Original article

Outbreak, Surveillance, Investigation & Response (OSIR) Journal
ISSN 2651-1061 (Online)
https://he02.tci-thaijo.org/index.php/OSIR
Email: osir@ddc.mail.go.th

September 2026
Volume 19, Issue 3
Article no. 279922

A *Clostridium perfringens* Food Poisoning Outbreak in a School Caused by Precooked Pork Skin, Thailand, 2024

Watcharapol Rongdech[1]*, Thanit Rattanathumsakul[1], Thanumas Sumanotayan[1], Kanchana Chaiyawan[2]

1 Field Epidemiology Training Program, Division of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand

2 Section of Communicable Disease, Office of Disease Prevention and Control 9 Nakhon Ratchasima, Department of Disease Control, Ministry of Public Health, Thailand

*Corresponding author, email address: dome-clever@hotmail.com

Received: 16 Jan 2026; Revised: 8 May 2026; Accepted: 22 Jun 2026
https://doi.org/10.59096/osir.v19i3.279922

Abstract

Objectives: In September 2024, a food poisoning outbreak occurred at a school in Buriram, a northeastern province of Thailand. We investigated to confirm the outbreak and diagnosis, describe its epidemiological characteristics, identify the source, and provide recommendations.

Methods: We reviewed food poisoning situations and conducted an active case finding in the school. A suspected case was anyone at the school between 17–21 Sep 2024 with diarrhea or vomiting; confirmed cases had gastrointestinal pathogens detected in stool specimens or rectal swabs. We conducted interviews on food preparation and a matched case-control study using conditional logistic regression model to identify the contaminated food. Samples of food, water, and utensils were also tested for bacterial and viral contamination.

Results: A total of 658 cases were reported (attack rate of 40.0%), 97.1% presenting with watery diarrhea. The outbreak began on 17 September in the afternoon, peaked that night, and ended on 21 September. Analytical study implicated spicy pork salad from 17 September lunch as the source (adjusted odds ratio 18.99, 95% confidence interval 1.86–193.70). Investigation revealed that its ingredient, precooked pork skin, was improperly stored and the cooked lunch was not reheated before serving. Testing confirmed *Clostridium perfringens* in 17 cases, as well as in leftover spicy pork salad and pork skin samples.

Public Health Recommendations: This incident highlights the risks of improper food handling. We recommend avoiding keeping food ingredients at room temperature, thorough reheating precooked ingredients, and adherence to food safety standards for the school canteen.

Keywords: food poisoning, school, outbreak, *Clostridium perfringens*

Introduction

Food poisoning is a disease caused by consumption of food or water (food-and-water borne) contaminated by bacteria, viruses, protozoa, or toxins. The most common symptoms are diarrhea, nausea, vomiting, abdominal pain or cramps, and fever. Symptoms usually occur within 24 hours after contaminated food consumption and are self-limiting within three days.[1]

Every year, food poisoning affects around 600 million people worldwide. Among all cases, 420,000 of them lost their lives and 30% of these are children under five years old. More than 100 billion USD is lost each year in productivity and medical expenses resulting from unsafe food in low-and-middle income countries.[1] This financial loss is likely to be underestimated.[1]

All material is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC-BY-NC-ND 4.0) License unless otherwise stated.

In 2023, Thailand's Digital Disease Surveillance (DDS) system reported 88,862 cases of food-poisoning (135 per 100,000 populations) without fatality.[2] Thailand's Modernized Event-based Surveillance program (M-EBS) reported 110 events of food-poisoning and acute diarrhea outbreaks with 20 deaths.[3] Studies in Thailand showed 3,041,699 food-poisoning admissions during 2014–2022 which 31.4% of them were children under five years (33.8 per 1,000 admission rate and 1 per 100,000 mortality rate among this age group).[4,5]

Food poisoning outbreaks could have an impact on many aspects. For public health, every hospitalization and death increased strain on health care systems. For food businesses, they cause loss of revenue and increase costs for food safety inspection and recall. For social impact, they usually lead to public anxiety, disruption to tourism industry, and social stigma associated with the outbreak.[6,7] Thailand established several campaigns such as "clean food good taste"—the government's official sanitation accountability network hygiene certifications along with food sanitation for school-canteen inspections, but food poisoning problem persisted.[8]

Clostridium perfringens (*C. perfringens*) is an anaerobic Gram-positive spore-forming bacillus. It can proliferate in foods that are improperly stored. And when ingested, it produces toxin which causes diarrhea. *C. perfringens* outbreaks are mostly associated with improperly heated or reheated gravy, poultry, or meats.[9] Even this pathogen is in the top five of food poisoning causing agents globally including norovirus, *Campylobacter*, non-typhoidal *Salmonell*a, and Shiga-toxin producing *E. coli* [10], but there was no report of *C. perfringens* outbreak in Thailand national surveillance system during 2019–2024.[3]

On 18 Sep 2024, the joint investigation team of the Department of Disease Control (DDC) was notified by the national situation awareness team of a food poisoning outbreak involving at least 150 students in a school, Nang Rong District, Buriram Province. The investigation team of the DDC, the Office of Disease Prevention and Control 9 Nakhon Ratchasima, Buriram Provincial Health Office (PHO), Nang Rong District Health Office and Nang Rong Hospital jointly investigated the outbreak during 19–20 Sep 2024. The objectives were to confirm the existence of the outbreak and confirm the diagnosis, describe epidemiological characteristics, identify possible sources of the outbreak, and provide recommendations for prevention and control measures.

Methods

Descriptive Study

Situation review

To confirm the community outbreak, we reviewed the number of food poisoning cases in Nang Rong District, Buriram Province, from DDS, which collected patient information from all government hospitals, from January 2019 to September 2024 and compared to the 5-year median. We also reviewed patient records of food poisoning cases in the district hospital during the last 30 days to find possible sources of the outbreak in this area.

Case definition and case finding

An active case finding was conducted on 20 September among all students and personnel in the school through room-by-room survey, then self-reported by those who had any symptoms to interviewers. A suspected case was anyone who had loose, mucous-bloody, or watery stool or vomiting between 17 and 21 Sep 2024. A confirmed case was a suspected case with positive result for gastrointestinal (GI) pathogen testing from fresh stool or rectal swab sample. Further case finding after 20 Sep 2024 (the investigation period), was performed by the teachers through daily screening in each room until no new cases for three days.

Laboratory testing

To confirm diagnosis, we collected fresh stool or rectal swab specimens from all school food handlers and suspected cases who still had symptoms and did not receive any antibiotics. The specimens were sent for reverse transcription polymerase chain reaction for GI pathogens including bacteria and viruses, either to Bamrasnaradura Infectious Disease Institute or National Institute of Health, Department of Medical Science, Ministry of Public Health. Food and ingredient samples of school lunches were also sent to National Institute of Health for GI pathogens testing. If no ingredients of the suspected food were left, we aimed to collect the same items from the same food supplier as the samples.

Environmental survey

We conducted a walkthrough survey of cooking and washing areas, canteens, toilets, and school buildings. Direct observations were conducted on ingredients buying, preparing, cooking, and serving of school lunch, which was the only meal provided by school, using the food sanitation standard checklist of the Department of Health.[11] Water samples used for food preparing and cooking were tested for residual chlorine level. Interviews were conducted with food

handlers and teachers about food supply, cooking, and serving processes in the school.

Analytical Study

Study design

All confirmed and suspected cases were described in terms of time, place, person, as well as the school and attendants. A matched case-control study (1:1) was carried out to identify the sources of the outbreak. Sample size calculation using 50% exposure among controls, the minimal odds ratio to be detected of 3.0, α=0.05, β=0.2 and r=0.2 required 71 pairs of cases and controls.[12] The case was a primary schooler who met the criteria of suspected or confirmed case from the descriptive study and control was a primary schooler who did not have any symptoms. Cases were randomly selected from every classroom (the number of cases selected per room was proportionate to the total number of cases in each room). Controls were selected from the same classroom of each case. Food item consuming in school lunch on 16–17 Sep 2024 were collected as exposures using questionnaire.

Statistical analysis

We described continuous data using medians with interquartile ranges and using frequencies and proportions for categorical data. Univariable and multivariable conditional logistic regression models were used to determine food items associated with being a case. Unconditional logistic regression models were used to determine dose-response relationships of certain food items. Food items with a p-value <0.1 were included in the final multivariable conditional logistic regression models. Odds ratios (OR) with 95% confidence intervals (CI) were calculated using R version 4.3.1. We used the "survival" package for the calculation.

Results

Descriptive Study

Situation review

The numbers of food poisoning cases from the DDS (January 2019–September 2024) was not higher than 5-year-median in both district and provincial levels. Medical records of food poisoning patients in the last 30 days from information system of the district hospital did not show any linkage to this event such as increasing number of food poisoning cases before the outbreak.

Case demographics and distributions

The school was for preschoolers and primary schoolers (grades 3 to 6). In September 2024, there were 1,519 students and 124 staff, including eight food handlers. According to the active case finding, 658 cases were reported (655 students, two food handlers, and one teacher). One primary schooler case was admitted to a hospital and was discharged two days later. The overall attack rate was 40.0% (658/1,643). The attack rate among personnel was 2.4% (3/124) and among students was 43.1% (655/1,519), and the highest attack rates were found in primary schoolers grades 3, 5 and 6 (Table 1).

Table 1. Distribution of cases in students by grade and personnel, Nang Rong District, Buriram Province, Thailand, 17–21 Sep 2024.

Occupation and grade (n)	Cases	Attack rate (%)
Total (1,643)	**658**	**40.0**
Personnel (124)	**3**	**2.4**
All students (1,519)	**655**	**43.1**
Preschoolers (4–6 years old) (291)	**37**	**12.7**
Pre 1 (44)	3	6.8
Pre 2 (121)	0	0.0
Pre 3 (126)	34	27.0
Primary schoolers (7–12 years old) (1,228)	**618**	**50.3**
Primary 1 (178)	36	20.2
Primary 2 (172)	34	19.8
Primary 3 (195)	135	69.2
Primary 4 (207)	117	56.5
Primary 5 (233)	148	63.5
Primary 6 (243)	148	60.9

A total of 175 cases were interviewed. We found that the two most common symptoms were watery diarrhea (97.1%) and abdominal pain (68.0%) (Figure 1). Most of them had the onset between the afternoon of 17 Sep 2024 and the morning of 18 Sep 2024, which around 4-16 hours after lunch (Figure 2). Therefore, the suspected cause was the school lunch on 17 Sep 2024.

Laboratory testing

Among 19 specimens collected from the cases, 14 of them (73.7%) were positive for *C. perfringens*. In addition, three out of five specimens from healthy food handlers were positive for the same pathogen. Other GI pathogens such as *E. coli* or *Salmonella* spp. were positive for some cases, but all of them were also positive for *C. perfringens*. In the leftover food from lunch on 17 Sep 2024 and its ingredient samples, *C. perfringens* was detected in Laab (spicy pork salad) and precooked pork skin (an ingredient of Laab, new lot from same vendor), at concentrations of 74,000 and 500 colony-forming units per gram (CFU/g), respectively.

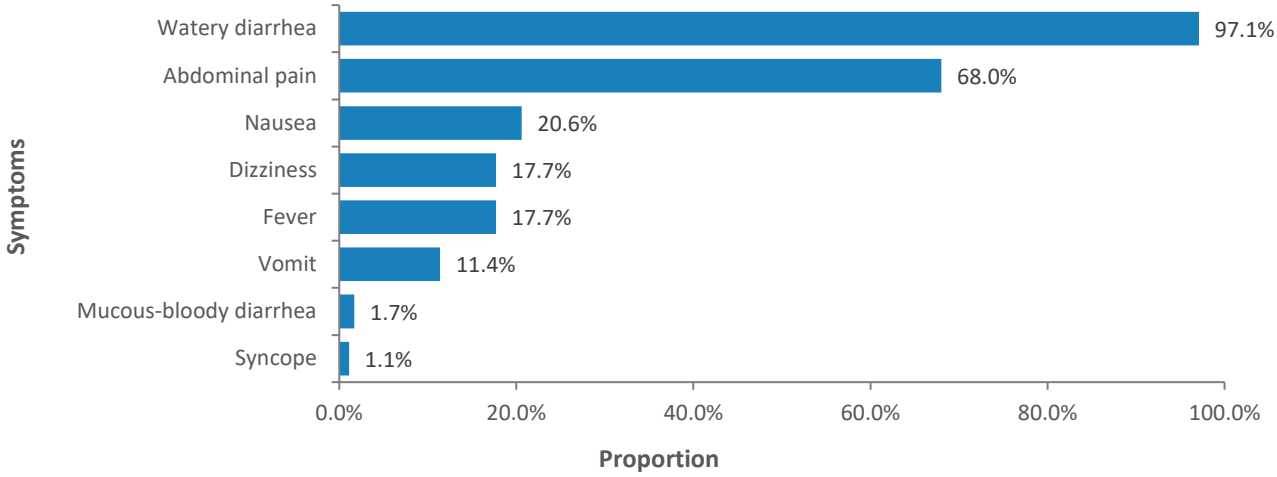


Figure 1. Symptoms of interviewed cases, food poisoning outbreak, Nang Rong District, Buriram Province, Thailand, 17– 21 Sep 2024 (n=175).

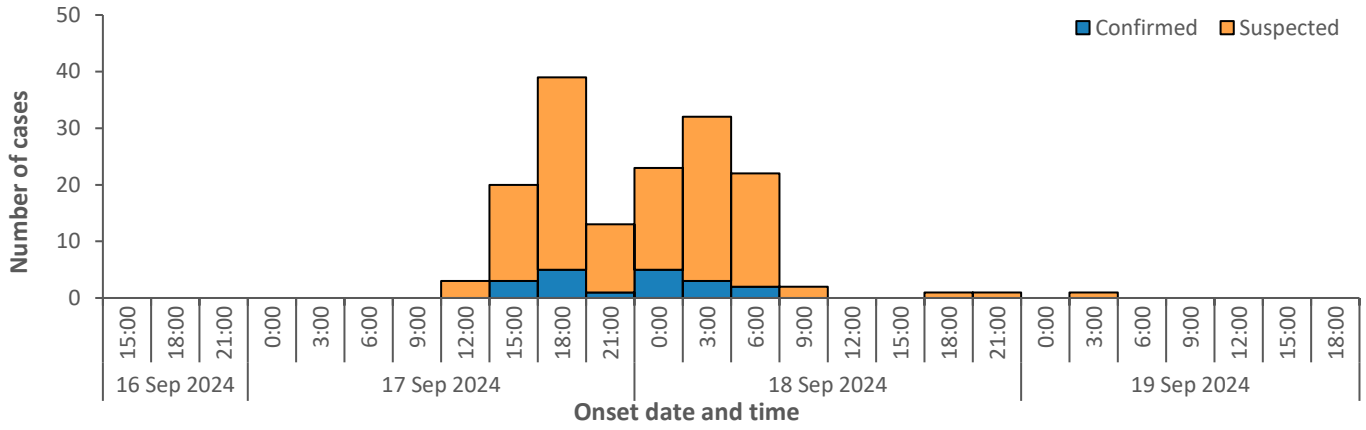


Figure 2. Onset date and time of interviewed cases, food poisoning outbreak, Nang Rong District, Buriram Province, Thailand, 17–21 Sep 2024 (cases with available onset time=157).

Environmental survey

According to the school's regular lunch cooking process, they ordered the ingredients from a vegetable shop and a butcher shop in the morning market. This butcher shop received animal carcasses from a legal slaughterhouse at night and butchered the carcasses and prepared for delivery in the morning. The pork skin was boiled and sliced in the same cutting board as other raw materials. The ingredients arrived at school around 5:00 AM. Food handlers checked their ingredients and prepared them by washing, peeling, and chopping then stored them at room temperature. Around 8:00 AM, food handlers started cooking all prepared ingredients together and finished cooking around 10:00 AM then portioned into containers for each grade. At 11:00 AM, food handlers started delivering to each canteen or rooms. The lunch was then served individually by the teacher of each class. After lunchtime, the trays were collected and washed at the washing area next to the cooking area. On 17 Sep 2024, food handlers ordered raw minced pork, boiled pork skin, pork offal, vegetables, and seasonings to make Laab, which is not usually included in the menu. All ingredients were stored in the cooking place at room temperature as usual. At cooking time, the food handlers started cooking raw minced pork until it was done then mixed it with precooked ingredients which were already kept at the room temperature for 4–5 hours and were not reheated (the separation of raw meat ingredients and cooking them at the different time before mixing together was not usually practice), then portioned, delivered, and served with cucumber and rice as usual. Food handler also ate Laab as their lunch.

For the walkthrough survey using the food sanitation standard checklist, we found that the places for food preparing, cooking and storing were lower than 60 centimeters above the floor level, some even were on the floor. The drying rack for washed utensils was also lower than 60 centimeters above the floor level and without any cover. The cooking area was located next to the washing area which was usually wet because

draining pipes from washing basins were broken. There was no trash bin with lid. Food handlers washed their hands in the same basins for washing the ingredients and no tissue paper or clean towel for hand wiping. Filtered tap water was used in cooking (changed the filter every four months), unfiltered tap water was used for cleaning ingredients and utensils. The residual chlorine level of unfiltered tap water was 0.4 parts per million. Sometimes well water was used through the same pipeline with tap water for washing. All eight food handlers were never officially trained, and no one had annual medicine check-up as required by a school canteen sanitation standard.

Analytical study

We interviewed a total of 175 pairs of cases and controls, of whom 74.8% were students in grades 4–6 of primary school. We found that most foods from lunch on 17 Sep 2024 along with bottled drinking water had turned out to be associated with the disease in univariable conditional logistic regression model (Table 2). Laab also showed dose-response relationship (Table 3). But after adjusted with multivariable conditional logistic regression model, only Laab and cucumber from 17 Sep 2024 were significant risk factors (p-value <0.05) (Table 4).

Table 2. Univariable conditional logistic regression of food items and being a case, food poisoning outbreak, Nang Rong District, Buriram Province, Thailand, 17–21 Sep 2024.

Food items	Pairs of case exposed but control not exposed	Pairs of control exposed but case not exposed	Odds ratio	95% CI	*P*-value
16 September lunch					
Fried rice	15	13	1.15	0.55–2.43	0.706
Cucumber	36	27	1.33	0.81–2.20	0.258
Watermelon	25	32	0.78	0.46–1.32	0.355
17 September lunch					
Laab (spicy pork salad)	32	1	32.00	4.37–234.2	<0.001
Rice	31	3	10.33	3.16–33.8	<0.001
Cucumber	48	20	2.40	1.43–4.04	0.001
Snack	37	35	1.06	0.67–1.68	0.814
Drink					
Bottled water	31	17	1.82	1.01–3.30	0.047
Filtered water	23	36	0.64	0.38–1.08	0.093
Tap water	12	10	1.20	0.52–2.78	0.670
Milk	23	31	0.74	0.43–1.27	0.278

CI: confidence interval.

Table 3. Unconditional logistic regression model of Laab (spicy pork salad) consumed amount and being a case, food poisoning outbreak, Nang Rong District, Buriram Province, Thailand, 17–21 Sep 2024.

Amount of Laab (scoop)	Cases	Controls	Odds ratio	95% CI
Not eat	1	32	Ref	Ref
<0.5	1	6	5.3	0.29–97.5
0.5	6	14	13.7	1.50–124
1	86	66	41.7	5.56–313
2	70	30	74.7	9.75–571
>2	11	4	88.0	8.86–874

CI: confidence interval. Ref: reference.

Table 4. Multivariable conditional logistic regression model of food items and being a case, food poisoning outbreak, Nang Rong District, Buriram Province, Thailand, 17–21 Sep 2024.

Food item	Adjusted OR	95% CI
Laab (spicy pork salad)	18.99	1.86 – 193.70
Rice	1.78	0.35 – 9.19
Cucumber, 17 September	1.85	1.00 – 3.40
Bottled water	1.55	0.77 – 3.13
Filtered water	0.55	0.29 – 1.06

OR: odds ratio. CI: confidence interval.

Discussion

This event was a school outbreak of food poisoning. However, the outbreak was not expanded into the community according to the number of food poisoning cases in the provincial and district level, and from hospital records were not higher than 5-year median. The epidemic curve's pattern was likely to be point common source, and the only common food of students were school lunches. The linkages were likely to be eating Laab (spicy pork salad) and cucumber in school lunch on 17 Sep 2024.

Among 19 specimens of cases, 14 of them had positive results of *C. perfringens*. Most of interviewed cases had the onset between the afternoon of 17 September and the morning of 18 September, and the two most common symptoms were watery diarrhea and abdominal pain. The incubation period of *C. perfringens* food poisoning was 6–24 hours, its symptoms usually last less than one day, and its common symptoms were diarrhea and stomach cramps.[13] Both onset and symptoms of cases were compatible with *C. perfringens* food poisoning.

The source of this outbreak was likely to be Laab on 17 Sep 2024's lunch. The analytical study shows the highest odds ratio and dose-response relationship for Laab. Pork skin was likely to be the implicated ingredient. It was precooked at the butcher shop and left at room temperature for at least 4–5 hours without reheating. It might be contaminated at butcher shop even if it was boiled through cutting them on the same cutting board used for raw pork. *C. perfringens* was also found in leftover Laab and precooked pork skin sample (new lot, same vendor). According to Thailand's Royal Gazette: Notification of the Ministry of Public Health (No. 416) B.E. 2563 (2020) and notification of the Department of Medical science, the number of *C. perfringens* must not exceed 1,000 CFU/g in raw food material and 100 CFU/g in ready-to-eat food.[14,15] Therefore, precooked pork skin was not safe for direct consumption without reheating or recooking. Moreover, many foods poisoning in schools were also caused by *C. perfringens*.[16–18] It is commonly found in meat, beef and poultry. Most often foods cooked in large batches and held at unsafe temperature (4–60 °C) are involved in outbreak of *C. perfringens* food poisoning.[19] To prevent food poisoning from *C. perfringens*, foods must be cooked to safe internal temperature. If food is cooked ahead of time, be sure to keep it warm at 140 °F (60 °C) or refrigerate it at 40 °F (4 °C) or lower within two hours after cooking and reheat it to 165 °F (74 °C) before serving.[20]

About the cucumber on 17 September lunch, it also posed a risk, but *C. perfringens* is not commonly found on vegetables. Cucumbers were prepared and delivered by the same food handlers as Laab and served together with Laab. Despite being brought from the same vendor, consumption of cucumber on 16 September lunch was not a risk factor. Thus, cucumber on 17 September lunch might be a risk factor due to cross-contamination with Laab and its ingredients.

Three of five healthy food handlers were tested positive for *C. perfringens*. All food handlers ate the school lunch they cook and were likely to get the pathogen from this meal. Despite food poisoning usually self-limited without treatment, both symptomatic and asymptomatic food handlers could still be the source of spreading.[21–23] Any measure to keep personal hygiene of food handlers in good state such as always washing hands with soap before cooking and after using toilet is recommended.[24]

According to the food sanitation standard for the school canteen, the school kitchen and food handlers did not meet the requirements.[11] For example, foods, ingredients, and utensil storage were placed lower than 60 centimeters above the floor level. The cooking place was usually wet. No trash bin with lid available. All food handlers have never been trained for food-safety, and no one had annual check-up. All these suboptimal findings could lead to contamination, disease introduction, and contribute to food-and-water borne outbreaks in the future.

Limitations

Some students, especially kindergarteners (preschoolers), could not provide accurate answers about onset of symptoms or food item consumed. This might result in memory bias. The random sampling of cases and controls without proper sampling frames might introduce selection bias to the analytical study and would affect the results of the study. There is only single pair of unexposed cases with exposed control on Laab, resulting in extremely wide 95% CI caused by the discordant pair imbalance. This could indicate imprecision of the analysis and potentially affect the conclusion.

Public Health Recommendations

To prevent similar outbreaks in the future, school food handlers must cook all meat thoroughly and all ingredients from butcher shop must be treated as raw ingredients, even if they are pre-cooked. School lunch must be served within two hours after cooking. If foods need to be stored more than two hours prior to serving

time, food must be kept over 60 °C or under 4 °C with reheating to 74 °C before serving. In addition, sick food handlers should take a leave until they have no symptoms. School director and canteen administrator should improve cooking process, place and utensils to meet the food sanitation standard, and deliver the food-safety training and health check-ups for food handlers annually. District hospitals should provide annual check-up for food handlers following the food sanitation standard. PHO should support the food-safety training course for food handlers to schools and continuously monitor the food sanitation standard of school canteens, as well as provide suggestions to school stakeholders on cooking place improvement following the food sanitation standard and food preparation practices.

Conclusion

There was a school food poisoning outbreak in Nang Rong District, Buriram Province between 17 and 21 Sep 2024. *C. perfringens* was the causative pathogen, and the primary implicated food was Laab (spicy pork salad) on 17 September school lunch (adjusted OR 18.99; 95% CI 1.86–193.70). Pork skin, an ingredient of Laab, was precooked from butcher shop, being kept at inappropriate temperature, and was not reheated before serving. The overall attack rate was 40.0%. One case was admitted and discharged two days later. The cooking process, place, and food handler's requirements did not meet the food sanitation standard for school canteen. Keeping the food hot or keeping it cold and reheating before serving and strictly following the food sanitation standard are recommended.

Acknowledgements

We would like to thank the school personnel, Buriram PHO, Nang Rong District Health Office, district hospital staff, Bamrasnaradura Infectious Disease Institute, the Department of Medical Science, and the joint investigation team of the Office of Disease Prevention and Control 9 Nakhon Ratchasima and DDC.

Author Contributions

Watcharapol Rongdech: Conceptualization, methodology, writing—original draft, writing—review & editing. **Thanit Rattanathumsakul:** Supervision. **Thanumas Sumanotayan:** Investigation. **Kanchana Chaiyawan:** Investigation.

Ethical Approval

Ethical clearance was waived as this investigation was conducted as part of a response to a disease outbreak. All results were aggregated without any individual-traceable data.

Informed Consent

Patient consent was waived due to the investigation was a part of outbreak response.

Data Availability

Data available on request due to privacy/ethical restrictions.

Conflicts of Interest

All authors do not have any conflict of interest in this study as part of a response to a disease outbreak.

Funding Support

All funding was provided by government. We did not receive any funding from private organizations in this investigation.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

We use AI only for grammatical error correction without any AI-generated content. The content produced by this tool was reviewed and edited by the authors, who accept full responsibility for the final text.

References

1. World Health Organization. Estimating the burden of foodborne diseases [Internet]. Geneva: World Health Organization; [cited 2025 Jan 23]. <https://www.who.int/activities/estimating-the-burden-of-foodborne-diseases>
2. Department of Disease Control, Ministry of Public Health (TH). Digital disease surveillance dashboard [Internet]. Nonthaburi: Department of Disease Control; [cited 2026 May 8]. <https://dvis3.ddc.moph.go.th/t/DDC_CENTER_DOE/views/DDS2/sheet33?%3Aembed=y&%3AisGuestRedirectFromVizportal=y>
3. Department of Disease Control, Ministry of Public Health (TH). Modernized event-based surveillance [Internet]. Nonthaburi: Department of Disease Control; [cited 2026 May 8]. <https://mebs-ddce.ddc.moph.go.th/events/search>
4. Srisaeng S, Chirapongsathorn S, Soonthornworasiri N, Poovorawan K, Pan-Ngum W. Burden of diarrhoeal diseases among hospitalised patients in Thailand: a retrospective national database analysis (2014-2022). Lancet Reg Health Southeast Asia. 2026 Apr 6;48:100761. doi:10.1016/j.lansea.2026.100761.

5. Charoenwat B, Suwannaying K, Paibool W, Laoaroon N, Sutra S, Thepsuthammarat K. Burden and pattern of acute diarrhea in Thai children under 5 years of age: a 5-year descriptive analysis based on Thailand National Health Coverage (NHC) data. BMC Public Health. 2022 Dec 1;22(1):1161. doi:10.1186/s12889-022-13598-8.

6. Pahtspot. Economic impact of foodborne illnesses in the food industry and how to prevent them PathSpot Technologies [Internet]. New York: Pathspot Technologies; [cited 2025 Jan 23]. <https://pathspot.com/economic-impact-of-foodborne-illnesses-in-the-food-industry-and-how-to-prevent-them/>

7. Bloomberg School. A foodborne illness outbreak could cost a restaurant millions, study suggests [Internet]. Baltimore (MD): Johns Hopkins Bloomberg School of Public Health; 2018 Apr 16 [cited 2025 Jan 23]. <https://publichealth.jhu.edu/2018/a-foodborne-illness-outbreak-could-cost-a-restaurant-millions-study-suggests>

8. Bureau of Food and Water Sanitation. Clean Food Good Taste Guideline. Nonthaburi: Department of Health, Ministry of Public Health (TH); 2021. Thai.

9. Heredia NL, Labbe RG. Clostridium perfringens Infection. In: Labbe RG, Garcia S, editors. Guide to foodborne pathogens. 2nd ed. Hoboken (NJ): Wiley; 2023 Aug 8. p.82–90. doi:10.1002/9781118684856.ch5.

10. National Center for Emerging and Zoonotic Infectious Diseases. Facts about food poisoning [Internet]. Atlanta: Centers for Disease Control and Prevention (US); 2025 Nov 24 [cited 2026 May 8]. <https://www.cdc.gov/food-safety/data-research/facts-stats/index.html>

11. Ministerial Regulation on Sanitation of Food. Standard food sanitation inspection form for canteen, 2018 [Internet]. Nonthaburi: Department of Health, Minisry of Public Health (TH); [cited 2025 Jan 23]. <https://foodsan.anamai.moph.go.th/th/food-sanitation/download/?did=204396&id=75018&reload=>. Thai.

12. StatsDirect; University of Liverpool. Sample size for matched case-control studies [Internet]. Wirral: StatsDirect; [cited 2026 May 29]. <https://www.statsdirect.com/help/sample_size/matched_case_control.htm>

13. National Center for Emerging and Zoonotic Infectious Diseases. Symptoms of *C. perfringens* food poisoning [Internet]. Atlanta: Centers for Disease Control and Prevention (US); 2025 Jan 30 [cited 2025 Jan 23]. <https://www.cdc.gov/clostridium-perfringens/signs-symptoms/index.html>

14. Ministry of Public Health. Notification of the Ministry of Public Health (No. 416) B.E. 2563 (2020) Issued by virtue of the Food Act B.E. 2522 Re: Prescribing the quality or standard, principles, conditions and methods of analysis for pathogenic microorganisms in foods. Royal Thai Government Gazette. Volume 137, Special part 237 Ngor (Date 2020 Sep 2): 9.

15. Department of Medical Science, Ministry of Public Health. The notification of the Department of Medical science: Microorganism quality standard for foods and utensils [Internet]. Nonthaburi: Department of Medical Science, Ministry of Public Health; 2017 [cited 2025 Jan 23]. 10 p. <http://bqsf.dmsc.moph.go.th/bqsfWeb/wp-content/uploads/2017/Publish/e-book/dmsc-micro3.pdf>. Thai.

16. Ameme DK, Alomatu H, Antobre-Boateng A, Zakaria A, Addai L, Fianko K, et al. Outbreak of foodborne gastroenteritis in a senior high school in South-eastern Ghana: a retrospective cohort study. BMC Public Health. 2016 Jul 13;16:564. doi:10.1186/S12889-016-3199-2.

17. Papanikou S, Sideroglou T, Chrysostomou A, Kyritsi MA, Spaniolas S, Bouboulis D, et al. A point source gastroenteritis outbreak in a high school putatively due to *Clostridium perfringens*: timely investigation is everything. Foodborne Pathog Dis. 2023 Feb 1;20(2):41–6. doi:10.1089/FPD.2022.0057.

18. Dominguez-Berjon MF, Sanz-Moreno JC, Redondo-Sobrado R, Azpiazu-Garrido M, Moreno-Civantos A, et al. [Foodborne outbreak by Clostridium perfringens in a school dining room]. Med Clin (Barc) [Internet]. 2003 Jun 14 [cited 2025 Jan 23];121(2):58–60. <https://pubmed.ncbi.nlm.nih.gov/12828885/>. Spanish.

19. National Center for Emerging and Zoonotic Infectious Diseases. About *C. perfringens* food poisoning [Internet]. Atlanta: Centers for Disease Control and Prevention (US); 2024 Apr 3 [cited 2025 Jan 23]. <https://www.cdc.gov/clostridium-perfringens/about/index.html>

20. National Center for Emerging and Zoonotic Infectious Diseases. Preventing *C. perfringens* food poisoning [Internet]. Atlanta: Centers for Disease Control and Prevention (US); 2024 Apr 3 [cited 2025 Jan 23]. <https://www.cdc.gov/clostridium-perfringens/prevention/index.html>

21. National Center for Emerging and Zoonotic Infectious Diseases. Treating *C. perfringens* food poisoning [Internet]. Atlanta: Centers for Disease Control and Prevention (US); 2024 Apr 3 [cited 2026 May 29]. <https://www.cdc.gov/clostridium-perfringens/treatment/index.html>

22. Dryden MS, Keyworth N, Gabb R, Stein K. Asymptomatic foodhandlers as the source of nosocomial salmonellosis. J Hosp Infect. 1994;28(3):195–208. doi:10.1016/0195-6701(94)90102-3.

23. Todd ECD, Greig JD, Bartleson CA, Michaels BS. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 2. Description of outbreaks by size, severity, and settings. J Food Prot. 2007;70(8):1975–93. doi:10.4315/0362-028X-70.8.1975.

24. National Center for Emerging and Zoonotic Infectious Diseases. Preventing food poisoning [Internet]. Atlanta: Centers for Disease Control and Prevention (US); 2025 Nov 24 [cited 2026 May 29]. <https://www.cdc.gov/food-safety/prevention/index.html>