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Research Article

Food Poisoning Outbreak at Qarn Al Alam, Dakhliyah Governorate, Oman, January 2025

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Abstract

Background: From January 26 to January 30, 2025, an outbreak of foodborne sickness occurred among workers at a specific company camp in Qarn Al Alam, Al-Dakhyilia governorate, Oman. This outbreak clearly affected 49 workers, who experienced symptoms like diarrhoea, fever, , vomiting, and abdominal pain after eating food from the camp. The Rapid Response Team (RRT) of Al Dakhliyah governorate was activated to investigate and oversee the outbreak. Objectives: to confirm the existence of the outbreak, to identify the mode, vehicle of transmission, initiates appropriate control measures and roles to prevent the future similar outbreaks.Method: A case-control study was conducted to investigate the outbreak. Cases were defined as any workers/staff of the specific company who ate from the camp in Qarn Al Alam and had diarrhea and/or any one of the signs/symptoms of fever, vomiting, and abdominal pain among from 26th January 2025 to 30th January 2025. Any workers of the specific company who ate from same camp without reporting symptoms were defines as control. Data collection included interviews, environmental assessments, and clinical histories. Food samples and clinical specimens were tested to validate the causes of the illnesses and identify the most common foodborne germs. Data was analyzed by SPSS program. Results: A total of 49 workers were infected by the outbreak. The interval between the occurrence of the first and the last case was 76 hrs. Most of the cases were in the age group 20-39 years. The majority of cases were among Indians, who were followed by Pakistanis and Bangladeshis. The most common symptom, which affected workers of all ages, was diarrhea, which was followed by fever and abdominal pain. The clinical picture was compatible with mild acute gastroenteritis. A breakdown of food safety and basic personal hygiene was detected among the food handlers. The stool cultures of cases and food handlers were positive for Salmonella species. The identical DNA fingerprinting pattern confirmed Salmonella enteritis strains originating from the cases and food handlers. Conclusion: We concluded that the source of outbreak was the food handlers. The importance of food safety and rigors environmental safety is emphasized. Basic personal hygiene and training of food handlers in restaurants are recommended with public health measurements.

Keywords

Foodborne Illness, Outbreak, Dakhliyah Governorate, Oman, Salmonella

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1. Introduction

The Qarn Al Alam is an area situated about 140 kilometers from Adam town. Adam is a town located 200 km from Muscat, the capital city of Oman. Presently there are 2,400 workers of the concerned company taking meals in the camp. The camp has a well-established catering service and provides all meals, including breakfast, lunch, and dinner.

On 27th & 28th January 2025, informed by Qarn Alam clinic doctor, that 20 cases were reported within the contract laborers, having complaints of watery loose motion 5-6 times, followed with abdominal pain, nausea, and vomiting. All male patients were staying in the same camps.

On 29th January 2025, the Rapid Response Team (RRT) of Al Dakhliyah governorate responded by sending a team to Qarn Alam. Preliminary investigations confirmed that 44 cases were reported of suspected food poisoning with clinical findings of watery loose motion 5-6 times, followed by abdominal pain, nausea, and vomiting after eating the food on 27th January 2025 from mess in camps. All patients were treated in OPD and had mild to moderate dehydration with antidiarrheal and ORS. It looks like gastroenteritis cases need to be investigated for the source of infection.

Foodborne diseases are an important cause of morbidity and mortality and a significant impediment to socioeconomic development worldwide. The burden of foodborne diseases is substantial: every year almost 1 in 10 people fall ill and 33 million of healthy life years are lost. Diarrheal diseases are the most common illnesses resulting from unsafe food, 550 million people falling ill each year, including 220 million children under the age of 5 years. [1]. The Centers for Disease Control and Prevention (CDC) reports that around 48 million people in the United States suffer from a foodborne illness annually. Among these instances, more than 128,000 individuals necessitate hospitalization, and over 3,000 fatalities ensue because of these diseases [2]. According to the annual health report of the Ministry of Health in the Sultanate of Oman for the year 2023, there were 266 cases of food poisoning, 65 of which were in the Al Dakhiliyah Governorate [3]. Foodborne infections can be caused by different strains of bacteria found in food. Pathogens such as Salmonella, Shigella, and Listeria monocytogenes can potentially cause foodborne illnesses [4]. About 58% of foodborne diseases in the US are caused by norovirus, followed by Salmonella (11%) and Clostridium perfringens (10%) [2]. Between 2016 and 2020, SE affected 18 countries in Europe causing a child and an elderly person to die due to the infection [14].

Non-typhoidal Salmonella is a leading cause of bacterial gastroenteritis and a major global public health concern [5]. Pathogenic salmonella ingested with food survives the gastric acid barrier, penetrates the lining of the small and large intestine, and produces toxins [3]. The incubation period for Salmonella gastroenteritis (food poisoning) depends on the dose of bacteria. Symptoms usually begin 6 to 48 hours after ingestion of contaminated food or water and usually take the form of nausea, vomiting, diarrhea, and abdominal pain. Myalgia and headache are common; however, the cardinal manifestation is diarrhea. Fever (38 ℃ to 39 ℃) and chills are also common. At least two-thirds of patients complain of abdominal cramps. The duration of fever and diarrhea varies but is usually 2 to 7 days [4]. Salmonella remains one of the most significant foodborne pathogens contributing to the global burden of foodborne illness [10]. Outbreaks linked to domestic animals have been reported [11]. Contaminated drinking water is also a common source [12]. Poultry products (meat and eggs) account for 40% of Salmonella contamination [13]. Salmonella spreads via the fecal-oral route through environmental contamination from animal or human feces [15, 16].

Objectives

1) To confirm the existence of the outbreak.
2) To identify the mode, vehicle of transmission and initiates appropriate control measures.
3) To assess the severity and the extent of the current outbreak.
4) To set recommendations to prevent the future similar outbreaks.

2. Methodology

2.1. Outbreak Notification

Cases started reporting from morning at around 04:00 am on 27th January 2025 in Qarn Al Alam clinic, complaining of watery loose motion 5-6 times with abdominal pain, nausea, and vomiting. On 28th January 2025, RRT was activated to investigate the suspected food poisoning. RRT consisted of Regional Epidemiologist, an environmental and occupational health supervisor, Health Supervisor from public health, Adam town, and also a team from the municipality. RRT conducted a meeting with the company staff, Renaissance, doctors, and food handlers. The team interviewed the patients, prepared a format, trained staff to collect data, listed patients, collected patients stool samples, identified food samples and food handlers (sample stool and nasal swabs), and collected samples.

2.2. Study Design

As part of the outbreak investigation, we conducted a case-control study to confirm the source of contaminated food. Control Selection: Refers to individuals who ate at the company camp in Qarn Al Alam from 26th January 2025 to 30th January 2025 and showed no symptoms. Controls were randomly selected using simple random sampling from the eligible non-case population during the same exposure period.. Since the camp is located in the desert, there was no possibility that any of the

workers would have eaten any food item other than those served in the only mess in the camp.

2.3. Case Definition

1) *Case definition:* case having loose motions (>3 times) and/or any one of the signs/symptoms of fever, vomiting, and abdominal pain among the company workers who ate from the company camp in Qarn Al Alam from 26th January 2025 to 30th January 2025.
2) *Confirmed case:* As above with laboratory confirmation by stool culture.
3) *Probable case:* An individual who suddenly developed any of the following signs/symptoms of fever, vomiting, and abdominal pain among the company workers who ate from the company camp in Qarn Al Alam from 26th January 2025 to 30th January 2025.
4) *Control:* Any the company workers who ate from the company camp from 26th January 2025 to 30th January 2025 and did not develop illness or symptoms.

2.4. Statistical Analysis

Microsoft Excel and SPSS (Statistical Package for the Social Sciences) software program were used to clean the data and analyse Odds ratio. We considered P value less than 0.05 is significant.

Data collection: Scrutiny was done as per the case definition. Cases were tracked who were treated and admitted in health clinics. Relevant data elements were collected that included demographic profile, date of onset of signs and symptoms as per the case definition, and laboratory results wherever applicable. The available patient data in the company clinic was taken, and detailed clinical information, food taken, and samples collected.

2.5. Types of Investigation

Three types of investigation (epidemiologic, laboratory, and environmental) were conducted.

2.5.1. Epidemiological Investigation

(i). Descriptive Epidemiology

The study described cases by pattern (time, place, and person), frequency (number, percentage), age (age groups), disease distribution, and symptom distribution. It also analysed the spread pattern, source, duration, and onset time of the outbreak. The cases were localized in the specific camp in Qarn Al Alam, highlighting the importance of describing the time, place, and person to generate hypotheses about the outbreak's determinants (source, causes, risk factors, and mode of transmission).

(ii). Analytic Epidemiology

Analytical epidemiology was the first method to test the reliability of hypotheses about determinants and risk factors associated with outbreaks. A risk factor tested by analytical epidemiology was contaminated food, an indirect vehicle transmission route.

2.5.2. Laboratory Investigations

Suspected food poisoning cases (49) were reported, and stool samples were taken in 28 cases (57%). Stool samples were collected and sent to Adam Hospital under all cold chain. Stool culture was done at Nizwa hospital lab and CDC Nizwa. Given the suspicion of bacterial acute gastroenteritis, viral tests were not carried out.

2.5.3. Environmental Assessment

The team from MOH and the municipality visited company camp on 28th January 2025. The investigation team assessed the following:

1) General assessment: The team visited the storage area, preparing area, cooking area, and serving area. The team also checked food records and inventory records.
2) Food handlers were interviewed, and personnel hygiene was evaluated. They were asked about the preparation and handling of foods. Nasal swabs and stool samples were collected from all the food handlers.
3) Food Items: All food samples from 23rd January to 26th January 2025 (as per the menu served) were taken by the municipality. The samples of prepared food were available for examination. All items prepared were tested in the municipal laboratory in Seeb.
4) The source of water was identified, and a sample was collected and sent to the municipality lab. All samples were examined for microbiological analysis.

3. Results

3.1. Descriptive Epidemiology

3.1.1. Distribution of Cases by Person

(i). Age

The age distribution shows that all cases were in the age range of 20-59 years. Most of the cases were in the age group 20-39 years (n=32, 65%), followed by the age group 50-59 years (n=10, 20%), and the age group 40-49 years (n=7, 14%). All cases were males, working on the same campus and having food at the same place (Figure 1).

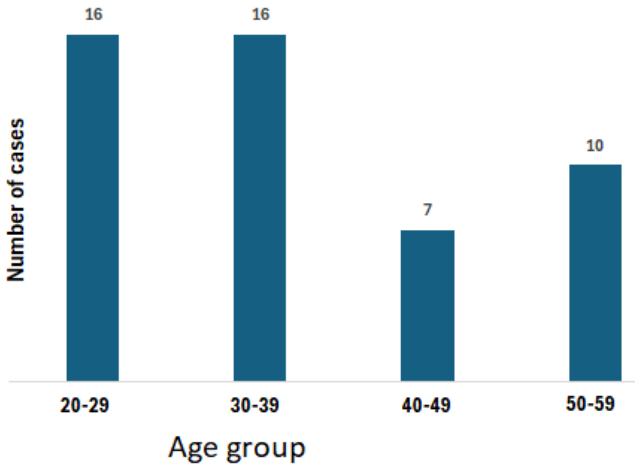

Figure 1. Distribution of cases by age groups of an outbreak at Qarn Al Alam, Oman, January 2025(n=49).

(ii). Nationality

Indians accounted for the largest percentage of cases (n=27, 55.10%), followed by Pakistanis (n=16, 32.65%) and Bangladeshis (n=3.6, 12%), as Shown in (Figure 2).

Figure 2. Distribution of cases by nationality of an outbreak at Qarn Al Alam, Oman, January 2025(n=49).

(iii). Clinical Presentation

All cases had diarrhoea (n=49,100%) followed by abdominal pain and crumps (n=26, 53%), fever (n=23, 47%), headache (n=8, 16%) and nausea with vomiting (n=7, 14%), (Table 1). The clinical picture was compatible with mild acute gastroenteritis. There were no melena or gastroenteritis complications due to Salmonella infection.

Table 1. Distribution of patients according to presenting symptoms of an outbreak at Qarn Al Alam, Oman, January 2025(n=49).

Clinical presentation	Number of cases	%
Diarrhoea	49	100%
Abdominal pain/cramps	26	53%
Fever	23	47%
Headache	8	16%
Vomiting/nausea	7	14%

3.1.2. Distribution of Cases by Time

The first symptomatic case was presented on 26th January 2025,2.00pm and the last case was on 30th January 2025,02:00 am. The majority of cases occurred on the second day (27th January), which is consistent with Salmonella infections, where the typical incubation period ranges from 6 to 72 hours (1 to 3 days). The incubation period ranged from 0 to 4 days. The minimum Incubation Period (IP) was 2 h 30 min and maximum was 54 h 50 min. The mean IP was 17 h 22 min with standard deviation 11.5(Figure 3).

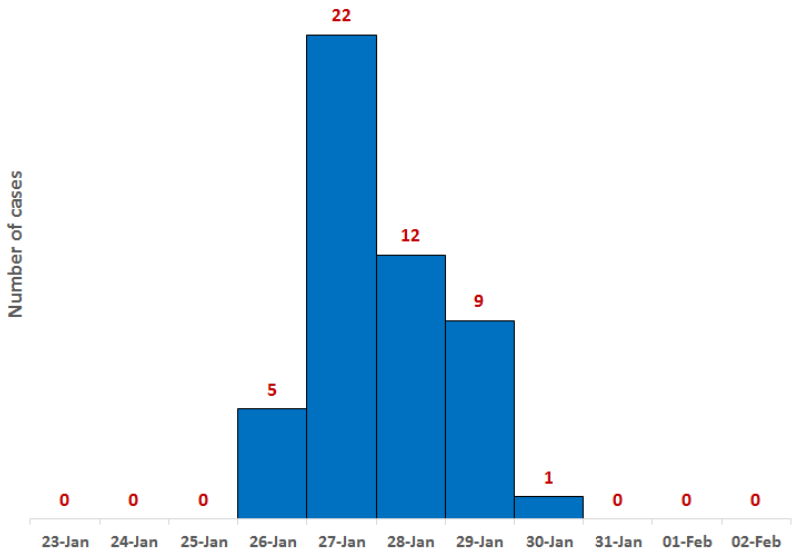

Figure 3. *Epidemic curve of an outbreak at Qarn Al Alam, Dakhliyah Governorate, Oman.*

3.2. Laboratory Investigation

Patients were treated in two health institutes: the company clinic and Galfar clinic. Out of total 28 stool culture samples, 9 samples (32%) had shown grown Salmonella species (Table 2).

Table 2. *stool samples of randomized cases of an outbreak at Qarn Al Alam, Dakhliyah Governorate, Oman, January 2025.*

Hospital	Total Cases at clinic	Stool samples	Salmonella species Group B isolated (n, %)
the company clinic	20	13	3
Galfar clinic	29	15	6
Total	49	28 (57%)	9 (32%)

Genotypic Examination of Isolated Salmonella Species

The bacteriology section of central public health lab (CPHL) further performed standardized molecular sub typing (or "fingerprinting") of Salmonella isolates by pulsed-field gel electrophoresis (PFGE). Three representative stool isolates and five food handlers' isolates have 100% Salmonella genotypic similarity which suggestive of same clone. However further collaborating evidence was not available since none of the food samples yielded the Salmonella growth as shown in dendogram (Figure 4).

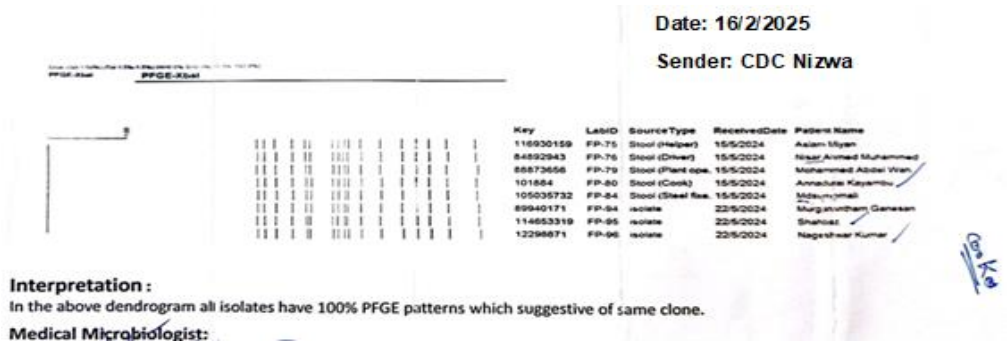

Figure 4. *three representative stool isolates and five food handlers' isolates have 100% genotypic similarity an outbreak at Qarn Al Alam, Dakhliyah Governorate, Oman, and January 2025.*

3.3. Environmental Investigation

a) *The kitchen:* Storage area, preparing area, cooking area, and serving area were all clean, disinfected, and free of insects or rodents. The food supplies were stored in a clean store near the kitchen.

b) *Water:* Three sources of water were identified: water cooler, cooking area and filter. Samples were collected on 29th January 2025 and sent to Municipality laboratory. All samples were examined for microbiological analysis. All sample came out to be passed.

c) *The food handlers:* Personnel hygiene and the preparation and handling of foods were satisfactory, and the food handlers were following all protocols. All food handlers had 40 stool samples and 20 nasal swabs taken. Four nasal swab samples (20%) tested positive for Non-Enterotoxin Staphylococcus Aureus. Three food handlers had stool samples that tested positive for Salmonella group B (Table 3).

Table 3. *Laboratory investigation of food handlers of an outbreak at Qarn Al Alam, Dakhliyah Governorate, Oman, January 2025.*

Samples	Total samples	Lab results n, (%)	Toxigenicity/serotyping results n, (%)
Nasal swabs	20	4 (20%) samples: positive for Non-Enterotoxin Staphylococcus Aureus isolated.	1 (5%) - Enterotoxin type A producing Staphylococcus aueures isolated. 1 (5%)- Enterotoxin type C producing Staphylococcus aueures isolated.
Stool samples	40	3 (7.5 %) samples: positive for Salmonella species	Salmonella Group B isolated

d) *Investigation of Food Items:* The samples of prepared food were available for examination. All items prepared were tested in the municipality laboratory. All of the samples were in good condition. On 26th January 2025 Staphylococcus aureus was identified in the Chicken Fried Rice and Beef Chow main. Additionally, on 28th January 2025, a sample of white rice lunch tested positive for Staphylococcus aureus (Table 4).

Table 4. *Laboratory investigation of food items of an outbreak at Qarn Al Alam, Dakhliyah Governorate, Oman, January 2025.*

Date sample production	Served food	Sample food	Lab result of food sample
26th January 2025	Dinner	Chicken Fried Rice	Staphylococcus aureus positive
		Beef Chow main	Staphylococcus aureus positive
28th January 2025	Lunch	white rice	Staphylococcus aureus positive

To elicit the history of consumption of food items served on 26th January a total 147 persons from residing in the camp were interviewed. Among them 49 were affected (cases) and 98 were non-affected (controls). The details about the type of food items consumed is shown in Table 5.

An analytical epidemiological study investigated a food-borne outbreak involving 49 cases and 98 controls. The study aimed to identify the food item most likely responsible for the outbreak. As shown in Table 5, Lentils (OR: 0.18, P-value: 0.003), beef (OR: 0.24, P-value: 0.02), and bread (OR: 0.14, P-value: 0.03) exhibited statistically significant protective associations with the outcome. However, the majority of other food items analysed did not show statistically significant associations.

Table 5. Analytic epidemiology results among cases and controls of an outbreak at Qarn Al Alam, Oman, January 2025.

Food items	Cases(n)=49		Control(n)=98				Chi-square statistics
	Exposed	Non-Exposed	Exposed	Non-Exposed	Odds Ratio	CI.95%	P-Value
Chicken Biriyani	25	24	52	46	0.82	(0.41-1.6)	0.56
Salad	7	42	10	88	1.3	(0.48-3.6)	0.60
Veg Biriyani	6	43	8	90	1.6	(0.51-4.8)	0.43
Beef	3	46	21	77	0.24	(0.07-0.84)	0.02
Lentils	3	46	26	72	0.18	(0.05-0.63)	0.003
Aloo Began	1	48	8	90	0.23	(0.03-1.93)	0.14
Vegetable Saloona	1	48	3	95	0.66	(0.07-6.5)	0.72
Rice (White/ Mota)	2	47	8	90	0.48	(0.1-2.35)	0.35
Chicken Saloona	1	48	6	92	0.32	(0.04-2.7)	0.27
Bread	1	48	13	85	0.14	(0.02-1.2)	0.03
Ice Cream	4	45	7	91	1.16	(0.33-4.2)	0.83

4. Discussion

On 26th January 2025, the afternoon lunch was served by the catering contractor of the specific company at Qarn Al Alam to all the residential staff (around 2,200). Of those who had taken dinner, 49 were affected with signs and symptoms of acute gastroenteritis. The last case occurred on 30th January 2025. All cases were treated in OPD in the company clinic. In all cases, the clinical presentation was mild with uneventful recovery. Although specific food items showed no contamination (Table 5), the presence of Salmonella in 97 cookers (Figure 4) highlights human-mediated contamination as a key risk factor. Random sampling identified potential carriers, stressing the need to address human transmission alongside food safety measures to effectively control *Salmonella* spread and protect public health. Salmonella enteritis's was isolated from stool samples from five patients and three food handlers presumed to be the cause of the outbreak. All isolates had identical PFGE patterns, suggesting the same source of infection.

As per reports from the European Centre for Disease Prevention and Control (ECDC) and the Zoonosis Reports by the European Food Safety Authority (EFSA), there are approximately 93.8 million instances of human enteric illnesses due to *Salmonella* infection annually, leading to an estimated 150,000 deaths [4]. Based on a World Health Organization (WHO) report, the estimated burden of foodborne diseases per population in the Middle East and North Africa region stands to be third highest globally, only surpassed by the African and South-East Asian regions [5]. About 70% of the total foodborne diseases in this area are caused by Campylobacter, E. coli, non-typhoidal Salmonella (NTS), and Norovirus [6]

Salmonella is a Gram-negative bacillus and facultative anaerobe, mainly divided into *Salmonella enteritidis (SE)* and *Salmonella Bongori*, which is the main pathogenic bacterium of bacterial foodborne diseases globally [7]. During the 1980s, SE emerged as an important cause of human illness. Now, SE is the most common serotype in the United States and in many other countries [8]. *Salmonella enteritidis* has a complex mode of transmission and can be transmitted through the air, water, food, and animals in the environment. The most common source of human infection with *Salmonella enteritidis* is usually poultry and livestock [9].

The result of the outbreak investigation described in this paper suggest that Salmonella enteritidis is associated with foodborn outbreak. Nasal samples of food handlers were positive for Non-Enterotoxin Staphylococcus aureus isolated. Stool samples of food handlers were positive for Salmonella spp. Dendrogram showed that Patient and food handlers had isolates 100% PFGE patterns which suggestive of same clone. Although there was no salmonella in the food samples, this can be explained by the fact that the food samples were tested before the food handler started preparing the food, as the company keeps samples of the food before it is used by the workers.

Eggs, poultry, meat, milk, and other foods are safe when handled properly. Cross-contamination occurs in the kitchen when unwashed hands or food preparation surfaces transfer SE from chicken to other foods. Keeping uncooked meat separate from other foods during storage and preparation can help

prevent cross-contamination. Prompt refrigeration of unused or leftover food prevents growth of bacteria.

Although food handlers confirm Salmonella enteritis and match it with patients isolates, they categorically state that they may be the source of infection since they had also consumed the same food prepared in the mess and thus might have subsequently acquired the infection.

5. Conclusion

In January 2025, 49 employees in a company camp in Al-Dakhyilia Governorate of Oman contracted food illness from Salmonella enteritidis. Laboratory and epidemiological data suggested that food handlers are to the source of the infection. The outbreak was exacerbated by a number of factors, including a violation of basic hygiene regulations, incorrect food handling, partially cooked food, a break in the cold chain, and favourable weather conditions for the fast proliferation of food agents. After this outbreak, several recommendations are needed to prevent further similar conditions in the future.

6. Recommendations

To ensure food safety, food handlers must follow safe practices, maintain personal hygiene, undergo regular health check-ups, and receive ongoing training. Staff should wash hands before eating, avoid sharing food or drinks, and refrain from taking packed meals to their rooms. Environmentally, proper storage of raw and cooked items, regular refrigerator temperature checks, food sample collection, utensil cleanliness, and routine drinking water testing are essential. These measures collectively reduce contamination risks and promote safer food handling.

7. Limitations

The main limitation of this investigation was the inadequate laboratory capacity to conduct testing for the majority of cases, which hindered comprehensive analysis and identification of potential pathogens. Additionally, recall bias was observed among several patients who were unable to accurately report the food items consumed at the onset of the current outbreak, further complicating efforts to pinpoint specific sources of contamination. These limitations highlight the need for enhanced laboratory infrastructure and improved data collection methodologies in future investigations.

Abbreviations

RRT	Rapid Response Team
CDC	Centers for Disease Control and Prevention
CPHL	Central Public Health Lab
PFGE	Pulsed-Field Gel Electrophoresis

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Author Contributions

Ahmed Al-Busaidi: Conceptualization, Data curation, Formal Analysis

Shady Abdelrahman Kamel: Funding acquisition, Investigation, Methodology

Mohammed Al-Tobi: Project administration, Resources, Software

Salim Al-Busaidi: Supervision, Validation, Visualization

Kishor Duthade: Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare they have no conflicts of interest.

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