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The Effects of Foodborne Bacteria on Outbreaks, Illnesses, and Hospitalizations in the U.S.

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☒ By checking this box, I indicate that my mentor has read and reviewed my draft proposal prior to submission

Abstract

Objective: To investigate the effects of foodborne bacteria on outbreaks, and outbreak-associated illnesses and hospitalizations in the United States (U.S.).

Methods: Aggregate data was obtained from the CDC WONDER (Wide-ranging Online Data for Epidemiologic Research) database showing the number of foodborne outbreaks (1993-2017), and outbreak-associated illnesses (1993-2017) and hospitalizations (1998-2017) caused by foodborne bacteria. Species of bacteria were grouped into 13 genera and 1 other. An Analysis of variance (ANOVA) test was used to compare the mean outbreaks, and outbreak-associated illnesses and hospitalizations for each of the years using the data by species for each year.

Results: There was no statistically significant difference in the mean outbreaks (p = 0.544), outbreak-associated illnesses (p = 0.462) and hospitalizations (p = 0.949) caused by foodborne bacteria.

Conclusion: Foodborne infections are generally self-limiting and may explain the lack of significant change in the mean bacterial foodborne outbreaks, illnesses, and hospitalizations in the U.S.

Key Words: foodborne, bacteria, outbreaks, illness, hospitalization.

Introduction

Foodborne pathogens are a threat to food security because they cause foodborne diseases and food poisoning.[1] Scallan *et al.* (2011) identified 31 major pathogens (bacteria, viruses, and parasites) that cause foodborne illnesses in the Unites States (U.S.), and these include the *Norovirus, Salmonella* spp.*, Escherichia coli, Listeria monocytogenes, Staphylococcus aureus,* and *Clostridium perfringes*.[2] Antibiotic-resistant bacteria are also found in the food chain and they cause foodborne infections every year.[3,4] For example, *Salmonella* spp. and *Campylobacter* spp. are two important food pathogens that cause about 660,900 antibiotic-resistant infections in the U.S. annually. [4,5]

The Centers for Disease Control and Prevention (CDC) estimates that each year, foodborne pathogens cause illnesses in about 48 million people, 128,000 hospitalizations, and 3000 deaths.[6] Despite the burden of foodborne outbreaks and the growing concern about antibiotic-resistant bacteria in food supply, there is limited literature discussing the statistical significance of outbreaks, illnesses, hospitalizations, and death caused by foodborne bacteria in the U.S.[6,7] Omer *et al.* (2018) conducted a global systematic review of bacterial foodborne outbreaks from 1980-2015; however, these researchers limited outbreak associations to the consumption of red meat and meat products.[8] Their report did not also discuss the statistical significance of their findings.

Our research study will investigate the effects of foodborne bacteria on outbreaks, and outbreak-associated illnesses and hospitalizations in the U.S. without an emphasis on food category.

Research Questions

Our goal is to answer three main research questions;

RQ1. Is there a significant difference in the annual outbreaks caused by foodborne bacteria?

RQ2. Is there a significant difference in the annual outbreak-associated illnesses caused by foodborne bacteria?

RQ3. Is there a significant difference in the annual outbreak-associated hospitalizations caused by foodborne bacteria?

Methods

Context/Protocol

The CDC gathers data from state, local, and territorial health departments, and publishes annual reports of domestic foodborne disease outbreaks.[9] These reports are available via the CDC WONDER (Wide-ranging Online Data for Epidemiologic Research) database, which is a publicly accessible database that houses the CDC's collection of public health information and resources.[10]

Data Collection

The CDC WONDER database was used to access the CDC's *Foodborne Outbreaks Annual Reports*. The number of reported foodborne disease outbreaks, outbreak-associated illnesses, and hospitalizations of bacterial etiology were included in our data, whereas those of chemical and toxin, parasitic, and viral were excluded. Bacterial species were grouped into 13 genera; *Bacillus*, *Brucella*, *Campylobacter, Clostridium, Escherichia coli, Enterococcus, Listeria, Salmonella, Shigella, Staphylococcus, Streptococcus, Vibrio, Yersinia*, and 1 Other. Species of foodborne bacteria of the same genera were grouped together; for instance, *Clostridium perfringes*, *Clostridium botulinum*, and other *Clostridium* were grouped under the genus *Clostridium.* Aggregate data from 1993 to 2017 was obtained for outbreaks and outbreak-associated illnesses, and from 1998-2017 for outbreak-associated hospitalizations. These numbers were exported into Microsoft Excel®.

Data Analysis

Our data was transferred from Microsoft Excel® to the Statistical Package Program for Social Sciences (SPSS) for analysis. Assuming normality, an Analysis of Variance (ANOVA) test was completed using SPSS to compare the number of outbreaks (RQ1) and outbreak-associated illnesses (RQ2) for each of the years 1993-2017 using the data by species for each year. A comparison between outbreak-associated hospitalizations (RQ3) during the years 1998-2008 and 2009-2017 were done using a paired *t*-test using the data by species for each year group. Results from all analyses were considered significant at the *P* value <.05.

Results

RQ1: A one-way ANOVA determined no statistically significant difference in the mean outbreaks caused by foodborne bacteria by year ($F_{2,56} = .615$, $p = 0.544$) (Table 1).

Table 1: Mean outbreaks caused by foodborne bacteria

Year	*n*	Mean (SD)
1993-1997	15	10.90 (22.55)
1998-2008	18	20.05 (34.94)
2009-2017	26	11.32 (26.18)

RQ2: An ANOVA did not also show a statistically significant difference in the mean outbreak-associated illnesses caused by bacteria by year ($F_{2, 56} = .784$, $p = 0.462$) (Table 2).

Table 1: Mean outbreak-associated illnesses caused by foodborne bacteria

Year	*n*	Mean (SD)
1993-1997	15	730.32 (2069.44)
1998-2008	18	511.55 (985.33)
2009-2017	26	234.97 (663.55)

RQ3: Lastly, there was no statistically significant difference in the mean outbreak-associated hospitalizations caused by these foodborne bacteria ($t_9 = 0.066$, $p = 0.949$) (Table 3).

Table 3: Mean outbreak-associated hospitalizations caused by foodborne bacteria

Years	*n*	Mean (SD)
1998-2008	18	35.78 (96.37)
2009-2017	26	25.82 (88.85)

Discussion

In our research study, we did not find a significant difference in the mean outbreaks and outbreak-associated illnesses caused by foodborne bacteria from 1993-2017 in the U.S. We also did not discover a statistical significance in the mean outbreak-associated hospitalizations from 1998-2017.

Most foodborne infections are mild, self-limiting, and do not require treatment.[11] This implies that people generally recover from most foodborne infections. As such, this may lead to an under or delayed reporting of cases to local health departments and the CDC, which may help explain our findings.

In addition, foodborne outbreaks have decreased over time, as concluded by Jones and Yackley (2018) in their historical overview of foodborne disease outbreaks in the U.S. from 1938-2015.[12] Therefore, foodborne bacteria may be playing less of a significant role in foodborne outbreaks each year in the U.S.

Limitations of our study include missing hospitalization data from 1993-1997. Consequently, the number of hospitalized individuals from serious foodborne illnesses may be underestimated in

our research study. Our study was also restricted to foodborne bacteria; therefore, a future direction would be to explore the effect of foodborne parasites and viruses on outbreaks, and outbreak-associated illnesses and hospitalizations in the U.S.

Conclusion

Foodborne pathogens such as bacteria, viruses, and parasites are a threat to our food security due to their ability to cause serious illnesses. Foodborne bacteria, including the ones that are also antibiotic-resistant, did not appear to have made a statistical impact in the outbreaks, and outbreak-associated illnesses and hospitalizations in the U.S. between 1993-2017. Factors such as underreporting of cases to local health departments and the CDC may have contributed to these findings. Despite this lack of statistical significance, the burden of foodborne outbreaks and antibiotic-resistant bacteria are valid concerns in the U.S. and preventative strategies to protect our food supply remain a priority.

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