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Environmental and Sociodemographic Factors Associated with Reported Diarrhea in East Kalimantan, Indonesia: A Secondary Analysis of 2023 Indonesian Health Survey

Muhammad Aidil Fitrah[1]*, Ayudhia Rachmawati[1], Vivi Filia Elvira[1], Morrin Choirunnisa Thohira[1], Syamsir Syamsir[1], Faris Rega Riswana[2]

[1.] Department of Environmental Health, Faculty of Public Health, Universitas Mulawarman, Indonesia
[2.] Master Program in Biomedical Science, Faculty of Medicine, Universitas Brawijaya, Indonesia

*Corresponding Author: aidilfitrah@fkm.unmul.ac.id

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Abstract

Introduction: Diarrhea is a major global public health concern that contributes substantially to morbidity and mortality. Environmental factors, including inadequate sanitation infrastructure and poor hygiene practices**,** have been associated with diarrhea. This study aimed to analyze the associations between environmental and sociodemographic factors and diarrhea occurrence in East Kalimantan Province.

Methods: This cross-sectional study used secondary data from 15,854 respondents in the East Kalimantan subset of 2023 SKI. The variables included gender, age, education, drinking water sources, water quality and treatment, storage containers, raw water sources, wastewater disposal, waste management, sanitation access, and hygiene practices. Data were analyzed using chi-square and multivariable binary logistic regressions. Survey weights, strata, and primary sampling units were incorporated to account for the complex sampling designs.

Results: The weighted prevalence of diarrhea was 2.1%. Bivariate analysis showed associations between diarrhea occurrence and age group, education, drinking water source, physical quality of drinking water, raw water source, waste management, and sanitation hygiene (p<0.05). The higher-risk age group (<5 and >70 years) was associated with higher odds of diarrhea than the lower-risk age group (aged 5–70 years) (AOR=2.933; 95% CI: 2.105–4.098; P <0.001). Unmet physical quality standards drinking water was also associated with higher odds of diarrhea (AOR=2.078; 95% CI: 1.254–3.443; p=0.005).

Conclusion: Higher-risk age groups and drinking water that unmet physical quality standards drinking water were associated with diarrhea. Efforts to improve water quality and provide greater protection for vulnerable age groups may contribute to broader diarrheal prevention strategies in East Kalimantan Province.

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

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Introduction

The environmental quality in residential areas is closely related to the occurrence of environmental diseases, including diarrhea. Globally, diarrheal diseases remain a major cause of morbidity and mortality across age groups.[1] Approximately 443,832 children under five years of age die from diarrheal diseases annually.[2,3] In Indonesia, diarrhea remains

an important public health problem, particularly among vulnerable age groups. 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 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 stunting.[5–8] Several studies have shown 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 older adults, 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 of basic sanitation practices.[9] In addition, household environmental conditions, including drinking water sources and quality, water storage practices, sanitation facilities, and housing characteristics, have been examined in relation to diarrhea occurrence in Indonesia.[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 diarrhea.[12] In addition, 75.56% of the raw water supply in East Kalimantan Province comes from rivers.[13] Human activities, such as domestic and industrial waste disposal, increase the potential for river pollution, which affects water quality. Given the substantial dependence on river water, contamination of these water sources may increase community exposure to enteric pathogens and, therefore, has direct implications for diarrhea prevention in East Kalimantan. 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/year.[14] Together, these water, sanitation, and waste management challenges provide a strong rationale for examining the environmental factors associated with diarrhea, specifically in East Kalimantan.

At the national level, Fitrah et al. analyzed data from 877,531 respondents in the 2023 Indonesian Health Survey and identified several household environmental factors associated with diarrhea in Indonesia.[11] However, pooled national estimates may not fully capture subnational variations in environmental exposure, infrastructure, population characteristics, and access to water and sanitation services. These variations are particularly relevant in East Kalimantan, where substantial dependence on river water, environmental pressures from domestic and industrial activities, and disparities in sanitation infrastructure may create an environmental risk profile that differs from the overall national patterns.

The present study used the East Kalimantan subset of the same parent survey dataset rather than an independent dataset. However, it differs from the previous national analysis in terms of geographical scope, analytical population, inclusion of sociodemographic variables, and emphasis on province-specific patterns of association. The novelty of the present study lies in the use of nationally standardized SKI 2023 data to generate province-specific evidence for East Kalimantan while jointly examining environmental and sociodemographic factors**.** Province-specific analysis is important because relationships observed in pooled national data may differ in magnitude or statistical significance when examined within a more homogeneous regional context. Accordingly, this study aimed to identify environmental and sociodemographic factors independently associated with reported diarrhea among respondents in the East Kalimantan subset

of the 2023 Indonesian Health Survey. It was hypothesized that unacceptable physical drinking water quality, unsafe water sources, inadequate sanitation and waste management, poor hygiene conditions, and low educational attainment were associated with higher odds of diarrhea.

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 evaluations. The SKI 2023 used a stratified, multistage cluster sampling design based on the 2020 Population Census sampling frame. Census blocks served as the primary sampling units and were selected within the sampling strata using probability proportional to size (PPS). Households were subsequently selected systematically from each selected census block, and eligible members of the selected households were included in the individual surveys. The sampling design was developed in collaboration with Statistics Indonesia (Badan Pusat Statistik/BPS) to generate estimates at the national and sub-national levels**.** For the present analysis, the study population was restricted to respondents from the East Kalimantan Province.

The East Kalimantan subset used in the present analysis consisted of 15,854 respondents. Respondents were eligible for inclusion if information on reported diarrhea occurrence and all selected sociodemographic and environmental variables were available. All 15,854 respondents in the analytical subset had complete information on the variables included in this study; therefore, no additional records were excluded because of missing outcome or covariate data. The final analytical sample comprised 15,854 respondents.

The independent variables comprised sex, age group, education level, drinking water source, physical quality of drinking water, drinking water treatment, drinking water storage, raw water source, sanitation access, wastewater disposal, solid waste management, and sanitation hygiene.

Variable Classification

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

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

Statistical Analysis

Data are presented as weighted frequencies and weighted percentages. Sampling weights, strata, and primary sampling units were incorporated using SPSS complex sample procedures. Weighted prevalence estimates and design-based 95% confidence intervals were calculated for each variable. Bivariate associations were assessed using complex sample crosstabulation with design-adjusted chi-square tests. Variables with $p<0.050$ were included in multivariable analysis. Multivariable analysis was performed using complex sample multivariable binary logistic regression. Statistical significance was set at $p < 0.050$. All analyses were performed using SPSS (version 26.0).

Table 1. Variable Classification

No	Variable	Category	Criteria by SKI Instrument
1	Diarrhea	Yes	Respondents who were reported to have been diagnosed with diarrhea by a health worker within the previous 1 month, including diagnoses made within the last 2 weeks or more than 2 weeks to 1 month before the survey
		No	Respondents who were reported not to have been diagnosed with diarrhea by a health worker within the previous 1 month
2	Gender	Male Female	Based on the respondent's self-identified gender
3	Age	Higher-risk age group	Respondents aged <5 years or >70 years
		Lower-risk age group	Respondents aged 5–70 years
3	Education Level	Low High	No School – Junior High School Senior High School – Bachelor 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 Standard Qualified Standard	Cloudy, colored, tastes bad, foamy, or smells unpleasant Clear, colorless, tasteless, non-foamy, and 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 is 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

Results

The frequency distribution of reported diarrheal occurrence and environmental risk factors among the respondents is presented in Table 2. It shows the frequency distribution of the risk factors for diarrhea among 15,854 respondents in East Kalimantan in 2023. The prevalence of diarrhea was 2.1%, while 97.9% of the respondents did not experience diarrhea. The respondents were predominantly female (53.1%) compared to male (46.9%). Most respondents were in the

lower-risk age group of 5–70 years (86.9%), while 13.1% were in the higher-risk age group of <5 or >70 years. The majority had a low level of education (65.0%), with the remainder having a high level (35.0%). Most respondents used safe drinking water sources (93.0%), and 94.9% of the drinking water met the physical requirements. However, 67.9% of the respondents did not treat drinking water before consumption, and only 32.1% treated drinking water.

A total of 82.7% of the respondents stored drinking water in closed containers, whereas 17.3% still used open containers. Regarding raw water sources, 16.5% of the respondents relied on unsafe sources, whereas 83.5% used safe sources. Most respondents practiced unsafe wastewater dumping (89.5%), while 10.5% practiced safe dumping. 60.4% In terms of waste management, 60.4% of the respondents reported proper management, while 39.6% did not manage waste properly. The majority of respondents had access to viable sanitation (98.6%) and reported good sanitation hygiene (89.3%); however, 10.7% still had poor sanitation hygiene conditions. These findings provide an overview of the distribution of sociodemographic and environmental risk factors associated with diarrhea among the study respondents. Table 3 shows the relationships between these risk factors and diarrheal occurrence.

Bivariate analysis showed statistically significant associations between diarrhea occurrence and age, education level, drinking water source, physical quality of drinking water, raw water source, waste management, and sanitation hygiene. Respondents in the higher-risk age group had higher odds of diarrhea than those aged 5–70 years (OR=3.272; 95% CI: 2.376–4.506; p<0.001). Low educational attainment was associated with a higher likelihood of diarrhea (OR=2.082; 95% CI: 1.485–2.918; P <0.001). Unsafe drinking water sources (OR=2.042; 95% CI: 1.267–3.291; P =0.003), drinking water that did not meet physical standards (OR=2.494; 95% CI: 1.459–4.261; P <0.001), and unsafe raw water sources (OR=1.729; 95% CI: 1.196–2.501; P =0.012) were also significantly associated with diarrhea. Improper waste management and poor sanitation hygiene were significantly associated with diarrhea (P =0.002 and P <0.001, respectively).

Meanwhile, sex (P =0.548), drinking water treatment (P =0.417), drinking water storage (P =0.184), wastewater dumping (P =0.697), and sanitation access (P =0.075) were not significantly associated with diarrhea occurrence. Variables with p<0.250 were considered for inclusion in the multivariate analysis. All variables with p-values <0.05 will be included in the multivariable analysis to identify the most influential factors associated with diarrhea occurrence. Table 4 presents the adjusted odds ratios (AORs) for the final models.

Table 4 presents the adjusted associations between the selected sociodemographic and environmental factors and reported diarrhea based on complex-sample multivariable logistic regression. After accounting for sampling weights, strata, primary sampling units, and the other variables included in the model, age group and the physical quality of drinking water remained significantly associated with reported diarrhea cases. Respondents in the higher-risk age group, defined as those aged <5 or >70 years, had nearly three times higher odds of reporting diarrhea than those aged 5–70 years (AOR = 2.933; 95% CI: 2.105–4.098; p < 0.001). Respondents whose drinking water did not meet the physical quality standards also had approximately twice the odds of reporting diarrhea compared with those whose drinking water met the standards (AOR = 2.078; 95% CI: 1.254–3.443; P = 0.005). Low educational attainment showed a borderline association with reported diarrhea (AOR = 1.408; 95% CI: 0.999–1.986; P = 0.051). Drinking water source, raw water source, waste management, and sanitation hygiene were not statistically significant after adjustment, as their 95% confidence intervals included the null value of 1.0. Overall, the findings indicate that vulnerable age groups and unacceptable physical drinking water quality were the principal factors independently associated with reported diarrhea in the final model.

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

Variable		Totals	Percent (%)
Reported Diarrhea Occurrence	Diarrhea	326	2.1
	No Diarrhea	15528	97.9
Gender	Male	7434	46.9
	Female	8420	53.1
Age	Higher-risk age group (<5 years or >70 years)	2067	13.1
	Lower-risk age group (5–70 years)	13787	86.9
Education	Low (No School – Junior High School)	10312	65.0
	High (Senior High 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 Standard	801	5.1
	Qualified Standard	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 3. Association between Risk Factors and Reported Diarrhea Occurrence in 2023

Variable	Reported Diarrhea Occurrence				OR (95% CI)	P Value
	Diarrhea		No Diarrhea			
	n	%	n	%		
Gender						
Male	147	45.1	7287	46.9	0.888 (0.673-1.171)	0.548
Female	179	54.9	8241	53.1		
Age						
Higher-risk age group (<5 years or >70 years)	94	28.8	1973	1973	3.272 (2.376-4.506)	<0.001
Lower-risk age group (5–70 years)	232	71.2	13555	13555		
Education						
Low (No School – Junior High School)	259	79.4	10053	64.7	2.082 (1.485-2.918)	<0.001
High (Senior High School – Bachelor degree)	67	20.6	5475	35.3		
Source of Drinking Water						
Unsafe	37	11.3	1070	6.9	2.042 (1.267-3.291)	0.003
Safe	289	88.7	14458	93.1		
Physical Quality of Drinking Water						
Not Qualified Standard	33	10.1	768	4.9	2.494 (1.459-4.261)	<0.001
Qualified Standard	293	89.6	14760	95.1		

Table 3. Continued…

Variable	Reported Diarrhea Occurrence				OR (95% CI)	P Value
	Diarrhea		No Diarrhea			
	n	%	n	%		
Drinking Water Treatment						
Not Treated	214	65.6	10547	67.9	0.846 (0.619-1.156)	0.417
Treated	112	34.4	4981	32.1		
Drinking Water Storage						
Unsafe	66	20.2	2682	17.3	1.192 (0.838 –1.695)	0.184
Safe	260	79.8	12846	82.7		
Raw Water Source						
Unsafe	71	21.8	2545	16.4	1.729 (1.196-2.501)	0.012
Safe	255	78.2	12983	83.6		
Wastewater Dumping						
Unsafe	289	88.7	13894	89.5	1.503 (1.111-2.033)	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	1.449 (0.924-2.273)	0.075
Viable	317	97.2	15308	98.6		
Sanitation Hygiene						
Poor	41	12.6	1656	10.7	1.236 (1.194-1.278)	<0.001
Good	285	87.4	13872	89.3		

Note: OR, odds ratio; CI, confidence interval. Reference groups were the second categories. p<0.05 was considered significant

Table 4. Logistic Regression Model of the Effect of Environmental Factors on the factors associated with reported diarrhea occurrence

Variable	Category comparison	AOR	95% CI	*p*-value
Education level	Low vs. high	1.408	0.999–1.986	0.051
Source of drinking water	Unsafe vs. safe	1.504	0.882–2.564	0.134
Physical quality of drinking water	Not qualified standards vs. qualified standards	2.078	1.254–3.443	**0.005**
Raw water source	Unsafe vs. safe	1.304	0.875–1.945	0.192
Waste management	Not proper vs. proper	1.221	0.909–1.639	0.184
Sanitation hygiene	Poor vs. good	1.311	0.844–2.039	0.228
Age group	Higher-risk age group (<5 or >70 years) vs. lower-risk age group (5–70 years)	2.933	2.105–4.098	**<0.001**

Note: AOR, adjusted odds ratio; CI, confidence interval. Bold values indicate $p<0.05$. Nagelkerke pseudo-R^2=0.046.

Discussion

The weighted prevalence of reported diarrhea among respondents in East Kalimantan in 2023 was 2.1%, which was lower than the national estimate of 4.3% reported in the 2023 Indonesian Health Survey.[11] Despite this relatively low prevalence, diarrhea remains a relevant environmental health issue because it is shaped by a combination of individual susceptibility, household conditions, and environmental exposures. In the adjusted analysis, age group and the physical quality of drinking water were the only factors that remained significantly associated with reported diarrhea cases. By applying a complex survey analysis to the East Kalimantan subset of the 2023 Indonesian Health Survey, this study provides province-specific evidence that complements previous findings derived from pooled national data.

Age group showed the strongest adjusted association with reported diarrhea. The higher odds observed among respondents aged <5 and >70 years were biologically plausible because both groups had increased physiological vulnerability. Children under five years of age have developing immune and gastrointestinal systems, whereas older adults may have reduced physiological reserves, comorbidities, and a lower capacity to tolerate dehydration and electrolyte imbalance.[1,3-6] However, these two age groups should not be assumed to share the same biological pathways. Their combination in the present analysis represents vulnerability at the extremes of age and should be interpreted as an epidemiological grouping rather than a homogenous clinical category.

The physical quality of drinking water was also associated with diarrhea. Respondents who reported drinking water that did not meet physical standards had approximately twice the odds of diarrhea compared with those whose drinking water met the standards (AOR = 2.078; 95% CI: 1.254–3.443; p = 0.005). Cloudiness, discoloration, unpleasant odor, foaming, or abnormal taste may reflect problems in water treatment, distribution, or household storage.[15] These characteristics do not confirm the presence of pathogenic microorganisms, but they indicate that the water requires further assessment.

This result is particularly relevant in East Kalimantan, where rivers remain an important source of raw water and may be affected by domestic and industrial activities.[13,16,17] Similar associations between inadequate water conditions and diarrhea have been reported in previous studies.[18] However, the present study relied on respondents' perceptions of water quality rather than laboratory measurements. Therefore, the results refer to perceived physical water quality and should not be interpreted as direct evidence of microbiological or chemical contamination.

Low educational attainment showed a borderline association with reported diarrhea (AOR = 1.408; 95% CI: 0.999–1.986; P = 0.051). Although the direction of the association was consistent with the possibility that education influences access to health information, water-handling practices, food hygiene, handwashing, and health care-seeking behavior, education was not statistically significant in the adjusted model. Previous studies have also linked educational attainment and hygiene-related knowledge with diarrhea prevention, particularly in households with young children.[24-26] However, the present result should not be described as statistically significant because the confidence interval included 1.0.

Improper waste management was associated with diarrhea in the bivariate analysis but not after adjustment (AOR = 1.221; 95% CI: 0.909–1.639; p = 0.184). The reduction in the magnitude of the association suggests that the crude relationship may have been influenced by age, education, water-related conditions, and other household characteristics. Poorly managed waste may contribute to vector breeding and environmental contamination, as reported in previous studies.[11,19,22] However, the present multivariable analysis did not identify waste management as an independent factor associated with diarrhea.

The descriptive finding that 39.6% of respondents practiced improper waste management remains important from a broader environmental health perspective. Household waste segregation, recycling, waste bank initiatives, and improvements in collection services may provide benefits beyond diarrheal prevention.[20,21,23]. Therefore, these measures should be viewed as general environmental health strategies rather than interventions shown in this study to directly reduce diarrhea.

Drinking water source, raw water source, sanitation hygiene, drinking water treatment, water storage, wastewater disposal, and sanitation access were not statistically significant in the adjusted model. This does not necessarily mean that these factors are unimportant. Most respondents were concentrated in the safer categories for several variables, including drinking water source, sanitation access, and water storage. The limited variation between the exposure groups may have reduced the ability of the model to detect differences. In addition, broad binary classifications may not capture the

differences in service reliability, maintenance, contamination pathways, or actual household practices.

Wastewater disposal illustrates this problem. Most respondents reported unsafe wastewater dumping, yet no significant association with diarrhea was observed. Open disposal into drains, soil, ditches, or rivers may contribute to the deterioration of surface water and groundwater quality.[11,28] the lack of statistical significance may be related to limited exposure contrast, measurement errors, or other unmeasured factors. Previous studies have reported associations between community-based sanitation programs, toilet access, water management, and diarrhea, although the findings may vary according to population characteristics and analytical methods.[27]

These results support the need for continued attention to drinking water safety, particularly the monitoring of physical quality, treatment, distribution, and household storage. Household drinking water treatment has declined in Indonesia alongside the growing use of bottled and refill drinking water.[29] However, packaged and refilled water cannot be automatically considered safe when the production, transport, handling, or storage conditions are inadequate.[30] Therefore, water quality surveillance, reliable drinking water services, risk communication, and household education should remain components of diarrhea prevention programs, particularly for households containing young children or older adults. These recommendations should be interpreted cautiously because the present study identified associations rather than causal effects.

This study has several limitations need to be considered. The cross-sectional design does not establish whether the exposures preceded the occurrence of diarrhea, and reverse causality cannot be excluded. For example, households may have changed their water treatment, storage, or hygiene practices after a recent diarrheal episode. Diarrhea status was reported by respondents or household informants based on a health worker diagnosis within the previous month, which may have introduced recall and reporting errors. Mild episodes for which healthcare was not sought may also have been missed. In addition, the physical drinking water quality was assessed subjectively and was not confirmed through laboratory testing.

Environmental variables were mainly measured at the household level, whereas diarrhea was assessed for individual respondents. Although the analysis incorporated sampling weights, strata, and primary sampling units, some correlations among individuals from the same household may remain. The model also had limited explanatory performance, with a Nagelkerke pseudo-R^2 of 0.046. This indicates that age group and perceived physical drinking water quality represent only part of the factors associated with reported diarrhea. Food hygiene, nutritional status, pathogen exposure, socioeconomic conditions, healthcare use, climate, and geographical characteristics may also contribute. Longitudinal studies with objective water quality measurements would help clarify temporal relationships and provide stronger evidence for intervention planning.

Conclusion

The weighted prevalence of reported diarrhea among respondents in East Kalimantan in 2023 was 2.1%. After adjusting for the complex survey design and other variables in the model, respondents aged <5 years or >70 years and those reporting drinking water that did not meet physical quality standards had higher odds of diarrhea. Other environmental factors, including drinking-water sources, raw water sources, waste management, and sanitation hygiene, were not independently associated with reported diarrhea in the final model.

These findings provide province-specific evidence derived from the East Kalimantan subset of the 2023 Indonesian Health Survey and may support the development of environmental health policies in the province. The findings support age-sensitive diarrhea prevention strategies and the continued monitoring and improvement of drinking water quality, particularly for households that include young children or older adults.

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 (https://layanandata.kemkes.go.id/).

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Author Contribution

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

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