

Acute Diarrhea Disease (ADD) Outbreak Investigation at Kebumen, Central Java, Indonesia

Bayu Satria Wiratama¹, Tutik Inayah Susilaningsih^{2*}, Yusrizal³, Muhammad Fadhil⁴, Akhmad Mukhibin⁵, Joao Manuel Correia Ximenes⁶

¹Field Epidemiology Training Program, Universitas Gadjah Mada

²Epidemiologist of Kokap I PHC, Kulon Progo District Health Office, Indonesia, tutikinayah87@gmail.com

³Lhokseumawe District Health Office, Aceh, Indonesia

⁴Safetynet, Philippines

⁵Kebumen District Health Office, Indonesia

⁶Faculty of Health Science, Universidade de Dili, Dili, Timor Leste, xiaomanuelcorreia23@gmail.com

*Corresponding Author: tutikinayah87@gmail.com

Abstract

Research Objective: On January 21, 2022, an increasing number of ADD with one infant death was reported from rural area Karangtanjung village, Kebumen district. An investigation was initiated to confirm, describe, and recommend measures for control. **Methodology:** A 1:4 unmatched case-control study was conducted. Cases were defined as person who had three or more loose watery stools per day in Karangtanjung between January 16 and 29, 2022. Controls were people who had no diarrhea symptoms. Clean water source samples were collected for bacteriological testing. Stools samples were no longer available during the investigation. The risk factors and environmental data were obtained through interviews and observation using questionnaires. The data were analyzed using logistic regression for multivariate. **Results:** There were a total of 100 participants, 20 cases and 80 controls. Most of the cases (55%) were female, three children hospitalized (15%), and one infant death. The median age was four years old. Infants have the highest attack rate (AR =100%). While in control groups, 55% were male, the median age was 36.5 years old. Of the four clean water source samples, 3 (75%) were positive for *faecal coliform* and exceeded the standard quality of clean water sources. From multivariate analysis with logistic regression, only the 0–5 years age category (OR 14.33; 95% CI: 1.14–179.71) was significantly related to ADD. **Conclusion:** An outbreak of ADD was confirmed in Karangtanjung and was likely associated with a clean water source contaminated by groundwater. The 0-5 years age category was a significant risk factor for ADD. Several protective measures could be prepared, such as promoting hygiene and sanitation practices also recognizing early symptoms of diarrhea. Providing chlorine (calcium hypochlorite) 65% was recommended for control.

Keywords: acute diarrhea, Kebumen, under five years old, outbreak, infant death

INTRODUCTION

Diarrhea is still a public health problem with high mortality and morbidity rates. In Indonesia, the prevalence of clinical diarrhea was 6.8% (range: 6.7%–6.9%) at all ages, 9% (range: 8.4%–9.7%) in infants, and 11.5% (range: 11.1%–11.9%) in children under five years old. In general, acute diarrhea more often affects children under five years of age (toddlers) because their immune systems are still weak and vulnerable to exposure to bacteria and viruses that cause acute diarrhea. In some cases, acute diarrhea may be accompanied by persistent vomiting and lead to dehydration. Vigilance against dehydration is carried out so that there is no delay in case management that can result in death (Fitriani *et al.*, 2021). In addition, acute diarrhea in children can have a negative impact on growth and cognitive development. (Mebrahtom *et al.*, 2022).

In addition to immunity factors, lack of availability of clean water and poor environmental sanitation are risk factors for diarrhea. Based on recent estimates, improved access to water, sanitation, and hygiene (WASH) could prevent 58% of dhiarrhea deaths among children under the age of five

globally each year (Otsuka *et al.*, 2019).

In Indonesia, diarrhea is still a major health problem and often causes an outbreak. Poor sanitation, unhygienic behavior, and low access to clean water are often the trigger factors for diarrhea outbreaks (Fitriani *et al.*, 2021). Suspicion of an outbreak of diarrhea in the working area of the Alian Public Health Center (PHC) began with a report from the rural area of Karangtanjung village, Alian sub-district, Kebumen district, on January 21, 2022, about infant deaths due to diarrhea in RT 7 of the village. An investigation was conducted in RT 7 RW 1, Karangtanjung village, Alian sub-district on January 21 and 22, 2022. In this 3rd week, it turned out an increasing acute diarrhea cases compared to the previous week's report. After the beginning investigation, 10 additional cases of acute diarrhea were found, bringing the total number of cases from the first investigation to 11 cases.

A follow-up investigation team was dispatched on January 26, 2022 to ensure the existence of an ADD outbreak, perform a descriptive analysis, identify risk factors, and determine measures to prevent and control an ADD outbreak in Karangtanjung village, Alian sub-district, Kebumen district, 2022.

Based on the preliminary field investigation, two hypotheses were developed: (1) the outbreak was associated with consumption of water from contaminated groundwater sources, and (2) children under five years old were at higher risk of developing acute diarrhea compared with older age groups.

METHODS

An observational study with a 1:4 case control approach (unmatched case control) was used to determine the risk factors associated with an outbreak of acute diarrhea disease in Karangtanjung village, Kebumen. The analysis used descriptive analysis by time, place, and person as well as analytical study of risk factors for acute diarrhea. An unmatched case-control design was selected because the outbreak investigation required rapid identification of risk factors in a limited population setting. Matching was not performed to avoid overmatching and to facilitate rapid recruitment of controls during the emergency response phase.

Controls were selected from residents living in the same neighborhood (RT 7) who had not experienced diarrhea symptoms during the outbreak period. Controls were recruited using systematic household visits to ensure that they originated from the same source population as the cases. The investigation for suspected acute diarrhea cases was carried out in the area of RT 7 Karangtanjung village, which reported an increasing of acute diarrhea cases during the third and fourth weeks of 2022. The population at risk is all residents of RT 7 Karangtanjung village with a total of 266 residents. Based on the alleged increase in cases of acute diarrhea in Karangtanjung village which is clustered in RT 7, acute diarrhea cases was defined as a person who had three or more loose watery stools per day, accompanied by additional symptoms such as abdominal cramps, slimy stools, bloody stools, fever, nausea, vomiting, in the area of RT 7 RW 1 Karangtanjung village between the 16th and 29th January, 2022. Whereas controls are people who had no diarrhea symptoms.

The surveillance period (16–29 January 2022) was selected based on the onset date of the earliest identified case and the last reported case during the outbreak investigation. Sample size was determined using total case sampling because all identified cases during the outbreak investigation were included. A 1:4 case-control ratio was selected to increase statistical power while maintaining feasibility in the field investigation. The data collected in the form of primary and secondary data. Primary data were obtained through direct interviews with cases and controls using an epidemiological investigation form. The risk factor data collected were age, age criteria, gender, family income, educational background, source of clean water used for drinking, habit of washing hands with soap before eating, habit of washing hands with soap after urinating and defecation, the habit of boiling drinking water, how to serve drinking water, the distance between the latrine and the source of drinking water, livestock ownership, environmental conditions, and coliform content in drinking water. Clean water source

samples were collected and sent to a local laboratory for laboratory-based bacteriological testing. Stools samples were no longer available during the investigation.

Environmental investigations included direct observation of household sanitation facilities, well construction characteristics, distance between wells and potential contamination sources, and water distribution systems. Four representative water samples were collected from commonly used water sources and transported to the laboratory under standard procedures for bacteriological examination.

Location data is taken using GPS which is then displayed with QGIS. Meanwhile, secondary data were in the form of monthly reports of acute diarrhea and weekly reports (W2) of the Alian PHC and population data obtained from the head of the local RT. The collected data was processed using Microsoft Excel 2019 software, STATA 15 for statistical analysis using logistic regression and QGIS for presenting the distribution of acute diarrhea cases based on regional maps. After processing, the data is presented in the form of narratives, tables, and graphs.

RESULTS

Based on the investigation result, the cases were occurred in RT 7, Karangtanjung village on 16 to 23 January 2022. The number of risk population are 266 people, with 20 total of cases. Most of the cases (55%) were female, three children hospitalized (15%), and one infant death. The median age was four years old (ranged from 6 months-59 years). Infants have the highest attack rate (AR =100%). While in control groups, 55% were male, the median age was 36,5 years

Descriptive Analysis

The results of this outbreak investigation, was obtained of 20 cases with 266 people as the population at risk. A total of 55% (11 cases) were female.

Table 1. Distribution of Acute Diarrhea Cases by Age Group in Karangtanjung Village, Kebumen District, January 2022

Age group	Population at risk (n=266)	Number of cases (n=20)	Number of death	Attack Rate (%)	Case Fatality Rate (%)
< 1 y.o	3	3	1	100	33
1 – 5 y.o	21	10	0	47.6	0
6 – 14 y.o	34	2	0	5.9	0
>15 y.o	208	5	0	2.4	0

Table 1 shows that the highest Attack Rate (AR) is in the age group less than 1 year (100%) all of the infant got diarrhea with the Case Fatality Rate (CFR) 33%.

By the sex, as many as 55% of cases were female and 45% of cases were male. Based on symptom, the cases describe as follows.

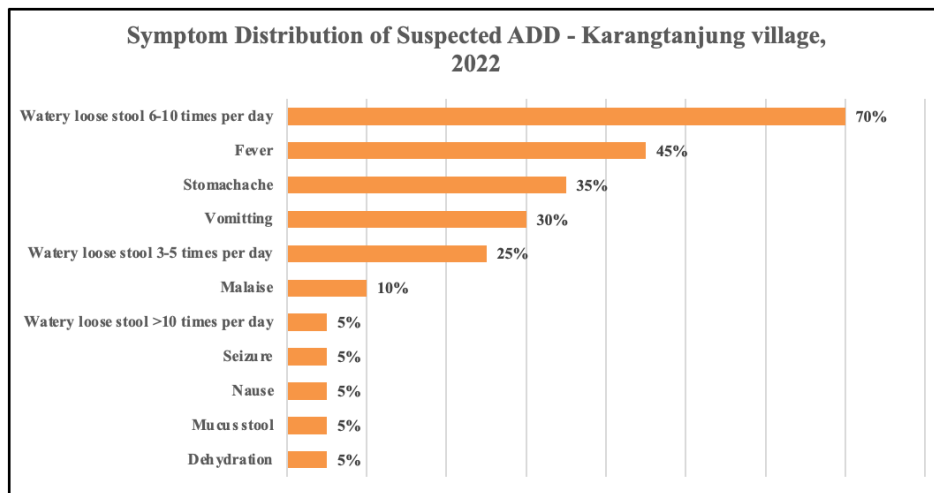


Figure 1. Symptom Distribution among Acute Diarrhea Cases in Karangtanjung Village, January 2022

Figure 1 shows that the most common symptoms experienced by case are watery loose stool 6-10 times per day (70%), fever (45%), and abdominal pain (35%). Meanwhile, based on place the case clustered in one neighborhood unit (*rukun tetangga*). According to the location of the cases, fifteen houses were obtained for two or three clustered. It can be seen wells as a source of drinking water and clean water around the sufferer's house.

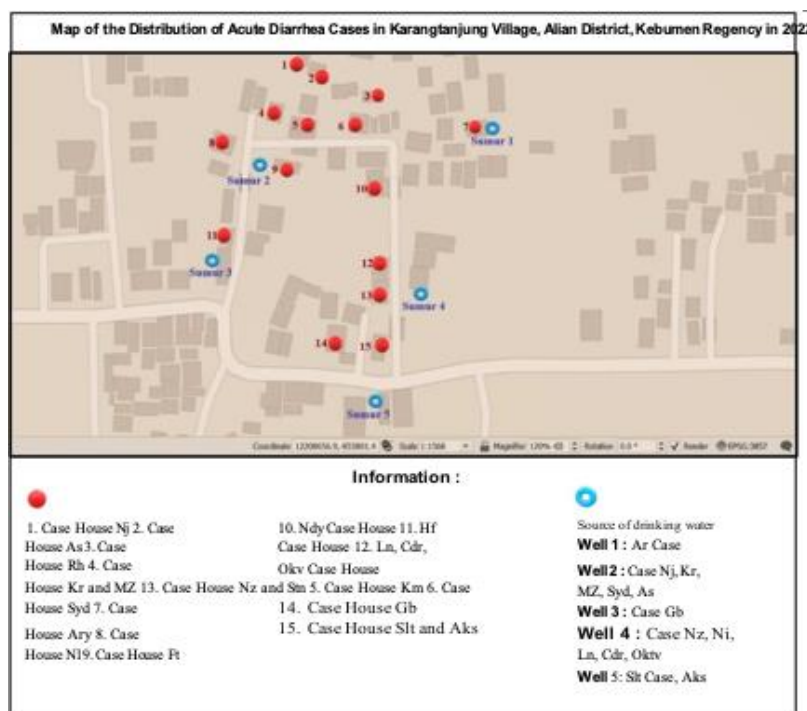


Figure 2. Cases Distribution of Acute Diarrhea Outbreak in Karangtanjung Village, Kebumen District

Epidemic curve for this outbreak shows continuous common source outbreak pattern, when the first people exposed to the same source but this exposure in different nature prolonged for several days and still happen even though the peak of the outbreak is unknown.

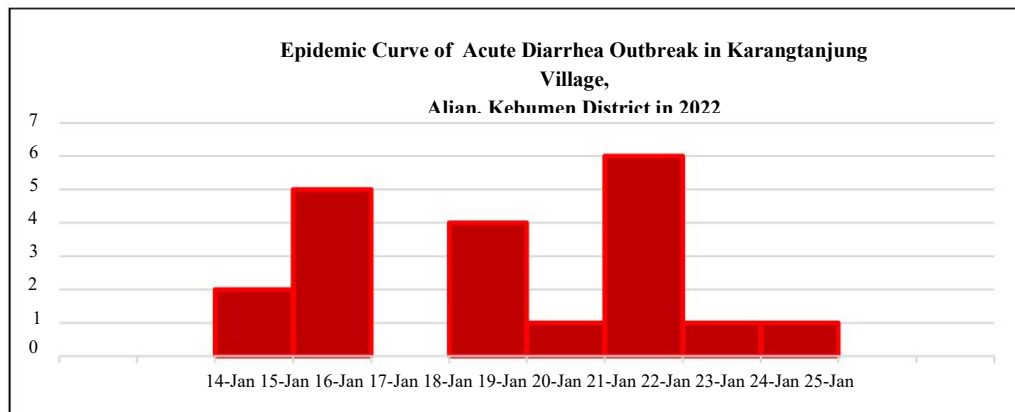


Figure 3. Epidemic Curve of Acute Diarrhea Outbreak in Karangtanjung Village, Kebumen District

Multivariate Analysis

After doing the descriptive analysis for place, person, and time, further analysis is needed to support the investigation process and answer the hypotheses that have been made.

Epidemiological study

This investigation using an observational study with a case control approach to answer the hypotheses, which the risk factor variables as the exposure will be associated with the incidence of acute diarrhea as the outcome. Sample size calculation was performed using total case sampling with 1:4 unmatched case-control (Mebrahtom *et al.*, 2022) of 100 people, consisting of 20 cases and 80 controls.

Based on bivariate analysis using the *Chi Square* test (shows in table 2), it was found that the variables associated with acute diarrhea in Karangtanjung Village and will test to multivariate analysis with a p -value < 0.25 were the age category of toddlers with an OR of 44.33 (95% CI 9.44 – 229.77), respondents' educational background of not attending school/not graduating from elementary school with an OR of 23.67 (95% CI 6.07 – 99.54), risky drinking water sources such as unprotected dug wells, rainwater wells, or wells near rivers with an OR of 2.73 (95% CI 0.69 – 15.68), and the behavior of not washing hands with soap before eating with an OR of 6.56 (95% CI 2.00 – 23.17).

Table 2. Bivariate Analysis of Acute Diarrhea Outbreak Risk Factor at Karangtanjung Village, Alian, Kebumen District

Variable	Cases (n=20)	Control (n=80)	<i>P</i> value	OR (CI)
Age Category			< 0.00001	44.33 (9.44 – 229.77)*
Not a toddler	6	76		
Toddler	14	4		
Sex			0.4229	0.67 (0.21 – 2.01)
Female	11	36		
Male	9	44		
Education			< 0.00001	23.67 (6.07 – 99.54)*
Elementary school	5	71		
NEET or out of school	15	9		
Income			0.4229	0.67 (0.21 – 2.01)
\geq minimum wage (Rp 1.906.781,84)	11	36		

< minimum wage (Rp 1.906.781,84)	9	44		
Source of drinking wates			0.1229	2.73 (0.69 – 15.68)*
Risk free	3	29		
Have a risk	17	54		
Hand washing behavior before eating			0.0002	6.56 (2.00 – 23.17)*
Washing the hand	6	59		
Un-washing the hand	14	21		
Hand washing behavior before after defecating			0.2869	1.89 (0.45 – 6.88)
Washing the hand	15	68		
Un-washing the hand	5	12		
Boiling the drinking water behavior			0.7986	1.35 (0.02 – 17.87)
Yes	19	77		
No	1	3		
Separation Distance			0.2752	1.93 (0.54 – 8.66)
Save separation distance	4	26		
Unsave separation distance	16	54		
Livestock			0.5854	1.36 (0.41 – 5.32)
Do not have livestock	5	25		
Have the livestock	15	55		
Coliform in the water			0.5854	1.33 (0.39 – 4.16)
Not detected	13	57		
Detected	7	23		

In addition, control between risk factor variables was performed using multivariate analysis with logistic regression testing. The results obtained showed that the toddler age category was a significant risk factor for acute diarrhea in Karangtanjung Village, Alian, Kebumen District, with an aOR of 14.33 (95% CI 1.14 – 179.71). This means that children under five years of age have a 14 times higher risk of experiencing acute diarrhea compared to those who are not under five years of age after controlling for other variables. Although the association remained statistically significant, the very wide confidence interval (95% CI: 1.14–179.71) indicates limited precision of the estimate. This may be related to the relatively small sample size and the low number of cases within some exposure categories.

Table 3. Multivariate Analysis of Acute Diarrhea Outbreak Risk Factor at Karangtanjung Village, Alian, Kebumen District

Risk Factors	Odds Ratio (OR)	Adjusted Odds Ratio (aOR)	P value	CI (95%)
Age Category	44.33	14.33	0.039	1.14 – 179.71
NEET (have no education)	23.67	2.793	0.397	0.26 – 30.14
Drinking water source at risk (unprotected well)	2.73	4.157	0.124	0.68 – 25.60
Did not washing the hand before eating	6.56	1.90	0.412	0.41 – 8.81

Environmental Study

An investigation of the environment was conducted by observing the residential environment in RT 7, Karangtanjung Village, Alian. All houses have private toilets, while clean water sources include dug wells, Pamsimas, and PAM. Almost all of the dug wells available are unprotected dug wells located close to river flows. This means that river pollution can seep into the wells due to the unprotected condition of the dug wells. Each well is usually used by 3 to 5 households, with water being pumped through pipes to each household.



Figure 4. The River Around the Well as the Clean Water Source

Laboratory Study

Laboratory studies were originally planned to confirm the diagnosis of acute diarrhea, but at the time of the investigation, stool samples were no longer available, so a laboratory diagnosis could not be confirmed and only a case definition based on clinical symptoms was made. Of the four clean water samples taken, 3 (75%) were positive for coliform bacteria and exceeded the quality standards for water health requirements for hygiene and sanitation purposes.

DISCUSSION

Diarrhea in infants and toddlers, if not treated immediately, can cause dehydration accompanied by prolonged sodium and potassium imbalances (Radlović *et al.*, 2015). Infants and toddlers who experience diarrhea will suffer from growth disorders. This occurs because food intake is interrupted due to vomiting or loss of appetite, while the need for nutrients continues to increase. The CFR for diarrhea in Karangtanjung village occurred in the infant group (33%). This is in line with Tri Novita, 2020, who wrote that infants and toddlers are the most vulnerable group to health and nutritional disorders due to their immune status, diet, and psychology, which are still in the developmental stage (Novita, 2020).

Based on the results of multivariate analysis, it was found that the toddler age category was a significant risk factor (aOR 14.33; 95% CI: 1.14 – 179.71). Based on the research by Fitriani, *et al.* (2021), which states that there is a significant relationship between a child's age and the incidence of diarrhea in toddlers. This is because toddlers are the most vulnerable to various infections, including diarrhea (Fitriani *et al.*, 2021). Toddlers experience a period where they are often exposed to various sources of infection due to excessive motility, crawling, walking, putting anything in their mouths, or consuming unhealthy foods (Asfaha *et al.*, 2018).

Regarding the variable of washing hands with soap before eating, several studies have found a significant relationship between this variable and the incidence of diarrhea. Fitriana, *et al.* (2021) and Mebrahtom, *et al.* (2022) explain that not washing hands with soap can increase the risk of diarrhea (Fitriani *et al.*, 2021; Mebrahtom *et al.*, 2022). The results of the investigation into the diarrhea outbreak in Karangtanjung are in line with Otsuka's (2019) study, which found that there was no significant relationship between washing hands with soap and the incidence of diarrhea. In his study, Otsuka found

that the variable of using a clean towel after washing hands was associated with the risk of diarrhea, not the use of soap. The effectiveness of using a clean towel after washing hands results in fewer *E. coli* bacteria on the hands than drying with air. Using a towel after washing hands can reduce the presence of pathogens that cause infectious diseases (Otsuka *et al.*, 2019). Similarly, Jayanti stated that there was no significant relationship between hand washing and the incidence of diarrhea because the use of spoons when eating meant that hands did not come into direct contact with the food we consume (Jayanti *et al.*, 2021). Meanwhile, in this investigation of diarrhea, the researchers did not take into account the variables of hand drying or spoon use.

Wells, as a source of clean water, must meet certain requirements and conditions. Protected wells that meet these requirements are important for preventing contamination with pathogens, primarily *E. coli*. Wells that do not meet the requirements for clean water are susceptible to external contamination, which can cause acute diarrhea 2.4 times more often. Wells provide water from groundwater layers that are relatively close to the ground surface, causing contamination in the water filtration layer from human and animal waste disposal facilities (Sri Mulyani *et al.*, 2011). Based on a systematic and meta-analysis from Wolf J., *et al* that children in low and middle-income countries can experience a 24% decrease in the prevalence of diarrhea illness when enhanced sanitation measures are implemented (Wolf J., *et al*, 2022). Although water contamination was not statistically significant in the multivariable model, environmental observations demonstrated that most wells were unprotected and located near river flows. Furthermore, 75% of sampled water sources were positive for faecal coliform contamination. These findings suggest that contaminated groundwater likely contributed to the outbreak but may not have reached statistical significance because of limited sample size and insufficient statistical power.

The education variable in this investigation showed no significant relationship with the incidence of diarrhea. This may be because the number of cases was too small to represent the actual situation in the field, or because the education levels of the respondents were similar. This contrasts with Pradhana's study, which found that toddlers with poor knowledge of the disease and poor caregivers or mothers had a three times higher risk of contracting diarrhea (Pradhana Putra *et al.*, 2017). The relatively small number of outbreak cases may have reduced statistical power and contributed to unstable estimates in multivariable analyses.

CONCLUSION

This investigation had several limitations. First, the number of identified cases was relatively small, which may have reduced statistical power and contributed to wide confidence intervals. Second, recall bias may have occurred because exposure information was obtained through interviews after illness onset. Third, stool specimens were unavailable at the time of investigation, preventing laboratory confirmation of the causative pathogen. Fourth, some environmental exposures may have been misclassified because measurements relied partly on participant reports.

An outbreak of acute diarrhea was confirmed in Karangtanjung Village, Alian, Kebumen District and was likely associated with a clean water source contaminated by groundwater. The 0-5 years age category was a significant risk factor for acute diarrhea outbreak. Several protective measures could be prepared, such as promoting hygiene and sanitation practices also recognizing early symptoms of diarrhea. Providing chlorine (calcium hypochlorite) 65% was recommended for control measure.

Author Contributions: Conceptualization: BSW, TIS, Y; methodology: BSW, TIS, MF ; data curation: BSW, TIS, MF ; formal analysis: BSW, TIS; investigation, TIS, Y; resources: TIS, Y, AM; supervision: BSW; writing-original draft preparation: BSW, TIS, Y, MF, AM, JMCX; writing-review and editing: BSW, TIS, Y, MF, AM, JMCX. The author has read and approved

the final version of the manuscript.

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Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request. The data are not publicly available due to ethical and privacy considerations.

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