3-14-2024

Environmental Health Assessments for Foodborne Illness Outbreaks in the United States from 2017- 2019

Alyssa Shontel Woods
Walden University

Walden University

College of Health Sciences and Public Policy

This is to certify that the doctoral study by

Alyssa Woods

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Tolulope Osoba, Committee Chairperson, Public Health Faculty
Dr. Daniel Okenu, Committee Member, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2024

Abstract

Environmental Health Assessments for Foodborne Illness Outbreaks in the United States from 2017- 2019

by

Alyssa Shontel Woods

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

Walden University

May 2024

Abstract

Individual cases of foodborne illness can lead to outbreaks that result in severe morbidity and fatality. As the United States' food scene continues to evolve and diversify, there is a need to consider cultural variations and how they may affect food safety practices. This quantitative study, based on the National Environmental Assessment Reporting System (NEARS) data, grounded in the socio-ecological model, examined the prevalence and factors associated with salmonella outbreaks in ethnic versus non-ethnic food service establishments (FSEs) in the U.S. from 2017 to 2019. The research questions involved understanding the relationship between the primary language spoken, food safety training, and implicated food type and FSE type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019. Over 800 reported foodborne illness outbreaks were analyzed, and ethnic FSEs slightly more often reported Salmonella outbreaks. Logistic regression analyses showed no statistically significant link between the primary language, implicated food, and FSE type, but there was a significant relationship between food safety training and FSE type. The implications for positive social change include enhancing food safety training, especially in culturally diverse FSEs, which can play a vital role in reducing foodborne illness outbreaks and thereby protecting public health and ensuring the safety of the diverse food landscape in the United States. Tailored interventions that consider cultural variations in food handling practices could lead to more effective prevention strategies, contributing to safer eating environments for all.

Environmental Health Assessments for Foodborne Illness Outbreaks in the United States from 2017- 2019

by

Alyssa Shontel Woods

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

Walden University

May 2024

Table of Contents

List of Tables

List of Figures

Section 1: Foundation of the Study and Literature Review

Introduction to the Study

This research examined possible links between environmental assessment findings in ethnic food service establishments (FSE) and Salmonella outbreaks reported to the Centers for Disease Control and Prevention's National Environmental Assessment Reporting System (NEARS) between 2017 and 2019. NEARS is a surveillance system that uses environmental assessment data from foodborne illness outbreak investigations to enhance food safety initiatives nationwide. Between 2017 and 2019, approximately 881 foodborne illness outbreaks were reported to NEARS, with roughly 44% (390) of those outbreaks occurring in ethnic FSEs, and Salmonella accounted for about 26% (103) of those NEARS-reported suspected/confirmed foodborne illness outbreaks, trailing only Norovirus with 261outbreaks. Additionally, approximately 52% of those Salmonella outbreaks occurred within ethnic FSEs. In response, this study will include an exploration of the effect of language, training practices, and implicated foods on Salmonella outbreaks in ethnic FSEs. Social implications of this study include exploring the impact of culture and how particular cultural practices may be considered risk factors for foodborne illness.

A foodborne disease outbreak is when two or more people experience a similar illness resulting from ingesting a common food (CDC, n.d.). Individual foodborne illnesses can contribute to outbreaks that cause significant morbidity and mortality. According to the Centers for Disease Control and Prevention (CDC), one in every six Americans will become ill as a result of consuming contaminated food or beverage, and

approximately 3,000 will perish each year (CDC, 2022). Environmental assessments can provide additional insight into the increased rates of foodborne diseases in such communities, allowing researchers to determine whether cultural factors influence poor food processing and sanitation practices. The objective of this research was to investigate the potential correlation between food safety training methods, implicated food, and language used in FSEs and the incidence of Salmonella outbreaks in ethnic FSEs.

Background

Understanding culture through food is an exploratory process because once a person, such as a health inspector, begins asking questions like how something is made or what ingredients are in it, the answers gained go beyond culinary learning (Sibal, 2020). According to Sibal (2020), food can and is frequently used to examine culture, habits, rituals, and traditions. As a result, environmental and public health experts must continue investigating the food safety and preparation practices of different cultures serving their communities in food service settings. This knowledge enables the environmental and public health fields to interact with these establishments more effectively and support their goal of safely sharing cultural dishes in their most authentic form. Panelists at the International Association for Food's 2021 Conference agreed that more science-based data is required to create food safety and cultural preservation rules. Thus, one goal of this research was to encourage environmental and public health researchers to investigate how culture may influence food safety and preparation laws in the United States. Though that work may be best accomplished qualitatively or through a combination of methods,

this study's quantitative findings provide insight into this environmental and public health focus.

Food preparation practices, behaviors, and environmental circumstances contribute to pathogens getting into or growing in food, causing outbreaks (CDC, 2023). Furthermore, according to the CDC, contributing variables are preventable sources of foodborne illness outbreaks (2023). The 30 contributing factors are divided into three categories: contamination (pathogens and other hazards get into food), proliferation (pathogens already in food expand), and survival (pathogens survive the process to kill or reduce them; (CDC, 2023). Salmonella outbreaks are most likely the result of contamination and survival. For example, improper preparation of raw and ready-to-eat foods (for example, preparing raw vegetables on the same cutting board as raw chicken) makes the food contaminated.

Furthermore, suppose Salmonella is present in raw chicken, which is not entirely cooked to 165 degrees Fahrenheit for at least 15 seconds. In that case, the pathogen will survive and potentially be eaten by the restaurant's patrons. Public health education is an efficient strategy for raising awareness of foodborne pathogens and reducing outbreaks of foodborne illness; a prevention method that aligns with the Food and Drug Administration (FDA) Food Safety Modernization Act (FSMA), which aims to shift focus from responding to foodborne illness outbreaks to preventing it (FSMA, 2022). This study can catalyze further research and policy changes in the food safety regulatory field by reaching a larger, more diverse population of owner-operators and, as a result,

creating more meaningful relationships cultivated through cultural awareness and collaboration.

United States cuisine continues to develop and diversify. Environmental health experts continue to investigate the public health consequences of popular cuisines in the United States, such as barbeque and soul food, but as people from other countries immigrate to the United States and open restaurants and other FSEs, environmental health professionals must continue to investigate the complex dishes, ingredients, cooking tools, and cooking/preparation styles brought over from other countries. For example, the preparation stages for sizzling rice soup in Chinese restaurants exemplify an understudied dish. Rice is a food that must be time-and-temperature controlled (TCS) for protection. Rice is thoroughly cooked after 15 seconds at 135 degrees Fahrenheit. When cooling hot foods, the cooling procedure must be followed. The cooling process takes 6 hours to finish. This procedure included cooling hot foods from 135 degrees Fahrenheit to 70 degrees Fahrenheit in 2 hours, and from 70 degrees Fahrenheit to 41 degrees Fahrenheit or lower in the remaining 4 hours using ice baths, blast chillers, or other approved means. This procedure is critical for slowing bacteria development when hot foods are in the danger zone. When making rice for sizzling soup, the rice does not go through the chilling process. It can dry at room temperature outside of cooling units until crispy, making the rice vulnerable to bacterial growth that can contribute to foodborne illness. These procedures necessitate further scientific research and evaluation to create effective public health measures while concurrently adhering to the authenticity of one's cultural practices.

Several studies have been conducted to identify and characterize epidemiological factors associated with Salmonella outbreaks. However, little research on Salmonella outbreaks has been done using an environmental assessment approach that can help identify foodborne illness-causing environmental antecedents in ethnic restaurants. Providing evidence on the determinants of foodborne illnesses in ethnic food service facilities will increase awareness of barriers and promote proper food handling practices in ethnic restaurants, thereby decreasing foodborne illness outbreaks from such establishments. Local environmental health professionals should receive extra training and tools regarding ethnic FSE inspections, including cultural nuances that may impact food safety practices. Furthermore, research indicates that current food safety training materials must be modified to meet the cultural and linguistic requirements of the ethnic food service community.

Research notes that linguistic relativity causes difficulties in the restaurant setting because language influences people's perceptions of direction, time, color, and blame (Sebastian, 2019). Communication issues arise between health inspectors and restaurant owners/operators during the inspection process, particularly those whose first language is not English. The FDA Food Code's comprehension and interpretation may differ based on one's ability to communicate in English. Other languages, such as Spanish and Mandarin, are also available for the Food Code. However, cultural interpretation differences must be recognized to properly implement the Food Code regulations. The FDA Food Code is revised every four years with the assistance of the Conference for Food Protection.

This study can facilitate future research on the cultural effect of food safety and how to safely integrate cooking styles and practices prevalent in other parts of the United States and beyond. The statistics on risk factors associated with cuisine type are limited, resulting in an information gap. Despite being outdated, some available data suggest the need for more current studies, tools, and resources on ethnic food service cuisine and establishment characteristics.

Problem Statement

Little or no research seeks to understand if the findings from environmental assessments conducted due to foodborne illness outbreaks are common occurrences within FSEs. As a result, cultural differences and practices that impact food safety must still be clarified. A general characterization of the outbreak and reaction, establishment characterizations, manager interviews, establishment observations, suspect/confirmed foods and ingredients, positive lab samples, and contributing factors are all included in the NEARS data. By identifying gaps in food safety policies and practices and the kinds of establishments susceptible to outbreaks, NEARS data can help prioritize training and interventions for state and local food safety programs and the retail food establishment industry (Lipcsei et al., 2019). This system can be critical in developing and sustaining culturally relevant food safety.

Findings can point to environmental factors contributing to foodborne illness outbreaks, a significant step toward finding lesser-known risk factors. Environmental assessments are essential to the work of food safety inspectors in this study. A national online poll of food safety professionals found that food safety professionals throughout

the United States encountered a variety of ethnic-food establishments and ethnic foods for which they lacked ethnic-food safety resources (Mauer, et al., 2006). As previously stated, we must examine outbreak data collected from previous environmental assessments for food safety professionals to understand the "why" behind Salmonella outbreaks and other foodborne illness outbreaks within ethnic FSEs, and to equip inspectors with innovative resources reflecting ethnic cuisine.

Purpose of Study

Contaminated equipment, food from unsanitary sources, improper holding times and temperatures, insufficient cooking, and poor personal hygiene are the five most common risk factors for foodborne disease. Environmental studies of FSEs are performed before and after foodborne illness outbreaks to find risk factors and to prevent or determine the cause of an outbreak. This quantitative study aims to identify correlations between environmental assessment findings and the occurrence of Salmonella outbreaks in ethnic FSEs. Independent variables for this research include restaurant environmental characteristics, such as implicated food, languages spoken in restaurants by employees, and training practices. Salmonella infections in Ethnic and American FSEs is the dependent variable.

Research Questions and Hypotheses

The research questions raised in this study include the following:

RQ1: Is there a statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Ho1: There is no statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA1: There is a statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

The data will be categorized by establishments where English is or is not the primary spoken language. A chi-square test will be conducted to determine the strength of the association between the language spoken and the occurrence of Salmonella outbreaks.

RQ2: Is there a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Ho2: There is no statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA2: There is a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

The data were ranked based on the strength of the relationship between food safety training practices and the occurrence of Salmonella outbreaks in ethnic vs. non-

ethnic FSEs. A Chi-square test was conducted to determine if there is a significant difference between the training practices in the two types of establishments.

RQ3: Is there a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Ho3: There is no statistically significant relationship between the implicated food (identified or suspected) and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA3: There is a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

The data were categorized and ranked based on the strength of the relationship between the implicated food and the type of FSE where the Salmonella outbreak occurred. A chi-square test was conducted to determine if there is a significant association between the implicated food and the type of establishment.

Theoretical Framework

The socio-ecological model, the epidemiological framework, and the cultural competence model are just a few of the theoretical frameworks to which this study can be linked. Another possible framework is the cultural competence model, which stresses the significance of knowing and respecting cultural differences in health behaviors and outcomes. In this framework, the primary language spoken in FSEs is a cultural factor affecting communication and understanding of food safety practices. This research can

help find strategies for enhancing cultural competence in FSEs and lowering the risk of outbreaks by examining the relationship between language and Salmonella outbreaks. Overall, the theoretical framework for this study emphasizes how crucial it is to comprehend the intricate interactions between social, cultural, and personal factors that affect food safety practices and Salmonella outbreaks.

In addition to the models above, the epidemiologic triangle is a model that scientists have developed for studying health problems, specifically to understand infectious diseases and how they spread (Devoe, 2017). Agent, patient, and surroundings comprise the epidemiological triangle's three elements. This study includes a theoretical framework traditionally used to analyze the social effects of foodborne disease outbreaks and determine how an illness spreads and how to treat it. When Salmonella (agent) outbreaks occur in ethnic FSEs, the epidemiological triangle can identify the establishment's environmental factors (environment), including the implicated food items, language, and training procedures that may be to blame (host).

The socio-ecological model is most applicable to this research. Psychologist Urie Bronfenbrenner, in the late 1970s, recognized that individuals affect and are affected by a complex range of social influences and nested environmental interactions (Benning, 2021). This model, which suggests that health behaviors are influenced by numerous factors, including individual, interpersonal, community, and societal factors, is one possible framework for this research. The model considers the complex interplay between individual, relationship, community, and societal factors (*The Social-Ecological Model: A Framework for Prevention*, 2022). The social-ecological model understands health to

be affected by the interaction between the individual, the group/community, and the physical, social, and political environments (Agency for Toxic Substances and Disease Registry, 2015).

Nature of the Study

A correlational research design was used to find possible relationships between particular environmental antecedents and Salmonella outbreaks within ethnic FSEs to answer the research questions in this quantitative study. Correlational research is ideal because it assesses the strength of relationships between variables. To enhance food safety initiatives, NEARS is a surveillance system that collects environmental assessment data from foodborne illness outbreak investigations. This initiative is entirely voluntary. Alaska, California, Connecticut, Delaware, Georgia, Indiana, Iowa, Kentucky, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New York, North Carolina, Oregon, Rhode Island, South Carolina, Tennessee, Utah, Virginia, Washington State, and Wisconsin are current NEARS members. All environmental assessment answers required to complete this research are included in the NEARS dataset, including Salmonella outbreaks in ethnic and non-ethnic FSEs, training practices, spoken languages, and implicated foods/ingredients for each establishment. This raw data were converted into numerical figures and carefully analyzed before being imported into the SPSS statistical program.

Literature Search Strategy

To perform the review, databases, search engines, and libraries such as the Walden Library, Google Scholar, Journal of Food Protection, Journal of Environmental

Health, Science Direct, The Centers for Disease Control and Prevention, and the Journal of Food Science were used. *Food safety, foodborne illness, food disease, food service inspections in Georgia, ethnic restaurants, critical food violations, Salmonella contributing factors,* and *Salmonella outbreaks* were among the keywords searched. The review's scope encompasses related literature published in the last five years. Some of the results in the literature date back more than five years. The content, however, is relevant to this research and other current food safety studies.

Theoretical Framework

This study's theoretical framework drew on ideas from various fields, including public health, epidemiology, and sociology. The study's emphasis on Salmonella outbreaks in FSEs emphasizes the significance of understanding the social and cultural factors that can contribute to the spread of foodborne illnesses. The social-ecological model, which suggests that health behaviors are influenced by numerous factors, including individual, interpersonal, community, and societal factors, was one possible framework for this research. Food service establishment type (ethnic vs. American or non-ethnic) and primary language spoken are community-level factors that can impact food safety practices and the risk of Salmonella outbreaks, according to this framework. Individual-level factors such as food safety training can influence food safety practices and lower the risk of outbreaks.

This study followed the socio-ecological framework as it best fit the purpose of this research. One example of a study that drew upon concepts from public health, epidemiology, and sociology is "Food safety knowledge, Attitudes and Practices among

Consumers in developing countries: An International Survey" (Odeyemi et al., 2019), along with an article titled "Listening to Food Workers: Factors that impact proper health and hygiene practice in Food Service" (Clayton, M. et al., 2015) used the socio-ecological model to discuss food safety practices and factors that impact implementation in the workplace by conducting interviews with food service workers in Baltimore, MD, USA. The social-ecological framework is widely employed in public health research and practice (Golden et al., 2015), including in studies of food safety practices. This model presupposes that people will change due to appropriate social environment changes and that population support is crucial for enacting environmental changes (McLeroy et al., 1988).

Literature Review Related to Key Variables and Concepts

Salmonella

Salmonella, a vegetative bacterium that produces diarrheal illness when consumed in food, was found to be the second most recognized agent by NEARS between 2017 and 2019. Salmonella, a bacterium that causes illness, was discovered in 1885 by an American scientist, Dr. Daniel E. Salmon (Belleza, 2021). Salmonella can be found in both human and livestock intestines. Most people who acquire Salmonella will have diarrhea, stomach pain, and a fever. Salmonella infection through feces, body tissue, or fluids requires a laboratory test. Antibiotics are rarely needed to treat Salmonella; however, high-risk individuals (the elderly, immunocompromised individuals, infants, and pregnant women) may require antibiotics to recuperate from the infection (CDC, 2019). The CDC states that Salmonella bacteria cause approximately 1.35 million

illnesses, 26,500 hospitalizations, and 420 deaths annually (CDC, 2019). Salmonella can be spread by food handlers who do not wash their hands or the surfaces and tools they use between food preparation stages, and when people consume raw or undercooked foods, according to the FDA (Salmonella (Salmonellosis), 2019). Salmonella is found in various foods, including poultry, beef, pork, eggs, fruits and vegetables, and processed foods (CDC, 2019). In 2022, a nationwide Salmonella outbreak was recently linked to tomatoes from an ethnic food chain eatery.

A Salmonella outbreak caused by implicated red, white, and yellow onions affected 650 people in 37 states in 2021 (Schuster-Bruce, 2021). According to additional research, such as that performed by Cartsens et al. (2019), the number of multistate Salmonella outbreaks linked to fresh produce has increased significantly. These outbreaks are blamed on increased consumption of fresh produce in its raw form, with no processing steps to remove pathogens. (Cartsens et al., 2019). Sher et al. (2021) retrieved and examined Salmonella outbreak data spanning 25 years. According to the findings, egg-based dishes were the most prevalent vehicle linked with those Salmonella outbreaks, followed by meat, vegetables, chicken, dairy products, and bakery items. (Sher et al., 2021). An epidemiological study of a Salmonella outbreak in China related to egg fried rice revealed the need to improve education for food handlers and consumers about the risk of cross-contamination of eggs and food and hygiene practices (News Desk, 2022). With ethnic cuisines such as Chinese remaining popular in the United States, there may be a need to emphasize the significance of these foodborne disease prevention methods.

Understanding whether the foods most frequently implicated in outbreaks reflect the most common food exposures in the population or whether these foods are at a higher risk of contamination or failure to eliminate pathogens during processing and preparation may improve interventions (Richardson et al., 2021). These researchers make a critical point in determining which foods, based on population, are more likely to be Salmonella carriers. According to Richardson et al., the greater frequency of consumption increases the chance of contamination or mishandling of certain pathogenic foods. (2021). In terms of ethnic FSEs, this study could aid in identifying commonalities in implicated foods within these establishments, ensuring interventions are tailored to meet specific needs and address gaps causing these outbreaks.

Training

This study investigates training practices in ethnic FSEs to see which technique is most commonly used for providing food service education and employee training. The person in charge (PIC) of the establishment during an inspection shall demonstrate to the health authority knowledge of foodborne disease prevention, application of the hazard analysis and critical control point principles (HACCP), and Code requirements, according to the Food and Drug Administration (FDA) Food Code. The FDA Food Code also mandates the PIC in most FSEs to be a food safety manager with a certificate from an accredited food safety program. Employee food safety instruction is the certified food safety manager's (CFSM) responsibility. The authority impacts the efficacy of food safety management (Appling et al., 2018). As stated, most food service businesses must

have a certified food safety manager. During an inspection, the PIC must show food safety knowledge as the food code requires.

Appling et al. (2018) examined the impact of food safety management characteristics on risk factor violations in 546 routine inspections conducted in Bloomington and Richfield, MN, between 2016 and 2017. The results of this study show that active managerial control resulted in fewer significant violations discovered during inspections. However, differences and complexities in management characteristics (PIC, certified food manager (CFM), or certified food manager of record (CFMR)) result in a wide range of significant violation outcomes. With this research, Appling et al. began an opportunity for future studies to examine the role of CFSMs and how employee training affects the result of an inspection.

In Kansas, 500 restaurants were randomly chosen for additional analysis of food service violations within ethnic and non-ethnic restaurants to determine specific food safety training needs. According to the findings, ethnic restaurant employees require more food safety training, particularly for crucial behaviors such as time and temperature control and hand washing. (Kwon et al., 2010). CFSM must educate their staff on the best practices for avoiding the occurrence of these risk factors. The literature stated that determining the effectiveness of food safety training methods can aid in the reduction of food outbreaks. (McFarland et al., 2019). Furthermore, a study conducted in 2018 showed that hands-on training should be required as knowledge-based training is not always sufficient to activate best practices for avoiding foodborne illness. Furthermore, as demonstrated in a study by Yu et al. (2018), hands-on training is required, particularly

during peak operation times, as knowledge-based training is not always sufficient to activate best practices for avoiding foodborne illness. Furthermore, investigating these ethnic FSEs training styles/practices provides a stronger foundation for future interventions that help to prevent Salmonella outbreaks within ethnic FSEs.

Ethnic Food Service Establishments

Food and beverage sales in the restaurant and food service business were expected to reach $789 billion in 2021 (National Restaurant Association, 2021), making food safety an essential aspect of public health. Ethnic restaurants offer food from countries other than the host country's traditional cuisine. (Boutros, 2019). An ethnic food service establishment is defined in this study as any FSE that does not offer conventional American-style dishes. (e.g., Chinese, Mexican, Italian, Thai, Jamaican, African). Among 87% of consumers who order ethnic fare or food with ethnic flavors when eating out, nearly one-third (32%) are willing to pay extra for authenticity, according to Technomic's 2018 Ethnic Food & Beverage Consumer Trend Report (Berry, 2018). Asian and Middle Eastern flavors have increased in popularity among consumers over the past few years (Zarling, 2018). Zarling credits the surge in interest in ethnic cuisine to the increasing millennial demographic and the increase in companies targeting Hispanic and Asian populations (2018).

As the restaurant industry becomes more diverse, recognizing potential language/communication barriers within ethnic food service businesses is critical to developing and revising food safety knowledge. According to economists, the limited English abilities of foreign-born US employees cost US corporations $65 billion in lost

productivity each year (Neal, 2015). According to Panchal et al. (2012), restaurant food handlers' limited knowledge of the English language may contribute to restaurant-associated foodborne illness if it interferes with the communication of educational food safety information or is associated with cultural food safety practices that differ from those expected in the United States. In one research study to find risk factors associated with food safety questionnaire scores, Spanish-speaking food handlers scored lower than English-speaking food handlers. (Panchal et al., 2012). Participants were given surveys in both English and Spanish.

According to a University of Florida study, there was a rise in the frequency of foodborne illness outbreaks associated with ethnic foods from 1990 to 2000 (*Customizing Food Safety Training Programs for Ethnic Food Vendors | National Agricultural Library,* n.d.). From 1990 to 2008, 8.7% of foodborne disease outbreaks (17,640 total outbreaks) in the United States were linked to three prominent ethnic cuisine categories (Italian, Mexican, and Asian; Matheus, 2016b). According to researchers, ethnic restaurants have more violations than non-ethnic restaurants in food time/temperature violations, cross-contamination, and food condition/surface/labels (Liu & Lee, 2017). The study found that food safety professionals throughout the United States encountered a variety of ethnic-food establishments and ethnic foods for which they lacked ethnic-food safety resources, especially at the local level (Liu & Lee, 2017). As a result, analyses that reveal common traits in environmental assessment results within ethnic facilities experiencing Salmonella outbreaks are being conducted.

Definitions

Centers for Disease Control and Prevention (CDC): CDC is the nation's leading science-based, data-driven service organization that protects the public's health (About CDC, 2022).

Contributing factors: Practices leading to outbreaks (Centers for Disease Control and Prevention, n.d.).

Culture: Values, beliefs, systems of language, communication, and practices that people share in common and that can be used to define them as a collective (Cole, 2019).

Environment: Everything external to the host, including air, food, water, animals, plants, climate, etc. (Selman & Guzewich, 2014).

Environmental Antecedents: Supporting factors for food contamination, survival, or increase of biological or chemical agents (Selman & Guzewich, 2014).

Environmental Health Specialist: A public health professional who conducts research or investigates environmental hazards and toxic exposures that may affect individual or population health (*How to Become an Environmental Health Specialist in 2021*, n.d.).

Environmental assessment: A tool used to determine how and why germs get into the environment and spread to make people sick (*What Are Environmental Assessments*?, 2022).

Epidemiological Triangle: Model made up of three components that contribute to the spread of disease: an external agent, a host, and an environment in which the agent and host meet (*What Factors Comprise the Epidemiologic Triangle?,* 2023)

Ethnicity: The quality or fact of belonging to a population group or subgroup made up of people who share a common cultural background or descent (CDC, 2023).

Food Service Establishment: Public or private establishments that prepare and serve meals, lunches, short orders, sandwiches, frozen desserts, or other edible products directly to the consumer for carryout or service within the establishment (Georgia Department of Public Health, 2022).

Farm-to-Fork Continuum: How food gets from its source to the point of final service (Centers for Disease Control and Prevention, 2022).

Food and Drug Administration (FDA) Food Code: A model for safeguarding public health and ensuring food is unadulterated and honestly presented when offered to the consumer (Food Code, 2022).

Food and Drug Administration (FDA): An agency responsible for protecting public health by ensuring the safety, efficacy, and security of human and veterinary drugs, biological products, and medical devices and by ensuring the safety of our nation's food supply, cosmetics, and products that emit radiation (Office of the Commissioner, 2023).

Foodborne illness risk factors: Characteristics of restaurants commonly linked to foodborne illness outbreaks, including food from unsafe sources, inadequate cooking, improper hot/cold holding temperatures, contaminated equipment, and poor personal hygiene (*FDA releases report on Foodborne Illness Risk factors in Delis,* 2021)

Foodborne illness: Any sickness caused by consuming foods or beverages contaminated with specific infectious or noninfectious agents (Boslaugh, 2013).

Foodborne illness outbreak: When two or more persons from separate households experience a similar illness resulting from ingesting a common food or drink (CDC, 2023b).

Salmonella: A bacterium that causes salmonellosis (CDC, 2023a).

Assumptions

My previous work as an environmental health professional has given me firsthand knowledge of FSEs. This experience taught me about the factors that impede restaurants' ability to follow food safety rules and regulations. Language barriers, a lack of desire to completely conform with local health authorities' food service rules and regulations, financial barriers, and self-incompetence in inspecting ethnic cuisine were all discovered during inspections. This evidence influenced the study's goal and assumptions that cultural influences significantly impact food safety practices in ethnic FSEs. Furthermore, assumptions include the fact that the vast majority of ethnic food service companies are owned and operated by people who are ethnically and culturally representative of the cuisines they prepare and serve. It is also believed that most food workers in these establishments are of those ethnicities.

Scope and Delimitations

Analyzing specific environmental antecedents and how they may serve as catalysts to Salmonella outbreaks within ethnic food service businesses was one of the aspects of the research issue that will be addressed. This focus was selected due to the empirical nature of my prior experience as an environmental health specialist. This study's boundaries include limiting the analysis to FSEs not offering traditional

American cuisine. Furthermore, this research is restricted to ethnic and non-ethnic food establishments that have collaborated with the CDC to provide precise details about their outbreak investigation. However, no theories relevant to this research are included. They are mainly qualitative in nature and involve the idea that food safety practices are overly complicated.

Limitations

Organizing and evaluating NEARS data using a computer system is not possible currently. As a result, human error in analyzing this data was possible because all data were carefully examined. Variables and other information not needed for this study were removed to best control this limitation. As a result, the emphasis was exclusively on the data required for analysis. In addition, this data were thoroughly and repeatedly reviewed.

Significance

As previously stated, little literature exists on the relationship between the characteristics of FSEs found through environmental assessment results and the frequency of Salmonella outbreaks within ethnic FSEs This study adds to the field of public health in several ways. To begin with, over one million immigrants come to the United States each year (Budiman, 2020). As the nation evolves and becomes more diverse, so does its cuisine. Compared to traditional American cuisine, ingredients, and preparation methods, this research sheds new light on the significance of identifying nuances in ethnic cuisine, including ingredients and preparation methods. Second, studies indicate that turnover rates in local health departments are significant (LHD). The study's

gaps offer workforce development opportunities by offering innovative and relevant training on cultural sensitivity and typical food preparation practices across cultures.

The Farm-to-Fork Continuum of Food Service consists of four food service steps: source, processing and manufacturing, distribution, and site of ultimate service. Step 4, the final point of contact, can be improved by undertaking more relevant and inclusive research. Finally, environmental health experts with a better grasp of common ingredients and practices can conduct ethnic food service inspections, resulting in more thorough inspection findings and robust, effective prevention and mitigation strategies. Reduced Salmonella and other foodborne outbreaks from this knowledge are likely critical, given the increasing popularity of ethnic food consumption among US residents.

Summary and Conclusions

Common themes include the increased frequency of foodborne illness outbreaks linked to ethnic cuisine, the general gap in the literature on ethnic cuisine, and the need for additional research on environmental antecedents in ethnic FSEs. Researchers have discovered similar risk factors that contribute to outbreaks. Environmental health practitioners have found gaps in confidence among their inspectors when inspecting establishments that offer non-American foods. The possible effect of culture on the behaviors of operators and food service workers is unknown. This research will help fill a gap in the literature about various cuisines and facilitate future discussions about the influence and impact of cultures in the workplace. Using the socio-Ecological Model will support the implementation of these efforts by identifying links between Salmonella outbreaks and environmental influences.

Section 2: Research Design and Data Collection

Introduction

In this research, I attempted to identify links between environmental assessment findings and the occurrence of NEARS-reported Salmonella outbreaks in ethnic FSEs across the US. This is a quantitative, non-experimental study. The following section includes the research plan and data collection techniques, including an overview of the study population and sampling procedures, operationalization for each variable, statistical tests, and validity threats.

Research Design and Rationale

Independent variables for this study include environmental traits of the restaurants, i.e., implicated food(s), primary language spoken in restaurants amongst workers, and training practices. The dependent variables for this study are ethnic and non-ethnic FSE that experienced Salmonella outbreaks between 2017-2019. This study focused on ethnic FSEs but includes American or non-ethnic cuisine for comparison purposes. One covariate for this study includes specific cuisine types, which aim to identify commonalities within each cuisine (Chinese, Italian, Mexican, etc.) without mediating or moderating variables. This correlational research design is non-experimental and tested to see if and how strongly variables are related. This design provides a clear picture of relationships and trends, which is required for further research into this topic in the future, but it did not imply causation. This design demonstrates whether specific environmental assessment findings correlate with Salmonella outbreak incidents within ethnic FSEs compared to non-ethnic service establishments. This study explored the

strength of the relationship between the primary language spoken within these establishments, training practices, and implicated foods and these outbreaks, not implying they caused the outbreak but for the sake of exploration and identifying trends.

Methodology

Population

This study's population(s) include ethnic and non-ethnic FSEs in the NEARS network that experienced Salmonella outbreaks between 2017 and 2019. This study's NEARS participants included municipal, regional, state, and territorial governments. Confirmed or suspected Salmonella outbreaks accounted for 103 of the roughly 881 foodborne illness outbreaks reported between 2017 and 2019. The population also includes 52% of the confirmed or suspected Salmonella cases reported.

Sampling Procedures

The NEARS database creators used voluntary response sampling. At the end of each year, NEARS participants enter their foodborne illness outbreak environmental assessment data into the database, which is then collectively converted into raw data. Environmental health assessment data from NEARS participants who identify as operating an ethnic FSE are among the inclusion criteria. The data focuses on years 2017, 2018, and 2019. This research excluded non-NEARS participants' environmental health assessment data and data collected before 2017 and after 2019.

Data Collection

The NEARS surveillance system of the Centers for Disease Control and Prevention (CDC) collects environmental assessment data from foodborne illness outbreak investigations to enhance food safety programs and better comprehend outbreaks in participating jurisdictions (*NEARS Support*, n.d.). The raw data were organized in a spreadsheet that does not include the restaurant's name for privacy reasons but does include their answers to their environmental assessment; it is quantified. This study does not include precise details that could lead to identifying a specific restaurant, such as the evaluation number, responder name, or restaurant location. A data request form was submitted to Dr. Laura Brown of the Centers for Disease Control and Prevention (CDC) National Center of Environmental Health (NCEH), Water, Food, and Environmental Health Practice Branch (WFEHSB) to obtain assess to this information. Dr. Brown and I met via Teams to discuss the study and why the NEARS data would be helpful to this research and the overall public health field. I was then connected to another colleague on Dr. Brown's team who provided me with the datasets needed to complete the study. Because it comes straight from the field, these data were the best source for this study. These are direct responses from restaurant employees who have been affected. These data are believed to be truthful and needed for impactful and effective public health interventions and food safety campaigns. The sample size for this research was determined using Power Analysis.

For this test, G*Power 3.1 was used. According to Faul et al., G*Power is a stand-alone power analysis program for many statistical tests commonly used in the social,

behavioral, and biomedical sciences (2007). Two common types of power analysis can be distinguished for intended purposes (Faul et al., 2007): Priori and Poc-Hoc power analysis. According to Faul et al., a priori analysis, the type of power analysis used for this study, provides an efficient method of controlling statistical power before a study is conducted (2007). The necessary sample size is computed as a function of user-specified values for the required significance level α, the desired statistical power 1-β, and the to-be-detected population effect size (Faul et al., 2009). These two-tailed tests have an effect size, alpha, and power level of .3, .05, and .80, respectively. The sample size for this research is 82.

Instrumentation and Operationalization of Constructs

NEARS is an online tool from the CDC used by jurisdictions across the United States to track environmental assessments that result from foodborne illness investigations (NEARS Support, n.d.). The data are held on a central server complying with all security policies for the CDC and the US Department of Health and Human Services. NEARS is a companion system to the National Outbreak Reporting System (NORS), an outbreak surveillance system typically used by state epidemiologists to report epidemiology and laboratory components of outbreak data (CDC, 2022). Contributing factors leading to foodborne illness outbreaks are underreported, and environmental antecedents (why outbreaks occur) are not reported using the NORS system. To close these gaps, CDC developed NEARS in April 2014, which addresses both critical factors to foodborne illness outbreaks. This tool has been used to publish articles using data collected from these environmental health assessments.

Operationalization for Each Variable

Independent Variables

The independent variables used in this research include primary spoken language training practices and implicated foods. The definition of each variable is as follows: primary spoken language refers to the most common language spoken by staff and managers in an FSE. This variable will be measured by identifying both English and non-English speakers within this target population to determine if there is a higher incidence of Salmonella outbreaks amongst non-English compared to English speakers. This variable was categorized and measured nominally using "English" or "non-English" responses. Secondly, training practices are defined as how managers and staff are trained in restaurants, i.e., ANSI accredited class or course, class or course taken at an educational institution, or on-the-job training. This variable was categorized and measured nominally using "on the job", "class/course taken at a university, culinary school etc." and a combination of both. Implicated foods are found through environmental sampling to serve as the primary source of pathogen contamination. Implicated foods were also categorized by produce, poultry and other and measured nominally.

Dependent Variable

The dependent variable for this study is FSE type (ethnic or non-ethnic) that experienced Salmonella outbreaks between 2017-2019. Ethnic FSEs included a combination of fixed or mobile restaurants that serve non-American cuisines, e.g., Mexican, Chinese, Italian, etc. These establishments were selected by analyzing self-

reported “cuisine type” responses to the environmental assessments. I manually categorized the establishments that experienced confirmed or suspected Salmonella outbreaks within the chosen timeframe.

Data Analysis Plan

IBM SPSS Version 28 is a statistical program used to conduct statistical analysis for this study. Because there is no automated mechanism for processing NEARS data, the data for this study were physically filtered, cleaned, and evaluated. The data set included multiple raw data Excel sheets that had to be cross-referenced with the NEARS codebook, which contains all variables and response options. Missing data were visually displayed and discussed alongside the findings from complete data. This study required logistic regression analysis. Logistic regression models a relationship between predictor variables and a categorical response variable and helps to determine the probability of an event occurring (Penn State, n.d.). The research questions are as follows:

RQ1: Is there a statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Ho1: There is no statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA1: There is a statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

The data were categorized by establishments where English is or is not the primary spoken language. A chi-square test was conducted to determine the strength of the association between the language spoken and the occurrence of Salmonella outbreaks.

RQ2: Is there a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

Ho2: There is no statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA2: There is a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

The data were ranked based on the strength of the relationship between food safety training practices and the occurrence of Salmonella outbreaks in ethnic vs. non-ethnic food service establishments. A Chi-square test was conducted to determine if there is a significant difference between the training practices in the two types of establishments.

RQ3: Is there a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Ho3: There is no statistically significant relationship between the implicated food (identified or suspected) and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA3: There is a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

The data were categorized and ranked based on the strength of the relationship between the implicated food and the type of FSE where the Salmonella outbreak occurred. A Chi-square test was conducted to determine if there is a significant association between the implicated food and the type of establishment.

This research used inferential statistics to draw speculation about the larger population from which this sample came. As previously mentioned, NEARS data are collected voluntarily from registered participants. Therefore, the data from this sample were used to produce presumptions regarding the ethnic food service population within the United States and its territories. Chi-square tests were used to determine the strength of the variables in these research questions. A Chi-square test is a statistical test used to compare observed and expected results. A Chi-square test has three major assumptions: individual observations should be independent, and the expected cell frequencies should not exceed 5 *(Assumptions of Chi-square test,* n.d.).

Additionally, descriptive statistics aided in describing the raw data, which were depicted graphically by charts, scatterplots, and histograms. For research question 1, I calculated the frequency and proportion of NEARS-reported Salmonella outbreaks in

ethnic and non-ethnic FSE between 2017-2019 and calculated the frequency and proportion of NEARS-reported Salmonella outbreaks in establishments where English is or is not the primary spoken language. Additionally, I created a contingency table and calculated the chi-square test statistic to assess the association between primary language spoken and NEARS-reported Salmonella outbreaks.

Research question 2 required a calculation of the frequency and proportion of NEARS-reported Salmonella outbreaks in ethnic and non-ethnic FSEs between 2017-2019, a measure of the frequency and proportion of FSEs that have had food safety training, and the creation of a contingency table and chi-square test statistic to assess the association between food safety training and FSE type in NEARS-reported Salmonella outbreaks. Lastly, research question 3 included a calculation of the frequency and proportion of NEARS-reported Salmonella outbreaks in ethnic and non-ethnic FSEs between 2017-2019, the frequency and proportion of NEARS-reported Salmonella outbreaks by implicated food (identified or suspected), and the creation of a contingency table and the chi-square test statistic to assess the association between implicated food and FSE type in NEARS-reported Salmonella outbreaks.

Threats to Validity

Threats to validity might make the reliability or accuracy of the research results less certain. Some possible threats to validity for each of the aforementioned study questions are as follows. For the first research question, "Is there a statistically significant relationship between the primary language spoken in ethnic and non-ethnic food service establishments in NEARS-reported Salmonella outbreaks between 2017-2019," the

sampling bias is notable, as if the sample of FSEs chosen for the study is not representative of the larger population, the results may not be generalizable. Also, regarding confounding variables, other factors such as location, size, or type of establishment could influence the occurrence of Salmonella outbreaks, and they could result in incorrect conclusions about the connection between language and outbreaks if not taken into consideration. Research question 1's reporting bias is if the languages used in an establishment are not correctly recorded, the language of the establishment may be incorrectly classified, which could lead to a false association between the language and Salmonella outbreaks.

For the second research question, "Is there a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS reported Salmonella outbreaks between 2017-2019," a self-selection bias was possible where FSEs that choose to participate in food safety training programs may differ systematically from those that do not, leading to biased results. Furthermore, the data for the study may rely on self-reported information, which could be subject to recall bias, meaning that establishments may not accurately report their food safety training. Lastly, similar to the first study question, other factors that were not considered could result in incorrect conclusions about the connection between food safety training and the occurrence of outbreaks, known as confounding variables.

For the third research question, "Is there a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-

2019," data quality may present as a threat to validity. The implicated food may be misclassified if not correctly recorded or identified, leading to an incorrect association between the implicated food and Salmonella outbreaks. Like the first two research questions, confounding variables were a threat as other variables that affect the likelihood of Salmonella outbreaks may not be considered, which could result in incorrect conclusions about the causal link between implicated foods and outbreak occurrence. Finally, referring to sample size, there may not have been many Salmonella outbreaks during the selected time period, which would reduce the statistical strength and generalizability of the findings.

Ethical Procedures

This section will address potential ethical considerations for data collection, management, analysis, and interpretation pertaining to privacy and confidentiality, informed consent, bias and fairness, respect for cultural and linguistic diversity, transparency, and benefit and harm. To safeguard the confidentiality and privacy of the people and establishments connected to the outbreaks, it is crucial to ensure that any data used in the research is de-identified. When utilizing information from NEARS or other sources, it's vital to confirm that the people and establishments involved have provided their informed consent for using their data in research, in addition to ensuring that the study was carried out objectively and fairly without advancing any specific agenda or interest. Furthermore, the cultural and linguistic diversity of the examined communities must be respected and acknowledged when studying language and ethnicity. It is critical to be transparent about the research methods used, including any limitations or potential

biases, and to ensure that the findings are presented accurately and clearly. The possible benefits and risks of the research were weighed, and steps were taken to mitigate any risks while maximizing the benefits.

The Institutional Review Board (IRB) oversees verifying that all Walden University research adheres to the university's ethical standards and governmental regulations in the United States (Academic Guides: Research Ethics: Research Ethics Review Process by IRB, n.d.). I completed Form A, compiled IRB request materials, and addressed ethical concerns to obtain IRB permission. By employing pre-established secondary data, human participants incurred few hazards.

Summary

By examining environmental assessments from NEARS, this quantitative study attempted to discover possible parallels in environmental features across ethnic and non-ethnic FSEs. NEARS is a surveillance system that uses data from foodborne illness outbreak investigations to improve food safety measures nationwide. Because little or no research has been conducted on the relationship between FSE characteristics discovered through environmental assessments and the frequency of Salmonella outbreaks in ethnic FSEs, cultural differences and practices that affect food safety must be clarified. The Social-ecological Model has been widely employed in public health research and practice, including investigations of food safety practices. The chi-square test was used to assess the model. Section 3 will focus on the presentation of results and findings.

Section 3: Presentation of the Results and Findings

Introduction

This quantitative research aimed to identify associations between environmental assessment findings and the occurrence of Salmonella outbreaks in ethnic FSEs. The research questions raised in this study include the following:

RQ1: Is there a statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Ho1: There is no statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA1: There is a statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

The data were categorized by English, non-English, and more than 1 [language]. A chi-square test was conducted to determine the strength of the association between the language spoken and the occurrence of Salmonella outbreaks.

RQ2: Is there a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

Ho2: There is no statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA2: There is a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

The data were organized by food safety training type: on the job, in a class/course taken at a university, community college, culinary school, or other educational institution, and a combination of both in no particular order. A Chi-square test was conducted to determine if there is a significant difference between the training practices in the two types of establishments.

RQ3: Is there a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Ho3: There is no statistically significant relationship between the implicated food (identified or suspected) and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA3: There is a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

Implicated foods were grouped by poultry, produce, and other in no particular order. A Chi-square test was conducted to determine if there is a significant association between the implicated food and the type of establishment.

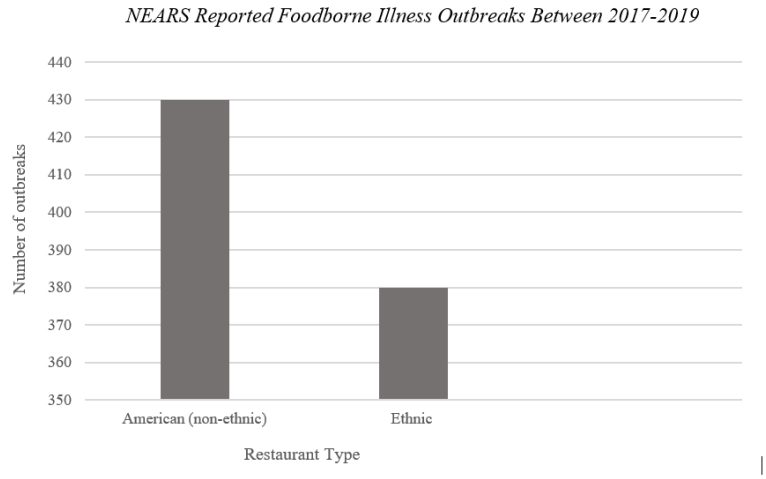
In Chapter 3, the results and findings will be presented. I accessed the data set for the secondary data, report statistical analysis, and summarize answers to research questions.

Accessing the Data Set for Secondary Analysis

The timeframe for which the data set is drawn is from 2017 to 2019. This research included collecting environmental assessments from various FSEs collected over the three year time period. The use of data, as described in Section 2, was executed as planned. Therefore, there were no discrepancies in the plan. From 2017-2019, over 800 reports of foodborne illnesses were voluntarily reported to NEARS. Approximately 430 (53%) outbreaks occurred in American or non-ethnic FSEs, with 380 (47%) occurring in ethnic establishments. Roughly 240, or 30% of total reports, omitted a suspected or confirmed pathogen. Therefore, the number of establishments that experienced Salmonella outbreaks may be higher.

Figure 1

NEARS Reported Foodborne Illness Outbreaks Between 2017-2019

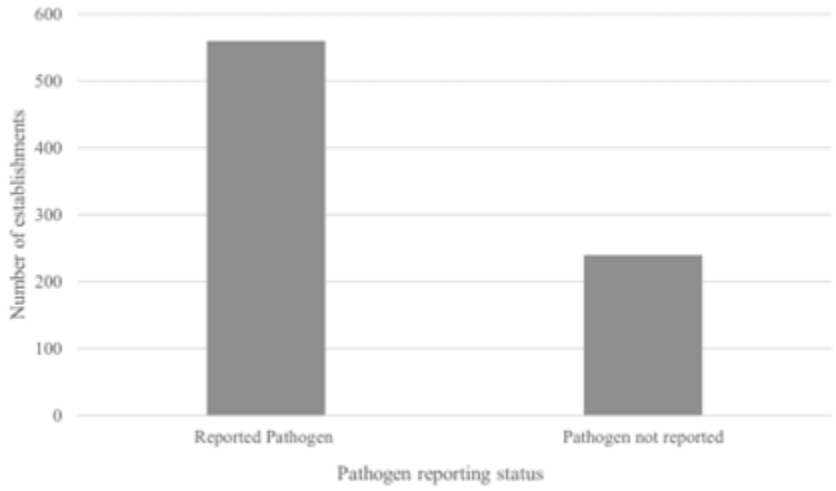


Note. Number of ethnic establishment outbreaks = 430, number of American establishment outbreaks = 380, total *N*=810

Note. Number of ethnic establishment outbreaks = 430, number of American establishment outbreaks = 380, total *N*=810

Figure 2

Establishments with Reported Confirmed/Suspected Pathogens



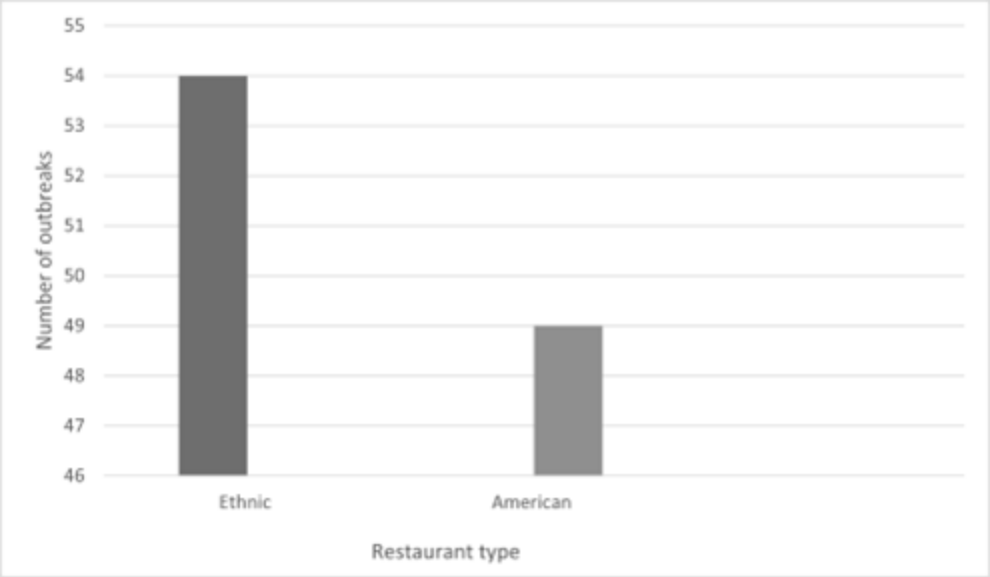
Note. Number of establishments with a reported pathogen=560, number of establishments without a reported pathogen=240, total *N*=800, total missing=10

Results

This study yielded 103 (18% of the reports with confirmed or suspected pathogens) suspected confirmed Salmonella outbreaks: 49 in American, non-ethnic, and 54 in ethnic establishments. Ethnic FSEs account for roughly 5% more reported Salmonella outbreaks between 2017-2019. As previously mentioned, roughly 240, or 30% of total reports, did not include a suspected or confirmed pathogen. Therefore, the number of establishments that experienced Salmonella outbreaks may be higher. In 2017, there were 21 reported Salmonella outbreaks, 42 in 2018, and 40 in 2019. Three major assumptions are associated with Chi-square tests: data must be qualitative, individual observations should be independent, and the expected cell frequencies should not exceed 5. All assumptions were met in research questions 1 and 2. Research question 3 was in violation due to a cell count of less than 5. The results were not impacted as the association was insignificant.

Figure 3

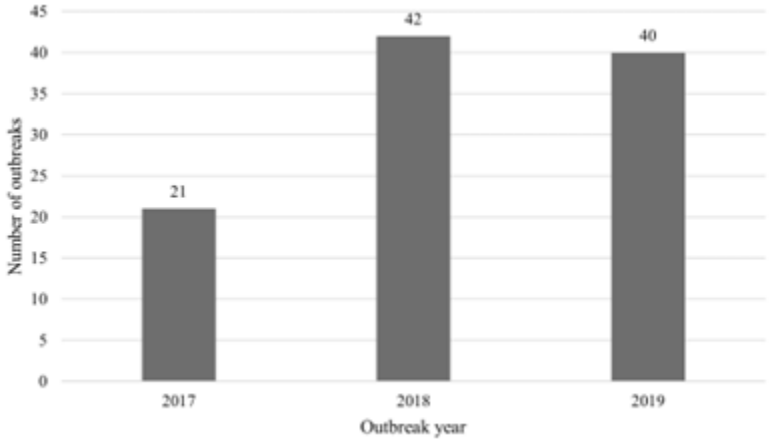
Number of Reported Salmonella Outbreaks Between 2017-2019 by Establishment Type



Note. Number of outbreaks in ethnic establishments=54, number of outbreaks in American establishments=49, total *N*=103

Figure 4

Number of Salmonella Outbreaks by Year



Note. Number of *Salmonella* outbreaks in 2017=21, number of *Salmonella* outbreaks in 2018=42, number of *Salmonella* outbreaks in 2019=40, total *N*=103.

The following includes statistical analysis findings organized by research questions:

RQ1: Is there a statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Ho1: There is no statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA1: There is a statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

Table 1

Primary Language Spoken in the Establishment Crosstabulation

	English Only		Non-English or More Than 1 Language			
	N	%	N	%	N	%
American (non-ethnic)	13	48.1%	31	50.0%	44	49.4%
Ethnic	14	51.9%	31	50.0%	45	50.6%
Total	27	100.0%	62	100.0%	89	100.0%

Table 2

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.026[a]	1	.872		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.026	1	.872		
Fisher's Exact Test				1.000	.528
Linear-by-Linear Association	.026	1	.873		
N of Valid Cases	89				

Note: a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.35. b. Computed only for a 2x2 table.

A chi-square test of independence was conducted to examine the relationship between the primary language spoken and the occurrence of NEARS-reported Salmonella outbreaks between 2017-2019 in ethnic and non-ethnic FSEs. The results revealed a statistically insignificant relationship, X^2 (1, N=89) = 26 p=.872. Therefore, I accept the null hypothesis, which states no statistically significant relationship exists between the primary language spoken in ethnic and non-ethnic food services establishments in NEARS-reported Salmonella outbreaks between 2017-2019.

RQ1: Is there a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

Ho2: There is no statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA2: There is a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

Table 3

Most Common Training Type in Facility Crosstabulation

	On the job		Class/course taken at a university, community college, culinary school, or other educational institution		On the job and class/course			
	N	%	N	%	N	%	N	%
American	15	50.0%	2	16.7%	17	58.6%	34	47.9%
Ethnic	15	50.0%	10	83.3%	12	41.4%	37	52.1%
Total	30	100.0%	12	100.0%	29	100.0%	71	100.0%

Table 4

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.079[a]	2	.048
Likelihood Ratio	6.562	2	.038
Linear-by-Linear Association	.915	1	.339
N of Valid Cases	71		

Note: a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.75.

A chi-square test of independence was conducted to examine the relationship between training type and the occurrence of NEARS-reported Salmonella outbreaks between 2017-2019 in ethnic and non-ethnic FSEs. The p-value was less than the commonly used significance level (0.05), indicating a significant relationship, X^2 (2, N=71) = 6.079, p=.048. Based on these results, I accept the alternate hypothesis, which states a statistically significant relationship exists between food safety training and FSE type (ethnic vs. non-ethnic) in NEARS reported Salmonella outbreaks between 2017-2019.

RQ3: Is there a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Ho3: There is no statistically significant relationship between the implicated food (identified or suspected) and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

HA3: There is a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

Table 5

Implicated Food in Outbreak Crosstabulation

	Poultry		Produce		Other		Total	
	N	%	N	%	N	%	N	%
American	16	59.3%	2	28.6%	16	45.7%	34	49.3%
Ethnic	11	40.7%	5	71.4%	19	54.3%	35	50.7%
Total	27	100.0%	7	100.0%	35	100.0%	69	100.0%

Table 6

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.455[a]	2	.293
Likelihood Ratio	2.503	2	.286
Linear-by-Linear Association	.356	1	.551
Fisher-Freeman-Halton Exact Test	2.377		.299
N of Valid Cases	69		

Note: 2 cells (33.3%) have expected count less than 5. The minimum expected count is 3.45.

A chi-square test of independence was conducted to examine the relationship between implicated food (identified or suspected) and the primary language spoken and the occurrence of NEARS-reported Salmonella outbreaks between 2017-2019 in ethnic and non-ethnic FSEs. The p-value was greater than the commonly used significance level (0.05), indicating the lack of statistical significance, X^2 (2, N=69) =2.455, p=.293. Because the cell counts are low, the Fisher-Freeman-Halton Exact, observed at .299, was used. Therefore, I accept the null hypothesis, which states no statistically significant relationship exists between the implicated food (identified or suspected) and FSE type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019.

Logistic Regression

Table 7

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	49	47.6
	Missing Cases	54	52.4
	Total	103	100.0
Unselected Cases		0	.0
Total		103	100.0

Note: a. If weight is in effect, see classification table for the total number of cases.

Table 8

Dependent Variable Encoding

Original Value	Internal Value
American	0
Ethnic	1

Table 9

Categorical Variables Codings

		Frequency	Parameter coding (1)	(2)
Implicated food/cause of outbreak	Poultry	19	.000	.000
	Produce	3	1.000	.000
	Other	27	.000	1.000
Most common training type in facility	On the job	19	.000	.000
	Class/course taken at a university, community college, culinary school, or other educational institution	9	1.000	.000
	On the job and class/course	21	.000	1.000
Primary language spoken in the establishment	English Only	13	.000	
	Non-English or More Than 1 Language	36	1.000	

Table 10

Omnibus Tests of Model Coefficients

		Chi-square	Df	Sig.
Step 1	Step	4.352	5	.500
	Block	4.352	5	.500
	Model	4.352	5	.500

Table 11

Model Summary/Hosmer and Lemeshow Test

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	63.556[a]	.085	.113

Note: Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 12

Variables in the Equation

		B	S.E.	Wald	Df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 1[a]	Primary language spoken in the establishment (1)	.025	.702	.001	1	.971	1.026	.259	4.063
	Most common training type in facility			3.274	2	.195			
	Most common training type in facility (1)	1.528	.959	2.540	1	.111	4.611	.704	30.215
	Most common training type in facility (2)	-.154	.649	.057	1	.812	.857	.240	3.055
	Implicated food/cause of outbreak			.897	2	.639			
	Implicated food/cause of outbreak(1)	1.172	1.345	.760	1	.383	3.230	.231	45.063
	Implicated food/cause of outbreak(2)	.389	.641	.368	1	.544	1.475	.420	5.183
	Constant	-.452	.832	.295	1	.587	.636		

Note: a. Variable(s) entered on step 1: Primary language spoken in the establishment , Most common training type in facility , Implicated food/cause of outbreak.

A binomial logistic regression test was performed to determine the effects of spoken language, training type, and implicated food on the likelihood of ethnic FSEs being the epicenter of Salmonella outbreaks. Overall, this model is statistically insignificant. The statistical insignificance of the logistic regression model (p=.500 and df=5) suggests that the predictors collectively do not significantly predict the likelihood of ethnic FSEs being the epicenter of Salmonella outbreaks. The Hosmer-Lemeshow result of .913 indicates a good-fitting model. The model explained 11.3% (Nagelkerke R^2) of the variance in ethnic FSEs and correctly classified 61.2% of findings. Compared

to those who only speak English in a FSE, those who speak more than one language in conjunction with English were 1.26 times more likely to be in the ethnic category. Other classification metrics were observed: those trained in food safety by taking a course, attending a university, or culinary school were 4.61 times more likely to be in the ethnic foodservice category than on-the-job training or a combination of training types. Finally, establishments whose implicated foods were in the "produce" category were 3.23 times more likely to be in the ethnic group and 1.47 time more likely for foods in the "other" category.

To ensure the accuracy of these tests, individual logistic regression tests were performed for each research question.

RQ1: Is there a statistically significant relationship between the primary language spoken and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Table 13

Omnibus Tests of Model Coefficients

		Chi-square	Df	Sig.
Step 1	Step	.026	1	.872
	Block	.026	1	.872
	Model	.026	1	.872

Table 14

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	123.343[a]	.000	.000

a. Estimation terminated at iteration number 2 because parameter estimates changed by less than .001.

Table 15

Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Primary language spoken in the establishment (1)	-.074	.461	.026	1	.872	.929	.376	2.294
	Constant	.074	.385	.037	1	.847	1.077		

a. Variable(s) entered on step 1: Primary language spoken in the establishment .

The results of this test confirm an overall insignificant model with a p-value of .872. The Nagelkerke R2 result of .000 indicates an overall poor-fitting model. No statistical significance between primary language spoken in the establishment and FSE type.

RQ2: Is there a statistically significant relationship between food safety training and food service establishment type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Table 16

Omnibus Tests of Model Coefficients

		Chi-square	Df	Sig.
Step 1	Step	6.562	2	.038
	Block	6.562	2	.038
	Model	6.562	2	.038

Table 17

Hosmer and Lemeshow Test

Step	Chi-square	Df	Sig.
1	.000	1	1.000

Table 18

Variables in the Equation

							95% C.I.for EXP(B)	
		B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Most common training type in facility			5.167	2	.076			
	Most common training type in facility (1)	1.609	.856	3.532	1	.060	5.000	.933	26.785
	Most common training type in facility (2)	-.348	.525	.440	1	.507	.706	.252	1.975
	Constant	.000	.365	.000	1	1.000	1.000		

a. Variable(s) entered on step 1: Most common training type in facility .

The results of this test show an overall statistically significant model with a p-value of .038. The Hosmer and Lemeshow test results indicate a good fitting model with a significance of 1.000. No statistical significance was found between the independent

variables and FSE type. The results do show stronger odds between ethnic FSE and those who were trained in food safety in a university, culinary school or other types formal education with ethnic FSEs being 5.00 times more likely to fall into that category.

RQ3: Is there a statistically significant relationship between the implicated food (identified or suspected) and food service establishments type (ethnic vs. non-ethnic) in NEARS-reported Salmonella outbreaks between 2017-2019?

Table 19

Omnibus Tests of Model Coefficients

		Chi-square	Df	Sig.
Step 1	Step	2.503	2	.286
	Block	2.503	2	.286
	Model	2.503	2	.286

Table 20

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.000	1	1.000

Table 21

Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Implicated food/cause of outbreak			2.363	2	.307			
	Implicated food/cause of outbreak(1)	1.291	.924	1.953	1	.162	3.636	.595	22.234

	Implicated food/cause of outbreak(2)	.547	.518	1.112	1	.292	1.727	.626	4.769
	Constant	-.375	.392	.915	1	.339	.688		

a. Variable(s) entered on step 1: Implicated food/cause of outbreak.

The results of this test show a statistically insignificant model with a p-value of .286. In addition to being statistically insignificant, it is good fitting as the Hosmer and Lemeshow test shows a significance value 1.000. Additionally, there is no statically significant relationship between the independent variables and FSE type. However, the model shows that ethnic FSE were 3.636 and 1.727 times more likely to experience a Salmonella outbreak from foods included in the "produce" category and implicated foods included in the "other" category respectively.

Summary

This study showed statistical significance for one of the three research questions. Training type is associated with the outcome of Salmonella outbreaks in ethnic and American FSEs. The odds are higher for ethnic FSEs that employ persons only trained in food safety by taking a course or attending a university or culinary school. Additionally, there were stronger odds ratios (Exp(B)) for ethnic restaurants compared to American FSEs found in some of the independent variables. No statistical significance was observed for language spoken in the establishment or implicated food. The final chapter will include an interpretation of the study, limitations, recommendations, and implications for professional practice and social change.

Section 4: Application to Professional Practice and Implications for Social Change

Introduction

As the United States continues to grow and diversify, we are continually being introduced to various cuisines from across the globe. Because of this, food safety professionals have begun studying the nuances of ethnic cuisine to identify similarities and differences in food safety techniques, preparations, and cooking styles. This quantitative research aimed to identify associations between environmental assessment findings and the occurrence of Salmonella outbreaks in ethnic and American FSEs. Results show no statistical significance between implicated food, the primary language spoken in the establishment, and the occurrence of Salmonella outbreaks. However, statistical significance was observed between training practices and NEARS-reported Salmonella outbreaks between 2017-2019.

Interpretation of the Findings

This study aimed to determine whether social and cultural practices were possible critical variables in foodborne illness outbreaks. Because researchers discovered that ethnic restaurants have more violations than non-ethnic restaurants in areas such as food time/temperature violations, cross-contamination, and food condition/surface/labels (Liu & Lee, 2017), it was critical to learn why these violations are frequently reported to devise the best plan of action to address these issues. The study's findings broaden understanding of the discipline, as stated in the literature review in Section 1 of this report that ethnic restaurant personnel require greater food safety training (Kwon et al., 2010). The findings of this study confirmed that the type of food safety training

employees receive, whether on the job, through a course/study at a university, or a combination of the two, plays a significant role in the incidence of Salmonella outbreaks in both ethnic and American (non-ethnic) FSEs. Furthermore, based on this dataset, there was a greater chance for Salmonella outbreaks to occur in an ethnic FSE than in American (non-ethnic) FSEs.

Additionally, according to Panchal et al. (2012), restaurant food handlers' limited knowledge of the English language may contribute to restaurant-associated foodborne illness if it interferes with the communication of educational food safety information or is associated with cultural food safety practices that differ from those expected in the United States. However, this was not discovered in this dataset as language was found to be a statistically insignificant factor in Salmonella outbreaks. Although this variable was insignificant overall, the regression analysis showed that ethnic FSEs are more likely to be impacted by languages when more than one language, including English, is spoken. First-hand observations, as mentioned in an article about restaurants with failing health scores, explained that inspectors run into substantial challenges when attempting to communicate with food safety workers who do not speak English during unannounced inspections (Boone, 2020). Boone (2020) also raises the question of whether a lack of communication or understanding plays a role in poor inspection scores. To address the apparent contradiction between the lack of statistical significance for language and the regression analysis suggesting its role in ethnic establishments, several factors were explored. All logistic regression assumptions were met to include proper sample size, a binary and ordinal dependent variable, independent observations, little to know

correlation between independent variables, and linearity of independent variables and log odd. Therefore, these findings are most likely due to random chance. Furthermore, it was acknowledged that in addition to inspectors encountering language barriers, the restaurant owner sometimes adjusts to new cultural norms and expectations, contributing to poor inspection outcomes and leading to foodborne illness outbreaks (Boone, 2020).

The results of this study show no statistical significance between the implicated food and outbreaks. However, this does not imply ethnic cuisine, including ingredients and preparation techniques, does not require further exploration, especially since the odds ratios featured in the regression analysis show stronger associations with ethnic establishments and implicated food. A relationship between implicated food and ethnic establishments was observed. After reviewing the logistic regression assumptions and other factors, this result could be due to improper size sample size which should be at least 5.

The socio-ecological framework was best suited to highlight the potential impacts of one's environment by exploring how individuals could be influenced by interpersonal relationships, community, institution and policy, and how those interactions influence their food safety and preparation behaviors. The framework was successful as it helped to successfully guide this research. For example, the discovery of training type as a significant factor in Salmonella outbreaks in this dataset demonstrated how the institutional piece (school/training) impacted the individual, influencing certain food safety behaviors. Also, in examining the appropriateness of this model I discovered how public policy influences the individual – meaning if there is a lack of training and

resources at the local level, inspectors are not equipped to conduct a thorough and accurate health inspection within an ethnic FSE or to understand their processes. Ethnic FSE competency is needed to provide proper support in the development of culturally specific food safety materials within these establishments.

Limitations of the Study

Human error was a risk to the study's validity due to the impossibility of electronically cleansing and organizing data. Several sheets of Excel data were manually reviewed and arranged to capture the data needed for statistical analysis. Depending on the complexity and frequency of the task, human data entry errors can yield high error rates (Tilleli, 2022). To control this limitation effectively, all extraneous data was eliminated from the datasets, leaving only the data needed to complete the study.

The 2019 NEARS dataset should have included certified food safety manager (CFSM) data for each establishment, but after cleaning and arranging the data, I discovered that the data were missing. As a result, CFSM data were excluded from the analysis. I originally sought to use this data as a cofounder for RQ2 (training). If this research is to be continued in the future, determining whether the person-in-charge, holds a CFSM certificate would be an important piece to include since it is required in most restaurants. This is critical because the literature suggests that the presence of a certified food protection manager reduces the risk for a foodborne outbreak for an establishment and was a distinguishing factor between restaurants that experienced a foodborne illness outbreak and those that had not.

While cleaning the data, I noticed some key pieces of information were missing. For example, not all of the establishments had information on language, implicated food or training. Therefore, I had to weed those missing pieces out. That resulted in the exclusion of several pieces of data, which resulted in small cell counts, limiting the ability to test the complete dataset for more conclusive results. The cause of the missing data is unknown.

Recommendations

Several short-term and long-term food safety recommendations can be made from this research including utilizing data cleaning tools, expanding the study to include other foodborne illnesses, including CFSM data, and incorporating community-based research in future studies. I learned throughout this process that several electronic data cleaning tools are available. I recommend future researchers utilize one of these tools. Though I am confident with my final data set, I do think this step would have added an extra layer of assurance to the data set.

Once I gained full access to the data, I knew this study would benefit from broadening the scope of illness to all reported FBI's instead of limiting it to only one. Though I had an appropriate sample size, opening it up to all could have possibly increased cell counts and yielded more robust findings. As previously mentioned, I recommend including CFSM data in future studies so that we can identify possible widespread compliance issues within these establishments and others, but to primarily determine if lack of CFSM makes an establishment more likely to experience an outbreak, as the literature suggests.

Finally, incorporating the community-based research (CBR) approach would add depth to this research. The CBR approach is a collaborative approach to research in which researchers, organizations, and community members work together on all aspects. The study is done for and with the community or target audience and not conducting research *of* the community. Showing effort to build trust and demonstrating respect for the target audience may produce more accurate findings.

Implications for Professional Practice and Social Change

Professional Practice

Seeking further understanding of ethnic FSEs to build meaningful relationships is one implication for professional practice. From firsthand experience, I've observed how uncomfortable interactions between heath inspectors and FSE workers can be; this is where the CBR approach would be appropriate. By encouraging food service workers to express their views about experiences with health inspectors, these firsthand accounts will help us understand how inspectors are perceived and if lack of trust between the two parties influences improper food handling/outbreaks. But primarily, we create a collaborative environment to tackle the training gaps on both ends of the issue -- on the local level and within the ethnic FSEs.

An additional implication for professional practice is to increase knowledge of culturally prepared dishes by implementing ways to support and better prepare health inspectors for these types of encounters. With more conversations around this implication, public health professionals should be able to include more ethnic food safety content into the training material since literature shows there is a need for it.

Positive Social Change

This study identifies opportunities to create positive social change at an individual, organizational, and policy level. Individuals could be moved to partake in additional hands-on training opportunities given the statistical relevance of training type and the frequency of Salmonella outbreaks. On an organizational level, this research provides environmental health departments, public health researchers, and the restaurant industry with the unique opportunity to develop cuisine-specific campaigns and interventions. The logistic regression results showed greater odds between some of the independent variables and ethnic FSEs. Those findings support this statement.

The literature explained the discovery of a stronger correlation between implicated food and ethnic FSEs. Additionally, the literature described the observed need to provide additional training and resources to health inspectors when inspecting ethnic establishments. On a policy level, this research and future research of a similar nature may influence changes to the food code and state-required trainings to include cuisine-specific or culturally specific guidance. This will improve inspector knowledge, competence and general relationships between industry and public health professionals/researchers.

Conclusion

Firsthand experiences influenced this study. Personal contact with people of various cultural origins whose food safety practices and beliefs and the challenges encountered as inspectors sparked the idea that culture could be regarded as a

contributing factor to foodborne illness outbreaks. The findings of this study only touched the surface of the effort to uncover strategies to improve food safety from a cultural standpoint. Through this study, I confirmed that how restaurant staff are trained plays a statistically significant role in the odds of a Salmonella outbreak happening. With this information, public health experts can expand on this research to establish a more comprehensive foodborne illness prevention effort.

References

Academic Guides: Research Ethics: Research Ethics Review Process by IRB. (n.d.). Walden University. https://academicguides.waldenu.edu/research-center/research-ethics/review-process#:~:text=The%20Institutional%20Review%20Board%20%28IRB%29%20is%20responsible%20for,before%20participant%20recruitment%2C%20data%20collection%2C%20or%20dataset%20access.

Agency For Toxic Substances and Disease Registry. (2015, June 25). Chapter 1: Models and Frameworks | Principles of Community Engagement | ATSDR. Cdc.gov. https://www.atsdr.cdc.gov/communityengagement/pce_models.html

Appling, X. S., Lee, P., & Hedberg, C. W. (2018). Understanding the relation between establishment food safety management and risk factor violations cited during routine inspections. *Journal of Food Protection*, *81*(12), 1936–1940. https://doi.org/10.4315/0362-028x.jfp-18-278

Assumptions of Chi-Square test - javatpoint. (n.d.). www.javatpoint.com. https://www.javatpoint.com/assumptions-of-chi-square-test-in-spss#:~:text=So%20the%20first%20assumption%20of%20the%20Chi-square%20test,expected%20cell%20frequencies%20should%20not%20be%20too%20small.

Belleza, M., RN. (2021). Salmonella Infection (Salmonellosis). *Nurseslabs*. https://nurseslabs.com/salmonella-infection-salmonellosis/#:~:text=First%20discovered%20by%20an%20American%20scientist%20named%20Dr.,cramps.%20Illness%20from%20these%20bacteria%20is%20called%20salmonellosis.

Benning, S. (2021). About the socio-ecological model | Leadership education in maternal & child public health. *Leadership Education in Maternal & Child Public Health*. https://mch.umn.edu/sem/

Berry, D. (2018, November 14). Authenticity central to ethnic flavor development. *Food Business News*. https://www.foodbusinessnews.net/articles/12867-authenticity-central-to-ethnic-flavor-development#:~:text=Among%20the%2087%25%20of%20consumers%20who%20order%20ethnic,2018%20Ethnic%20Food%20%26%20Beverage%20Consumer%20Trend%20Report.

Boslaugh, S. E. (2013, December 23). *Foodborne illness | pathology*. Encyclopedia Britannica. https://www.britannica.com/science/foodborne-illness

Boone, R. (2020, February 17). Does a language barrier contribute to some restaurants' poor health inspections? The Daily Chronicle. https://www.chronline.com/stories/does-a-language-barrier-contribute-to-some-restaurants-poor-health-inspections,5290

Boutros, B. (2019). *Self-reported food safety behaviors in independent ethnic restaurants: An application of the social cognitive theory*. Retrieved April 24, 2023, from https://fsmec.org/wp-content/uploads/2019/03/Self-reported-Food-Safety-Behaviors-in-Independent-Ethnic-Restaurants-An-Application-of-the-Social-Cognitive-Theory.pdf

Budiman, A. (2020, August 20). Key findings about U.S. immigrants. *Pew Research Center*. https://www.pewresearch.org/short-reads/2020/08/20/key-findings-about-u-s-immigrants/

Carstens, C. K., Salazar, J. K., & Darkoh, C. (2019). Multistate outbreaks of foodborne illness in the United States associated with fresh produce from 2010 to 2017. *Frontiers in Microbiology*, *10*. https://doi.org/10.3389/fmicb.2019.02667

Centers for Disease Control and Prevention (2022). *About CDC*. https://www.cdc.gov/about/

Centers for Disease Control and Prevention. (2023b, August 9). Foodborne germs and illnesses. Centers for Disease Control and Prevention. https://www.cdc.gov/foodsafety/foodborne-germs.html

Centers for Disease Control and Prevention. (2023, October 4). Glossary. Centers for Disease Control and Prevention. https://www.cdc.gov/scienceambassador/nerdacademy/glossary.html

CDC. (2019). Salmonella . Centers for Disease Control and Prevention. https://www.cdc.gov/salmonella/index.html

Centers for Disease Control and Prevention. (2022a, January 18). The social-ecological model: A framework for prevention. Centers for Disease Control and Prevention. https://www.cdc.gov/violenceprevention/about/social-ecologicalmodel.html

Centers for Disease Control and Prevention. (2023a, April 24). *Questions and answers.* Centers for Disease Control and Prevention. https://www.cdc.gov/salmonella/general/index.html

Clinical and Translational Science Awards Consortium, Community Engagement Key Function Committee, Task Force on the Principles of Community Engagement. (2011). *Principles of community engagement*. [Washington, D.C.] :Dept. of

Health and Human Services, National Institutes of Health, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, Clinical and Translational Science Awards.

Clayton, M. L., Smith, K., Neff, R. A., Pollack, K. M., & Ensminger, M. E. (2015). Listening to food workers: Factors that impact proper health and hygiene practice in food service. *International Journal of Occupational and Environmental Health*, *21*(4), 314–327. https://doi.org/10.1179/2049396715y.0000000011

Cole, N. L., PhD. (2019). So what is culture, exactly? *ThoughtCo*. https://www.thoughtco.com/culture-definition-4135409

Customizing Food Safety Training Programs for Ethnic Food Vendors | National Agricultural Library. (n.d.). https://www.nal.usda.gov/research-tools/food-safety-research-projects/customizing-food-safety-training-programs-ethnic-food

Devoe, J. (2017, September 27). *Epidemiological Triangle for Malaria*. prezi.com. https://prezi.com/cjfbpwnpgnwr/epidemiological-triangle-for-malaria/

Ethnic-food safety concerns: an online survey of food safety professionals. (2006, June 1). PubMed. https://pubmed.ncbi.nlm.nih.gov/16779999/#:~:text=The%20study%20found%20that%20food%20safety%20professionals%20throughout,ethnic-food%20safety%20resources%2C%20especially%20at%20the%20local%20level.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160. https://doi.org/10.3758/brm.41.4.1149

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. https://doi.org/10.3758/bf03193146

Food Code 2022. (2023, November 7). U.S. Food And Drug Administration. https://www.fda.gov/food/fda-food-code/food-code-2022

Food Safety Modernization Act (FSMA). (2022). *U.S. Food And Drug Administration*. https://www.fda.gov/food/guidance-regulation-food-and-dietary-supplements/food-safety-modernization-act-fsma

Foodborne Illness. (2022, August 24). Food Protection. https://www.in.gov/health/food-protection/foodborne-illness/

Georgia Department of Public Health. (2022, August 4). *Rules and Regulations: Food Service*. https://dph.georgia.gov/document/document/food-service-rules-and-regulations-511-6-1/download

Golden, S. D., McLeroy, K. R., Green, L. W., Earp, J. A., & Lieberman, L. D. (2015). Upending the social ecological model to guide health promotion efforts toward policy and environmental change. *Health Education & Behavior*, *42*(1_suppl), 8S-14S. https://doi.org/10.1177/1090198115575098

How to Become an Environmental Health Specialist in 2021. (n.d.). CORP-MPH1 (PHD). https://www.publichealthdegrees.org/careers/environmental-health-specialist/

Kwon, J., Roberts, K. R., Shanklin, C. W., & Yen, W. (2010). Food safety training needs assessment for independent ethnic restaurants: review of health inspection data.

Food Protection Trends, 30(7).

Lipcsei, L. E., Brown, L., Coleman, E. W., Kramer, A. D. I., Masters, M. R., Wittry, B. N., Reed, K., & Radke, V. (2019). Foodborne illness outbreaks at retail establishments — National environmental assessment reporting system, 16 state and local health departments, 2014–2016. *Morbidity and Mortality Weekly Report, 68*(1), 1–20. https://doi.org/10.15585/mmwr.ss6801a1

Liu, P., & Lee, Y. H. (2017). An investigation of restaurant food safety performance: A comparison between ethnic and nonethnic and chain and independent restaurants in Louisiana. *Journal of Foodservice Business Research*, *20*(2), 204–217. https://doi.org/10.1080/15378020.2016.1206770

Matheus, A. (2016a, March 1). *A Historical Look at the Prevalence of Foodborne Disease Outbreaks Associated with Asian Foods in the United States*. International Association for Food Protection. https://www.foodprotection.org/publications/food-protection-trends/archive/2016-03-a-historical-look-at-the-prevalence-of-foodborne-disease-outbreaks-associated-with-asian-foo/#:~:text=From%201990%20to%202008%2C%208.7%25%20of%20the%20foodborne,cases%29%20of%20the%20totals%20associated%20with%20ethnic%20foods.

Matheus, A. (2016b, March 1). *A Historical Look at the Prevalence of Foodborne Disease Outbreaks Associated with Asian Foods in the United States*. International Association for Food Protection.

https://www.foodprotection.org/publications/food-protection-trends/archive/2016-03-a-historical-look-at-the-prevalence-of-foodborne-disease-outbreaks-associated-with-asian-foo/#:~:text=From%201990%20to%202008%2C%208.7%25%20of%20the%20foodborne,cases%29%20of%20the%20totals%20associated%20with%20ethnic%20foods.

Mauer, W. A., Kaneene, J. B., DeArman, V. T., Roberts, C. A., Miller, R., Pong, L., & Dickey, T. E. (2006). Ethnic-food safety concerns: an online survey of food safety professionals. Journal of environmental health, 68(10), 32–38.

McFarland, P., Sielaff, A. C., Rasco, B., & Smith, S. A. (2019). Efficacy of Food Safety Training in Commercial Food Service. *Journal of Food Science*, *84*(6), 1239–1246. https://doi.org/10.1111/1750-3841.14628

McLeroy, K. R., Bibeau, D. L., Steckler, A., & Glanz, K. (1988). An Ecological Perspective on Health Promotion Programs. *Health Education Quarterly*, *15*(4), 351–377. https://doi.org/10.1177/109019818801500401

Mittal, A. (2021, April 1). Data cleansing: Why it's important. DATAVERSITY. https://www.dataversity.net/data-cleansing-why-its-important/

National Restaurant Association. (2021, August 31). National Restaurant Association Releases 2021 Mid-Year State of the Restaurant Industry Update. *Cision*. https://www.prnewswire.com/news-releases/national-restaurant-association-releases-2021-mid-year-state-of-the-restaurant-industry-update-301365454.html#:~:text=Food%20and%20beverage%20sales%20in%20the%20r

estaurant%20and,%24789%20billion%20in%202021%2C%20up%2019.7%25%20from%202020.

NEARS Support. (n.d.). NEHA SC. https://www.neha.org/nears

News Desk. (2022, January 16). *Chinese Salmonella outbreak linked to egg fried rice | Food Safety News*. Food Safety News. https://www.foodsafetynews.com/2022/01/chinese-salmonella-outbreak-linked-to-egg-fried-rice/#:~:text=Resistance%20gene%20analysis%20showed%20that%20the%2020%20outbreak,prevent%20illness%20caused%20by%20Salmonella%20enteritidis%2C%20said%20researchers.

Penn State, Eberly College of Science (n.d.). *12.1 - Logistic Regression | STAT 462*. (2018). https://online.stat.psu.edu/stat462/node/207/

Odeyemi, O. A., Sani, N. A., Obadina, A. O., Saba, C. K. S., Bamidele, F. A., Abu-Ghoush, M., Asghar, A., Dongmo, F. F. D., Macer, D., & Aberoumand, A. (2019). Food safety knowledge, attitudes and practices among consumers in developing countries: An international survey. *Food Research International, 116*, 1386–1390. https://doi.org/10.1016/j.foodres.2018.10.030

Office of the Commissioner. (2023, November 21). What we do. U.S. Food And Drug Administration. https://www.fda.gov/about-fda/what-we-do

Panchal, P. P., Liu, L. L., & Dworkin, M. D. (2012). Food safety knowledge is lower among Spanish- speaking than among English- speaking restaurant food handlers in Chicago. *Food Protection Trends*. https://www.foodprotection.org/files/food-

protection-trends/Jan-12-Dworkin.pdf

Richardson, L. C., Cole, D. J., Hoekstra, R. M., A, R., Johnson, S. C., & Bruce, B. B. (2021). Foods implicated in U.S. outbreaks differ from the types most commonly consumed. *Journal of Food Protection*, *84*(5), 869–875. https://doi.org/10.4315/jfp-20-293

Salmonella (Salmonellosis). (2019). *U.S. Food And Drug Administration*. https://www.fda.gov/food/foodborne-pathogens/salmonella-salmonellosis

Schuster-Bruce, C. (2021, October 22). Salmonella linked to onions has infected more than 650 people in 37 states, CDC says. *Business Insider*. https://www.businessinsider.com/cdc-onions-salmonella-mexico-652-people-sick-throw-away-2021-10#:~:text=At%20least%20652%20people%20in%2037%20states%20have,been%20tested%20for%20the%20bacteria%2C%20the%20CDC%20said.

Sebastian, J. (2019, May 16). *The effect of culture on food safety risks*. Food Quality & Safety. https://www.foodqualityandsafety.com/article/regional-cultures-connection-to-food-safety-risks/

Selman, C. A., & Guzewich, J. (2014, January 1). *Public Health Measures: Environmental Assessment in Outbreak Investigations*. Elsevier eBooks.

Sher, A. A., Mustafa, B. E., Grady, S. C., Gardiner, J. C., & Saeed, A. (2021). Outbreaks of foodborne Salmonella enteritidis in the United States between 1990 and 2015: An analysis of epidemiological and spatial-temporal trends. *International Journal of Infectious Diseases*, *105*, 54–61. https://doi.org/10.1016/j.ijid.2021.02.022

Centers for Disease Control and Prevention. (2022). System Theory. Environmental Health Services (EHS). https://www.cdc.gov/nceh/ehs/ehsnet/system-theory.htm#:~:text=The%20farm-to-fork%20continuum%20is%20the%20path%20food%20takes,and%20manufacturing%2C%20distribution%2C%20and%20point%20of%20final%20service

Tilleli , F. (2022, August 22). How manual data entry and human error are costing you money. *Integrated Platform Services - EDI & ERP Systems.* https://www.connectpointz.com/blog/manual-data-entry-costing-you-money

FDA. (2021). *FDA releases report on Foodborne Illness Risk factors in Delis.* U.S. Food and Drug Administration. https://www.fda.gov/food/cfsan-constituent-updates/fda-releases-report-foodborne-illness-risk-factors-delis

U.S. Food and Drug Administration (2022). *Food Code 2009*. https://www.fda.gov/food/fda-food-code/food-code-2009#:~:text=The%20Food%20Code%20is%20a%20model%20for%20safeguarding,food%20offered%20at%20retail%20and%20in%20food%20service.

Centers for Disease Control and Prevention. (n.d.). *What are Contributing Factors?* Environmental Health Services (EHS). https://www.cdc.gov/nceh/ehs/nears/what-are-contributing-factors.htm#:~:text=Contributing%20factors%20are%20food%20preparation%20practices%2C%20behaviors%2C%20and,food%3B%20these%20pathogens%20in%20food%20can%20cause%20outbreaks

What Are Environmental Assessments? | EHS | CDC. (2020, March 17). Www.cdc.gov.

https://www.cdc.gov/nceh/ehs/nears/environmental-assessment.htm

What Factors Comprise the Epidemiologic Triangle? (2023, April 23). *Kent.* https://onlinedegrees.kent.edu/college-of-public-health/community/what-factors-comprise-the-epidemiologic-triangle

Yu, H., Neal, J., Dawson, M. R., & Madera, J. M. (2018). Implementation of behavior-based training can improve food service employees' handwashing frequencies, duration, and effectiveness. *Cornell Hospitality Quarterly*, *59*(1), 70–77. https://doi.org/10.1177/1938965517704370

Zarling, P. Z. (2018, August 13). *Consumers crave authentic ethnic food — and will pay more*. Food Dive. https://www.fooddive.com/news/consumers-crave-authentic-ethnic-food-and-will-pay-more/529282/