Foodborne Illness and Seasonality Related to Mobile Food Sources at Festivals and Group Gatherings in the State of Georgia

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Abstract **Little is known about the relationship of location and season to the pathogen and impact of foodborne illness. A sample of 244 foodborne illness outbreaks from the Foodborne Outbreak Online Database System stemming from festivals (mobile food sources) and group gatherings in Georgia between 1998 and 2010 was examined to determine if season and location were related to pathogen and the number of ill or hospitalized individuals. Results of Chi-square tests of independence, one-way analysis of variance, and the Kruskal-Wallis test showed that norovirus and *Salmonella* were more strongly associated with group gatherings; *Staphylococcus* outbreaks were more associated with festivals; norovirus was more frequent during winter; and *Salmonella* was more associated with summer and autumn events. Location and impact were significant for outbreaks associated with group gatherings, resulting in more hospitalizations than outbreaks associated with festivals. No statistically significant difference occurred between the numbers of reported illnesses stemming from festivals versus group gatherings nor did a seasonal difference occur in the total number of individuals who fell ill or were hospitalized.**

Introduction

In 2011, approximately 9.4 million foodborne illnesses caused by 31 known pathogens occurred in the U.S. leading to nearly 56,000 hospitalizations and approximately 1,300 deaths (Centers for Disease Control and Prevention [CDC], 2011). Relatively little previous research has been conducted on foodborne illness in the state of Georgia, and little is known about the influence of factors such as location and season on the pathogen and impact of foodborne illness. The current study contributes to the knowledge base by examining the role of location and season on foodborne illness stemming from mobile food sources at festivals and group gatherings in the state of Georgia in 1998–2010.

I examined the following research questions and hypotheses. First research question: does location (defined as festivals or group gatherings) or season of the outbreak (defined as winter, spring, summer, or autumn) correlate with the etiology (defined as the type of pathogen)? First hypothesis: location correlates with the type of pathogen that causes foodborne illnesses in Georgia. Second hypothesis: the season of the outbreak correlates with the type of pathogen that causes foodborne illnesses in Georgia. Second research question: does the location or the season of the outbreak correlate with the impact (number ill and number hospitalized)? Third hypothesis: a significant difference exists between the festivals and group gatherings for the reported number of illnesses or number hospitalized. Fourth hypothesis: seasonality is associated with the number of reported illnesses or number hospitalized.

Methods

Georgia is a state on the southeastern coast of the U.S. It has a population of nearly 10 million and an area of 59,441 square miles (153,951 km^2), with a humid subtropical climate. Archival data on foodborne illness in Georgia between 1998 and 2010 from the Centers for Disease Control and Prevention's (CDC's) Foodborne Outbreak Online Database were examined. Data included (a) month and year, (b) pathogen, (c) location, (d) total ill, (e) total hospitalizations, (f) total deaths, and (g) vehicle (i.e., food source). I used a retrospective correlational methodology to examine possible relationships between the independent variables of location (limited to mobile food trucks and group gatherings) and season (defined as winter: December–February, spring: March–May, summer: June–August, and autumn: September–November), and the dependent variables of pathogen and impact (number of ill and the number of hospitalized individuals). Festivals included events such as mobile food sources at fairs, carnivals, and rodeos. Group gatherings included picnics, private homes, or wedding receptions.

TABLE 1

Descriptive Statistics for Categorical Study Variables (*N* = 244)

Variable	#	%
Location		
Festivals	6	2.5
Group gatherings	56	23.0
Other		
Restaurants	71	29.1
Miscellaneous[a]	67	27.5
Unknown, unreported	44	18.0
Season		
Winter	59	24.2
Spring	65	26.6
Summer	69	28.3
Autumn	51	20.9
Pathogen		
Norovirus	94	38.5
Salmonella	73	29.9
Staphylococcus	27	11.1
Clostridium	17	7.0
E. coli	12	4.9
Other	21	8.6

[a]Banquet halls, schools, workplaces, churches/temples, nursing homes, hospitals, prisons/jails, camps, and daycare centers.

TABLE 2

Cross Tabulation of Location and Pathogen (*N* = 244)

Pathogen	Location			Total
	Festivals	Group Gatherings	Other	
Norovirus	0 (0.0%)	15 (26.8%)	79 (43.4%)	94 (38.5%)
Salmonella	3 (50.0%)	26 (46.4%)	44 (24.2%)	73 (29.9%)
Staphylococcus	3 (50.0%)	2 (3.6%)	22 (12.1%)	27 (11.1%)
Clostridium	0 (0.0%)	1 (1.8%)	16 (8.8%)	17 (7.0%)
E. coli	0 (0.0%)	6 (10.7%)	6 (3.3%)	12 (4.9%)
Other	0 (0.0%)	6 (10.7%)	15 (8.2%)	21 (8.6%)
Total	6 (100.0%)	56 (100.0%)	182 (100.0%)	244 (100.0%)

Note. $\chi^2(10, N = 244) = 33.96, p < .001$.

An *a priori* power analysis was conducted by means of G*Power 3.10 (Faull, Erdfelder, Lang, & Buchner, 2007) on the most conservative statistical approach to be used, which suggested a minimum sample size of 210 cases. The final sample consisted of 244 cases.

Results

Table 1 shows descriptive statistics for the variables of location, season, and pathogen. The most common pathogen was norovirus, followed by *Salmonella*, *Staphylococcus*, *Clostridium*, and *E. coli*. Twenty-one cases (8.6%) had relatively rare pathogens, with no more than three cases with the same pathogen in this sample. For seasonality, number of cases varied from 51 in autumn to 69 (28.3%) in summer. Group gatherings were the most common location at 56 (23.0%) with an additional six cases (2.5%) occurring at festivals. One hundred eighty-two cases occurred in other locations.

Restaurants were the most common source of illness, followed by group gatherings. Six cases (2.5%) were attributable to festivals. The remaining cases with identified locations (27.5%) occurred across banquet halls, schools, workplaces, churches/temples, nursing homes, hospitals, prisons/jails, camps, and daycare centers.

The first hypothesis was tested using a Chi-square test of independence, with location (festival, group gathering, or other) as the independent variable and pathogen as the dependent variable. Results were statistically significant, $\chi^2(10, N = 244) = 33.96$, $p < .001$ (Table 2). At group gatherings, 46.4% of the cases were the result of *Salmonella*, and an additional 26.8% were the result of norovirus. For festivals, 50.0% of the cases resulted from *Salmonella*, and the other 50.0% from *Staphylococcus*. At the other events, the most common pathogens were norovirus (43.4%), *Salmonella* (24.2%), and *Staphylococcus* (12.1%).

The second hypothesis was tested using a Chi-square test of independence, with season as the independent variable and type of pathogen as the dependent variable. Results were statistically significant, $\chi^2(15, N = 244) = 26.63$, $p = .032$, indicating that season and pathogen were related (Table 3). In winter, 55.9% of cases were caused by norovirus, compared to 43.1% in spring, 29.0% in summer, and 25.5% in autumn. *Salmonella* accounted for a higher percentage of summer and autumn cases than winter or spring cases.

Before conducting statistical tests of the third and fourth hypotheses, I examined the distribution of scores of the dependent variables, the number of illnesses, and the number of hospitalized individuals for normality. Scores were standardized (to have a mean of 0 and standard deviation of 1) for the examination of normality; both distributions were positively skewed, with a few outbreaks having very large standard scores in excess of the absolute value of 3 typically used to define outliers. Four such outbreaks existed for each variable (total of ill and total of hospitalized individuals). I removed these outliers from the analyses in the second research question, resulting in 240 cases instead of the 244 cases included in the analyses of the first research question. Levene's test assessed the homogeneity of variances assumption (Howell, 2010). For the analysis of total ill as a function of case location, Levene's test was not statistically significant, $F(2, 237) = 0.81$, $p = .444$. For the analysis of total ill as a function of season, Levene's test was not statistically significant, $F(3, 236) = 0.16$, $p = .924$. For the analysis of total hospitalized individuals as a function of season, Levene's test was not statistically significant, $F(3, 189) = 1.84$, $p = .141$ (the assumption of the homogeneity of variances was met in these three instances). For the analysis of total hospitalized as a function of case location, however, Levene's test was statistically significant, $F(2, 190) = 11.42$, $p < .001$ (the assumption of homogeneity of variances was violated). Therefore, for the analyses of total ill individuals as a function of location, total ill individuals as a function of season, and total hospitalized individuals as a function of season, the planned one-way analyses of variance (ANOVAs) were performed. For the analysis of total hospitalized individuals as a function of location, I performed a Kruskal-Wallis test in place of the planned one-way ANOVAs because the assumption of the equality of variances is not required for the Kruskal-Wallis test (Howell, 2010). In the analysis of hypothesis 3 (Table 4), total ill individuals by location, the ANOVA was not statistically significant, $F(2, 237) = 0.55$, $p = .579$. In the analysis of total hospitalized individuals as a function of location, the Kruskal-Wallis test was statistically significant, $\chi^2(2, N = 197) = 18.42$, $p < .001$. The number of individuals hospitalized was higher for group gatherings ($M = 6.50$, $SD = 9.71$) than for festivals ($M = 2.00$, $SD = 2.45$) or other types of events ($M = 2.14$, $SD = 6.02$).

In the analysis of hypothesis 4, total ill individuals as a function of season, the ANOVA was not statistically significant, $F(3, 236) = 0.19$, $p = .902$, as was the case for total hospitalized individuals as a function of season, $F(3, 189) = 0.52$, $p = .671$. Thus, no significant difference occurred in the number of reported illnesses or number hospitalized during winter, spring, summer, or autumn.

TABLE **3**

Cross Tabulation of Season and Pathogen (*N* = 244)

Pathogen	Season				Total
	Winter	Spring	Summer	Autumn	
Norovirus	33 (55.9%)	28 (43.1%)	20 (29.0%)	13 (25.5%)	94 (38.5%)
Salmonella	14 (23.7%)	13 (20.0%)	28 (40.6%)	18 (35.3%)	73 (29.9%)
Staphylococcus	7 (11.9%)	7 (10.8%)	6 (8.7%)	7 (13.7%)	27 (11.1%)
Clostridium	3 (5.1%)	7 (10.8%)	3 (4.3%)	4 (7.8%)	17 (7.0%)
E. coli	0 (0.0%)	4 (6.2%)	6 (8.7%)	2 (3.9%)	12 (4.9%)
Other	2 (3.4%)	6 (9.2%)	6 (8.7%)	7 (13.7%)	21 (8.6%)
Total	59 (100.0%)	65 (100.0%)	69 (100.0%)	51 (100.0%)	244 (100.0%)

Note. $\chi^2(15, N = 244) = 26.63$, $p = .032$.

TABLE **4**

Mean Scores for Total Ill and Total Hospitalized Individuals as a Function of Location (*N* = 240)

Variable	Location			Total
	Festivals	Group Gatherings	Other	
Total ill individuals ($N = 240$)	38.33 ($SD = 48.64$)	44.4 ($SD = 63.88$)	35.88 ($SD = 49.08$)	37.90 ($SD = 52.71$)
Total hospitalized individuals ($n = 193$)	2.00 ($SD = 2.45$)	6.50 ($SD = 9.71$)	2.14 ($SD = 6.02$)	3.18 ($SD = 7.24$)

Note. For total ill individuals as a function of location, the analysis of variance was not statistically significant, $F(2, 237) = 0.55$, $p = .579$. For total hospitalized individuals as a function of location, the Kruskal-Wallis test was statistically significant, $\chi^2(2, N = 197) = 18.42$, $p < .001$.

Discussion

In the existing literature, very little research has addressed the topic of the current study, which focused on exploring differences in etiologies of foodborne illness outbreaks as a function of location and season. In terms of seasonality, two studies have demonstrated that outbreaks are more common in the warmer summer months (Ackerman, 2011; U.S. Department of Agriculture [USDA], 2011). A possible reason for this is that outdoor temperatures in the summer are closer to the temperatures at which the bacteria that most likely cause illness thrive (e.g., 90°F–110°F, or 32°C–43°C). Additionally, people spend more time outside or in large groups during the summer months, and more people cook outside during the summer months (USDA, 2011).

Despite these past studies showing that foodborne illness outbreaks are more common during the summer months, studies on the differences between the types of outbreaks that occur at various times of year were sparse.

In the current study, norovirus was found to be more of a problem in Georgia in winter, while *Salmonella* was found to be more of a problem in summer and autumn than in winter or spring. This finding extends the results of past studies by providing more detailed information on seasonality, suggesting that all types of foodborne illness outbreaks may not be equally common in the summer months. Current results indicate that in Georgia, norovirus is an apparent exception to research indicating outbreaks were more common during the summer months. Different types of outbreaks will have unique origins, prevention measures, and prognoses.

Measures to prevent cross contamination of foods being consumed in mobile food areas or outside the home include cleaning and sanitizing of food contact surfaces, effective hand washing, and the separation of raw animal foods from ready-to-eat foods. Further research is needed to explore different organisms and the association with seasonality in order to provide the most beneficial recommendations for prevention and control.

The results from this study showed that in Georgia, norovirus and *Salmonella* outbreaks were more commonly associated with group gatherings and less commonly at festivals or other venues, while *Staphylococcus* outbreaks were more commonly associated with festivals than group gatherings or other venues. Prevention strategies specific to these pathogens should be targeted at the venues most likely to see outbreaks. Current results suggest that in Georgia, a focus on norovirus and *Salmonella* prevention at group gatherings and on *Staphylococcus* prevention at festivals could reduce the number of outbreaks and reported illnesses. Similarly, the finding that norovirus is more of a problem in winter while *Salmonella* is more of a problem in summer and autumn suggests that prevention efforts and education in Georgia should be increased and aimed appropriately at the pathogens more commonly causing illness during these times of year.

Several limitations were present in this study, the first being its reliance on archival data. Only the variables collected and provided by CDC were used in the analysis. Since the dataset did not contain information on how commonly people eat at these locations, I was not able to analyze the total exposed, which would have given me a stronger epidemiological measure.

The data were limited to 1998–2010. Using data up to 14 years old may have affected the results by presenting a view of foodborne illness outbreaks based on outdated information. The nature of foodborne illnesses in Georgia has possibly changed in the past decade, making the older data in this study misleading or making the lack of data from the most recent several years misleading. The extent to which this is true may present an inaccurate reflection of the current dangers posed by foodborne illnesses.

This analysis focused on foodborne illness outbreaks occurring from mobile food sources at festivals as well as group gatherings. Therefore, the extent to which the results from this study would apply to all foodborne illness outbreaks in Georgia is unknown.

This study was significant because of the frequency and impact of foodborne diseases. CDC (2011) estimated that foodborne outbreaks cause 76 million illnesses, 325,000 hospitalizations, and 5,200 deaths each year in the U.S. According to CDC, foodborne illnesses result from a lack of understanding of the hazards by food handlers and failure to use adequate controls. The results from this study can be used to reduce the number of incidents stemming from festivals and group gatherings.

I analyzed data from Georgia only. Whether the results of this study apply to foodborne illness outbreaks in other states is unknown. Given the availability of data from other states through the CDC Web site, updates and replication of this study using national data or data from other states could be accomplished relatively easily, as updates are posted to the CDC Web site each year. Research on the generalizability of the findings to other states and expansion of the scope of the study to a national scale to include foodborne illness outbreaks that occurred in a wider variety of locations are recommended. I also recommend analyzing total exposed, as it would be helpful to know actual incidence and prevalence rates in future studies.

Conclusion

This study has several strengths. Few prior researchers have discussed seasonality or location as predictors of pathogen for foodborne illness outbreaks. The results from this study have extended this past research. Findings from the current study that norovirus is more strongly associated with outbreaks in winter contradict other findings that foodborne illness outbreaks are more common in the summer months (Ackerman, 2011; USDA, 2011). The reason for this contradiction may lie in the specificity of these findings for norovirus and locations in particular. Further research into the role of these factors is required.

Most foodborne outbreaks go largely undiagnosed because of incomplete or lack of prompt and accurate reporting by individual states (CDC, 2011). Many states lack the technology or expertise to identify foodborne outbreaks and pathogens involved so that proper treatment can be provided. The results of this study identified the degree to which factors of setting and season were important in the transmission of foodborne illness in Georgia, revealing directions for future research and improving the ability of both state health departments and the federal government to prevent outbreaks. The results from this study underscore the importance of a deeper analysis of foodborne illness outbreaks in terms of season and location.

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References

Ackerman, J. (2011). Food—how safe? *National Geographic Magazine*. Retrieved from http://science.nationalgeographic.com/science/health-and-human-body/human-body/food-safety/#page=4

Centers for Disease Control and Prevention. (2011). *CDC estimates of foodborne illness in the United States*. Retrieved from http://www.cdc.gov/foodborneburden/index.html

Faul, F., Erdfelder, E., Lang, A., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191.

Howell, D. (2010). *Fundamental statistics for the behavioral sciences* (7th ed.). Belmont, CA: Wadsworth.

U.S. Department of Agriculture. (2011). *Foodborne illness peaks in summer—why?* Retrieved from http://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/foodborne-illness-and-disease/foodborne-illness-peaks-in-summer/