

# Epidemiological Investigation of an Acute Gastroenteritis Outbreak in a Tribal Colony of Palakkad District, Kerala, India

C SREEDEVI<sup>1</sup>, PM SHEEBA<sup>2</sup>, N DIVYAMOL<sup>3</sup>, KIRAN THOMAS<sup>4</sup>, LINTU MATHEW<sup>5</sup>, KS DEEPAK<sup>6</sup>



## ABSTRACT

**Introduction:** Diarrhoeal disease is a major cause of morbidity and mortality, especially among vulnerable population groups. Globally, India remains one of the nations with the highest rates of diarrhoeal diseases reported annually. Identifying the causes and factors leading to an outbreak of diarrhoea is an important public health response for the prevention and control of the same, especially in vulnerable populations. The current investigation was undertaken when an outbreak of acute gastroenteritis with three fatalities was reported from a tribal colony in Palakkad district, Kerala, India. In general, the tribal populations are socially, culturally, and economically backward and live in resource-limited, remote areas. Identifying the determinants of disease is crucial to accelerate public health interventions among these populations.

**Aim:** To describe the epidemiology of the acute gastroenteritis outbreak and propose recommendations for control and prevention of the same in a tribal colony in Palakkad district.

**Materials and Methods:** The present descriptive study was conducted from 03/07/2024 to 30/07/2024, in a tribal colony of Kanjirappuzha Panchayath Palakkad district, Kerala, India to investigate an outbreak of acute gastroenteritis. There were a total of 23 cases in the outbreak. The investigators identified the cases from the outpatient, inpatient and line list

records available at the hospitals and Family Health Centre (FHC), where the patients sought treatment. For active case finding, the investigators visited the colony and conducted an environmental assessment. The data were analysed by descriptive statistics using Statistical Package for Social Sciences (SPSS) version 20.0.

**Results:** The outbreak had 23 cases of acute gastroenteritis, with 43.5% (n=10) of patients over 45-year-old and 52.2% (n=12) females. There were three fatalities, two involving Acute Kidney Injury (AKI). The attack rate in the outbreak was 14.8% and the case fatality rate was 8.7%. The epidemic curve indicated a point-source outbreak with possible secondary transmission. Residents had an inadequate, intermittent water supply and often used unsanitary alternatives. Laboratory tests found both Rota and Astro viruses from the rectal swabs of two patients (PCR), and all the water samples (six in number) tested for bacteriological standards gave unsatisfactory results.

**Conclusion:** An outbreak of mixed viral gastroenteritis caused by Astrovirus and Rotavirus occurred in the tribal colony, resulting in three deaths. The major cause of the outbreak was identified as a lack of safe drinking water. Enhanced Water, Sanitation, and Hygiene (WaSH) practices coupled with regular water quality surveillance are recommended to prevent future outbreaks.

**Keywords:** Acute kidney injury, Dehydration, Diarrhoea, Drinking water, Infectious disease, Viral outbreak, Water-borne illness

## INTRODUCTION

Acute gastroenteritis, or diarrhoea, is often a symptom of an intestinal infection caused by various bacteria, viruses, or parasites [1]. Transmission occurs via contaminated food, water, or person-to-person due to inadequate hygiene [1]. Based on modified case definitions of the integrated disease surveillance program, Acute Diarrhoeal Disease (ADD) -including gastroenteritis is defined as passing three or more stools, with or without vomiting [2].

Diarrhoeal disease is a leading cause of child mortality and morbidity worldwide [1]. World Health Organisation (WHO) reports that India consistently ranks among nations with the highest rates of diarrhoeal diseases. The year-wise trend of high-prevalence disease outbreaks in India (2017-2023) identifies a unique set of infectious diseases, with ADDs regularly dominating outbreaks each year [3]. In 2024, a total of 1005 ADD outbreaks were reported to the Integrated Disease Surveillance Program (IDSP) in India, of which 39 were from the state of Kerala [4].

The leading causes of ADD burden are lack of access to safe drinking water and basic sanitation [5]. Globally, 58% of ADD deaths are attributed to inadequate drinking water, sanitation, and hygiene [5]. The tribal populations are socially, economically, and culturally isolated and underserved [5]. Access to drinking water is comparatively low among the tribal population. Their health

literacy is also poor [6]. This can make them vulnerable to diarrhoeal outbreaks and other infectious diseases.

The Government of Kerala established the State Prevention of Epidemics and Infectious Diseases (PEID) cell and Regional PEID (RPEID) cells in all government medical colleges for boosting the state's surveillance system [7]. In July 2024, the Regional Prevention of Epidemics and Infectious Diseases Cell (RPEID cell) of Government Medical College Palakkad, Kerala, India at the request of the District Surveillance Officer, investigated an acute gastroenteritis outbreak in one tribal colony in Kanjirappuzha Panchayath, Palakkad District, Kerala, India. The colony had 135 residents, living in 33 newly built houses that had been occupied for one year. The death of a patient (index case) prompted the request for a detailed parallel investigation by the RPEID cell. The Present investigation aimed to describe the epidemiology of the outbreak and propose recommendations for the control and prevention in the future.

## MATERIALS AND METHODS

The present descriptive study for investigating the outbreak of acute gastroenteritis reported in the settled tribal colony in Kanjirappuzha panchayath, Palakkad district, Kerala, India. The study was conducted over one month from 03/07/2024 to 30/07/2024, after the index case was notified. The Institutional Ethics Committee

approved the report on completion of the investigation. The investigation was a public health response to an outbreak undertaken to identify the source and implement control measures. Oral consent was taken before examining the cases. The investigation did not involve any human laboratory sample collection, and there were no invasive investigations or medical interventions/experiments. The investigation report was submitted to the district health authority upon completion. The report was also approved by the Institutional Ethics Committee, vide letter no. IEC/GMC/PKD/34/2024/145.

### Study Procedure

A probable case of acute gastroenteritis was defined as an acute onset of illness presenting with any of the following symptoms: abdominal pain, vomiting, diarrhoea with/without fever, or an epidemiologically linked person presenting with the same symptoms [8]. Accordingly, residents and past visitors to the tribal colony who developed symptoms during the outbreak were included in the study after obtaining informed consent. The exclusion criterion was non-willingness to participate.

A total of 23 cases were studied in the outbreak. The data were collected through active case finding involving house visits and passive case finding from records of hospitals in the catchment area, as well as line lists available at the FHC, Kanjirappuzha. During the visit, information on the course of illness, source of drinking water, drainage system, defecation practices, important events before the onset of illness, public gatherings, exposure to outside food, and interactions with animals was obtained by interviewing household members of the affected families. An environmental examination was conducted by visiting the water sources and storage systems, accompanied by the key informants, including community health workers and residents. The investigators reviewed the microbiological results of water samples available at the FHC.

### STATISTICAL ANALYSIS

The outbreak investigation involved analysis of time and person distribution, symptom profile, course of illness and environmental factors using SPSS version 20. The results were summarised as measures of central tendency, proportions, attack rate and case fatality rate. Observations during the field visit are narrated qualitatively. The entire team of investigators comprised 3 public health experts, one microbiologist, one physician and one statistician.

### RESULTS

A total of 23 cases of gastroenteritis were reported from 10<sup>th</sup> of June to 5<sup>th</sup> of July, of which 12 (52.2%) cases were females. The median age of patients was 35 years, with an interquartile range of 25 years. The ages of the cases ranged from six months to 85 years. A 10 (43.48%) of those affected were above 45-year-old. Most of them presented with loose stools (n=21, 91.3%), while vomiting was the second most common clinical presentation (n=6, 26.1%). There were three deaths in the outbreak, all above 50 years, two showing signs of AKI. One was brought dead to the hospital, with an autopsy report consistent with myocardial infarction. Most of the cases (n=20, 86.96%) were residents of the colony. Additionally, 3 (13.04%) epidemiologically linked cases were from a nearby village; they had attended the funeral of one of the cases in the colony on 24/06/2024. The attack rate in this outbreak was 14.8%, (20 patients/135 residents). Excluding the death due to myocardial infarction, the current outbreak had a case fatality rate of 8.7%. [Table/Fig-1] shows the clinicoepidemiological profile of cases in the outbreak.

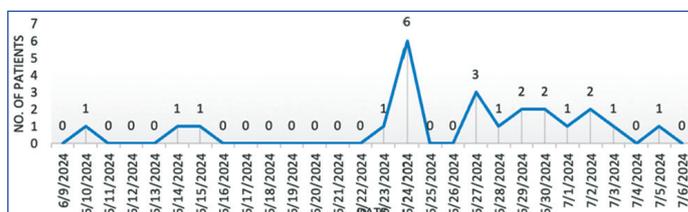
The first case was reported to the PHC on 10<sup>th</sup> June 2024 and was considered the primary case of the outbreak. The maximum number of cases occurred between 23<sup>rd</sup> June and 2<sup>nd</sup> July 2024. The last case was reported on 5<sup>th</sup> July 2024. The graph shows a low number of cases (0-1) during June 10-June 23,

Variables	No of patients (%)
<b>Age groups (5 year groups)</b>	
0-5	2 (10.53%)
6-15	2 (10.53%)
16-45	9 (36.84%)
46-60	7 (26.32%)
>60	3 (15.79%)
<b>Gender</b>	
Females	12 (52.2%)
Males	11 (47.8%)
<b>Symptoms</b>	
Vomiting	6 (26.1%)
Loose stools	21 (91.3%)
Fever	2 (8.7%)
<b>Course of illness</b>	
Relieved without complications	17 (73.91%)
Acute kidney injury cured	3 (13.04%)
Death following acute kidney injury	2 (8.70%)
Brought dead	1 (4.35%)

[Table/Fig-1]: Clinico epidemiological profile of patients (N=23).

indicating sporadic occurrences of acute gastroenteritis in the community. There was a sharp increase to six cases on June 24<sup>th</sup>, suggesting an outbreak. This could be due to a common source of infection, such as contaminated food or water, or a rapid spread through close contact. Intense control measures were implemented at this point, including active and passive case surveillance, public health education on hygiene practices, and the distribution of chlorine tablets for water disinfection. The correlation between these actions and the subsequent decline in case numbers could suggest their effectiveness. A smaller peak of 2-3 cases was observed around June 27-30<sup>th</sup>. This could represent secondary transmission from the initial outbreak or a separate, smaller exposure event. The clustering of cases within the same household indicates that secondary transmission was more likely. During July 1 to 6, the number of cases returned to baseline levels, indicating that the outbreak had been contained or had run its course. Monitoring continued for two weeks to ensure that the outbreak did not resurge.

From an epidemiological perspective, this graph suggests a point-source outbreak of acute gastroenteritis, followed by possible secondary transmission, and then control of the outbreak. Cases occurring in varying incubation periods during the outbreak indicate intermittent exposure to the source of infection [Table/Fig-2].



[Table/Fig-2]: Epidemic curve of the outbreak.

### Environmental Assessment

The colony with 33 houses was situated on a sloped terrain. The current outbreak occurred during the rainy season. The major water supply in the colony was through a piped water supply to individual houses from the Jalajeevan mission, which was intermittent (once a week). As the water supply was inadequate, the residents stored the water in small tanks and other containers. The residents also used rainwater collected on the terrace and water from a nearby stream without any treatment [Table/Fig-3]. There were two private wells that the residents relied on as alternative sources. One of the wells was unsanitary, lacking a

proper parapet wall, an inner lining, and a covering [Table/Fig-4,5]. Both the stream and private wells were situated downhill, posing a higher risk of contamination with surface run off following the rains. Some of the residents also had the habit of drinking water without boiling. There were no pet animals in the colony. All houses had toilet facilities. Open defecation was neither reported nor observed. The possibility of wild or street animals contaminating the water sources could not be ruled out. There was no routine drinking water surveillance in place. [Table/Fig-3-5] give the environmental findings.



[Table/Fig-3]: Water storing methods (containers and rain water collection on the terrace with outlet pipes).



[Table/Fig-4]: Condition of private well no.1 in the outbreak area.



[Table/Fig-5]: Condition of private well no.2 in the outbreak area (insanitary).

The investigators reviewed the results of the bacteriological quality of water available at the FHC. The samples tested for bacteriological standards gave unsatisfactory results with coliforms grown in culture (Most Probable Number >16/100 mL) in the water collected from two private wells, a nearby stream, two rainwater stores, and the Jalajeevan Mission supply stored in a house.

### Human Lab Investigations

Three patients' stool samples were investigated by routine examination and bacteriological culture. Routine microscopy of stool samples

yielded insignificant findings. Culture and sensitivity examination yielded negative results for bacterial growth (*Salmonella*, *Shigella*, and *Vibrio cholerae*). Two random representative cases were investigated by Widal tests for the diagnosis of typhoid, which were also negative. One paediatric case was investigated for the diagnosis of dengue and leptospirosis, yielding negative results. Rectal swabs from five patients were sent to the State Public Health lab. These samples were collected from the patients who were admitted during the initial phase of the outbreak. Two rectal swabs were positive for both Rota and Astro viruses by the PCR method. One rectal swab was weakly positive for Astrovirus by PCR. A nasopharyngeal swab was also collected from one among them, keeping influenza as a differential diagnosis, which gave a negative result by PCR. Since the diagnosis was established to be of mixed viral aetiology, no further samples were tested. Histopathological examination of a renal biopsy from a patient with AKI revealed features consistent with severe acute tubular injury.

### Control Measures

The health system was alerted, and a prompt outbreak response was initiated. Both active and passive case surveillance were carried out, alongside dehydration management. Health education sessions were organised, and Oral Rehydration Salt (ORS) sachets were distributed among the residents. Adequate stocks of ORS sachets were maintained with field-level workers and Accredited Social Health Activists (ASHA), and early referral and management of reported cases were ensured. Surveillance of drinking water was done along with superchlorination of water sources, which also included private wells. Chlorine tablets were distributed for disinfection of stored water. Behaviour change communication activities addressing hand hygiene, food hygiene, drinking of boiled water, and use of ORS were also done. Early health seeking and special precautions for those with comorbidities were also ensured.

### DISCUSSION

This investigation identified 23 cases of acute gastroenteritis in a tribal colony between June 10 and July 5, 2024, with an attack rate of 16.6% and a case fatality rate of 8.7%. Recent outbreaks across the country have reported attack rates ranging from 1.24 to 37% [5,8-11]. While most cases were among residents, three were epidemiologically linked to a nearby village, indicating possible transmission during communal gatherings.

The demographic analysis indicates a notable vulnerability among older adults, with 43% of cases occurring in individuals over 45 years of age. Acute gastroenteritis disproportionately affects individuals at the extremes of age, particularly children and the elderly [12]. Joshi MS et al., reported an increasing attack rate with age, peaking at 55% in those over 60 years [9]. Similarly, a recent outbreak in Kollam district demonstrated greater impact among the youngest and oldest age groups [8]. Multiple studies attribute the increased susceptibility in the elderly to factors such as reduced gastric acidity and compromised immunity [13,14].

In the current outbreak, 5 (21.7%) patients were affected with AKI, and two succumbed to it (8.7%), highlighting the critical need for targeted interventions in these high-risk groups. There are other reported studies concluding that GE-AKI is significantly more common in the elderly [15,16]. [Table/Fig-6] gives a comparison of outbreak investigations done for acute gastroenteritis [5,8-11].

Laboratory tests confirmed a mixed viral aetiology (Rotavirus and Astrovirus), aligning with global data that viruses are responsible for the majority of gastroenteritis outbreaks [12,17]. A wide range of pathogens, including viruses, bacteria, and parasites, as well as toxins, chemicals, and other non-infectious factors, are responsible for acute gastroenteritis [12]. Among these, viruses are the most common (70%) cause of gastroenteritis episodes [12]. AGE-associated viruses include rotaviruses, noroviruses, enteric adenoviruses, astroviruses, and sapoviruses [11,12,17].

S. No.	Author's name and year	Place of study	Number of cases	Objective	Parameters assessed	Conclusion
1	Rakesh PS et al., 2016 [8]	Kollam, Kerala	57	To describe the source of the outbreak and epidemiological features of the same.	Microbiological analysis of water samples. Culture of stool samples.	Outbreak among general population, occurred during December 2015-January 2016. Attack rate 13.38%. Highest attack rate among <14 years followed by >60years. Outbreak was due to pipeline contamination. Water samples had <i>E. Coli</i> . No bacterial growth found in stool culture.
2	Joshi MS et al., 2019 [9]	Devli Karad village, Maharashtra	258	To describe epidemiological, environmental, and virological investigations.	Viral investigations on fecal specimens	Affected tribal population. Occurred in November 2017. Attack rate was 22.6%. 96% patients were >14 years of age. Rotavirus B was the aetiological agent.
3	Maramraj KK et al., 2020 [5]	Pedda-Gujjil- Thanda, Telangana	191	To describe the epidemiology, identify risk factors.	Stool culture. Water samples for faecal contamination by H2S method.	Tribal village affected. Outbreak Occurred in June 2017 following rainfall. Attack rate was 37%. Illiteracy, hand-washing practice and household water treatment showed association. Stool culture was negative for <i>V.cholerae</i> . Water samples from shallow bore-wells located in downhill were positive for faecal contamination by H2S method.
4	Dolma KG et al., 2024 [10]	East Sikkim	106	To identify the source of the infection and causative pathogens and prevent the spread of the outbreak.	Stool samples, rectal swabs, water samples, and suspected food samples by culture and PCR	Outbreak in higher educational institution between Jan-Feb 2023. Attack rate was 1.24%. Multiple pathogens were identified, including <i>Campylobacter</i> , <i>Shigella spp.</i> , EIEC, ETEC, EAEC, EPEC, <i>Proteus mirabilis</i> , Astrovirus, and Rotavirus. Sewage and fecal contamination of drinking water and poor maintenance of the water distribution system most likely caused the outbreak.
5	Orysbayeva M et al., 2022 [11]	Kazakhstan	154	To describe epidemiological and clinical characteristics, determine associated factors, and identify the source to control the outbreak.	Stool and water samples investigated by PCR	Affected the rural population between May-June 2021. Attack rate of 26/1000. Mixed viral aetiology-Norovirus, Astrovirus, Rotavirus, and Enterovirus, including Coxsackievirus. Untreated tap water was the probable source
6	Present study	Kanjirappuzha, Kerala	23	To describe the epidemiology of the acute gastroenteritis outbreak and propose recommendations for control and prevention of the same.	Bacteriological quality of water. Stool culture. Viral investigations	Affected tribal population during June-July 2024. Outbreak during rainy season. Attack rate was 16.6%. Three deaths occurred 43% of cases were > 45 years. 2 deaths showed AKI. Mixed viral aetiology (Rotavirus and Astrovirus). Outbreak attributed to lack of safe water for drinking.

**[Table/Fig-6]:** Comparison of outbreak investigation (5,8,9,10,11).

Clinical characteristics of illnesses caused by the different viruses are indistinguishable [18]. Rotaviruses and Astroviruses have been found associated with outbreaks in closed communities, other food or waterborne outbreaks among wider communities [17]. Rotaviruses induce a clinical illness characterised by vomiting, diarrhoea, abdominal discomfort, fever, and dehydration (or a combination of some of these symptoms) [17]. In Astroviral infections, nausea is prominent, with vomiting, non-bloody diarrhoea, and abdominal cramps occurring in most cases. The most important and common complication of viral gastroenteritis is dehydration, often with electrolyte abnormalities [18]. Acute gastroenteritis caused by Astrovirus carries a lower risk of dehydration than gastroenteritis caused by Rotavirus [17]. In the current outbreak, patients presented with all major symptoms of both infections, though the majority had loose stools (91.3%) and other symptoms were less frequent.

Food, water, and close contact remain the major modes of transmission in acute viral gastroenteritis outbreaks in closed and wider communities [17]. Systematic reviews of epidemiological evidence from intervention studies, especially outbreak investigations, suggest that drinking-water quality plays an important role in faecal-oral transmission [19]. Water source contamination has been attributed to the cause of acute gastroenteritis in many studies [5,8,10,11]. Moreover, the outbreak coincided with the rainy season, which further enhanced the risk of source contamination, as is evidenced by other studies [5,20]. In the current outbreak, the environmental assessment identified multiple contaminated water sources-private wells, rainwater stores, a stream, and stored piped supply-testing positive for coliforms, and the timing during the rainy season likely exacerbated

contamination risks. The community's reliance on unsafe water, intermittent supply, and lack of routine surveillance were major contributing factors.

Prompt public health interventions- including health education, water chlorination, and ORS distribution- were critical in containing the outbreak, supporting WHO and national recommendations for WaSH improvements [5,21,22]. According to the WHO report, 58% of cases of diarrhoea in middle and low- income countries are estimated to be attributable to inadequate drinking water, inadequate sanitation and poor hand hygiene [23]. Safely managed drinking water must satisfy quality, accessibility and availability criteria [21]. The village's use of unsafe water sources and unboiled water likely caused the acute gastroenteritis outbreak. Moreover, Almost 10% of the global disease burden could be reduced by improving water supply, sanitation, hygiene, and water resource management [22]. The UN Sustainable Development Goal 6 (SDG 6) was established to ensure the availability and sustainable management of water and sanitation for all by 2030 [21]. Achieving this requires public health interventions to enhance WaSH practices and the implementation of regular drinking water surveillance to prevent future outbreaks. To accelerate such public health interventions, especially in resource-limited tribal areas, stronger political and financial support, along with effective community mobilisation, are essential.

### Limitation(s)

Recall bias is possible, as the histories were obtained retrospectively. Mild and subclinical cases would have gone unreported in the outbreak. Limited laboratory capacity restricted extensive testing for viral agents.

## CONCLUSION(S)

A mixed viral gastroenteritis outbreak due to human astrovirus and rotavirus was reported in the tribal colony which caused three fatalities. The outbreak is mainly attributed to the scarcity of safe and wholesome drinking water in the colony. Improving water sanitation hygiene practices and incorporation of an active surveillance system with epidemiological and laboratory support can prevent similar outbreaks in the future. The investigation has shed light on the social and environmental determinants leading to poor health outcome, which calls for greater political commitment and community mobilisation.

## Acknowledgement

The Authors are grateful to District Medical Officer and District Surveillance Officer Palakkad, Medical Officer and health workers of the Family Health Centre Kanjirappuzha.

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### PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Community Medicine, Government Medical College, Palakkad, Kerala, India.
2. Additional Professor, Department of Microbiology, Government Medical College, Palakkad, Kerala, India.
3. Associate Professor, Department of Community Medicine, Government Medical College, Palakkad, Kerala, India.
4. Associate Professor, Department of General Medicine, Government Medical College, Palakkad, Kerala, India.
5. Assistant Professor, Department of Community Medicine, Palakkad Institute of Medical Sciences Walayar, Palakkad, Kerala, India.
6. Statistician cum Lecturer, Department of Community Medicine, Government Medical College, Palakkad, Kerala, India.

### NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. N Divyamol,  
Associate Professor, Department of Community Medicine, Government Medical College, Palakkad, Kerala, India.  
E-mail: divyanallat@gmail.com

### AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

### PLAGIARISM CHECKING METHODS: [Jan H et al.]

- Plagiarism X-checker: Oct 17, 2025
- Manual Googling: Jan 03, 2026
- iThenticate Software: Jan 06, 2026 (4%)

### ETYMOLOGY: Author Origin

EMENDATIONS: 7

Date of Submission: **Sep 20, 2025**  
Date of Peer Review: **Nov 03, 2025**  
Date of Acceptance: **Jan 08, 2026**  
Date of Publishing: **Apr 01, 2026**