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Epidemiology of Reported Foodborne Outbreaks in Al-Ahsa Region, Saudi Arabia 2020-2025

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ABSTRACT:

Background: Foodborne diseases remain a public health concern worldwide, although many can be prevented through safe food handling. This study described patterns in reported foodborne disease outbreaks in Al-Ahsa between 2020 and 2025 by year, season, setting, food category, and causative agent, and examined factors associated with outbreak size.

Methods: Archived foodborne disease outbreak records from Al-Ahsa, Saudi Arabia, were analyzed at the outbreak level. Descriptive statistics summarized patterns by time, season, setting, food category, and causative agent. Univariable analyses and Poisson regression examined factors associated with the number of cases per outbreak.

Results: A total of 498 cases involving 163 reported outbreaks were identified. Reported outbreak counts increased over the study period and were highest from April to June. Restaurants were the most common setting of food preparation, whereas homes were the most common setting of food consumption. Poultry was the most frequently reported food category, and Salmonella was the predominant recorded causative agent. Most outbreaks involved few cases, with a median of two cases per outbreak. After adjustment for food-preparation setting, outbreaks in which food was consumed at home had a higher expected number of cases than outbreaks in which food was consumed in restaurants (adjusted case-count ratio = 1.26, 95% CI: 1.01–1.56; $p = 0.041$).

Conclusion: Reported foodborne outbreaks in Al-Ahsa varied by season, setting, and food category. The findings support seasonal food-service inspection, food-handler training, and public guidance on safe food transport, storage, and preparation. Health education should reinforce practical food-safety habits among consumers, families, and food handlers.

INTRODUCTION

Foodborne disease is illness caused by consuming contaminated food or drink (World Health Organization, 2006). WHO's 2026 estimates indicate that unsafe food causes approximately 866 million illnesses and 1.5 million deaths annually worldwide (World Health Organization, 2026). The Ministry of Health guide requires immediate notification and telephone communication for emergencies, including outbreaks involving at least 30 cases, a death, or a critical case (Ministry of Health, 2022a). Bacteria, viruses, parasites, and chemicals, including heavy metals, can contaminate food and cause illness. Contamination can occur during food production, distribution, or consumption (World Health Organization, n.d.). Understanding outbreak patterns can help guide prevention and control measures (Alzahrani, 2025). A foodborne disease outbreak is defined as two or more cases of a similar foodborne illness linked to a common food source (Skovgaard, 2009).

Common symptoms of foodborne diseases include nausea, vomiting, diarrhea, abdominal pain, dehydration, and fatigue (Alfaleh et al., 2025). These diseases can affect people of all ages, genders, and income levels (Alzahrani & Shatwan, 2024). Surveillance and outbreak investigations help assess and improve food-safety interventions, policies, and practices (Sarno et al., 2021; Skovgaard, 2009).

In Saudi Arabia, climate, cultural practices, food imports, and rapid urbanization pose challenges for food safety. Alsubaie and Berekaa (2020) emphasized the need for coordinated food-safety governance, surveillance, inspection, workforce training, and consumer education. Their review identified gaps in food-safety capacity, coordination across sectors, and public awareness. Addressing these gaps can support early detection, timely investigation, and prevention in food-service and household settings.

Saudi Arabia's geography, population, and socioeconomic conditions shape its foodborne disease patterns (Alamri et al., 2026). Annual Ministry of Health statistics recorded 134 outbreaks and 1,270 cases reported in 2020, 181 outbreaks and 1,133 cases in 2021, 176 outbreaks and 1,188 cases in 2022, 296 outbreaks and 1,891 cases in 2023, and 833 outbreaks and 4,085 cases in 2024 (Ministry of Health, 2020, 2021, 2022b, 2023, 2024). A national analysis reported a decline in foodborne disease outbreak counts and associated cases from 2017 to 2020, followed by an increase through 2023 (Alzahrani, 2025). Studies also report regional differences in foodborne disease occurrence (Alamri et al., 2026). The Eastern Region and Al-Ahsa had incidence levels above the national average, supporting closer study of local outbreak patterns (Alfaleh et al., 2025).

Saudi studies have examined food sources, outbreak settings, and causative agents. Public sources were associated with a higher outbreak burden than home sources (Alfaleh et al., 2025; Alzahrani, 2025). Restaurants and other public food settings were frequently implicated, suggesting that food prepared or consumed outside the home contributes substantially to reported outbreaks (Alfaleh et al., 2025; Alzahrani, 2025). Implicated foods and causative agents varied across regions and datasets. Salmonella is among the commonly reported causes of foodborne infection in Saudi Arabia (Alfaleh et al., 2025). Examining these patterns can help target local prevention and regulatory action.

National studies have described foodborne disease trends in Saudi Arabia. Local outbreak records can provide further information on food sources, preparation and consumption settings, and outbreak size. This study described reported foodborne disease outbreaks in Al-Ahsa between 2020 and 2025 by year, season, setting, food category, and causative agent, and examined factors associated with the number of cases per outbreak.

MATERIALS AND METHODS

Study Design and Setting

This retrospective analytical study used outbreak reports from Al-Ahsa for January 2020 to December 2025. Records were obtained from the Public Health Department at Al-Ahsa Health Cluster, which archives reports submitted by governmental and private medical facilities in the region. The reports used Ministry of Health reporting forms and followed the procedures in the Guide for Reporting Foodborne Disease Outbreaks (Ministry of Health, 2022a).

Data Source and Outbreak Eligibility

The analysis was conducted at the outbreak level. The dataset included all foodborne disease outbreaks reported between January 2020 and December 2025 in Al-Ahsa. Individual and sporadic cases were excluded from the study.

Data Collection

Data were extracted from paper outbreak reporting forms archived at the Public Health Department of Al-Ahsa Health Cluster (Ministry of Health, 2022a). The forms recorded dates and locations of food preparation, food consumption, and symptom onset, as well as diagnostic reports, case counts, age, sex, nationality, symptoms, and health outcomes. Records were reviewed at the department, and relevant information was entered into Microsoft Excel to create an outbreak-level dataset. Outbreaks with incomplete information were retained, with missing values recorded as unknown where applicable. The review covered outbreaks reported between January 2020 and December 2025, using the outbreak reporting date.

Statistical Analysis

Data were organized in Microsoft Excel and analyzed in SPSS. Categorical variables were summarized as frequencies and percentages. Continuous variables were summarized using the mean and standard deviation or the median and interquartile

range. Univariable analyses used the Kruskal–Wallis test, Mann–Whitney U test, and Spearman correlation, as appropriate. Poisson regression examined factors associated with the number of cases per outbreak. Statistical significance was set at $p < 0.05$.

Ethical Considerations

The study was approved by the Institutional Review Boards (IRBs) of Imam Abdulrahman bin Faisal University and Al-Ahsa Health Cluster. The relevant authority permitted access to the archived outbreak records. No identifiable patient information was used.

RESULTS

A total of 163 foodborne disease outbreaks were included in the analysis. These outbreaks accounted for 498 related cases in Al-Ahsa from 2020 to 2025.

Reported outbreaks increased overall during the study period, from 1 (0.6%) in 2020 to 60 (36.8%) in 2025, with a slight decline in 2023. The highest count was recorded in 2025 and the lowest in 2020.

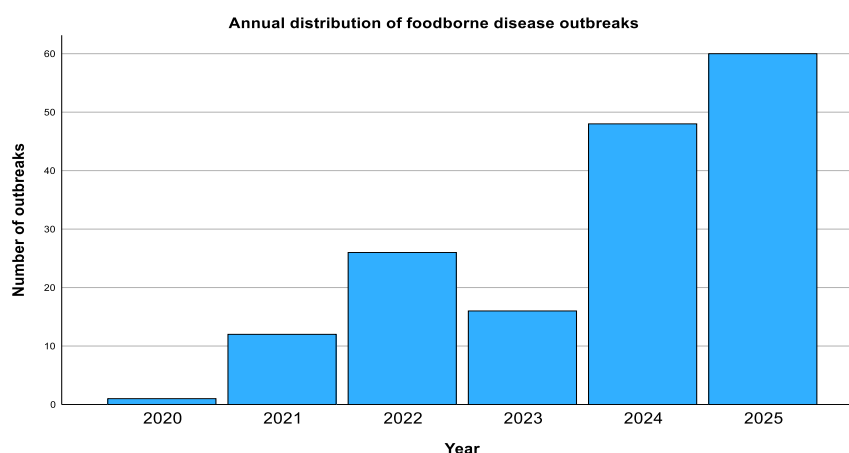


Figure 1 Annual distribution of foodborne disease outbreaks in Al-Ahsa, 2020–2025.

June had the highest proportion of outbreaks (19.6%), followed by May (15.3%) and April (14.1%). February had the lowest proportion (2.5%), followed by January with 5 outbreaks (3.1%). March accounted for 15 outbreaks (9.2%). July, August, September, October, and November each had 10 outbreaks (6.1%), and December had 9 (5.5%) (Figure 2).

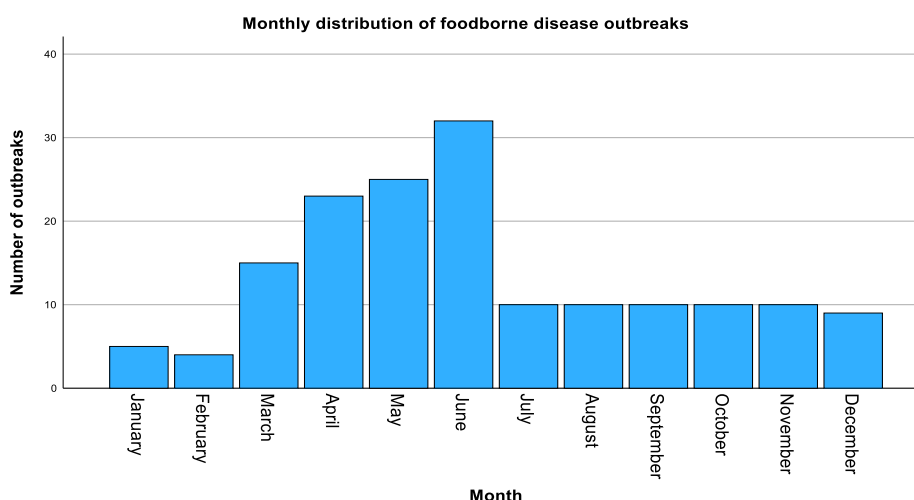


Figure 2 Monthly distribution of foodborne disease outbreaks in Al-Ahsa, 2020–2025.

Spring had the highest number of outbreaks, with 63 (38.7%), followed by summer with 52 (31.9%). Autumn accounted for 30 outbreaks (18.4%) and winter for 18 (11.0%) (Figure 3).

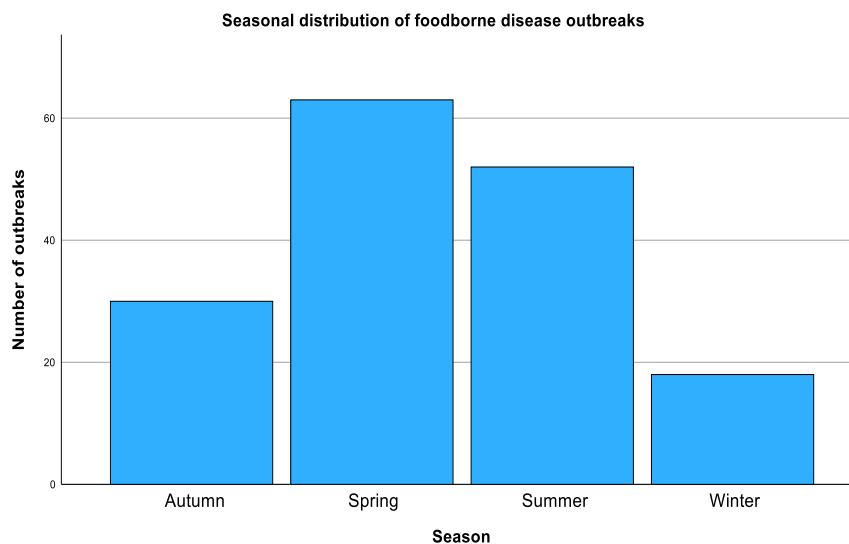


Figure 3 Seasonal distribution of foodborne disease outbreaks in Al-Ahsa, 2020–2025.

Most outbreaks were linked to food prepared in restaurants (132, 81.0%). Food was prepared at home in 24 outbreaks (14.7%) and at an institution in 4 (2.5%). The preparation setting was unknown in 3 outbreaks (1.8%) (Figure 4).

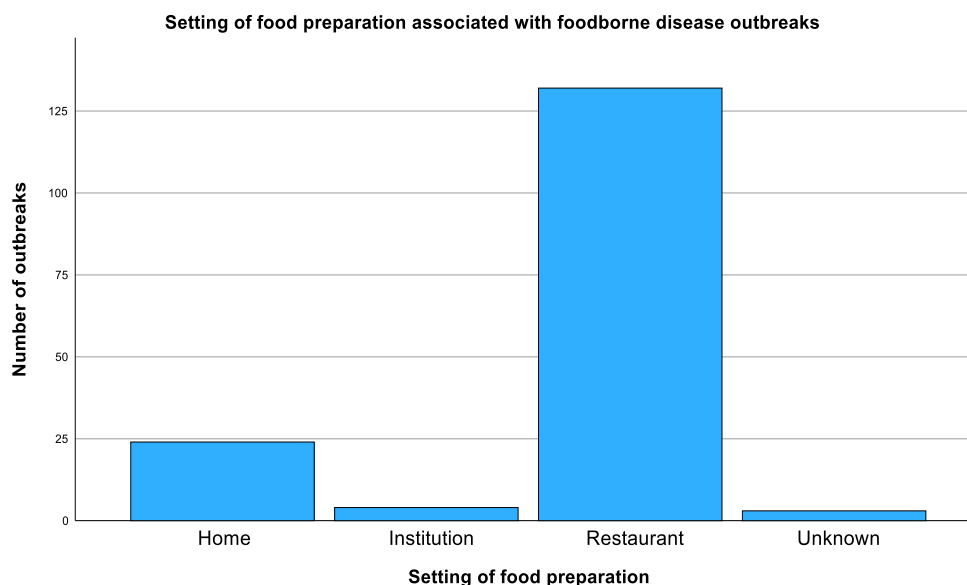


Figure 4 Setting of food preparation associated with foodborne disease outbreaks in Al-Ahsa, 2020–2025

Poultry was the most frequently reported food category (67 outbreaks, 41.1%), followed by fast food (31 outbreaks, 19.0%). Meat was linked to 13 outbreaks (8.0%), while baked goods and rice dishes each accounted for 12 (7.4%). Less frequent

categories were sides (8 outbreaks, 4.9%), pasta/noodles (7 outbreaks, 4.3%), unknown foods (5 outbreaks, 3.1%), and desserts and seafood (4 outbreaks each, 2.5%) (Figure 5).

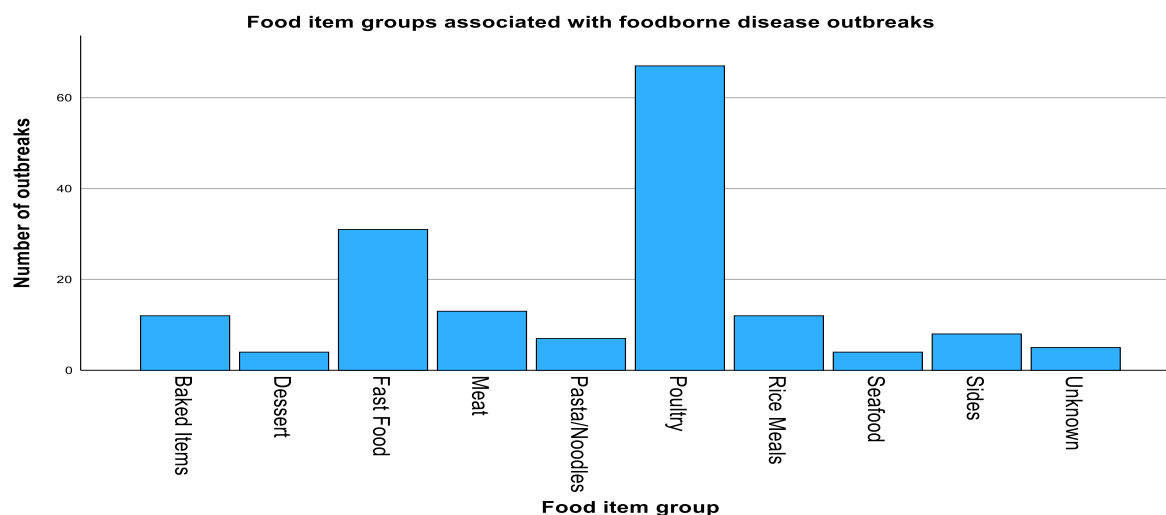


Figure 5 Food groups associated with foodborne disease outbreaks in Al-Ahsa, 2020–2025

Salmonella was the most frequently recorded causative agent, accounting for 114 outbreaks (69.9%), followed by Staphylococcus aureus with 32 (19.6%). Bacillus cereus accounted for 12 outbreaks (7.4%). E. coli and unknown agents each accounted for 2 outbreaks (1.2%), and Clostridium botulinum for 1 (0.6%) (Figure 6).

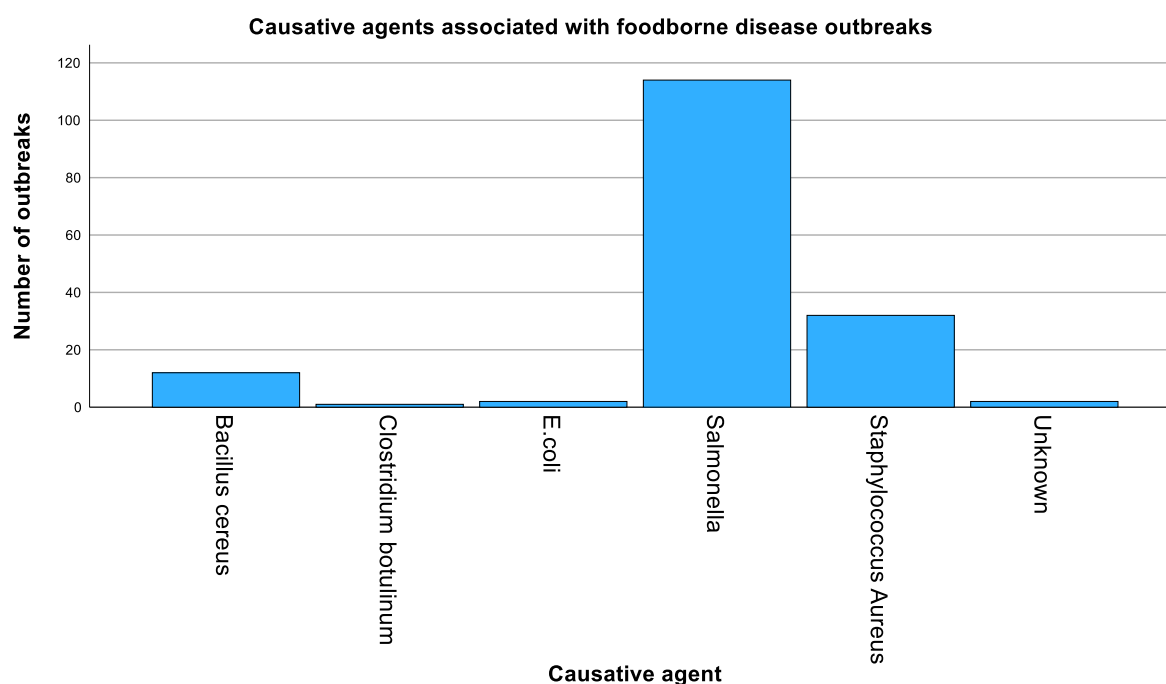


Figure 6 Causative agents associated with foodborne disease outbreaks in Al-Ahsa, 2020–2025.

Most outbreaks involved few cases. The median number of cases per outbreak was 2.0 (IQR = 1.0), and the mean was 3.06 (SD = 1.92). Outbreak size ranged from 1 to 16 cases.

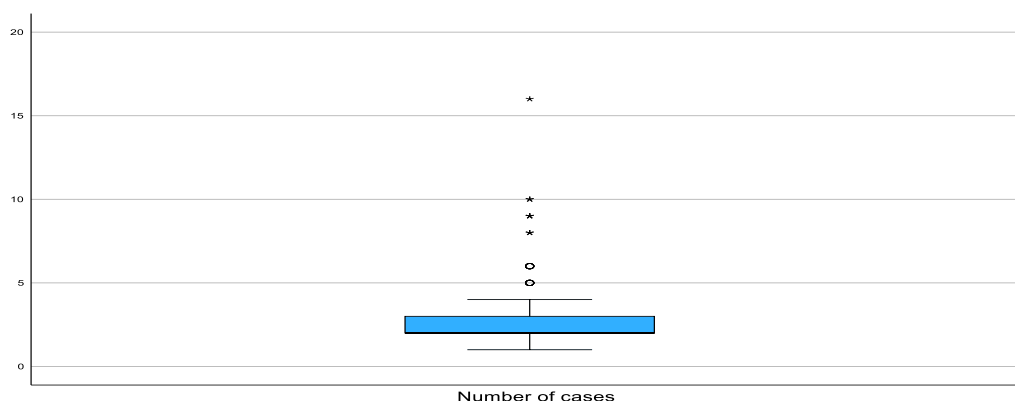


Figure 7 Boxplot of the number of cases per foodborne disease outbreak in Al-Ahsa, 2020–2025.

Severe outcomes were generally uncommon across outbreaks. The median number of admission cases per outbreak was 0.0 (IQR = 0.0), while the mean was 0.45 (SD = 1.50), with a range of 0 to 13 cases per outbreak. Deaths were rare, with a median of 0.0 (IQR = 0.0), a mean of 0.01 (SD = 0.16), and a maximum of 2 deaths in a single outbreak. Treated cases were more frequently recorded, with a median of 2.0 (IQR = 1.0), a mean of 2.59 (SD = 1.45), and a range of 0 to 10 cases per outbreak.

Table 1 Descriptive statistics for treated, admission, and death cases per foodborne disease outbreak in Al-Ahsa, 2020–2025

Variable	Mean	SD	Median	IQR	Minimum	Maximum
Treated cases	2.59	1.45	2.00	1.00	0	10
Admission cases	0.45	1.50	0.00	0.00	0	13
Death cases	0.01	0.16	0.00	0.00	0	2

Incubation periods were positively skewed. The median was 7.0 hours (IQR = 11.0), and the mean was 10.23 hours (SD = 11.69), with a range of 0 to 99 hours.

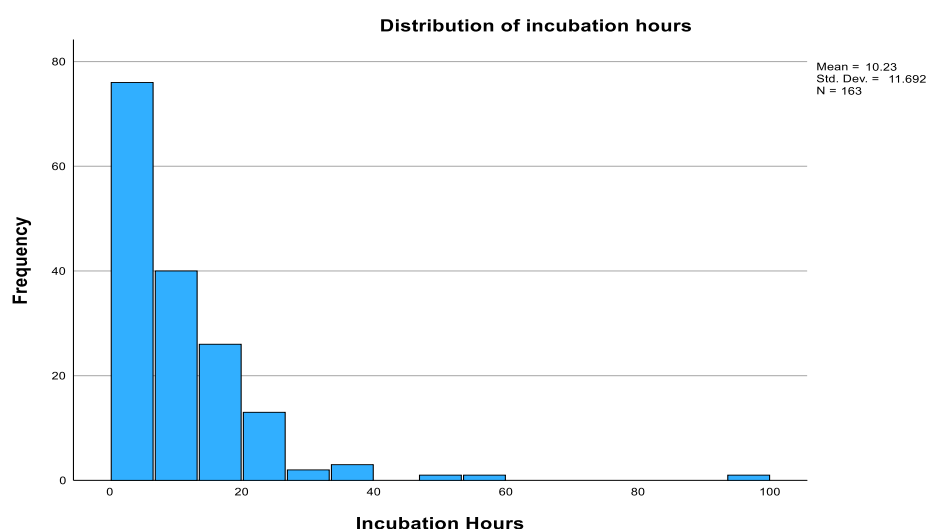


Figure 8 Distribution of incubation hours per foodborne disease outbreak in Al-Ahsa, 2020–2025.

Vomiting was the most frequently recorded symptom (380 cases), followed by diarrhea (366 cases) and abdominal pain (363 cases). Nausea was reported in 278 cases, fever in 129, and other symptoms in 48. Bloody stool was the least frequent symptom, with 7 cases.

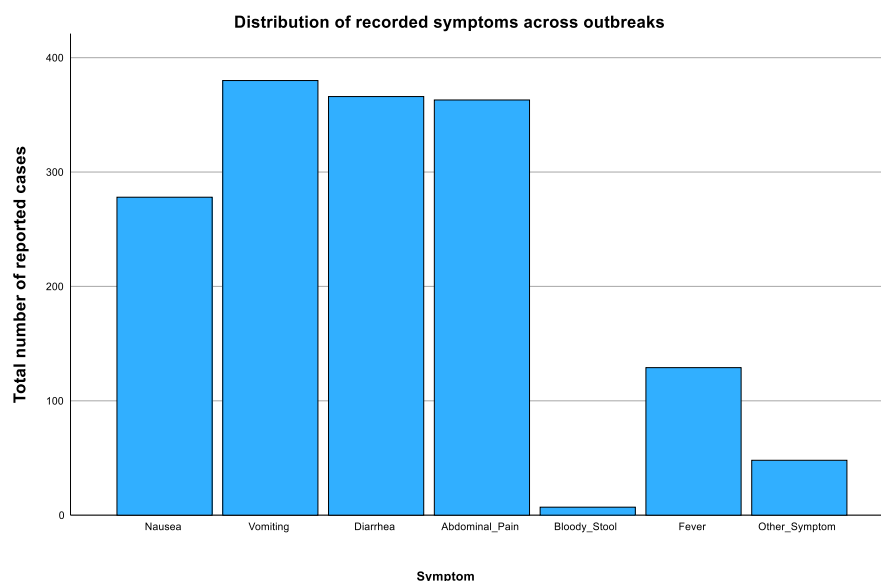


Figure 9 Distribution of recorded symptoms across foodborne disease outbreaks in Al-Ahsa, 2020–2025.

Univariable analyses examined associations between the number of cases per outbreak and selected outbreak characteristics. No statistically significant associations were found for food item group (Kruskal–Wallis, $p = 0.578$), setting of food preparation (Kruskal–Wallis, $p = 0.068$), month of food consumption (Kruskal–Wallis, $p = 0.588$), season of food consumption (Kruskal–Wallis, $p = 0.642$), causative agent (Kruskal–Wallis, $p = 0.093$), or incubation hours (Spearman’s $\rho = -0.009$, $p = 0.906$). Food-consumption setting showed a statistically significant association with the number of cases per outbreak (Kruskal–Wallis test, $p = 0.042$).

A post hoc comparison examined differences between food-consumption settings. The Mann–Whitney U test showed a statistically significant difference between outbreaks linked to food consumed at home and those linked to food consumed in restaurants ($U = 2096.500$, $Z = -2.095$, $p = 0.036$). Outbreaks linked to food consumed at home had a higher mean rank (84.45) than those linked to food consumed in restaurants (69.08). Outbreaks involving food consumed at home tended to include more cases.

Table 2 Univariable analysis of factors associated with the number of cases per foodborne disease outbreak in Al-Ahsa, 2020–2025

Variable	Statistical test	Test statistic	p-value	Result
Food item group	Kruskal–Wallis	$H = 7.572$	0.578	Not significant
Setting of food preparation	Kruskal–Wallis	$H = 7.142$	0.068	Not significant
Setting of food consumption	Kruskal–Wallis	$H = 8.186$	0.042	Significant
Month of food eating	Kruskal–Wallis	$H = 9.364$	0.588	Not significant
Season of food eating	Kruskal–Wallis	$H = 1.678$	0.642	Not significant
Causative agent	Kruskal–Wallis	$H = 9.432$	0.093	Not significant
Incubation hours	Spearman’s ρ	$\rho = -0.009$	0.906	Not significant

Table 3 Post hoc pairwise comparison for the setting of food consumption and the number of cases per outbreak

Comparison	Statistical test	Test statistic	p-value	Interpretation
Home vs Restaurant	Mann–Whitney U	U = 2096.500, Z = -2.095	0.036	Significant difference; outbreaks linked to food consumed at home had a higher mean rank than those linked to food consumed in restaurants

Poisson regression examined the association of food consumption and preparation settings with the number of cases per outbreak. The model fit was significantly better than the intercept-only model (Likelihood Ratio Chi-square = 6.511, df = 2, $p = 0.039$).

After adjustment, the setting of food consumption remained significantly associated with the number of cases per outbreak (Wald Chi-square = 4.185, $p = 0.041$). Compared with outbreaks linked to food consumed in restaurants, outbreaks linked to food consumed at home were associated with a higher number of cases ($B = 0.228$, 95% CI for B: 0.010 to 0.446). In contrast, the setting of food preparation was not significantly associated with the number of cases per outbreak after adjustment (Wald Chi-square = 0.757, $p = 0.384$).

Table 4 Poisson regression model for factors associated with the number of cases per foodborne disease outbreak in Al-Ahsa, 2020–2025

Predictor	B1	Standard Error1	Wald square1	Chi-square1	p-value1	95% CI for B
Setting of food consumption (Home vs Restaurant)	0.228	0.111	4.185		0.041	0.010 to 0.446
Setting of food preparation (Home vs Restaurant)	0.109	0.125	0.757		0.384	-0.136 to 0.354

DISCUSSION

Reported foodborne disease outbreaks in Al-Ahsa increased over the study period, with the highest count in 2025. Outbreaks were more frequent in spring and summer, especially from April to June. Restaurants were the main food-preparation setting, while homes were the most common consumption setting. Poultry was the most frequently reported food category, and Salmonella was the most common causative agent. Food-consumption setting was associated with outbreak size: outbreaks involving food consumed at home had more cases than those involving food consumed in restaurants.

The increase in reported outbreaks from 2020 to 2025 broadly follows the national pattern. Saudi data show a decline in outbreaks and cases before 2020, followed by an increase in later years (Alzahrani, 2025). The increase in Al-Ahsa may reflect changes in outbreak occurrence, reporting practices, healthcare-seeking behavior, or surveillance following the COVID-19 pandemic. The available data cannot distinguish these explanations. Higher reported counts therefore do not necessarily indicate an increase in the underlying incidence of foodborne disease (Alfaleh et al., 2025; White et al., 2022).

Outbreaks were most frequent during the warmer months, particularly April–June. A study in Riyadh also reported the highest number of food poisoning cases in June, followed by April and August (Alajlan et al., 2025). A national study reported peaks in summer and autumn and an association between warm weather and some foodborne diseases, including salmonellosis and amoebic dysentery (Alamri et al., 2026). The Al-Ahsa peak occurred earlier than the national peak, although both studies reported more outbreaks in warmer seasons. Food-handling risks related to temperature may contribute to this pattern.

Restaurants were the most common food-preparation setting in the Al-Ahsa records. National Saudi studies also reported more outbreaks and cases linked to public sources than to home sources (Alamri et al., 2026; Alfaleh et al., 2025; Alzahrani, 2025). The national category of “public sources” includes settings beyond restaurants, but the findings support continued attention to

commercial food preparation. Restaurants serve multiple people and involve several stages of handling, preparation, storage, and service, each of which needs appropriate food-safety controls.

Homes were the most common setting of food consumption, which does not mean that the food was prepared there. Saudi outbreak reports record preparation and consumption sites separately (Alfaleh et al., 2025). Food prepared in restaurants may be eaten at home as takeaway or delivery meals, including during family gatherings. These are possible explanations for the pattern observed in Al-Ahsa. Poultry and fast food were the most common food categories, suggesting that prevention efforts should address both commercial preparation and household handling after purchase.

Salmonella was the most frequently recorded causative agent, followed by Staphylococcus aureus. National Saudi data also identify Salmonella as a common cause of foodborne infection (Alfaleh et al., 2025). Another national study found that salmonellosis cases increased significantly from 2015 to 2023 (Alamri et al., 2026). Poultry was the most common food category in Al-Ahsa, supporting attention to safe handling and thorough cooking of animal foods. A Riyadh study similarly identified chicken as the most frequently reported food vehicle and commonly found Salmonella contamination in meat and poultry samples (Alajlan et al., 2025). Vomiting, diarrhea, and abdominal pain were the most common symptoms in the present study. National Saudi reports also describe gastrointestinal symptoms, including nausea, vomiting, and diarrhea (Alfaleh et al., 2025).

Food-consumption setting remained associated with outbreak size after adjustment for food-preparation setting. Outbreaks involving food consumed at home had a higher expected case count than those involving food consumed in restaurants. Shared household meals, family gatherings, or meals prepared elsewhere and eaten at home may help explain this association. These factors were not measured and remain hypotheses for future research. The finding also supports recording preparation and consumption settings separately, as recorded in Saudi outbreak investigations (Alfaleh et al., 2025).

Local surveillance can help identify changes in outbreak timing and settings and guide prevention during higher-risk periods (Alamri et al., 2026; Alzahrani, 2025). Food-service inspection and food-handler training should address cooking, storage, reheating, and prevention of cross-contamination (Alzhrani & Shatwan, 2024; Badri & Khan, 2025; Javed & AL-Mohaithef, 2024). Community education should also cover safe food handling and reheating (Alhashim et al., 2022; Ayaz et al., 2018). The seasonal findings support increased attention to food safety during April–June (Alamri et al., 2026). Reporting forms should be completed as fully as possible, particularly for preparation and consumption settings, implicated foods, causative agents, laboratory results, and outcomes. Standardized categories would improve consistency across reports. Coordination among health authorities, the food industry, and policymakers can help translate surveillance findings into preventive measures (Alzahrani, 2025).

These local findings support the national food-safety priorities described by Alsubaie and Berekaa (2020). Prevention should connect controls in food-service settings with household education. Seasonal surveillance can guide inspection, food-handler training, and public advice on safe transport, storage, and reheating of prepared foods.

This study used retrospective data from archived outbreak reports. Incomplete or inconsistent records may have introduced misclassification. Only reported outbreaks were included, so mild or unreported events may have been missed, potentially underestimating the local burden. The observed associations cannot establish causality because the study was observational and used outbreak-level data.

CONCLUSION

Reported foodborne disease outbreaks in Al-Ahsa increased over the study period and were most frequently reported from April to June. Restaurants were the main food-preparation setting, while homes were the main setting of food consumption; poultry and Salmonella were also common features of recorded outbreaks. Local prevention should combine seasonal food-service inspection and food-handler training with consumer guidance on the safe transport, storage, and reheating of prepared foods. Strengthening laboratory confirmation and the completeness of outbreak reporting will improve the identification of high-risk settings and support evaluation of prevention measures.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Mr. Aljassem and Dr. Alsubaie conceptualized and designed the study. Aljassem conducted the statistical analysis. Both authors wrote and critically revised the manuscript, interpreted the findings, approved the final version, and accept responsibility for the accuracy and integrity of the work.

DECLARATION OF AI

ChatGPT (OpenAI) was used to improve language and readability and reduce repetition in the manuscript. The authors reviewed and approved all edits and take full responsibility for the accuracy and integrity of the final manuscript.

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