Media Kesehatan Masyarakat Indonesia
Volume 20 Issue 3 2024
DOI : 10.30597/mkmi.v20i3.2024
Website : http://journal.unhas.ac.id/index.php/mkmi

Foodborne Outbreak Investigation in Elementary School Students in Bantul, Yogyakarta, 2023

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ARTICLE INFO

Article History:
Received Apr, 4th, 2024
Accepted Sep, 26th, 2024
Published online Sep, 30th, 2024

Keywords:
Elementary school;
foodborne;
outbreak;
Salmonella;

ABSTRACT
Bantul District Health Office received notification that 75 students in elementary school were sick with symptoms of nausea, vomiting, and dizziness after they consumed snacks from the school canteen. An epidemiological investigation was conducted to confirm the outbreak, identify additional cases, determine risk factors and causes, and recommend preventive measures. This investigation conducted active case finding followed by a retrospective cohort study. Individuals who experience one or more symptoms, such as nausea, vomiting, diarrhea, stomach pain, dizziness, fever, and malaise after consuming snacks were defined as cases. Data was collected through direct interviews with students, teachers, staff, and food sellers. Samples of food and vomit were collected and sent to the health laboratory. Data were analyzed using chi-square and multiple binomial regression. There were 150 cases. Most cases were found in the female group (53.22%), 9-year-old group (55.32%), and third-grade students (65%). Dizziness (66.67%), vomiting (56.67%), and nausea (46%) were the most common symptoms. The epidemic curve was a common source, with incubation periods ranging from one to 26 hours. Meatballs were associated with the increased risk of becoming a case in this outbreak (aRR = 1.49; 95% CI = 1.22-1.81). The causative agent was suspected to be Salmonella spp, but the laboratory analysis results were inconclusive due to contamination. Potential risk factors were large storage in the refrigerator, insufficient reheating, and cross-contamination. Improvements in food safety monitoring for schools and food handlers, along with appropriate sampling by healthcare facilities, are required to control outbreaks.

INTRODUCTION

Humans neednutrition to survive; nevertheless, certain foods can cause diseases and even death in people who have symptoms such as diarrhea, headache, vomiting, nausea, abdominal cramps, and more. Due to globalization and active food trade between countries, foodborne outbreaks have recently become increasingly severe.[1] Countries have different laws to regulate food safety and disease prevention, but foodborne illnesses are still rising. Regardless of economic circumstances, animal-based products are the leading cause of bacterial diseases such as *E. coli, Salmonella, Listeria monocytogenes, Campylobacter*, and *Staphylococcus aureus.*[2]

Every year, contaminated food causes 600 million instances of foodborne illness and 420,000 fatalities. Foodborne illness affects 7.69% (600 million) of the world's population (7.8 billion) each year, accounting for 7.50% (420,000) of all deaths (56 million) that year.[3] A foodborne disease outbreak happens when two or more people become sick as a result of consuming food that has been epidemiologically proven to be a source of infection.[4]

According to the 2023 report of BPOM Indonesia, food poisoning in Indonesia affected 8,937 people, with 4,729 showing symptoms (52.91%). However, there were eighteen fatalities (a case fatality rate of 0.38%). The attack rate increased between 2019 and 2021 and then decreasedin 2022 (45.29% in 2019, 46.62% in 2020, 69.40% in 2021, 50.64% in 2022).[5] Food poisoning affects 54.6% more women than men. The age ranges were highly diverse, but most were dominated by school-age and adults.[6] Snack food and celebrations are common situations for foodborne outbreaks. Based on location, food poisoning is most common in the household, followed by schools and factories.[6] In 2022, food poisoning is the most common type of outbreak in the Yogyakarta Special Region province in 2022.[7]

On February 3, 2023, the Bantul District Health Office received notification from the Pleret Public Health Center that 75 students were sick with symptoms of nausea, vomiting, and dizziness at one of the elementary schools. It happened after students consumed snacks from the school canteen the day before. Because all of the children had gone home from school that day, the epidemiological investigation continued the next day, on February 4, 2023. The investigation found that 150 students had complaints and a history of consuming nearly the same food.

Foodborne diseases represent a considerable yet preventable public health concern, and identifying the source of contamination is a crucial step in outbreak investigations to prevent foodborne illnesses.[8] Accordingly, this investigation is needed to confirm an outbreak and define a working case definition. This assessment must be initiated and completed quickly to prevent further illnesses. It should include checking the validity of the information, obtaining reports of applicable laboratory tests that have been performed, identifying cases and obtaining information about them, and ensuring the collection of appropriate clinical specimens and food samples.[4]

MATERIAL AND METHOD

An active case finding followed by a retrospective cohort study was used in this investigation. The population at risk in this study includes all students, teachers, education staff, and other school people in elementary school, Bantul District. Case is defined as an individual who has one or more symptoms of food poisoning such as nausea, vomiting, diarrhea, stomachache, dizziness, fever, and weakness after consuming canteen snacks on February 2, 2023. The exposed group consisted of individuals who ate canteen snacks on February 2, 2023, and the unexposed group consisted of those who did not eat canteen snacks on February 2, 2023.

The epidemiological investigation begins with confirming the existence of an outbreak by visiting elementary schools and communicating with school principals. In addition, food and biological samples were collected and sent to the laboratory. Interviews were conducted with students, teachers, education staff, and food sellers in the school canteen using Google Forms. We collected various data, including individuals' age, gender, symptoms felt after consuming or not consuming canteen snacks, the time when they consumed canteen snacks, and when the symptoms developed. Food samples from the canteen, which included pizza, spaghetti, meatballs, fruit salad, orange ice, and tap water,

were collected by the investigation team on the first day of the investigation and immediately distributed for examination to the regional laboratory (Balai Laboratorium Kesehatan) in Yogyakarta on February 3, 2023. The following day, four samples of vomit from sick students were also collected by the investigation team and sent to the laboratory.

On February 6, 2023, an environmental investigation was conducted by interviewing food sellers using a questionnaire and conducting observations by visiting food production houses to watch over procedures in preparing food, such as cooking, storing, and serving.

The data was analyzed using the STATA 17 software.[9] A descriptive analysis of the foodborne outbreak investigation was conducted by describing the data based on person (age, gender, signs and symptoms, time of onset, snacks consumed) and time variables. The attack rate was calculated for case distribution. The epidemic curve was used to examine time variables. The bivariate analysis estimated food-specific risk using a Risk Ratio (RR) with a 95% Confidence Interval (CI). The Chi-square test was also used to test the hypothesis of each food item. Food items with a p-value less than 0.25 will be included in multivariate analysis using multiple binomial regression to estimate adjusted RR.

RESULTS

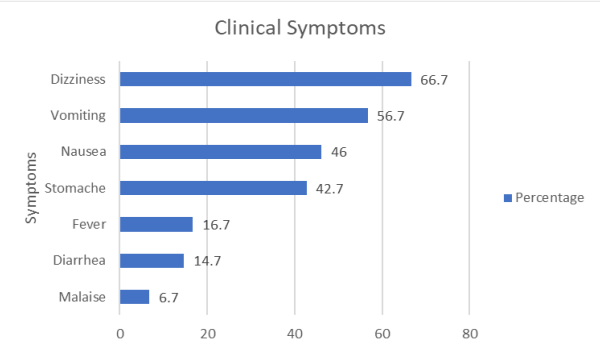
According to school administration data, there were 353 students, 27 teachers and education staff, and 3 food sellers as the population at risk on February 2, 2023. However, only 344 (89.8%) persons were successfully interviewed. Most cases were found in the female group (53.22%), 9-year-old group (55.32%), and third-grade students (65%). Detailed information on case distribution can be found on Table 1 below. Figure 1 shows that dizziness (66.67%), vomiting (56.67%), and nausea (46%) were the most common symptoms. No symptoms or danger signs were found in this outbreak investigation. Further details related with symptoms can be found on Figure 1.

Based on the epidemic curve in Figure 2, the type of outbreak transmission was a common source, where the same cause caused this type of transmission, and cases increased rapidly. Snack consumption began on February 2, 2023, at 09.00 am. An hour later, at 10.00 am, the first cases occurred, reaching a peak on February 3 2023 at 04.00 am, then gradually decreasing. The shortest incubation period is one hour, and the longest is 26 hours, with an average of 15 hours and 12 minutes and a median of 16 hours.

The following day, on February 3, 2023, at 1:00 pm, the investigation was done by visiting schools and interviewing all at-risk groups on February 4, 2023, at 9:00 am. Additionally, the Public Health Center treated individuals who were still symptomatic and educated students and their parents on the same day.

Table 2 shows food-specific RR figures. According to the table, meatballs, spaghetti, egg roll sausage, guava juice, and apollo chocolate had the highest RR. Meatballs had RR of 1.49, implying that it was 1.49 times more likely to cause food poisoning in elementary schools.

Table 3 shows the result of multivariable analysis using multiple binomial regression. Spaghetti, meatballs, egg roll sausages, and guava juice were found to have significant relevance in this analysis, as shown by the p-value of less than 0.001. Meatballs had the largest and most significant relative risk, with an adjusted RR of 1.49 and a CI of 1.22-1.81. This shows that, after adjusting for other variables, students who eat meatballs have a 1.49 times higher risk of becoming sick than those who do not.



Source: Primary Data, 2023

Figure 1. Clinical Symptoms of the Foodborne Outbreak in Elementary School, Bantul, Yogyakarta

Table 1. Case Distribution and Attack Rate by Person

Characteristic	Population at Risk	Number of Case	Attack Rate
Sex			
Male	173	59	34.10
Female	171	91	53.22
Age (Year)			
6	11	6	54.55
7	48	26	54.17
8	61	33	54.10
9	47	26	55.32
10	52	23	44.23
11	71	23	32.39
12	34	13	38.24
13	0	0	-
14	3	0	0.00
21-30	9	0	0.00
31-40	6	0	0.00
41-50	2	0	0.00
Class			
1	57	27	47.37
2	53	28	52.83
3	40	26	65.00
4	66	31	46.97
5	57	21	36.84
6	54	17	31.48
Others	17	0	0.00

Source: Primary Data, 2023

Table 2. Relative Risk for Food Items Related to Foodborne Outbreak in Elementary School, Bantul, Yogyakarta

Food Items	RR	p-value	CI 95%
Iced tea	0.88	0.39	0.65-1.19
Orange juice	0.92	0.83	0.38-2.17
Rice	0.91	0.77	0.49-1.69
Kentucky tofu	1.08	0.81	0.60-1.91
Pizza bread	1.29	0.54	0.62-2.66
Fruit salad	0.71	0.64	0.14-3.54
Bread	1.07	0.89	0.40-2.87
Rambak crackers	0.00	0.18	0.00
Spaghetti	1.36	0.11	0.97-1.88
Corndogs	0.53	0.38	0.09-2.92
Meatballs	1.49	<0.001	1.19-1.85
Egg roll sausage	1.35	0.04	1.03-1.74
Egg roll meatballs	0.76	0.40	0.37-1.54
Guava juice	1.34	0.09	0.99-1.81
Brown sweet potato	0.71	0.64	0.14-3.54
Avocado juice	1.30	0.28	0.84-2.00
Apollo chocolate	1.33	0.15	0.94-1.89
Tempura	0.71	0.51	0.22-2.21
Egg Noodles	0.71	0.64	0.14-3.54
Other	1.29	0.64	0.85-1.78

Source: Primary Data, 2023

Table 3. Multivariable Analysis of Food Items Related to Foodborne Outbreak in Elementary School, Bantul, Yogyakarta

Food Items	Adjusted RR	p-value	CI 95%
Spaghetti	1.34	<0.001	1.16-1.54
Meatballs	1.49	<0.001	1.22-1.81
Egg roll sausage	1.39	<0.001	1.21-1.60
Guava juice	1.46	<0.001	1.25-1.49
Apollo chocolate	1.20	0.109	0.95-1.51

Source: Primary Data, 2023

According to the laboratory findings, every food sample contained mold or yeast. We did not receive results that matched the laboratory results when we compared them to the differential diagnosis based on symptoms and food type; this could be because the food sent was not a sample consumed on February 2, 2023, the day food poisoning was suspected. There is also the risk of contamination from the samples sent due to the lack of appropriate containers for taking food samples from the start. Laboratory results for meatball, which has the greatest RR, show contamination with many organisms, including mold/yeast, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. Based on the symptoms, incubation period, type of food, and risk factors, the differential diagnosis refers to *Salmonella* sp as the cause of food poisoning. Detailed information on the differential diagnosis with an outbreak can be found in Table 4 below.

The results of the vomit samples showed the presence of mold/yeast, indicating that these samples were contaminated. This could be because the sample container did not meet sample storage criteria, because the parents of each student provided it. Also, the vomit sample has been more than 24 hours since the student last ate snacks from the school canteen; the presence of various bacteria, such as the E. coli pathogen and Bacillus cereus, may be due to a combination with other food consumed by students. Table 5 shows the laboratory results for each sample.

Additional interviews with food handlers found that no food handlers got sick while processing food on that day or in the prior few days. A visit to the food handler's house revealed

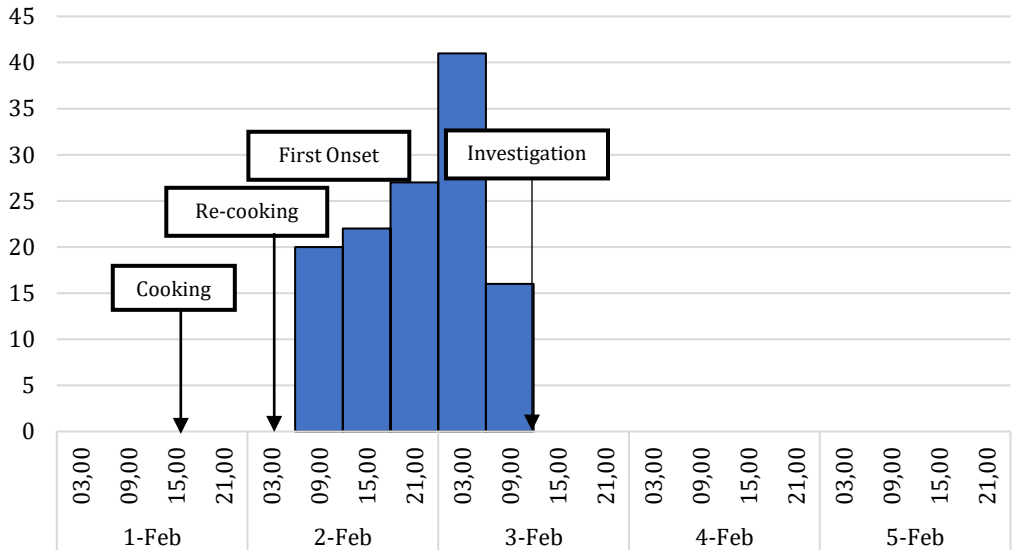
that huge amounts of meatballs were stored in the refrigerator. Regarding preparation, the purchased meatballs are boiled at home first, while the meatball soup is created in the school canteen using tap water. The seller noticed that the water was dirty at the time. A large amount of food stored in the refrigerator, incorrect reheating, and cross-contamination are all considerable risk factors.

Further investigations were also conducted at the place where the meatballs were produced. Around the area, there are animal cages and some litter. Meatballs are formed with ground meat blended with all the seasonings, then boiled twice in a meatball production machine. After boiling, the meatballs are chilled using a fan before being wrapped in white plastic and placed in the refrigerator. According to conversations with meatball suppliers, there were no food handlers got sick while processing food on that day or in the prior few days.

DISCUSSION

According to the findings of epidemiological investigations, meatballs are the food that causes food illness. Mold/yeast, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* were discovered in meatball samples during laboratory tests. This differs from the differential diagnosis, which suspects *Salmonella* bacteria as the cause of food-borne illness. The symptoms determine this, the type of food consumed, and the incubation period, which can last up to 26 hours. *Salmonella* species, which include *Salmonella typhimurium, Salmonella choleraesuis, Salmonella enteritidis*, and many more closely related species, can be one of the causes of food poisoning.[10]

Salmonellosis is the second most common gastrointestinal disorder in the EU caused by Salmonella-contaminated foods. Symptoms may include gastroenteritis, abdominal cramping, bloody diarrhea, fever, myalgia, headache, nausea, and vomiting.[11] The intensity of symptoms is determined by various factors, including serotype, bacterial cell count, age, and human susceptibility. Symptoms often occur between 12 to 72 hours, lasting 4 to 7 days. This is consistent with the 1–26 hour incubation period for foodborne outbreak in this case.



Source: Primary Data, 2023

Figure 2. Epidemic Curve of Foodborne Outbreak in Elementary School, Bantul, Yogyakarta

Table 4. Differential Diagnosis Related to Foodborne Outbreak in Elementary School, Bantul, Yogyakarta

Characteristic	*Bacillus cereus*	*Staphylococcus aureus*	*Escherichia coli*	*Salmonella* sp.	Outbreak
Symptoms					
Nausea	+	+	-	+	+
Vomiting	+	+	-	+	+
Dizziness	-	-	+	-	+
Stomache	+	+	+	+	+
Fever	-	-	±	±	±
Diarrhea	±	±	±	±	±
Malaise	-	-	-	±	±
Incubation Period	2-4 hours	30 minutes-8 hours	12-48 hours	12-36 hours	1-26 hours
Risk Factors	Storing cooked food at room temperature, storing cooked food in a big container in the refrigerator, and preparing meals several hours before serving	Storing cooked food at room temperature, storing cooked food in a big container in the refrigerator, touching cooked food at room temperature, and preparing meals several hours before serving	Infected people handling food, insufficient cold storage, inadequate cooking, cleaning and hygiene, ingesting raw or undercooked meat	Storing prepared food at room temperature, storing large quantities of food in the refrigerator, insufficient reheating, contamination cross-contamination,	Meatballs are stored in large quantities in refrigerators and reheated before consumption, and cross-contamination with tap water is possible.
Food Characteristic	Cooked rice	Ham, meat and poultry products, high protein foods	Half-cooked meat, cheese, water	Meat and poultry and processed products	Meatballs

Source: Primary Data, 2023

Table 5. Laboratory Results of Foodborne Outbreak in Elementary School, Bantul, Yogyakarta

Type of Sample		Results
Food Samples	Pizza	Mold/yeast, *Klebsiella pneumoniae, Staphylococcus capatis*
	Meatballs	Mold/yeast, *Klebsiella pneumoniae, Pseudomonas aeruginosa*
	Spaghetti	Mold/yeast, *Citrobacter freundii, Klebsiella ozaenae, Pseudomonas aeruginosa*
	Fruit Salad	Mold/yeast, *Citrobacter freundii*
	Orange Ice	Mold/yeast, *Staphylococcus capatis, Pseudomonas aeruginosa*
Water Sample	Tap Water	Mold/yeast, *E. coli non pathogen, proteus mirabilis, Bacillus thutingensis*
Vomit Samples	An. A	*Staphylococcus capitis*
	An. L	Mold/yeast, *E. coli pathogen, Staphylococcus capitis*
	An. Z	Mold/yeast, *Klesiella ozaenae*
	An. H	Mold/yeast, *Bacillus cereus*

Source: Primary Data, 2023

Healthy people can recover without the need for special care, but occasionally, germs can enter the circulation or lymphatic system, leading to a systemic infection and a more severe disease or even death.[10] Children under 5, elderly, and immunocompromised adults are more susceptible to salmonellosis. Salmonellosis is a self-limiting illness that ceases within a week, but deaths have been recorded mainly in vulnerable population groups such as the very young, elderly, and immunocompromised people.[12] In this outbreak, no severe cases were found.

A significant cause of *Salmonella* infection in humans is consuming foods derived from animals, particularly poultry. Raw and undercooked poultry, beef and pig, meat products, and many other foods are thought to be the most common *Salmonella* carriers involved in infection.[13] As the meatballs were made with the handler's beef food, the meat may have been contaminated with the *Salmonella* pathogen.

A study conducted in Sidoarjo, Indonesia, discovered that bacterial contamination of meatballs can occur at any stage of the production process, from cattle slaughter to packaging. Proper food hygiene and sanitation are essential for preventing microbe and bacterial contamination in meatballs.[14] Another study found a high prevalence of Salmonella in retail meat shops (46.3%), commercial broiler farms (19.2%), and hatcheries (10.3%). These findings show that Salmonella contaminates poultry meat at a high level during the production and retail processes.[15]

Furthermore, there is a significant risk of *Salmonella* infection not adequately heated before consumption.[15] This is consistent with the findings of interviews with food handlers, who stated that the purchased meatballs were boiled first at home, and the meatball broth was made in the school canteen with tap water. Its repeated heating may contribute to this outbreak.

Another study found that storing meatballs at room temperature rapidly increased the number of microbes. This is because room temperature (25-30°C) is ideal for bacteria to grow and reproduce rapidly.[16] One way to slow bacteria growth is to keep them at temperatures that are not ideal for microbes, such as 4°C, which can extend the shelf life of meatballs.[17] Therefore, storing meatballs properly is essential to stop bacterial growth and prevent outbreaks.

Salmonella spp. food poisoning is typically sporadic, with no obvious connection to previous cases. In many cases, the mode of transmission is also unknown.[13] According to another study, *Salmonella* has been identified in various areas within farms and slaughterhouses, and long-term livestock contamination appears to be a prevalent issue.[18] The primary transmission mode is through the consumption of organisms in food (milk, poultry, meat, eggs) derived from infected animals. Infected food workers, cross-contamination due to inadequate hygiene, and infected animals' or humans' excrement can contaminate food.[19] To prevent cross-contamination, raw meat should be stored in separate bags from foods ready to eat. The storage of meat is an essential and critical process. Raw meat and poultry should be stored in sealed bags at the bottom of the fridge as soon as possible.[20]

The findings raised concerns about food safety in schools. It is essential to improve food safety measures in schools.[21] To prevent future outbreaks, several measures should be implemented or improved. First, food handlers should receive formal education and training on food safety principles to enhance their knowledge, attitude, and practices. This is in line with research findings indicating the need for formal education and training programs aimed at positively influencing food handlers' knowledge and attitudes for them to improve their food-handling practices.[22] Second, schools should strictly manage the foods provided to students and staff, including selection, storage, and cooking processes. Additionally, public health efforts should raise awareness about food poisoning.[21]

Our epidemiological investigations had several limitations. First, the meatball samples were collected on February 3, 2023, rather than the first day of the suspected outbreak, February 2, 2023. Therefore, the results did not reflect the food samples considered the outbreak's source. Second, the vomit samples were collected more than 24 hours after the first symptoms, suggesting contamination could have occurred

from meals other than school canteen food consumed by students. Third, there is a risk of contamination of the samples sent due to the lack of appropriate containers for collecting food samples from the start.

CONCLUSION AND RECOMMENDATION

A foodborne outbreak occurred in an elementary school, with the most cases found in the female group, the 9-year-old group, and third-grade students. Meatballs are the source of outbreak transmission, and *Salmonella* is the causal agent. The laboratory results do not show supporting results; this could be because the food samples sent were not food samples at the time of the outbreak, and there was the possibility of contamination in the food samples examined. This could be due to the lack of standard containers at the start of sampling.

It is important to raise awareness among school residents, including students, teachers, education staff, and food handlers, to adopt a clean and healthy lifestyle and prepare healthcare facilities to take and store food samples to avoid contamination.

ACKNOWLEDGMENTS

We are grateful for the support that was offered during the outbreak investigation by the Bantul District Health Office and Pleret Public Health Center.

AUTHOR CONTRIBUTIONS

Conceptualization: SII, MJ. Data curation: SII, MJ. Formal analysis: SII, MJ, BSW. Methodology: SII, MJ, BSW. Writing –original draft: SII. Writing –review & editing: BSW, SA. SSI = Soraya Isfandiary Iskandar; MJ = Miftakhul Janah; BSW = Bayu Satria Wiratama; SA = Samsu Aryanto.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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