# Foodborne outbreak investigation in elementary school, Gunungkidul District, January 2024: a cohort retrospective study design

*Denis* Oxy Handika[1*], *Muhamad* Imam Utama[1], *Dwi* Rizki Ananda[1], *Ahmad* Watsiq Maula[2], *Riris* Andono Ahmad[2,3], *Sidig* Hery Sukoco[4]

[1]Field Epidemiology Training Program, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia
[2]Department of Biostatistics, Epidemiology, and Population Health, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia
[3]Center for Tropical Medicine, Faculty Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia
[4]Gunungkidul District Health Office, Yogyakarta, Indonesia

**Abstract.** On January 25, 2024, the Gunungkidul District Health Office was notified that three elementary school students fell ill after consuming snacks sold near the school. A team from Semanu II Health Center, in collaboration with the Gunungkidul District Health Office and Field Epidemiology Training Program Universitas Gadjah Mada residents, conducted an epidemiological investigation. This investigation aimed to identify the sources, risk factors, assess its extent, and provide suggestions for outbreak management. An active case-finding investigation was conducted, followed by a retrospective cohort study. Cases were individuals with one or more symptoms like nausea, vomiting, stomach pain, dizziness, chills, shortness of breath, and sore throat after consuming snacks sold near the school on January 25, 2024. In-depth interviews with structured questionnaires were used for data collection. Food handlers' hygiene practices were observed, and food samples were tested at a health laboratory. A statistical analysis using chi-square and log-binomial regression was performed to measure the association in this study. 102 individuals were interviewed, 12 were considered cases. Most cases were in males (66.67%), aged 5 to 11 (66.67%), primarily third-grade students (50%), and a common symptom was nausea (100.00%). The epidemic curve had a common source, with incubation periods varying from 30 minutes to 14 hours. The median incubation period was 1 hour, while the average was 2 hours 23 minutes. The "Egg Macaroni" was associated with higher illness risk in this outbreak (aRR=14.5; 95% CI=1.7 - 21.1). Biological pathogens were detected in lab tests. Factors like poor hygiene practices, improper storage, reheating, and cross-contamination posed risks. The conclusion is that a foodborne outbreak at elementary school occurred in Gunungkidul District on January 25, 2024, and was caused by *Bacillus cereus* and mold/yeast. Implementation of healthy canteens in the school environment and increased education to improve food safety supervision is recommended.

*Corresponding author : denisoxyhandika@mail.ugm.ac.id

# 1 Introduction

Foodborne is a significant public health issue and often causes high morbidity and mortality in many countries [1]. Globally, the World Health Organization (WHO) estimates that 600 million people experience illness from consuming contaminated food each year, with mortality reaching 420 thousand people per year [2]. This problem occurs due to consuming food contaminated by bacteria, viruses, parasites, chemicals, or harmful physical substances [3,4]. The impacts are not only related to the health of the affected individuals, but can also cause significant economic and social losses [5]. Food contamination can occur at various stages, from raw material preparation to food delivery [6,7]. Factors such as hygienic practices during food processing and serving, as well as personal hygiene before eating, can increase the risk of contamination [8,9].

According to Indonesia Minister of Health Regulation Number 2 Year 2013, Foodborne involves two or more people who become ill with the same or similar symptoms after consuming food, and through epidemiological analysis, the food is confirmed as the source of infection is categorized as an outbreak [10]. Outbreaks require a rapid and coordinated response from multiple agencies including health authorities, to identify, isolate and control the source of disease transmission or contamination [11]. This rapid response is critical to minimize the public health impact, reduce the risk of further spread, and ensure effective protection of the affected population [12].

In Indonesia, foodborne outbreaks have become an important issue [13]. Based on reports from The Indonesian Food and Drug Authority (BPOM) in 2022 through the SPIMKER (Sistem Pelaporan Informasi Masyarakat Keracunan) application, there were 72 foodborne outbreaks with the number of exposed individuals reaching 5,505 people, with 2,788 people experienced symptoms of illness (attack rate 50.64%). In addition, there were 5 reported cases of death due to foodborne disease (case fatality rate 0.18%). Foodborne outbreaks occurred in 26 provinces with the highest number of reports coming from Central Java with 9 reports (12.50%), followed by West Nusa Tenggara with 7 reports (9.72%), and East Java with 5 reports (6.94%). Most cases of foodborne outbreaks originated from household cooking (34.72%), followed by catering services (31.94%) and snacks (23.61%). The three main places where foodborne outbreaks most often occurred were in residences with 29 incidents (40.28%), elementary schools with 18 incidents (25.00%), and open places with 7 incidents (9.72%).

On January 25, 2024, the Gunungkidul District Health Office received a report from the Semanu II Community Health Center about suspected foodborne diseases involving three elementary school students. These students experienced symptoms of dizziness, nausea, vomiting, and sore throat after consuming snacks around the school. This incident indicates a potential outbreak of foodborne. In response to the potential outbreak of foodborne diseases, an epidemiological investigation conducted by The Rapid Response Team from Semanu II Community Health Center together with the Gunungkidul District Health Office and Field Epidemiology Training Program Universitas Gadjah Mada residents. The epidemiological investigation aims to identify the sources, risk factors and to assess its extent of foodborne diseases in elementary schools in Gunungkidul District to provide recommendations to prevent the occurrence of similar outbreak in the future.

# 2 Methods

## 2.1 Epidemiological investigation

An active case-finding investigation was conducted, followed by a retrospective cohort study. Cases were individuals presenting one or more symptoms such as nausea, vomiting, stomach

pain, dizziness, chills, shortness of breath, and sore throat after consuming snacks around the school at the Elementary School on January 25, 2024. Data was collected through interviews with all students using a standardized questionnaire. The data were then analyzed to evaluate the spatial, temporal, and individual relationships among the at-risk population who had consumed snacks around the school.

### 2.2 Environmental investigation

An environmental investigation was conducted by conducting interviews and direct observation of the environment in two homes of food vendors or food handlers who sold snacks on the same day as the incident notification was received. The status of hygiene and sanitation in food processing was evaluated. The investigation team also conducted a Hazard Analysis Critical Control Point (HACCP) of the snack production process to identify possible causes related to factors that may have contributed to the foodborne incident.

### 2.3 Laboratory investigation

Leftover food obtained from students and snacks from the vendors involved were collected and sent to the Yogyakarta Provincial Health Laboratory and Calibration Center for further investigation. Eight samples were collected, including leftover seasoned egg macaroni, macaroni, fresh egg macaroni, siomai, rolled egg, packaged seasoning powder, chili sauce, and soy sauce. The samples were analyzed for biological and chemical agents to determine their food safety.

### 2.4 Data analysis

Descriptive analysis was performed considering factors such as individuals, time, and location, using statistical methods such as percentages and the calculation of Attack rates (ARs). Epidemic curves were created by dividing time into daily steps, with intervals corresponding to half of the average incubation period. Statistical analysis involved chi-square test and log-binomial regression methods to obtain Relative Risk (RR) values along with 95% confidence intervals (CIs) to identify food products that may be the cause of this event.

## 3 Results and Discussion

The investigation of 102 students revealed that 12 students experienced one or more symptoms such as dizziness, nausea, vomiting, abdominal pain, chills, shortness of breath, or sore throat after consuming snacks that were sold around the elementary school on January 25, 2024. Based on Table 1, the highest attack rate for the disease was observed in male students, reaching 14.0%. In addition, the highest attack rate also occurred in students aged 6-10 years (11.9%), as well as in grade 3 students with an attack rate of 28.6%.

**Table 1.** Characteristics of cases

| Characteristics | Population at risk, (N=102) n(%) | Cases (N=12) n(%) | Attack Rate (%) |
|---|---|---|---|
| **Gender** | | | |
| Male | 57 (55.9) | 8 (66.7) | 14.0 |
| Female | 45 (44.1) | 4 (33.3) | 8.9 |
| **Age** | | | |
| 6 – 10 | 67 (65.7) | 8 (66.7) | 11.9 |
| > 10 | 35 (34.3) | 4 (33.3) | 11.4 |
| **Elementary school grade** | | | |
| 1 | 19 (18.6) | 0 (0.0) | 0.0 |
| 2 | 16 (15.7) | 2 (16.7) | 12.5 |
| 3 | 21 (20.6) | 6 (50.0) | 28.6 |
| 4 | 13 (12.7) | 0 (0.0) | 0.0 |
| 5 | 18 (17.6) | 3 (25.0) | 16.7 |
| 6 | 15 (14.7) | 1 (8.3) | 6.7 |

**Table 2.** Distribution of cases based on symptoms

| Symptoms | Cases | |
|---|---|---|
| | Total N=12 | Percentages (%) |
| Nausea | 12 | 100.00 |
| Vomiting | 11 | 91.67 |
| Stomach pain | 5 | 41.67 |
| Sore throat | 2 | 16.67 |
| Dizziness | 1 | 8.33 |
| Chills | 1 | 8.33 |
| Shortness of breath | 1 | 8.33 |

All cases presenting with at least one symptom, with most common symptoms (Table 2) were nausea (100.00%), followed by vomiting (91.67%), and stomach pain (41.67%). Based on the epidemiological curve in Figure 1 for this foodborne incidence, it is known that food handlers prepared egg macaroni and siomai started cooking on January 23, 2024 at 8:00 PM local time, and began selling their products in the morning on January 24, 2024 at 6:30 AM local time. The time interval between the start of cooking and the start of sales was approximately 10.5 hours. Elementary school students first consumed snacks around the school on January 24, 2024 at 7:30 AM, with the last meal at 8:00 AM. The time interval between the start of sales and the consumption by students was approximately 1.5 hours. Symptoms first

appeared on January 25, 2024 at 8:30 AM, and the last symptoms were recorded at 10:00 PM, peaking between 8:31 AM and 9:00 AM. The incubation period from food consumption to symptom onset varied, with a minimum of 30 minutes and a maximum of 14 hours. The median incubation period was approximately 1 hour, and the average incubation period was approximately 2 hours and 23 minutes. The epidemiological curve shows a "common source" pattern indicates that the observed cases of the disease originate from a single or centralized source within a specific time frame.

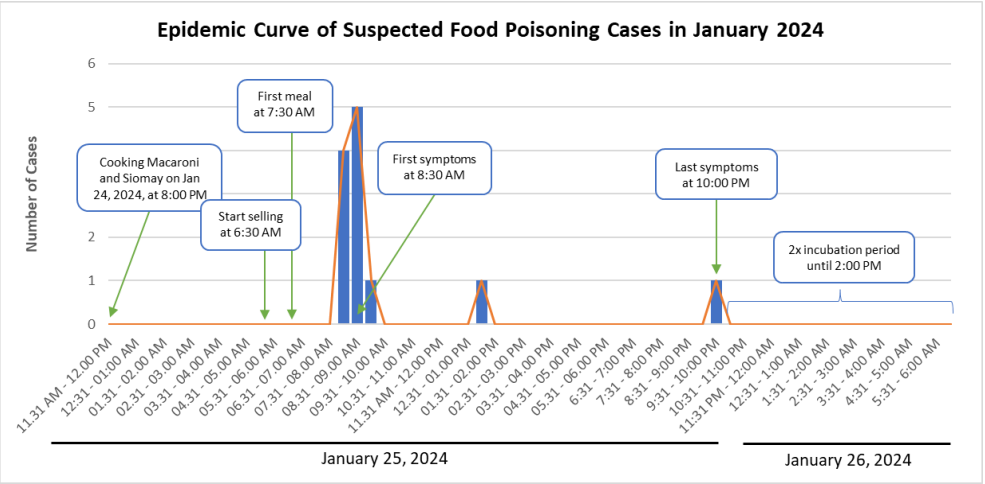


**Fig. 1.** Epidemic curve

**Tabel 3.** Food-specific attack rates of subjects

| Food items | Ate food item | | | Didn't eat food item | | | ARR | RR (95% CI) | aRR (95% CI) |
|---|---|---|---|---|---|---|---|---|---|
| | ill | Total | AR (%) | ill | Total | AR (%) | | | |
| Egg macaroni | 7 | 15 | 46.7 | 5 | 87 | 5.8 | 8.1 | 8.1* (2.9-22.6) | 14.5* (1.7-21.1) |
| Siomai | 4 | 14 | 28.6 | 8 | 88 | 9.1 | 3.1 | 3.1* (1.1-9.1) | 2.7 (0.9-10.9) |
| Rolled egg | 1 | 13 | 7.7 | 11 | 89 | 12.4 | 0.6 | 0.6 (0.1-4.4) | - |

*p-value < 0.05
AR, attack rate; ARR, attack rate ratio; RR, risk ratio; aRR, adjusted risk ratio

Based on Table 3, it is known that the egg macaroni food type has the highest Attack Rate Ratio (ARR), which is 8.12, and is also statistically significant in relation to the incidence of food poisoning in elementary schools in Gunungkidul District (aRR= 14.46; 95% CI: 1.72-21.11). This means that egg macaroni consumption is 8.12 times more likely to cause food poisoning compared to other foods.

Environmental studies were conducted through interviews and observations in the vicinity of a house where vendors of egg macaroni and siomai operate. The kitchen used for preparing egg macaroni still has a dirt floor, while the siomai vendor's kitchen has a concrete floor. The toilet located between both vendors is less than 2 meters away from the kitchen. There are no livestock pens near the kitchen area between the two vendors.

Food processing for the egg macaroni vendor began on January 24, 2024, at 8:00 PM by boiling noodles and preparing a mixture of egg and flour batter. The boiled noodles were drained in a tray to cool down. Once cooled, the noodles were stored in a jar in the refrigerator, while the egg-flour batter was placed in a bottle formerly used for mineral water and also stored in the refrigerator. On the morning of January 25, 2024, at 5:30 AM, the vendor started preparing the cart by arranging the boiled noodles and placing condiments such as sweet corn, grilled corn, sauce, and soy sauce in seasoning containers. At 6:30 AM, the vendor began selling around with a motorized cart. The vendor reported that on that day, the merchandise was in good condition as usual, with no unusual occurrences regarding the boiled noodles, egg-flour batter, or seasonings.


**Fig. 2.** Vendor of egg macaroni

Food processing for the siomai vendor began on January 25, 2024, at 3:00 AM by making siomai filled with egg. The dough was made using bulk flour and boiled well water. The egg-filled siomai was fried as usual using fresh oil. During siomai preparation, the vendor did not use gloves but had washed their hands beforehand without using soap. Once cooked, siomai was placed in a steamer for selling around. Condiments such as sauce and soy sauce were also placed in sauce bottles. At 07:00 AM, the siomai vendor started selling their products. According to the siomai vendor, all raw materials including flour, eggs, and sauce were in good condition.

Food samples were collected by the The Rapid Response Team from Semanu II Community Health Center on Thursday, January 25, 2024 at 15.00 WIB (on the same day). The laboratory examination results were issued by the Yogyakarta Health and Calibration Laboratory Center and were obtained by the surveillance officer of the Gunungkidul District Health Office on February 13, 2024. February 13, 2024. The laboratory test results for biological agents (Table 4) on the submitted samples indicated multiple contaminations, showing more than one type of biological contaminant. Egg macaroni, siomai, and rolled eggs are eaten in various ways, including with soy sauce, chili sauce, and seasoning powder. All of these have been shown in laboratory tests, and most food contains Bacillus cereus and mold/yeast. However, the chemical examination (Table 5) of all samples did not detect contamination by chemical agents such as

arsenic, phosphorus, and cyanide. This indicates that the samples were free from chemical contamination, which is regularly monitored for potential consumer health risks.

**Tabel 4.** Laboratory test results of biological agents in food samples

| Sample items | Result |
|---|---|
| Leftover seasoned egg macaroni | *Pseudomonas sp., Bacillus cereus* |
| Original macaroni | *Staphylococcus aureus*, *Bacillus cereus*, |
| Fresh egg macaroni | *Bacillus cereus*, Mold/yeast |
| Siomai | Mold/yeast |
| Rolled egg | *Bacillus cereus* |
| Packaged seasoning powder | Mold/yeast |
| Chili sauce | *Bacillus cereus*, Mold/yeast |
| Soy sauce | Mold/yeast, *Bacillus cereus* |

**Tabel 5.** Laboratory test results of chemical agents in food samples

| Sample items | Result | | |
|---|---|---|---|
| | Arsenic | Phosphorus | Cyanide |
| Leftover seasoned egg macaroni | Negative | Negative | Negative |
| Original macaroni | Negative | Negative | Negative |
| Fresh egg macaroni | Negative | Negative | Negative |
| Siomai | Negative | Negative | Negative |
| Rolled egg | Negative | Negative | Negative |
| Packaged seasoning powder | Negative | Negative | Negative |
| Chili sauce | Negative | Negative | Negative |
| Soy sauce | Negative | Negative | Negative |

Based on these symptoms, the highest aRR food agent and compared to the pathogens confirmed by laboratory testing, the suspected agents causing the illness are *Bacillus cereus* and mold/yeast. This is reinforced by the incubation period and also the food ingredients used in making these snacks.

*Bacillus cereus* and mold/yeast were frequent causes of foodborne outbreaks, was identified as the pathogen responsible for the foodborne outbreak investigated at an elementary school in Gunungkidul. The suspected source of contamination was egg macaroni from a vendor who sells food near the school. The pathogens were found in samples of leftover macaroni, other types of macaroni, and the seasoning sauce/powder used for the macaroni.

Macaroni is made from wheat flour and water. Wheat flour which is high in carbohydrates and sugar [14]. Where in cases of foodborne diseases caused by *Bacillus cereus* it usually occurs in rice, pasta, potatoes, and other starchy foods [15–17]. In addition, the incubation period of these pathogens causes symptoms ranging from 30 minutes - 5 hours [16]. Meanwhile, in the case of illness caused by mold/yeast, the incident generally occurs in food made from rice, wheat, or other ingredients that contain carbohydrates or sugar as a growth medium, with the incubation period of food poisoning caused by these pathogens ranges from 30 minutes - 2 hours [18].

Based on the results of an investigation into suspected food poisoning at an elementary school in Gunungkidul, it was discovered that cases generally experienced symptoms of nausea, vomiting and stomach ache. These symptoms indicate acute gastroenteritis that occurs in the upper gastrointestinal tract [19–21]. Acute gastroenteritis is usually caused by a viral, bacterial, or parasitic infection that affects the digestive tract [20]. Based on these symptoms, the highest aRR food agent and compared to the pathogens confirmed by laboratory testing, the suspected agents causing the illness are *Bacillus cereus* and mold/yeast. This is reinforced by the incubation period and also the food ingredients used in making these snacks.

*Bacillus cereus* is a Gram-positive, rod-shaped, facultative aerobic bacterium found in various environments, including soil, dust, and food [15–17]. This bacterium is well known as a cause of food poisoning, which can occur in two forms: emetic form (vomiting) and enteritis form (diarrhea) [16]. In the emetic form, poisoning is caused by cereulide toxin produced by bacteria in food. In contrast, in the enteritis form, poisoning is caused by enterotoxins produced by bacteria in the intestine after contaminated food is consumed [17]. Mold/yeast is a type of fungus that can cause illness if it grows in food materials. Some types of mold/yeast produce harmful mycotoxins, such as aflatoxins, that can cause poisoning. Mold/yeast can grow 8 hours after cooking at a temperature range between 5°C - 37°C [18].

*Bacillus cereus* cross-contamination occurs when this bacteria spreads from one source to other foods or surfaces, increasing the risk of food poisoning [16]. Meanwhile, mold/yeast contamination occurs when food that has been cooked is left in an open space and eventually contaminated with spores [22]. This can occur in various ways, such as using cookware that is not properly washed after contact with contaminated food or through work surfaces that are not properly cleaned after preparing raw food [8]. Unwashed hands after handling contaminated food can also spread bacteria, as can storing food at inappropriate temperatures, allowing *Bacillus cereus* and mold/yeast to grow and spread to other foods stored nearby [17].

Prevention of cross-contamination by pathogens is a key step in maintaining food safety [8,23]. This includes strict hygiene practices, such as washing cookware with hot water and soap after using it on contaminated or raw food. Kitchen work surfaces should be cleaned regularly with disinfectant to remove food debris and prevent the spread of pathogens [23]. Additionally, handwashing behavior with soap and running water before and after handling food is important, especially when moving from raw to cooked or ready-to-eat foods [23,24]. Ensure food is stored at a safe temperature; Hot foods should be kept hot (above 60°C) and cold foods cold (below 4°C) during storage and transport. In addition, separating raw foods from cooked or ready-to-eat foods is also necessary to reduce the risk of cross-contamination [8].

Snacks sold around schools by snack vendors are often not guaranteed to be clean and do not meet health standards [23,25,26]. Many traders do not pay attention to hygienic aspects of food

processing, from the raw materials used to the way it is served [23]. As a result, the food consumed by students can be contaminated by bacteria, viruses, other pathogens, or dangerous chemicals which can cause foodborne diseases. Apart from hygiene factors, lack of supervision from schools and parents also contributes to the frequent cases of food poisoning in elementary schools [27–29]. Many parents do not know the types of snacks their children consume at school, and schools often do not have a strict monitoring system for snack vendors around the school environment [27]. As a result, students are free to buy and consume snacks that may not be safe for their health. This is exacerbated by the lack of education regarding the importance of choosing healthy and safe food [29].

Therefore, it is important to increase strict supervision regarding food safety in schools by establishing healthy canteens and enforcing a ban on students from snacking carelessly outside the school environment [28,29]. Parents also have an important role in raising awareness about the types of safe snacks for their children [27]. It is hoped that they will pay more attention to choosing healthy and guaranteed clean food. On the other hand, related agencies need to intensify education and supervision efforts towards mobile food vendors[30]. This includes improving knowledge of good food safety practices and supervising food processing processes to ensure they comply with applicable health standards. By implementing these steps, it is hoped that we can create a safer and healthier school environment to support children's growth and development and prevent future food poisoning incidents.

The study was limited by recall bias, as young students may have difficulty accurately remembering their food consumption and the specific timing of their meals. Furthermore, the absence of human samples, such as vomit, precluded further analysis during the investigation.

## 4 Conclusion

There was a foodborne outbreak in Gunungkidul District on January 25, 2024, caused by double contamination of *Bacillus cereus* and Mold/yeast. Regulation and public health programs to promote healthy canteens in the school environment are urgently recommended to improve food safety supervision and increase knowledge about safe food for students, parents, and teachers.

## References

1. M., G. *et al.* Foodborne Diseases - A Public Health Challenge. *Indian J. Nutr. Diet.* **60**, 447–459 (2023). http://dx.doi.org/10.21048/IJND.2023.60.3.29867
2. World Health Organization. *WHO Global Strategy for Food Safety 2022–2030: Towards Stronger Food Safety Systems and Global Cooperation*. https://www.who.int/publications/i/item/9789240057685 (2022).
3. Gupta, A. K. & Chaudhary, A. Food Poisoning: Causes, Its Effects and Control. *INWASCON Technol. Mag.* **4**, 59–61 (2022). http://doi.org/10.26480/itechmag.04.2022.59.61
4. Sahar Abd, A.-D. Overview of Foodborne viruses: Important viruses, outbreaks, health concerns, food Handling and fresh produce. *J. Food Sci. Nutr. Ther.* **8**, 038–045 (2022). https://doi.org/10.17352/jfsnt.000038
5. Almaary, K. S. Food-Borne Diseases and their Impact on Health. *Biosci. Biotechnol. Res. Asia* **20**, 745–755 (2023). http://dx.doi.org/10.13005/bbra/3129
6. Lebelo, K., Malebo, N., Mochane, M. J. & Masinde, M. Chemical contamination pathways and the food safety implications along the various stages of food production: A review. *Int. J. Environ. Res. Public Health* **18**, (2021). https://doi.org/10.3390/ijerph18115795

7. Mohammed Rufai, S. & Wartu, J. R. Food contact surface contaminants: a review. *FUDMA J. Sci.* **7**, 140–148 (2024). https://doi.org/10.33003/fjs-2023-0706-2179
8. Kamboj, S., Gupta, N., Bandral, J. D., Gandotra, G. & Anjum, N. Food safety and hygiene: A review. *Int. J. Chem. Stud.* **8**, 358–368 (2020). https://doi.org/10.22271/chemi.2020.v8.i2f.8794
9. Han, L. *et al.* Hygiene Practices Among Young Adolescents Aged 12-15 Years in Low-and Middle-Income Countries: A Population-Based Study. *J. Glob. Health* **10**, 1–10 (2020). https://doi.org/10.7189/jogh.10.020436
10. Kementerian Kesehatan Republik Indonesia. *Buku Pedoman Penyelidikan Dan Penanggulangan Kejadian Luar Biasa Penyakit Menular Dan Keracunan Pangan*. (Kementerian Kesehatan Republik Indonesia, Jakarta, 2020).
11. Moore, M. *et al.* Preparedness in practice: An outbreak science approach to studying public health emergency response. *medRxiv* (2023) doi:https://doi.org/10.1101/2023.06.24.23291861
12. Greiner, A. L. *et al.* Challenges in Public Health Rapid Response Team Management. *Heal. Secur.* **18**, S-8-S-13 (2020). https://doi.org/10.1089/hs.2019.0060
13. Badan Pengawas Obat dan Makanan Indonesia. *Laporan Tahunan Badan POM Tahun 2022*. *Program* http://www.pom.go.id/ppid/2016/kelengkapan/laptah2015.pdf (2023).
14. Tamaroh, S. & Purwani, T. Physical, Chemical, and Preference Levels of Macaroni, formulated with wheat flour, mocaf flour, and purple yam flour. *IOP Conf. Ser. Earth Environ. Sci.* **1338**, 012041 (2024). doi.org/10.1088/1755-1315/1338/1/012041.
15. Leong, S. S., Korel, F. & King, J. H. Bacillus cereus: A review of "fried rice syndrome" causative agents. *Microb. Pathog.* **185**, 106418 (2023). https://doi.org/10.1016/j.micpath.2023.106418.
16. Rodrigo, D., Rosell, C. M. & Martinez, A. Risk of Bacillus cereus in Relation to Rice and Derivatives. *Foods* **10**, 302 (2021). https://doi.org/10.3390/foods10020302
17. Dietrich, R., Jessberger, N., Ehling-Schulz, M., Märtlbauer, E. & Granum, P. E. The Food Poisoning Toxins of Bacillus cereus. *Toxins (Basel).* **13**, 98 (2021). https://doi.org/10.3390%2Ftoxins13020098.
18. Erkmen, O. Yeasts and molds counting techniques. in *Microbiological Analysis of Foods and Food Processing Environments* 43–51 (Elsevier, 2022). doi.org/10.1016/B978-0-323-91651-6.00050-1.
19. Fleckenstein, J. M., Matthew Kuhlmann, F. & Sheikh, A. Acute Bacterial Gastroenteritis. *Gastroenterol. Clin. North Am.* **50**, 283–304 (2021). https://doi.org/10.1016/j.gtc.2021.02.002.
20. Orenstein, R. Gastroenteritis, Viral. in *Encyclopedia of Gastroenterology* 652–657 (Elsevier, 2020). doi.org/10.1016/B978-0-12-801238-3.65973-1.
21. Heckroth, M., Luckett, R. T., Moser, C., Parajuli, D. & Abell, T. L. Nausea and Vomiting in 2021. *J. Clin. Gastroenterol.* **55**, 279–299 (2021). https://doi.org/10.1097%2FMCG.0000000000001485.
22. Chou, K., Yan, C. T. & Hsiao, H. I. Identification of postbaking mold contamination through onsite monitoring of the baking factory environment: A case study of a bakery company in Taiwan. *Food Control* **145**, 109495 (2023). https://doi.org/10.1016/j.foodcont.2022.109495.
23. Reynolds, J. Review of Food Safety Violations: Urban School Foodservice. *Food Prot. Trends* **42**, 439–448 (2022). doi.org/10.4315/FPT-22-008.
24. Khomsan, A., Anwar, F., Riyadi, H. & Navratilova, H. F. Children's food habits, consumption, and food safety of popular snacks in school environments in Indonesia. *Int. J. Community Med. Public Heal.* **10**, 119 (2022). https://doi.org/10.18203/2394-6040.ijcmph20223535.
25. Luh Pitriyanti, Yosephina Ardiani Septiati, Annisa Pratiwi Putri & Mimin Karmini.

Handwashing behavior, snack eating habits and e.coli contamination with diarrhea in elementary school students in Tanjungpinang City and Cimahi City. *Int. J. Soc. Sci.* **3**, 423–428 (2023). https://doi.org/10.53625/ijss.v3i4.6991.

26. Hussain, A., Rahman, Z. U. & Khan, M. Microbiological Evaluation of Different Types of Branded and Non-branded Ready-to-Eat Snacks Sold in Elementary Schools of District Peshawar, Pakistan. *Biosci. Rev.* **5**, 1–9 (2023). http://dx.doi.org/10.32350/BSR.52.01.
27. Nurhidayati, V. A. & Seo, S. Parents' perceived risks and benefits on avoidance of street food near schools in Indonesia: Moderating role of school type. *Psychol. Sch.* **61**, 1393–1412 (2024). https://awspntest.apa.org/doi/10.1002/pits.23117.
28. Grigsby-Duffy, L. *et al.* The impact of primary school nutrition policy on the school food environment: a systematic review. *Health Promot. Int.* **37**, 1–18 (2022). https://doi.org/10.1093/heapro/daac084.
29. Wang, D., Shinde, S., Young, T. & Fawzi, W. W. Impacts of school feeding on educational and health outcomes of school-age children and adolescents in low- and middle-income countries: A systematic review and meta-analysis. *J. Glob. Health* **11**, 04051 (2021). https://doi.org/10.7189/jogh.11.04051.
30. Miranti, M. G. *et al.* Education on Sanitation and Hygiene Knowledge on Food Vendors in Semolowaru Culinary Tourism Center (CTC) Surabaya. *J. Pemberdaya. Masy. Madani* **6**, 351–367 (2022). http://dx.doi.org/10.21009/JPMM.006.2.10.