Outbreak, Surveillance, Investigation & Response (OSIR) Journal
Field Epidemiology Training Program, Division of Epidemiology
Department of Disease Control, Ministry of Public Health, Thailand
Tel: +6625903894, Fax: +6625903845, Email: osireditor@osirjournal.net, https://he02.tci-thaijo.org/index.php/OSIR

An Investigation of Food Poisoning Outbreak among Meeting Attendees in Pattaya City, Thailand, following Post-pandemic Kitchen Reopening, August 2022

Sutham Jirapanakorn[1]*, Saruttaya Wongsuwanphon[1], Kanlaya Jongcherdchootrakul[2], Phanthanee Thitichai[1], Seesai Yeesoonsang[3], Chuleeporn Jiraphongsa[4]

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

2 Phramongkutklao College of Medicine, Thailand

3 Office of Disease Prevention and Control Region 2 Phitsanulok, Department of Disease Control, Ministry of Public Health, Thailand

4 Senior Expert Committee, Department of Disease Control, Ministry of Public Health, Thailand

*Corresponding author, email address: suthamkku@gmail.com

Received: 15 Mar 2024; Revised: 20 Jun 2024; Accepted: 21 Jun 2024
https://doi.org/10.59096/osir.v17i2.268235

Abstract

On 9 Aug 2022, meeting attendees at Hotel B in Pattaya City developed gastrointestinal symptoms during a tourism reopening after Thailand had transitioned to the post-COVID-19 phase. We investigated to confirm the diagnosis, describe outbreak characteristics, identify possible sources and risk factors of the outbreak, and provide recommendations. A food poisoning case was an individual staying in Hotel B on 8–9 Aug 2022 and experienced at least one of the following symptoms: diarrhea, nausea, vomiting and abdominal pain. We sent a self-administered questionnaire to all attendees and interviewed the cases. Food preparation and processing were examined. We swabbed kitchenware and food handlers' hands and collected water samples for bacterial culture. We conducted a retrospective cohort study and used Poisson regression with a robust standard error model. Fifty-five percent of the attendees responded to the questionnaire; the attack rate was 34%. Common symptoms were diarrhea (100%) and abdominal pain (80%). The median incubation period was 7–13 hours. Stewed pork leg with kale had the highest adjusted risk ratio of 27.82×10^6 (95% CI 9.06×10^6–85.44×10^6). It was reported as cold with an unusual smell and taste. We found *Bacillus cereus* and *Aeromonas spp.* on kitchenware and in filtered water. The incubation period, symptoms, and laboratory results suggested that *Bacillus cereus* was the most likely pathogen from the stewed pork leg. We recommended sanitizing the kitchen and kitchenware, promoting food sanitary awareness, and ensuring the quality of water supply system, particularly for hotels preparing to reopen after prolonged closure.

Keywords: *Bacillus cereus*, food poisoning, outbreak, Pattaya City, Thailand

Introduction

In 2022, the World Health Organization estimated 600 million foodborne-illness cases, causing 420,000 deaths, and around 33 million years of healthy lives lost due to eating unsafe food worldwide each year.[1] In 2021, Thailand reported approximately 59,000 cases of food poisoning with an attack rate of around 90 cases per 100,000 population, most of the cases aged 15–24 years.[2] Furthermore, Thailand has reported an average of 50 foodborne outbreaks annually.[3]

Coronavirus disease 2019 (COVID-19) pandemic impacted tourism worldwide.[4] The Thai government restricted international tourists and domestic travel causing numerous hotels to experience financial setbacks and closures.[5,6] In Pattaya City, a vibrant tourist destination located on Thailand's eastern Gulf coast, 10%–50% of hotels experienced temporary closures for up to three months.[7]

As of 1 Jul 2022, Thailand entered the post-pandemic phase of COVID-19, allowing tourism to gradually

reopen.[8,9] On 10 Aug 2022, the Division of Epidemiology received a notification concerning a cluster of food poisoning cases related to a meeting of attendees from a medical school, held at Hotel B during 8–9 Aug 2022, in Pattaya City. Subsequently, an investigation was conducted by the Division of Epidemiology staff and local health staff on 10–11 Aug 2022 to confirm the diagnosis, describe outbreak characteristics, identify the possible source and risk factor of the outbreak, and provide recommendations for prevention.

Methods

Epidemiologic Investigation

We defined a food poisoning case as an individual staying in Hotel B on 8–9 Aug 2022 and experiencing at least one of the following symptoms: diarrhea, nausea, vomiting, and abdominal pain. We conducted active case finding among hotel staff and guests who were not meeting participants by interviewing the hotel staff to identify any food poisoning cases. For the meeting participants, we distributed online self-administered questionnaires through the medical school focal point, to gather information of meeting attendees including demographic characteristics, clinical information, and consumed food items between 8–9 Aug 2022. We additionally interviewed 20% of the cases using the convenience sampling method to gather information regarding their illness, treatment, and the suspected food associated with the food poisoning.

Subsequently, a retrospective cohort study was conducted to identify the possible source of the outbreak among the meeting attendees who responded to our questionnaires. Sample size estimation utilized data from a previous study of a food poisoning outbreak associated with eating stewed pork balls, similar to the stewed pork leg, which was suspected to be the source of this outbreak (detailed in the Results section).[10] To achieve 80% power with a 95% confidence interval (CI), the study required 15 participants each in the exposed and unexposed cohorts.

Environmental and Laboratory Studies

We inspected the kitchen environment and the water supply system and interviewed hotel staff and food handlers regarding raw material preparation, cooking processes, and food handling procedures. We collected samples including swabs from kitchen and kitchenware, food handler's hands, and water samples. We tested the samples for coliform bacteria with an SI-2 test kit of the Department of Health. The SI-2 is a peptone-lactose-bromocresol solution used to detect coliform bacteria. It works by detecting gas production and acidification caused by lactose fermentation.[11] Then we sent the samples to the Regional Medical Sciences Center 6 Chonburi for bacteria cultures. We additionally collected water samples for free residual chlorine levels with an O-31 test kit of the Department of Health.[12] It is an orthotolidine-arsenite solution, which reacts with free residual chlorine in a water-sample.[13] Furthermore, we interviewed staff of the Division of Public Health and Environment, Pattaya City about policies and practices governing food sanitary activities in Pattaya City.

Statistical Analysis

We conducted a descriptive study and calculated percentages, median and interquartile range (IQR). For the retrospective cohort study, risk ratio (RR) calculation was performed for each food item using Poisson regression with robust standard error model. Instead of using logistic regression, we used the Poisson regression due to its ability to provide adjusted risk ratio which is more understandable given that the disease was not rare among the affected population in this event. Multivariable analysis was conducted using Poisson regression with robust standard error model to calculate an adjusted RR, focusing on food items served in the most suspected meal, with p-value ≤ 0.1 from univariable analysis. Statistical significance was defined as a p-value ≤ 0.05. Statistical analysis was conducted using R version 4.2.1, with the tidyverse 1.3.1.[14]

Ethics

Since this study was a part of a routine outbreak investigation, ethics approval was not required.

Results

Background of the Event

The meeting of Medical School A included a diverse group of 80 health professionals including executives, instructors, and support staff. The meeting was held at Hotel B on 8–9 Aug 2022, after the official post-pandemic reopening of Thailand's tourism sector. Despite Hotel B remaining operational throughout the pandemic, one of its two kitchens (Kitchen A) underwent a temporary closure between April and June 2022.

Outbreak Description

One day before the meeting, none of the participants experienced any food poisoning symptoms. They had breakfast independently before arriving at Hotel B on the morning of 8 Aug 2022. Kitchen A exclusively catered for the meeting with 23 food items including two main buffet meals (lunch and dinner) on 8 August, as well as three snack breaks—two on 8 August, and one on 9 August.

No food poisoning cases were identified among hotel staff or guests who were not meeting participants. Among meeting participants, the response rate to our questionnaire was 55.0% (44/80). The median age of responder was 47.5 years (IQR 41.0–55.0). Of these, we identified 15 cases corresponding to an attack rate of 34.1% (15/44). The male-to-female ratio was 1:1.5 and the median age was 46.0 years (IQR 41.5–54.0). All cases (15/15) had diarrhea on average three times. Abdominal pain was reported by 80.0% (12/15) of cases, while 6.7% (1/15) experienced nausea and fever; none involved vomiting. All cases exhibited mild symptoms, used self-medication for symptomatic treatment and recovered quickly without seeking medical assistance.

The first case started at 9:00 PM on 8 August, marking the onset of a rising trend that peaked at 1:00 AM on 9 August. Subsequently, the number of cases declined, with the last case recorded at 5:30 AM on 10 August. The epidemic curve indicated a point common source outbreak with a median incubation period around 7–13 hours (Figure 1).

The most common food items among cases at lunch were stewed pork leg with kale (93.3%; 14/15), Tomyum kung (Thai spicy shrimp soup) (86.7%; 13/15), and green curry with chicken (73.3%; 11/15), with a median exposure-to-onset period of 13.0 hours. For dinner, the common items among cases were shrimp dip and vegetables, spicy pork salad, and spicy pork soup (66.7%; 10/15), with a median exposure-to-onset period of 7.0–8.5 hours (Table 1). Around sixty-seven percent (66.7%; 10/15) of the cases reported that the stewed pork leg with kale was perceived as cold, and had an unusual smell and taste, leading them to suspect this item as the potential source of the outbreak.

Table 1. The number of food poisoning cases who consumed each food item and median exposure-to-onset period of food items served in the meeting at Hotel B, Pattaya City, Thailand, 8–9 Aug 2022 (n=15)

Food items	Number of food poisoning cases consumed n (%)	Median exposure-to-onset period (hours)
Lunch		
Stewed pork leg with kale	14 (93.3)	13.0
Tomyum kung	13 (86.7)	13.0
Green curry with chicken	11 (73.3)	13.0
Stir-fried vegetables with oyster sauce	11 (73.3)	13.3
Fish cake	8 (53.3)	12.5
Papaya salad	7 (46.7)	14.5
Stir-fried pork with red curry	7 (46.7)	10.0
Dinner		
Shrimp dip and vegetables	10 (66.7)	7.0
Spicy pork salad	10 (66.7)	8.5
Spicy pork soup	10 (66.7)	7.0
Stir-fried broccoli with oyster sauce	9 (60.0)	7.0
Roasted duck with red curry	8 (53.3)	4.0
Stir-fried beef with black pepper	5 (33.3)	4.0
Stir-fried chicken with red curry	1 (6.7)	4.0
Snack and sweets		
Chicken satay	11 (73.3)	-8.5
Fruit	9 (60.0)	13.3
Fruit tart	9 (60.0)	-9.0
Shrimp dumplings	9 (60.0)	-9.0
Sweet water chestnuts	7 (46.7)	8.0
Tiramisu	7 (46.7)	7.0
Salmon quiche	6 (40.0)	12.5
Opera cake	5 (33.3)	-7.4
White chocolate eclair	4 (26.7)	-7.4

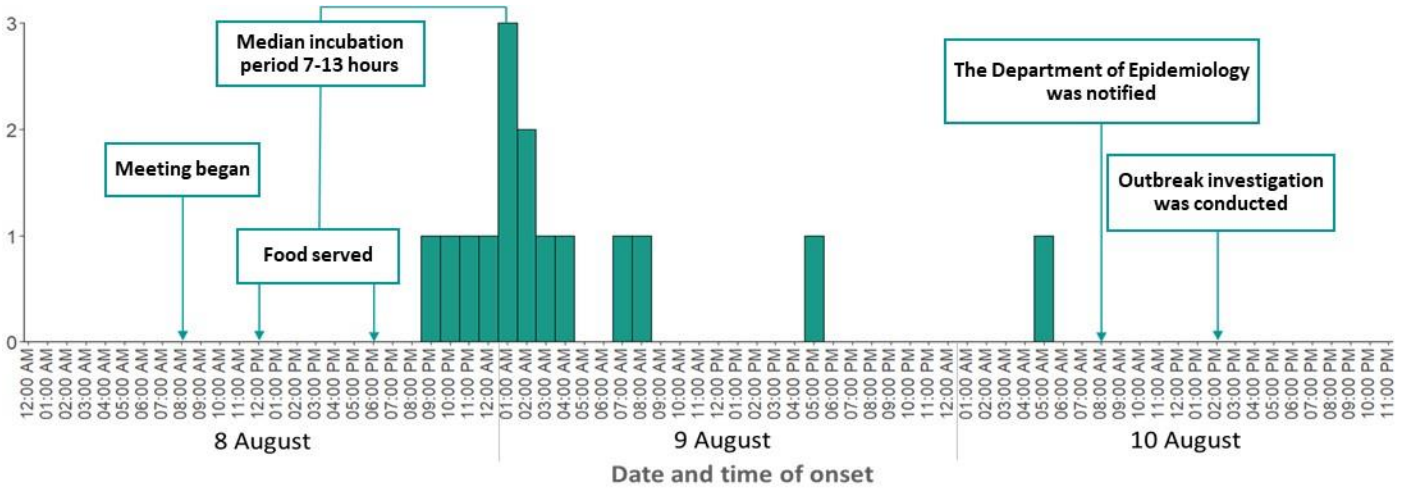

Figure 1. Number of food poisoning cases by date and time of onset in the meeting at Hotel B, Pattaya City, Thailand, 8–9 Aug 2022 (n=15)

Analytical Study Results

The univariable analysis indicated that stewed pork leg with kale served at lunch had the highest crude RR that was statistically significant (crude RR $34x10^6$, 95% CI $10x10^6$–$117x10^6$), followed by green curry with chicken served at lunch (crude RR 3.67, 95% CI 1.16–11.60), and shrimp dip and vegetables served at dinner (crude RR 2.53, 95% CI 1.02–6.28) (Table 2). Both the stewed pork leg with kale and the green curry with chicken were chosen for multivariable analysis. The stewed pork leg with kale had a statistically significant adjusted RR ($27.82x10^6$, 95% CI $9.06x10^6$–$85.44x10^6$), while green curry with chicken showed an adjusted RR of 2.96 (95% CI 0.94–9.32).

Table 2. Risk of being a food poisoning case by foods served in the meeting at Hotel B, Pattaya City, Thailand, 8–11 Aug 2022 (n=44)

Food items	Exposed Attack rate (case/total)	Non-exposed Attack rate (case/total)	Crude RR	95% CI	*P*-value
Lunch					
Stewed pork leg with kale	0.39 (14/36)	0.00 (0/5)	$34x10^6$*	$10x10^6$–$117x10^6$	<0.01
Green curry with chicken	0.52 (11/21)	0.14 (3/21)	3.67*	1.16–11.60	0.03
Tomyum kung	0.42 (13/31)	0.15 (2/13)	2.73	0.69–10.75	0.15
Stir-fried vegetables with oyster sauce	0.41 (11/27)	0.21 (3/14)	1.90	0.62–5.88	0.27
Stir-fried pork with red curry	0.33 (7/21)	0.35 (7/20)	0.95	0.40–2.28	0.91
Papaya salad	0.29 (7/24)	0.42 (8/19)	0.69	0.30–1.60	0.39
Fish cake	0.26 (8/31)	0.50 (6/12)	0.52	0.22–1.20	0.12
Dinner					
Shrimp dip and vegetables	0.53 (10/19)	0.21 (5/24)	2.53*	1.02–6.28	0.05
Stir-fried broccoli with oyster sauce	0.36 (9/25)	0.20 (3/15)	1.80	0.56–5.79	0.32
Spicy pork soup	0.43 (10/23)	0.25 (5/20)	1.25	0.47–3.36	0.66
Spicy pork salad	0.36 (10/28)	0.29 (4/14)	1.74	0.70–4.33	0.23
Stir-fried beef with black pepper	0.38 (5/13)	0.32 (9/28)	1.20	0.49–2.93	0.69
Roasted duck with red curry	0.35 (8/23)	0.33 (7/21)	1.04	0.45–2.43	0.92
Stir-fried chicken with red curry	0.20 (1/5)	0.30 (10/33)	0.66	0.10–4.32	0.67
Snacks and sweets					
Fruit	0.41 (9/22)	0.21 (4/19)	1.94	0.69–5.45	0.21
Salmon quiche	0.50 (6/12)	0.30 (9/30)	1.67	0.74–3.73	0.21
Chicken satay	0.28 (11/40)	0.29 (4/14)	1.28	0.48–3.40	0.62
Tiramisu	0.39 (7/18)	0.32 (8/25)	1.22	0.53–2.80	0.65
Shrimp dumplings	0.36 (9/25)	0.32 (6/19)	1.14	0.48–2.70	0.77
Fruit tart	0.35 (9/26)	0.33 (6/18)	1.04	0.44–2.45	0.93
Opera cake	0.36 (5/14)	0.38 (9/24)	0.95	0.39–2.33	0.92
Sweet water chestnuts	0.29 (7/24)	0.37 (7/19)	0.79	0.33–1.91	0.60
White chocolate eclair	0.25 (4/16)	0.39 (11/28)	0.64	0.24–1.71	0.37

*RR: risk ratio. CI: confidence interval. *P ≤0.05.*

Environmental Survey Result

Hotel kitchen information

The hotel kitchens were certified by hazard analysis and critical control points, and clean food good taste standards ensuring a stringent standard of food hygiene in Thailand. Kitchen A was divided into zones with individual bins, including a meat room, salad room, kitchen zone, and bakery zone. A team of 4–5 staff were assigned to work solely within their zone, prohibiting unauthorized access. The kitchen's environment was carefully maintained, and its surroundings and tools were observed to be clean. We observed separate tools for handling raw materials from those used for cooking, and the kitchen floor remained dry. All cooking surfaces were elevated on a 100-centimeter platform. Every kitchen staff underwent an annual health checkup in October 2021,

with normal results. They were supposed to participate in the annual food sanitary training program from the Division of Public Health and Environment, but it had been interrupted since 2020 due to the COVID-19 pandemic. All kitchen staff on the meeting date wore proper protective equipment and were healthy.

Food preparation process

Menu options were planned two days before the meeting to facilitate raw material preparation and staffing requirements. The raw materials were delivered from familiar suppliers to the hotel one day before the meeting and stored separately in a temperature-controlled stockroom.

The lunch menu preparation started at 7:00 AM, with raw materials such as meat, eggs, and vegetables being retrieved from stock and undergoing a quality check before being prepared. Soup or boiled dishes were cooked at 10:00 AM and kept warm, while fried or stir-fried dishes were cooked at 11:00 AM. Each menu item was taste-tested and wrapped individually before being served at noon.

The dinner preparation started with rinsing and chopping raw materials at 2:00 PM. Soup and boiled dishes were cooked at 4:00 PM and kept warm, while fried or stir-fried dishes were cooked at 5:00 PM. Each menu item was taste-tested, wrapped, and served at 6:00 PM. Any remaining food was discarded four hours after mealtimes. Hotel guests and staff were not allowed to take the leftover food outside the dining area.

However, the stewed pork leg with kale was prepared in the evening before the event. The pork leg was frozen separately from other raw materials, while the stewed soup was stored in a pot and kept warm overnight. All components were reheated together at 10:00 AM on 8 Aug 2022 and served at noon. Although there was no temperature monitor in the reheating step, food handlers reported that it had been boiled.

The water used in food preparation originated from tap water, which was then filtered through the hotel's filtration system. The filtration system was certified annually for biochemical standards by an external company. During the investigation, the free residual chlorine levels were 0.2 ppm in both the consumed water and the tap water. For safety, water for drinking was purchased in bottles, and ice was procured from a certified local ice factory.

Laboratory result

Of the tested kitchen environment surfaces, kitchenware, and food handler's hands samples, 33.3% (4/12) tested positive for coliforms. In the culture tests for enteropathogenic bacteria, 25.0% (3/12) exhibited positive results for *Bacillus cereus,* while 33.3% (4/12) tested positive for *Aeromonas spp.* (Table 3).

Table 3. Coliform test and enteropathogenic bacterial culture results from the Hotel B kitchen, Pattaya City, Thailand, 10 Aug 2022

Group	Specimens	Coliform test	Enteropathogenic bacterial culture
Staff	1st cook's hand	Negative	Negative
	2nd cook's hand	Negative	Negative
	Butcher's hand x2	Negative	***B. cereus***
Kitchen utensil	Knife and cutting board	**Positive**	***B. cereus***
Meat storage room utensils	Tray	Negative	***Aeromonas spp.***
	Gloves	Negative	Negative
	Scale	Negative	Negative
	Grinder	Negative	NA
	Table	Negative	NA
	Knife	**Positive**	NA
Salad preparation room utensils	Tray	**Positive**	***Aeromonas spp.***
	Knife and cutting board	**Positive**	***Aeromonas spp.***
Water	Filtered water	NA	***B. cereus, Aeromonas spp.***
	Tap water	NA	Negative
	Ice	NA	Negative

NA: not available.

Action Taken

We monitored the outbreak situation, and no additional cases of food poisoning in this hotel were reported. Health education session was conducted for hotel staff to raise awareness about pathogens and preventive measures against contamination. We encouraged the staff to promptly clean the kitchen and assess potential routes of contamination. Additionally, we advised the hotel to improve the quality of the water supply system.

Discussion

We confirmed the food poisoning outbreak among meeting attendees. This was the first documented food poisoning outbreak related to a kitchen reopening after the COVID-19 pandemic in Thailand. The findings suggested environmental contamination in this kitchen, and the stewed pork leg was the most suspected source. Although a confirmed diagnosis could not be established due to the lack of stool samples from the cases, laboratory results from environmental specimens indicated *B. cereus* and/or *Aeromonas spp.* might be the pathogen of this outbreak. Coinfection of *B. cereus* and *Aeromonas spp.* has previously been identified as an occasional cause of food poisoning outbreaks in Thailand. In a previous food poisoning outbreak investigation in 2020, both *B. cereus* and *Aeromonas spp.* were identified as pathogens, with similar symptoms of diarrhea and abdominal pain among cases, and a similar overall attack rate to our outbreak.[15] *B. cereus* can lead to two types of food poisoning: emetic and diarrheal syndromes depending on the type of food. The emetic type is associated with consumption of starchy foods such as rice and pasta, whereas the diarrhea type is associated with protein-rich foods such as meat and milk. *B. cereus* diarrhea typically presents with mild symptoms, afebrile, and self-limited within 24 hours. The incubation periods for the emetic and diarrheal types are 0.5–6 hours and 8–16 hours, respectively.[14,17] Food poisoning caused by *Aeromonas spp.* typically presents with watery diarrhea and occasionally persistent for a few days. About 50% of cases also experience fever and abdominal cramps, while nausea and vomiting are less common. The incubation period for Aeromonas food poisoning is 1–2 days.[18–20]

The epidemic curve of this outbreak suggested a median incubation period of 7–13 hours, consistent with *B. cereus* diarrhea syndrome rather than Aeromonas infection. Moreover, the clinical presentation, marked by predominant symptoms of diarrhea, a low incidence of fever, and the severity and duration of illness, closely resembled the characteristics of *B. cereus* diarrheal syndrome. Although coinfection with these two bacteria was possible, the collective evidence suggested that *B. cereus* was likely the major causative pathogen of this outbreak, affecting a larger portion of cases compared to *Aeromonas spp.*

In this outbreak, the stewed pork leg with kale was most likely the source. Despite being initially cooked, the overnight storage posed a potential risk of contamination, enabling the multiplication of pathogens. The reported characteristics of the stewed pork leg by cases, included cold temperature, and unusual taste and smell, which suggested inadequate reheating temperature. This leads to an additional hypothesis that contamination can also occur during the reheating, possibly originating from water used for deconcentrating the soup. Furthermore, the highest risk ratio supports the likelihood that the stewed pork leg with kale was the source of the outbreak. Several other food items in this outbreak showed a potential risk of food poisoning, possibly attributed to cross-contamination during the food preparation.[16,18]

The positive coliform test, coupled with positive bacterial culture from filtered water, and kitchenware, suggested potential cross-contamination, which might have occurred initially from filtered water to kitchenware, and finally to foods during various preparation steps. When reopening after a prolonged closure, restaurants should ensure the readiness of the water supply system. This includes regularly draining water during periods of closure to prevent bacterial growth in stagnant water, contacting the local water utility to inquire about recent water supply disruptions, and checking water disinfectant residuals, ensuring that all maintenance activities meet water standards regulation.[21,22] The COVID-19 pandemic significantly disrupted Thailand's tourism. This kitchen was temporarily closed from April to June 2022. At the same time, the annual food sanitary training program was suspended. These factors might have contributed to a decline in food safety awareness among staff, who overlooked certain food preparation processes e.g., reheating.

Limitations

We encountered several limitations. First, the low response rate and limited number of interviews might introduce selection bias. However, we attempted to mitigate this by urging attendees to respond to questionnaires and participate in interviews through the department leaders. Secondly, during interviews with kitchen staff, the presence of the hotel manager and head chef might introduce information bias regarding the food preparation process. To minimize this, we conducted individual interviews with kitchen staff, hotel manager, and head chef. Thirdly, as all cases were health professionals with mild symptoms who recovered quickly, we were unable to collect any stool samples to confirm the pathogen. Fourthly, the hotel's policy, which mandates the disposal of leftover food within four hours after the meal, hindered the collection of food samples. As a result, we lacked direct evidence of a pathogen from both cases and the

suspected food, casting caution on the interpretation of the suspected pathogen. Lastly, the limited number of variables to fit in the multivariable model resulted in a failure to demonstrate adjusted RR of food items. Nevertheless, the study findings were sufficient to identify the risk factors contributing to the outbreak and highlight areas for improving sanitation.

Recommendations

To prevent food poisoning, we recommend eating newly cooked food. To prevent *B. cereus* contamination, Hotel B should ensure that food is cooked and reheated at an appropriate temperature of >74 °C for at least 15 seconds, and that kitchenware is regularly washed.[17] Hotel B should identify and rectify routes of environmental and water supply contamination promptly. Moreover, hotels planning to reopen after a prolonged closure must prioritize checking the quality of the water supply systems to ensure a safe transition. Lastly, the Division of Public Health and Environment Pattaya City should resume the annual food hygiene training that was interrupted by the COVID-19 pandemic, to enhance sanitary awareness among food handlers.

Conclusion

The food poisoning outbreak occurred at Hotel B, Pattaya City, Thailand, in August 2022, during Thailand's post-COVID-19 tourism reopening. The stewed pork leg with kale was suspected to be the food source. The most likely pathogen was *Bacillus cereus*. Contamination might have occurred initially from filtered water to kitchenware, and finally to foods during various preparation steps. However, confirmation was hindered by lack of relevant samples from both the served foods and affected cases. Recommendations focus on improving food sanitation practices including thorough kitchenware cleaning, identifying, and addressing potential sources of contamination, promoting sanitary awareness among staff, and checking the water supply system quality following prolonged closure.

Acknowledgments

We extend our gratitude to the staff and trainees of the Thailand Field Epidemiology Training Program, the members from the Division of Epidemiology, Department of Disease Control, the Office of Disease Prevention and Control Region 6 Chon Buri, the Regional Medical Sciences Center 6 Chonburi, the Bang Lamung District Public Health Office, the Bang Lamung Hospital, and the Division of Public Health and Environment, Pattaya City.

Funding

This study received no funding.

Suggested Citation

Jirapanakorn S, Wongsuwanphon S, Jongcherdchootrakul K, Thitichai P, Yeesoonsang S, Jiraphongsa C. An investigation of food poisoning outbreak among meeting attendees in Pattaya City, Thailand, following post-pandemic kitchen reopening, August 2022. OSIR. 2024 Jun;17(2):70–7. doi:10.59096/osir.v17i2.268235.

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