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A community outbreak of *Salmonellosis* associated with consumption of contaminated local sweet beer at Ng'onga, Rumphi District, Malawi

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Abstract

In Malawi, community foodborne outbreaks are common even though most reported incidents are not fully investigated. Sanitary unhygienic conditions and improper food storage are the main drivers for the point source outbreaks. On 15th July 2024, Rumphi District Hospital rapid response team (DRRT) investigated a foodborne disease outbreak associated with the consumption of a locally prepared sweet beer, at Ng´onga in the district. The aim was to identify the cause and mitigate the potential contributing factors. A

retrospective cohort study was conducted on all probable cases that consumed locally prepared sweet beer. The DRRT headed by an epidemiologist, developed a case definition to line list all possible cases. Samples of local sweet beer, water, and stool were collected for microbiological analyses. Interviews with the victims and unaffected households were conducted concurrently with environmental risk assessment. There were 21 cases of which 11 (52.38%) were females. The overall mean age was 23.7 (SD =22.2). Most of the victims were children (1-15 years, 61.9%, n=13). All the cases reported acute bloody diarrhoea and vomiting, while others developed headaches and fever. Two bacterial isolates, Salmonella and E. coli, were identified from samples of local sweet beer and stool. The clinical and epidemic curve suggested a point source outbreak of Salmonella infection, with an attack rate of 100%. Even though a conclusive root cause of contamination could not be determined, the environmental assessment revealed some risk factors including animal droppings, unhygienic sanitary conditions, and the presence of infants within the compound. This paper provides an overview of the field investigation, including patients' clinical manifestations as well as a summary of descriptive epidemiological analyses of the outbreak.

Introduction

Food-borne disease outbreaks are common in most African countries due to limited access to drinking water, sanitation, and hygiene (WASH) [1]. They commonly occur in closed communities where food is prepared and served centrally for a sizable population [2]. The majority of foodborne illnesses are attributed to the consumption of common food or water sources contaminated with pathogenic microbes. Several pathogens, both bacteria and viruses, have been implicated in food poisoning. Among the bacterial causes of foodborne outbreaks include *Salmonella sp*, a genus of Gram-negative bacteria that stands out as the most predominant microbe among numerous foodborne pathogens, contributing to a significant number of mortality and morbidity worldwide [3]. In Africa, there are two main types of invasive *Salmonella* infections: the typhoid fever, caused by *Salmonella typhi*, and the invasive Non-Typhoidal *Salmonella* (iNTS) disease, primarily caused in our setting by *Salmonella typhimurium* [4]. The iNTS which has a human gastrointestinal tract as its reservoir, can be life-threatening, requiring effective antibiotic therapy in the face of emerging antibiotic resistance [5].

In Malawi, food-borne outbreaks associated with *Salmonella* are common, even though most of the incidents are under reported. Several studies have been conducted to understand and characterize genome, reservoirs, spatial variations of risks, and mode of transmission of *Salmonella* infections [4,6,7]. Districts such as Rumphi, Mzimba, and Neno report cases of community foodborne disease outbreaks every year even though such incidents are not fully investigated. The district hospital rapid response teams (DRRTs) are tasked to investigate and report such incidents. The success of such investigations depends on a number of things: technical knowledge and training, availability of transport for the responders, as well as the diagnostic capacity to determine the cause. Team preparation is therefore important for DRRTs to ensure a successful rapid response and control. On 15th July 2024, Rumphi DRRT investigated a foodborne disease outbreak associated with the consumption of a local sweet beer, at Munyongani village, T/A Chisovya, Ng´onga (Figure 1). The outbreak involved 21 cases, all coming from the same village, presenting with acute bloody diarrhoea, vomiting, headache, and fever. The investigation was conducted in order to identify its source, and causative agent, and to make proper recommendations on preventive measures against future outbreaks.

Methods

Nature of the problem and its public health importance: Munyongani village is 1.5 km from Ng´onga Health Centre and roughly 20 km from Rumphi District Hospital, a secondary referral health facility in the district. On Sunday, 14th July 2024, Ng´onga Health Centre, a facility under the Rumphi District Health Office, received cases of a food-borne illness following consumption of local sweet beer (Thobwa), prepared by one household in Munyongani village, T/A Chisovya, Ng´onga. The local sweet beer was prepared in preparation for field maize harvesting, in which several households within the community participated. Members of the households who consumed the Thobwa presented to the health center with acute gastrointestinal symptoms. The police department and the Director of Health and social services directorate were informed, which in turn alerted the DRRT. It was reported that several people went to the nearby Ng´onga Health center for treatment, while the majority who required hospitalization were referred to Rumphi District Hospital.

The rapid response team: the DRRT comprising environmental health officers, a medical doctor, a community nurse, and an epidemiologist conducted a field investigation to assess the extent of the outbreak, identify the cause, and mitigate the potential contributing factors that may have led to contamination of the locally prepared sweet beer (Figure 2). The team was carefully selected based on specific technical skills and responsibilities (Table 1).

Case definition: a case definition was quickly developed by the DRRT to find and line list all possible cases. The case definition was based on preliminary reports from the health center and police regarding the patient's clinical presentation, the location of the incident, as well as the suspected food source. A suspect case was defined as a person who had consumed local sweet beer at Munyongani village, T/A Chisovya on 14th July 2024 and subsequently developed any of the gastrointestinal symptoms such as acute diarrhoea, abdominal pains, and vomiting within the next 24 hours. At this stage, the etiological agent wasn´t known, as samples were yet to be collected and analyzed for confirmation of the cause.

Case finding: with the case definition and a known potential exposure, the DRRT first visited the Ng´onga health center to identify patients and review records of the discharged patients before heading to Munyongani village, where the incident happened. Some of the patients were ferried in a police vehicle to Rumphi District Hospital for treatment before the DRRT arrived. Household members of the victims were interrogated by the DRRT. After the field investigation, the rapid response team headed back to Rumphi District Hospital to further interrogate and line list hospitalized patients. Household members of the cases who never got sick were also asked about the food they ate on of the fateful day. All healthy household members indicated they never consumed Thobwa (Figure 3).

Hypothesis generation: through interviews, targeting both patients and other household members, we were able to identify potential exposure which pointed to a common source. Most of the questions asked, related to the kind of food they had consumed and the time of onset of clinical symptoms. Our preliminary hypothesis was that the consumption of local sweet beer caused the foodborne outbreak.

Study design: a retrospective cohort study design was used to identify the potential vehicle and source of the outbreak. This design was chosen because information about possible risks could be obtained from an identifiable group, most of whom were hospitalized. For the very sick people and young children under the age of 7, we interviewed their guardians. The information was captured on a form and then transferred to a line list. We further conducted descriptive statistical analyses to describe the demographic

characteristics of the suspects, including common clinical symptoms obtained during line listing.

Laboratory investigations: the laboratory manager who was part of the DRRT guided the collection of various samples including the implicated local sweet beer, water, and stool. Other additional samples of stool were collected at the main District hospital where most patients were admitted. All samples were submitted to the district laboratory department for various tests, including culture. Rumphi District Hospital Laboratory is accredited by the Southern Africa Development Community Accreditation Service (SADCAS). It has well-qualified and trained laboratory staff capable of conducting microbiological investigations. The diagnostic capacity of the microbiology section is quite improved, owing to the support of the Ministry of Health (MoH) through the Flemings fund.

Environmental assessment: environmental and sanitary assessment was carried out by environmental health officers and health surveillance assistants, who inspected the households and surroundings for any risk factors of food-borne disease. Besides, Interviews were randomly conducted with several household members to ascertain possible risk factors that might have led to exposure and subsequent outbreak. Questions were asked regarding the preparation procedure and storage of the local sweet beer, including the ingredients used.

Ethical consideration: the investigation was not human subject research but rather a public health response to an outbreak of suspected food poisoning. The purpose was to identify risks, and causative agents, and control the further spread of the disease. As such, ethical clearance was not required. However, as a routine public health practice, verbal consent was obtained from all adult respondents (≥18 years) while for those below 18 years as well as very sick persons, consent was obtained from their guardians. Besides, all the names in the line list used were reidentified with raw data kept in password-protected computers of the lead investigators.

Results

Descriptive epidemiology: there were 21 victims of the suspected food poisoning out of which 11 were females (52.38%) with a mean age of 26.3 (SD=24.7) against 10 males (mean=20.9, SD=19.9). The overall mean age was 23.7 (SD=22.2) Table 2. There was no statistical significance in the mean age difference between males and females (P=0.5929). The majority of the victims were children (1-15 years n=13), representing 61.9% of the total cases. All the victims came from the same village and had similar exposure (Thobwa).

Clinical findings: in terms of clinical presentation, it was observed that all the cases developed acute bloody diarrhoea and vomiting. Of the 17 hospitalized patients, 47.6% (n=10) and 42.9% (n=9), developed headache and fever respectively in the course of receiving treatment. There was a significant difference among the three age groups (1-15 years, 16-59 years, > 59 years) in terms of the occurrence of fever ($Chi^2(2)= 9.6923$, P=0.008) (Table 3). The likelihood of fever increased with age, though the sample size was too small to make a meaningful conclusion.

Laboratory results: test analysis on samples was done using the Cholera rapid test, Microbiological culture media (BA, CHO, MAC, TCBS, SS media), and Biochemical tests (catalase, oxidase, Sulfur, Indole, and Motility) for identification of pathogenic bacteria. There was marked growth on most of the culture media, with consistent findings of gram-negative rods. Biochemical tests confirmed two bacterial isolates, associated with food and waterborne disease outbreaks: the consistent presence of hydrogen sulfide and subsequent Indole and API 20E distinguished two bacterial isolates identified as *Salmonella* and *E. coli*. Cholera rapid diagnostic test and culture on TCBS media including subsequent oxidase test

came out negative for *Vibrio cholerae*, a bacteria that causes cholera.

Environmental evaluation: environmental assessment revealed some risk factors that might have played a role in the outbreak of salmonellosis, though causality or association could not be proven. Such risk factors included animal droppings, unhygienic sanitary conditions, and the presence of infants within the compound.

Epidemiological findings: an epidemic curve was plotted to determine the type of outbreak and frequency of new cases from the onset of the disease. Results shown in the epidemic curve (Figure 4) are typical of a point source outbreak, suggestive of a common source and a biological agent with a short incubation period. As shown in the Table 4 of the line listing in the appendix, almost all the cases consumed common food sources.

Discussion

Contamination as a driving factor for foodborne illness often happens when the food is exposed for a prolonged period, thus allowing for the multiplication of bacteria and viruses [5]. Thobwa, a locally prepared sweet beer, has been implicated in many incidents of food poisoning because it is often prepared in advance for a good number of people. This increases the likelihood of exposure and multiplication of toxins-producing bacteria, considering that most households in the village do not have proper food storage or preserving equipment such as fridges and microwaves.

With respect to the outbreak, the local sweet beer was the most incriminating food item, considering that a 100% attack rate (AR) was observed in persons who had consumed the local sweet beer when compared with those who had consumed other foods. Moreover, the laboratory findings strongly pointed to a possible contamination of the local sweet beer with *Salmonella*. The results are in agreement with both clinical and epidemiological findings, suggestive of salmonellosis: *Salmonella* infections have an incubation of 6 to 48 hours following ingestion of contaminated food or water [8]. It is reported that all patients who consumed the local sweet beer (Thobwa) in the morning of Sunday experienced acute gastroenteritis in the afternoon hours, with others subsequently developing headache (47.6%) and fever (42.9%), which are common clinical features of *Salmonella* infections [9]. Much as a conclusive source of contamination could not be traced during the investigation, several contributing factors were identified: signs of animal intrusion, evidenced by the presence of a sheep kraal and droppings within the compound; and a poor storage place accessible to children. It was also noted that the local sweet beer was laid out at room temperature overnight before consumption. This might have increased the likelihood of contamination, as during that time, low temperatures may have allowed the multiplication of pathogens following exposure.

Food-borne outbreaks in Rumphi District are quite common, especially during harvesting seasons, where Thobwa is often prepared in advance for members volunteering to harvest in the field. In 2021, several people were brought to Rumphi District Hospital, following consumption of contaminated Thobwa. Staphylococcus aureus (resistant to vancomycin) was isolated from stool and thobwa specimens, suggesting possible contamination with staphy toxins. In 2023, several people were reported sick at Rumphi Teachers Training College (TTC) church rally and were rushed to Rumphi District Hospital, following the consumption of contaminated food. This year in March, 2024, an outbreak related to the consumption of food was also reported, though there was a high suspicion of maize-preserving chemicals as the cause. One child was reported dead. Even though the laboratory capacity has been good as far as confirmation of outbreaks is concerned, high-tech PCR and genomic tests are required in order to better understand the specific serotypes and species of *Salmonella* most prevalent in the district.

Conclusion

While no fatality was registered in the reported food-borne outbreak in Rumphi, rapid response to such event encountered delays due to team disorganization, lack of readily available transport (fuel scarcity), and hesitancy in notification of signals and verification of events from the health centers. By learning from these experiences, we are optimistic that responses to similar events will be swift. Therefore, we commend efforts by the Ministry of Health to include Health Surveillance Assistants (HSAs) and health facility in-charges in the ongoing event-based surveillance (EBS) training as that may lead to improved notification and verification of signals relating to disease outbreaks in the communities.

Recommendation and action: to minimize the frequency of community food-borne outbreaks, we encourage the involvement of different stakeholders as well as multiple strategies focusing on water sanitation and hygiene: community awareness campaigns on personal hygiene and practices that minimize possible fecal contamination during and after preparation of local sweet beer and other perishable foods are of paramount importance. Social meeting points such as churches, health centers, and market places can be used as platforms for raising awareness of hygiene practices tailored to community settings. We also recommend further research and innovation: research will allow for a better understanding of the vehicle that drives contamination. On the other hand, innovation will allow for the development of simple, less expensive methods and technologies for controlling microbial food contamination during preparation and storage, in rural settings. Additionally, there is a need for the expansion of laboratory diagnostic capacity to rural health centers for quick detection of possible causes of outbreaks. Early confirmation of the cause helps guide outbreak management in terms of treatment, isolation protocol, and containment measures.

Competing interests

The authors declare no competing interests.

Authors' contributions

Brany Mithi: contributed towards conception and design, analysis, drafting of the article; Kenani Mfune: contributed to the acquisition of data, article drafting; Alicy Khonje: designed, drafted and reviewed the manuscript draft. All the authors read and approved the final version of this manuscript.

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Tables and figures

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Table 4: line listing of suspected *Salmonella* cases

Figure 1: Munyongani village, T/A Chisovya Ng'onga

Figure 2: rapid response team field visit to the affected households at Munyongani village

Figure 3: an 81-year-old granny receiving treatment at Ng'onga Health Center

Figure 4: epidemic curve of the food poisoning cases from Ng'onga, Rumphi

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Table 1: composition of the district rapid response team, position, and responsibilities		
Name	**Position**	**Responsibility**
Dr Alicy Khonje	SMO/ (trainee intermediate FETP)	Case management developed a case definition. Involved in reviewing investigation reports.
Brany Titus Mithi	District laboratory manager/ epidemiologist	Guided sample collection, transportation, methods of analysis, and interpretation of results. Drafted final investigation report.
Kenani Mfune	Environmental health officer/IDSR coordinator	Conducted environmental risk assessment/line listing of cases
Fredrick Kasanga	Community health nurse	Environmental risk assessment and case management
Geoffrey Shumba	Environmental health officer/WASH Coordinator	Environmental risk assessment
Umar Mwamadi	Environmental health officer	Environmental risk assessment
Mweso	Driver	
IDSR: Integrated Disease Surveillance and Response; WASH: Water Sanitation and Hygiene; SMO: Senior Medical Officer; FETP: Field Epidemiology Training Program		

Table 2: age description of cases across sex							
Sex	**Mean**	**SD**	**Skewness**	**kurtosis**	**Min**	**Max**	**N**
0:F	19.83333	20.91034	2.250541	7.360936	3	81	12
1:M	28.88889	24.01793	0.731259	1.959623	10	70	9
Total	23.71429	22.18816	1.450759	3.948769	3	81	21

Table 3: episodes of fever among different age groups					
	Fever				
Age group	**No**	**Yes**	**Total**	**Percentage (%)**	**Cum.**
(1 - 15)	9	4	13	61.9	61.9
(16 -59)	0	5	5	23.81	85.71
(> 59)	0	3	3	14.29	100
Total	9	12	21	100	
Pearson Chi^2 (2)	9.6923		P = 0.008		
Fisher's exact	0.007				

Table 4: line listing of suspected *salmonella* cases									
Age	**Age-group**	**Sex**	**Vomiting**	**Bloody diarrhea**	**Headache**	**Abdominal pains**	**Fever**	**Sample taken**	**Consumed Thobwa**
3	(1 - 15)	F	Yes	Yes	No	Yes	No	No	Yes
4	(1 - 15)	F	Yes	Yes	Yes	Yes	No	No	Yes
8	(1 - 15)	F	Yes	Yes	Yes	Yes	No	No	Yes
8	(1 - 15)	F	Yes	Yes	Yes	Yes	No	Yes	Yes
10	(1 - 15)	M	Yes	Yes	No	Yes	No	No	Yes
10	(1 - 15)	M	Yes	Yes	Yes	Yes	No	No	Yes
10	(1 - 15)	M	Yes	Yes	No	Yes	No	No	Yes
11	(1 - 15)	M	Yes	Yes	Yes	Yes	No	No	Yes
12	(1 - 15)	M	Yes	Yes	No	Yes	No	No	Yes
13	(1 - 15)	F	Yes	Yes	No	Yes	Yes	No	Yes
14	(1 - 15)	F	Yes	Yes	No	No	Yes	No	Yes
14	(1 - 15)	F	Yes	Yes	No	Yes	Yes	No	Yes
15	(1 - 15)	F	Yes	Yes	No	Yes	Yes	Yes	Yes
25	(20 -59)	F	Yes	Yes	Yes	Yes	Yes	No	Yes
26	(20 -59)	F	Yes	Yes	No	Yes	Yes	No	Yes
27	(20 -59)	F	Yes	Yes	No	Yes	Yes	No	Yes
36	(20 -59)	M	Yes	Yes	Yes	Yes	Yes	No	Yes
39	(20 -59)	M	Yes	Yes	Yes	Yes	Yes	No	Yes
62	(> 59)	M	Yes	Yes	Yes	Yes	Yes	No	Yes
70	(> 59)	M	Yes	Yes	No	Yes	Yes	No	Yes
81	(> 59)	F	Yes	Yes	Yes	Yes	Yes	No	Yes

Figure 1: Munyongani village, T/A Chisovya Ng'onga

Figure 2: rapid response team field visit to the affected households at Munyongani village

Figure 3: an 81-year old granny receiving treatment at Ng'onga Health Center

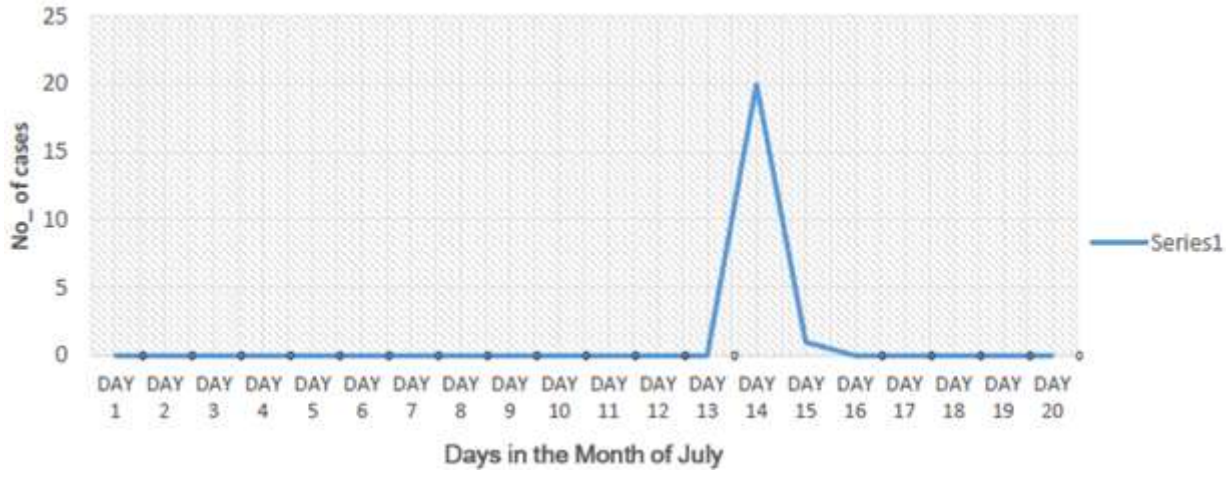

Figure 4:epidemic curve of the food poisoning cases from Ng'onga, Rumphi