
8. Desyanti C, Nindya TS. Hubungan Riwayat Penyakit Diare dan Praktik Higiene dengan Kejadian Stunting pada Balita Usia 24-59 Bulan di Wilayah Kerja Puskesmas Simolawang, Surabaya. *Amerta Nutrition*. 2017;3:243–51. doi:10.2473/amnt.v1i3.2017.243-251
9. Kasmara DP, Sarli D. Faktor - Faktor yang Berhubungan dengan Kejadian Diare pada Balita. *JK JURNAL ILMU KESEHATAN*. 2023;7:93–103. doi:10.33757/jik.v7i1.659
10. Utami AP, Sudaryanto A. Kepatuhan Konsumsi Tablet Tambah Darah dengan Kejadian Anemia pada Remaja Putri. *JK (JURNAL ILMU KESEHATAN)*. 2025;9:104–10. doi:10.33757/jik.v9i1.1266
11. Fitrah MA, Saefurrohm MZ, Firmansyah YW. Exploring environmental risk factors for diarrhea: Evidence from the Indonesian Health Survey, 2023. *Environ Anal Health Toxicol*. 2026;41:e2026001. doi:10.5620/eaht.2026001
12. Yudo S, Hernaningsih T. KEBUTUHAN AIR BERSIH MASYARAKAT DI DAERAH PERDESAAN NELAYAN Di Wilayah Pesisir Kabupaten Pasir, Kalimantan Timur. *Jurnal Air Indonesia*. 2018;2:128–38. doi:10.29122/jai.v2i2.2302
13. Badan Pusat Statistik. Statistik Air Bersih Provinsi Kalimantan Timur. Vol. 23. Samarinda: Badan Pusat Statistik Provinsi Kalimantan Timur; 2024. 1–58 p.
14. Kementerian Lingkungan Hidup dan Kehutanan. Timbulan Sampah Tahun 2025. Jakarta; 2025.
15. Susanto N. Factors water characteristic as predicting diarrhea under 5 years. *Jurnal Riset Kesehatan*. 2021;10:12–8. doi:10.31983/jrk.v10i1.6494
16. Azwari F, Siahaya ME, Hadidjah K, Supriadi A, Benedicta CE. Analisis Kualitas Air Sungai Sepaku sebagai Penyedia Air Bersih di Ibu Kota Nusantara (IKN), Kalimantan Timur. *Jurnal Nusa Sylva*. 2025;25:33–41. doi:10.31938/jns.v25i1.797
17. BPS. Statistik Air Bersih Provinsi Kalimantan Timur 2023. Badan Pusat Statistik Provinsi Kalimantan Timur, editor. Badan Pusat Statistik Provinsi Kalimantan Timur; 2024.
18. Girma M, Hussein A, Norris T, Genye T, Tessema M, Bossuyt A, et al. Progress in Water, Sanitation and Hygiene (WASH) coverage and potential contribution to the decline in diarrhea and stunting in Ethiopia. *Matern Child Nutr*. 2024;20. doi:10.1111/mcn.13280 PubMed PMID: 34738323.
19. McClelland PH, Kenney CT, Palacardo F, Roberts NLS, Luhende N, Chua J, et al. Improved Water and Waste Management Practices Reduce Diarrhea Risk in Children under Age Five in Rural Tanzania: A Community-Based, Cross-Sectional Analysis. *International Journal of Environmental Research and Public Health* 2022, Vol 19, Page 4218. 2022;19:4218. doi:10.3390/IJERPH19074218 PubMed PMID: 35409904.
20. Kementerian Lingkungan Hidup dan Kehutanan. Kementerian Lingkungan Hidup dan Kehutanan [Internet]. 2024 [cited 2025 Oct 16]. Sistem Informasi Pengelolaan Sampah Nasional. Available from: <https://sipsn.kemenvh.go.id/sipsn/public/data/timbulan>
21. Purnomo CW. Solusi Pengelolaan Sampah Kota Edisi Kedua. Edisi Kedua. Sleman: Gadjah Mada University Press; 2024.
22. Kitole FA, Ojo TO, Emenike CU, Khumalo NZ, Elhindi KM, Kassem HS. The Impact of Poor Waste Management on Public Health Initiatives in Shanty Towns in Tanzania. *Sustainability* 2024, Vol 16, Page 10873. 2024;16:10873. doi:10.3390/SU162410873
23. Hidayah NN, Prabamurti PN, Handayani N. Determinan Penyebab Perilaku Pengelolaan Sampah Rumah Tangga dalam Pencegahan DBD oleh Ibu Rumah Tangga di Kelurahan Sendangmuljo. *Media Kesehatan Masyarakat Indonesia*. 2021;20:229–39. doi:10.14710/mkmi.20.4.229-239

24. Claudine U, Kim JY, Kim EM, Yong TS. Association between sociodemographic factors and diarrhea in children under 5 years in Rwanda. *Korean Journal of Parasitology*. 2021;59:61–5. doi:10.3347/kjp.2021.59.1.61 PubMed PMID: 33684988.
25. Cha YE, Fu YZ, Yao W. Knowledge, practice of personal hygiene, school sanitation, and risk factors of contracting diarrhea among rural students from five western provinces in China. *Int J Environ Res Public Health*. 2021;18. doi:10.3390/ijerph18189505 PubMed PMID: 34574432.
26. Desta BK, Assimamaw NT, Ashenafi TD. Knowledge, Practice, and Associated Factors of Home-Based Management of Diarrhea among Caregivers of Children Attending Under-Five Clinic in Fagita Lekoma District, Awi Zone, Amhara Regional State, Northwest Ethiopia, 2016. *Nurs Res Pract*. 2017;2017:1–8. doi:10.1155/2017/8084548
27. Khasanah K, Setiyabudi R. The Relationship of STBM with the Event of Diarrhea Children in Maos Health Centre, Cilacap Regency. *Pancasakti Journal Of Public Health Science And Research*. 2023;3:55–61. doi:10.47650/pjphsr.v3i1.705
28. Irawan DE, Puradimaja DJ, Yeni D, Kuntoro AA, Julian MM. Decreasing groundwater quality at Cisadane riverbanks: groundwater-surface water approach [Internet]. 2016 [cited 2025 Nov 12]. Available from: <https://arxiv.org/pdf/1603.09380>
29. Badan Pusat Statistik (BPS), Badan Kependudukan dan Keluarga Berencana Nasional (BKKBN), Kementerian Kesehatan. Laporan Survei Demografi dan Kesehatan 2017 [Internet]. 2018. Available from: <http://www.DHSprogram.com>.
30. Ikhsan AN, Thohira MC, Daniel D. Analysis of packaged drinking water use in Indonesia in the last decades: trends, socio-economic determinants, and safety aspect. *Water Policy*. IWA Publishing; 2022. p. 1287–305. doi:10.2166/wp.2022.048