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RESEARCH CONTRIBUTIONS:

Ventilated and Unventilated Cooling Methods in Onsite Foodservice Operations

Food Safety Needs in Independently-Owned Chinese Restaurants: Food Safety Inspectors' Perspective

Exploring Restaurant Service Sabotage Behaviors in the U.S.

Educational Affordances of Google Glass as a New Instructional Platform for Foodservice Training

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ABSTRACTS

Research Manuscripts

Ventilated and Unventilated Cooling Methods in Onsite Foodservice Operations

The 2017 Food and Drug Administration (FDA) Food Code states that food shall be cooled from 135 ºF (57 ºC) to 70 ºF (21 ºC) within two hours and from 135 ºF (57 ºC) to 41 ºF (5 ºC) within a total of six hours or less. This study examined if methods used to cool chili would meet Food Code cooling standards. Chili was cooled covered and uncovered in a walk-in refrigerator. Covered cooling methods took significantly longer to cool than uncovered cooling methods; no method met Food Code standards. Recommendations for future research included cooling chili at shallower depths.

Food Safety Needs in Independently-Owned Chinese Restaurants: Food Safety Inspectors' Perspective

The purpose of this study was to explore food safety inspectors' views on food safety needs of Chinese-speaking foodservice workers in independently-owned Chinese restaurants. Twenty-eight food safety inspectors completed a web-based questionnaire and identified language barriers and cultural differences as major challenges faced by inspectors when conducting food safety inspections. Critical and non-critical violations commonly observed during inspections were identified as improper cooling of foods and unclean non-food contact surfaces, respectively. Providing food safety training and educational tools in Chinese language was considered critical to improve food safety practices in Chinese restaurants.

Exploring Restaurant Service Sabotage Behaviors in the U.S.

Service sabotage refers to employee's deliberate actions that negatively influence the delivery of service or service standards. Extent literature asserts that service sabotage is prevalent, costly, and detrimental in the service industry. However, the expression of service sabotage may vary drastically depending on the industry because service sabotage behaviors are context-specific. Therefore, the purpose of the study was to explore prevalent restaurant service sabotage behaviors. A total of 419 non-managerial front-of-house frontline employees in full-service restaurants in the U.S. were recruited from an online restaurant employee panel. Results show that 80.4% of the respondents had sabotaged restaurant service at least once a year, and eight out of 39 types of restaurant service sabotage behaviors were conducted by 51.7% or more of the research participants. Among identified restaurant sabotage behaviors, complaining about customers with colleagues was the most prevalent, followed by passive-aggressive sabotage behaviors. According to the cluster analysis, service saboteurs tend to be younger and a larger proportion of them work in fine-dining restaurants (30.9%) compared to those who had lower propensity to sabotage service (19.7% in fine-dining restaurants). This study yielded practical insights for restaurant managers to more effectively manage service sabotage and provide a foundation for scale development in future research.

Educational Affordances of Google Glass as a New Instructional Platform for Foodservice Training

Foodservice training delivered through wearable computers is a new type of instructional delivery method, yet little is known about how it impacts training outcomes. Three educational properties of a wearable computer-based foodservice training platform were compared to traditional, strictly video-based, classroom training. Results showed the efficiency of using the wearable computer as an on-the-job training method, as participants required less than 50% of the time to view and execute the training and food handling tasks compared to the strictly video-based group. Food industry stakeholders should weigh the costs and benefits of using wearable computers when considering upgrading existing training methods.

Research Contribution

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VENTILATED AND UNVENTILATED COOLING METHODS IN ONSITE FOODSERVICE OPERATIONS

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ABSTRACT
The 2017 Food and Drug Administration (FDA) Food Code states that food shall be cooled from 135ºF (57ºC) to 70ºF (21ºC) within two hours and from 135ºF (57ºC) to 41ºF (5ºC) within a total of six hours or less. This study examined if methods used to cool chili would meet Food Code cooling standards. Chili was cooled covered and uncovered in a walk-in refrigerator. Covered cooling methods took significantly longer to cool than uncovered cooling methods; no method met Food Code standards. Recommendations for future research included cooling chili at shallower depths.

Keywords: cooling; schools; foodservice; FDA; Food Code

Acknowledgements: This research was funded in part by a grant from the Foodservice Systems Management Education Council (FSMEC). Bradley University Dining Services provided the use of their university residence dining center kitchen for data collection. The Department of Family and Consumer Sciences at Bradley University provided all temperature monitoring equipment used in this study.

INTRODUCTION

Food safety is a critical issue in the United States (U.S.) and maintaining excellent food safety standards in a foodservice operation is imperative to protect customers and employees from foodborne illness (National Restaurant Association Educational Foundation, 2017). Foodborne illness is estimated to affect 48 million people in the United States annually, along with 128,000 hospitalizations and 3,000 deaths (Centers for Disease Control and Prevention [CDC], 2011). Of these 48 million foodborne illnesses, 20% are attributed to 31 known foodborne pathogens (CDC, 2011; Scallan et al., 2011).

The improper cooling of food products is a significant factor contributing to foodborne illness outbreaks in foodservice operations (Brown et al., 2012; Schaffner et al., 2015; U.S. Food and Drug Administration [FDA], 2018). The potential for outbreaks of foodborne illness exists in environments where food is prepared in large batches. Quantity production of food in a single location is a common process found in institutional foodservice operations, and single locations accounted for 94% of 5,022 outbreak reports in the United States and Puerto Rico from 2009–2015 (Dewey-Mattia, Manikonda, Hall, Wise, & Crowe, 2018). *C. perfringens*, a bacteria associated with improper food temperatures, is estimated to account for 965,958 cases of foodborne illness that occur annually in the United States (Scallan et al., 2011). *Bacillus cereus* (*B. cereus*), another bacteria associated with improper food temperatures, is estimated to cause over 63,400 foodborne illnesses each year (Scallan et al., 2011).

Past studies have identified cooling as a critical control point that school foodservice directors should address while planning food safety programs (Olds, Roberts, Sauer, Sneed, & Shanklin, 2013; Pogostin et al., 2008). From 1998-2006, the third highest contributing risk factor in 16 of 298 school-associated foodborne outbreaks was identified to be inadequate or "slow" cooling of food prepared on school premises (Pogostin et al., 2008). The Centers for Disease Control and Prevention collected data via the Foodborne Disease Outbreak Surveillance System from 2000-2010 pertaining to foodborne illness outbreaks in school settings (Venuto, Garcia, & Halbrook, 2015). The study found that the second highest contributing risk factor for the proliferation of pathogens in food was that no effort was made to control the temperature of food items or the length of time that those food items were not under temperature control (Venuto et al., 2015). The third highest contributing risk factor for the growth of pathogens was improper cold holding caused by faulty refrigeration equipment (Venuto et al., 2015). These two factors above accounted for a total of 38.2% of 105 identified food safety errors contributing to the proliferation of pathogens in this study (Venuto et al., 2015). These factors are of significant importance in school foodservice operations where only breakfast and lunch meals are prepared, and employees typically leave work for the day shortly after the start of cooling procedures, with little or no opportunity for actively monitoring cooling procedures (Roberts, Olds, Shanklin, Sauer, & Sneed, 2013).

The FDA Food Code provides uniform and systematic recommendations to ensure that food offered in foodservice and retail establishments is safe to eat and is presented honestly to customers (FDA, 2017). The FDA Food Code is commonly adopted by government agencies responsible for preventing foodborne illness; these agencies inspect and regulate foodservice operations in restaurants, schools, and hospitals (National Restaurant Association Educational Foundation, 2017).

The FDA Food Code receives input from the Conference for Food Protection , a non-profit organization comprised of members from the foodservice industry, academia, regulatory agencies, and other professional organizations (Conference for Food Protection, 2018; FDA, 2017). Collaboration also occurs between the FDA, the U.S. Department of Agriculture's (USDA) Food Safety and Inspection Service and the Centers for Disease Control and Prevention of the U.S. Department of Health and Human Services in establishing FDA Food Code requirements (FDA, 2017). The input of the Conference for Food Protection, USDA Food Safety and Inspection Service , and the CDC is used to periodically update the FDA Food Code; the Food Code was most recently updated in 2017, with prior updates in 2013, 2009, 2005, 2001, 1999, and 1997 (FDA, 2017).

Section 3-501.14 of the 2017 FDA Food Code states that "cooked time/temperature control for safety food shall be cooled: (1) Within 2 hours from 57ºC (135ºF) to 21ºC (70ºF); and (2) Within a total of 6 hours from 57ºC (135ºF) to 5ºC (41ºF) or less" (FDA, 2017, p. 94). This two-part cooling standard is classified by the FDA as a "priority item", which means that it "contributes directly to the elimination, prevention or reduction to an acceptable level, hazards associated with foodborne illness or injury and there is no other provision that more directly controls the hazard" (FDA, 2017, p. 16). The purpose of

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this cooling standard is to minimize the time that food spends in the "temperature danger zone" (41ºF – 135ºF) to prevent the rapid growth of bacteria, such as *C. perfringens*, in food undergoing cooling (National Restaurant Association Educational Foundation, 2017). Foods can be contaminated with a wide variety of bacteria having a wide range of infectious doses (FDA, 2012). Cooling times exceeding FDA Food Code standards may allow bacteria to multiply to unsafe levels, which may lead to foodborne illness outbreaks (National Restaurant Association Educational Foundation, 2017).

The 2017 FDA Food Code (§ 3-501.15) outlines acceptable cooling methods based upon the type of food product. These cooling methods include: (a) portioning food into shallow pans; (b) dividing food into smaller portions; (c) utilizing specialized rapid-cooling equipment (such as a blast chiller) to cool food quickly; (d) placing food containers in an ice water bath and stirring the food product; (e) using food containers that permit heat to be easily transferred from the food product; (f) adding ice to food as a part of the food preparation process; and (g) utilizing other effective cooling methods (FDA, 2017). An example of an "other effective cooling method" is to place uncovered food at 2 in. depths in a walk-in freezer to cool (Roberts et al., 2013). Section 3-501.15 of the 2017 FDA Food Code recommends that when food is placed in cooling or cold holding equipment, food containers in which food is being cooled shall be arranged to provide maximum heat transfer through the container walls. Food shall also be loosely covered or uncovered during the cooling period to facilitate heat transfer from the surface of the food, if it is protected from overhead contamination as specified under Subparagraph 3-305.11(A)(2) of the 2017 FDA Food Code.

Several studies have explored the ongoing problems and challenges associated with cooling large quantities of foods within FDA Food Code cooling standards in foodservice operations (Beardall, Paez, Phebus, Watkins, & Gragg, 2019a; Beardall, Paez, Phebus, Watkins, & Gragg, 2019b; Brown et al., 2012; Krishnamurthy & Sneed, 2011; Olds et al., 2013; Olds & Sneed, 2005; Roberts et al., 2013; Schaffner et al., 2015; Watkins, Gragg, Beardall, Phebus, & Paez, 2016). Schaffner et al. (2015) found that during cooling, unventilated (covered) food products were twice as likely to take longer to cool as ventilated (uncovered) food products. Brown et al. (2012) observed cooling practices in foodservice operations and found that in 160 of 466 walk-in refrigerators (34.3%) observed, food being cooled was not ventilated, despite FDA Food Code recommendations that cooling food should be ventilated (FDA, 2017). These studies indicate that unventilated cooling of food is both a common and risky practice in foodservice operations.

Krishnamurthy and Sneed (2011) studied cooling practices used in U.S. schools. From a sample of 411 respondents, 78% reported that food prepared in schools was cooled for reheating and service. Most school foodservice directors (76%) stated that 2 in. stainless steel foodservice pans were utilized for cooling food. Other responses included the use of 4 in. foodservice pans for cooling (39%), 6 in. foodservice pans (9%), and stockpots (6%), all of which increased in cooling time as the depths and/or amounts of food product undergoing cooling also increased. Respondents also indicated that they used chill sticks (37%) and ice baths (38%) while cooling food products in their foodservice operations.

The purpose of this research was to determine if practices commonly used to cool food produced in onsite foodservice operations would meet established 2017 FDA Food Code standards. To the best of the author's knowledge, no study had previously explored the comparisons between ventilated and unventilated cooling of chili con carne with beans in a walk-in refrigerator, while utilizing a variety of sizes of foodservice storage containers, including a 5-gallon high-density polyethylene bucket. This study provided insights into preventing outbreaks of foodborne illness caused by methods that facilitate the improper cooling of food. The main objectives of this study were to: (a) compare the time and temperature differences between ventilated and unventilated cooling methods commonly utilized to cool chili con carne with beans in a walk-in refrigerator; and (b) determine the optimal cooling method(s) for chili con carne with beans from ventilated and unventilated cooling methods tested in this study.

METHODOLOGY

Sample Selection and Preparation

USDA school recipes, available online from the Institute of Child Nutrition, University, Mississippi, were used for preparation of food products. Chili is a food item commonly prepared and cooled in the U.S. National School Lunch Program (Krishnamurthy & Sneed, 2011; Olds & Sneed, 2005; Roberts et al., 2013). For this study, chili was prepared using a standardized recipe (Chili con Carne with Beans, USDA Recipe #D-20) from the *USDA Recipes for Schools* (Institute of Child Nutrition, 2016).

Chili con carne with beans recipe ingredients were procured from local retail food suppliers. Chili was prepared in a modern university residence dining center kitchen using standard foodservice equipment at Bradley University (Peoria, Illinois). The principal investigator was granted exclusive use of the facilities over the summer recess and no other concurrent food production or service activities occurred during data collection procedures. Chili was prepared on a commercial gas range in 26-quart aluminum stockpots. Chili was heated to 212ºF and then transferred while still hot (>135ºF) into selected foodservice storage containers at varying depths/ amounts for testing. Containers used included stainless steel foodservice pans, all with 12 in. widths, varying lengths (10 in. and 20 in.), and varying heights (2 ½ in. and 4 in.). These containers included: 12 in. x 10 in. x 2 ½ in. pans with 2 in. chili depths, 12 in. x 20 in. x 2 ½ in. pans with 2 in. chili depths, 12 in. x 10 in. x 4 in. pans with 3 in. chili depths, and 12 in. x 20 in. x 4 in. pans with 3 in. chili depths. Additional containers used included 20-quart aluminum stockpots and 5-gallon high-density polyethylene buckets, all with 12 in. diameters and varying heights (10½ in. for the stockpots with 3 gallons of chili and 13 in. for the buckets with 5 gallons of chili) (see Table 1).

Comark RF512 Wireless Temperature Transmitters (Comark USA, Beaverton, OR) were connected to Comark RFAX100D thermistors (Comark USA, Beaverton, OR). The thermistors were affixed in the geometric center of the chili to measure the hottest area of the containers during cooling. The 2017 FDA Food Code states that "the geometric center or thickest part of a product are the points of measurement of product temperature particularly when measuring critical limits for cooking" (FDA, 2017, p. 606). The transmitters recorded time and temperature data during cooling. A Comark RF500 temperature monitoring system (Comark USA, Beaverton, OR) was used to download and aggregate the recorded data from the transmitters.

Cooling Procedures

A commercial walk-in refrigerator located in a university residence dining center kitchen at Bradley University (Peoria, Illinois) was used for all cooling procedures. A Comark RF512 Wireless Temperature Transmitter recorded the ambient air temperature of the walk-in refrigerator, which was operated at a mean temperature of 34.6ºF (*SD* = 1.36ºF). The walk-in refrigerator had 100% free capacity (0% load) prior to foodservice storage containers being placed inside for testing. No other items were present in the walk-in refrigerator while

Table 1. Materials and Methods Used to Cool Chili, Covered or Uncovered, in a Commercial Walk-in Refrigerator from 135ºF to 41ºF

Container Dimensions Width (W), Length (L), Height (H), Diameter (D)	**Depth or Amount of Chili**	**Cooling Method (CM)**	**Ventilation During Cooling**	**Number of containers used per replication**	**Number of replications**
Stainless Steel Foodservice Pan 12 in. W x 10 in. L x 2 ½ in. H	2 in.	CM1	Covered*	3	3
		CM2	Uncovered	3	3
Stainless Steel Foodservice Pan 12 in. W x 20 in. L x 2 ½ in. H	2 in.	CM3	Covered*	3	3
		CM4	Uncovered	3	3
Stainless Steel Foodservice Pan 12 in. W x 10 in. L x 4 in. H	3 in.	CM5	Covered*	3	3
		CM6	Uncovered	3	3
Stainless Steel Foodservice Pan 12 in. W x 20 in. L x 4 in. H	3 in.	CM7	Covered*	3	3
		CM8	Uncovered	3	3
20-quart Aluminum Stockpot 12 in. D x 10½ in. H	3 gallons	CM9	Covered**	1	3
		CM10	Uncovered	1	3
5-gallon High-Density Polyethylene Bucket 12 in. D x 13 in. H	5 gallons	CM11	Covered**	1	3
		CM12	Uncovered	1	3

*Wrapped tightly with a single layer of plastic foodservice film.
**Wrapped tightly with a single layer of aluminum foil.

the covered and uncovered containers of chili were cooling. Containers undergoing testing were placed in the walk-in refrigerator equidistantly apart from one another on standard wire-rack shelving, which facilitated air circulation around all sides of the containers. For all cooling methods tested, the door to the walk-in refrigerator remained closed and locked during cooling, until all containers of chili had reached 41ºF.

Prior studies demonstrated that covered food products cooled slower than uncovered products (Brown et al., 2012; Institute for Food Safety and Health, 2011; Olds, Mendonca, Sneed, & Bisha, 2006; Schaffner et al., 2015). This study expanded upon prior cooling methods used in ventilated (uncovered) chili cooling studies by Olds & Sneed (2005) and Roberts et al. (2013). For this study, chili was cooled using two methods: (a) ventilated (uncovered) containers; and (b) unventilated containers (containers covered with a single layer of plastic foodservice film or a single layer of aluminum foil). Selected foodservice storage containers containing hot chili (>135ºF) were either covered (wrapped with plastic foodservice film or aluminum foil) or left uncovered and both placed in a commercial walk-in refrigerator for concurrent cooling. For each of the six sizes of foodservice containers used in this study, two forms of ventilation (covered or uncovered) were tested, equating to a total of 12 cooling methods (CM1 – CM12). Three replications were conducted for each of the 12 cooling methods tested. For each replication, equal numbers of covered (unventilated) and uncovered (ventilated) containers of identical size were cooled concurrently in the walk-in refrigerator until all containers of chili had reached 41ºF.

All odd-numbered cooling methods used covered containers and all even-numbered cooling methods used uncovered containers. Covered and uncovered cooling methods that were tested concurrently included: CM1 & CM2, CM3 & CM4, CM5 & CM6, CM7 & CM8, CM9 & CM10, and CM11 & CM12 (see Table 1). Stainless steel foodservice pans were wrapped tightly with a single layer of plastic foodservice film for covered cooling methods CM1, CM3, CM5, and CM7. Twenty-quart aluminum stockpots and 5-gallon high-density polyethylene buckets were wrapped tightly with a single layer of aluminum foil and secured with large rubber bands for covered cooling methods CM9 and CM11. Equipment used to secure the thermistors in the geometric center of the chili did not permit the use of the regular lids for the aluminum stockpots and the 5-gallon high-density polyethylene buckets. It was determined that aluminum foil as covering would be a logical substitute for the aluminum stockpot lid. Aluminum foil was accordingly selected as covering for the buckets as time and temperature data from the stockpots and the buckets were planned for comparison. Thus, a single layer of aluminum foil, secured around the circumference of the stockpots and buckets with large rubber bands, was the method used to ensure the stockpots and buckets remained tightly wrapped while cooling. No plastic foodservice film or aluminum foil was used for uncovered cooling methods CM2, CM4, CM6, CM8, CM10, and CM12 (see Table 1).

For each replication, temperatures of the geometric center of the chili in the containers were measured with Comark RFAX100D thermistors, which were connected to Comark RF512 Wireless Temperature Transmitters. Temperature data were logged at 1-minute intervals and recorded on the transmitters during testing. Upon the completion of each replication, the transmitters were removed from the walk-in refrigerator, disconnected from the thermistors, and transported from the dining center kitchen to a computer laboratory for data analysis.

Data Analysis

Time and temperature data from the Comark RF512 Wireless Temperature Transmitters were downloaded to the Comark RF500A wireless monitoring gateway. Data were analyzed using Microsoft

Excel 2013 (Microsoft Corporation, Redmond, WA) and SPSS Statistics version 25 (International Business Machines [IBM] Corporation, Armonk, New York). Means and standard deviations of time and temperature data ranges (135ºF to 70ºF, and 135ºF to 41ºF) for each cooling method were calculated for comparison with FDA Food Code cooling standards. Representative mean time and temperature cooling curves were plotted using Microsoft Excel 2013.

RESULTS AND DISCUSSION

This section outlines the results found from the cooling methods. The main objectives of this study were to compare the time and temperature differences between ventilated and unventilated cooling methods and determine which of those methods successfully met (or did not meet) 2017 FDA Food Code cooling standards. To comply with the 2017 FDA Food Code, these standards must be satisfied when cooked food is cooled.

Mean cooling times for all cooling methods tested in this study are shown in Table 2. None of the 12 uncovered or covered cooling methods tested met 2017 FDA Food Code cooling standards in the walk-in refrigerator. No cooling method cooled chili con carne with beans from 135ºF to 70ºF within two hours and no cooling method cooled chili from 135ºF to 41ºF within a total of six hours.

A two-factor (2x2) repeated measures Analysis of Variance (ANOVA) procedure was used to analyze time and temperature data. To investigate the influence of covering method and chili depth/amount (main effects) on the cooling time, cooling methods with identical container widths and lengths or identical container diameters were compared for time and temperature data ranges of 135ºF to 70ºF and 135ºF to 41ºF. Two independent variables, each with two levels, were tested for effects on the dependent variable: covering method (covered or uncovered), and depth/amount of chili (2 in. or 3 in. depths for pans and 3 gallon or 5 gallon amounts for stockpots/ buckets). Significant interactions between the independent variables were explored using profile plots and related pairwise t-tests to analyze data for comparison at the treatment level. The significance threshold for the effects of the variables and variable interactions was set at $p \leq .05$.

Analysis of chili cooled from 135ºF to 70ºF (see Table 3).

Stainless steel foodservice pans: 12 in. widths x 10 in. lengths.

For cooling methods CM1 & CM2, compared with CM5 & CM6, there was a significant main effect of covering method on cooling time ($F(1, 8) = 36.28$, $p < .001$). Covered containers ($M = 0.176$) took longer to cool than uncovered containers ($M = 0.126$). In addition, there was a significant main effect of the depth of chili on cooling time ($F(1, 8) = 121.93$, $p < .001$). Containers at 3 in. depths ($M = 0.177$) took longer to cool than containers at 2 in. depths ($M = 0.126$). No interaction effect was observed between covering method and depth of chili ($F(1, 8) = 0.51$, $p = .497$).

Table 2. Results of Testing Commonly Used Foodservice Storage Containing Hot Chili, Cooled in a Commercial Walk-in Refrigerator, including Mean Cooling Times for Covered and Uncovered Cooling Methods from 135ºF to 70ºF and 135ºF to 41ºF

Container Dimensions Width (W), Length (L), Height (H), Diameter (D)	Depth or Amount of Chili	Mean Walk-In Refrigerator Ambient Air Temperature in Degrees Fahrenheit ± Standard Deviation	Cooling Method (CM)	Covering Method During Cooling	Mean Cooling Time Hr : Min ± Standard Deviation 135ºF to 70ºF* *2017 FDA Food Code Standard: ≤ 2:00 hr	Mean Cooling Time Hr : Min ± Standard Deviation 135ºF to 41ºF** **2017 FDA Food Code Standard: ≤ 6:00 hr	Mean Difference in Cooling Method Times (CM Covered - CM Uncovered) Hr : Min ± Standard Deviation 135ºF to 70ºF	Mean Difference in Cooling Method Times (CM Covered - CM Uncovered) Hr : Min ± Standard Deviation 135ºF to 41ºF
Stainless Steel Food-service Pan 12 in. W x 10 in. L x 2 ½ in. H	2 in.	34.9 ± 1.20	CM1	Covered	3:33 ± 0:14	9:41 ± 0:47	1:07 ± 0:32	3:05 ± 1:27
			CM2	Uncovered	2:26 ± 0:10	6:36 ± 0:31		
Stainless Steel Food-service Pan 12 in. W x 20 in. L x 2 ½ in. H	2 in.	34.6 ± 1.36	CM3	Covered	3:54 ± 0:14	10:42 ± 0:33	1:33 ± 0:35	4:19 ± 1:20
			CM4	Uncovered	2:21 ± 0:09	6:23 ± 0:30		
Stainless Steel Food-service Pan 12 in. W x 10 in. L x 4 in. H	3 in.	34.5 ± 1.32	CM5	Covered	4:53 ± 0:26	13:23 ± 1:09	1:16 ± 0:41	3:37 ± 1:45
			CM6	Uncovered	3:37 ± 0:15	9:46 ± 0:46		
Stainless Steel Food-service Pan 12 in. W x 20 in. L x 4 in. H	3 in.	34.6 ± 1.30	CM7	Covered	4:54 ± 0:34	13:40 ± 1:25	1:07 ± 0:16	3:25 ± 0:34
			CM8	Uncovered	3:47 ± 0:25	10:15 ± 1:31		
20-quart Aluminum Stockpot 12 in. D x 10½ in. H	3 Gallons	34.8 ± 1.50	CM9	Covered	7:21 ± 0:12	20:17 ± 1:00	1:28 ± 0:07	4:05 ± 0:38
			CM10	Uncovered	5:53 ± 0:09	16:12 ± 1:03		
5-gallon High-Density Polyethylene Bucket 12 in. D x 13 in. H	5 Gallons	34.5 ± 1.44	CM11	Covered	12:25 ± 0:18	34:47 ± 1:13	2:58 ± 0:12	9:35 ± 1:44
			CM12	Uncovered	9:27 ± 0:07	25:12 ± 0:32		

Table 3. Two-way (2x2) Repeated Measures ANOVA – Analysis of Data for Chili Cooled from 135ºF to 70ºF

Cooling Methods (CM) Compared	Main Effect of Covering Method	Mean of Covered (*SE*)*	Mean of Uncovered (*SE*)*	Main Effect of Depth of Chili	Mean of 2 in. Depth (*SE*)*	Mean of 3 in. Depth (*SE*)*	Interaction of Covering Method & Depth of Chili
CM1 & CM2 (12 in. x 10 in. x 2 in. chili depths) CM5 & CM6 (12 in. x 10 in. x 3 in. chili depths)	$F(1, 8) = 36.28$, $p < .001$	0.176 (0.006)	0.126 (0.003)	$F(1, 8) = 121.93$, $p < .001$	0.125 (0.003)	0.177 (0.004)	$F(1, 8) = 0.51$, $p = .497$
CM3 & CM4 (12 in. x 20 in. x 2 in. chili depths) CM7 & CM8 (12 in. x 20 in. x 3 in. chili depths)	$F(1, 8) = 70.86$, $p < .001$	0.184 (0.007)	0.128 (0.004)	$F(1, 8) = 94.74$, $p < .001$	0.130 (0.004)	0.181 (0.006)	$F(1, 8) = 5.52$, $p = .047$**

Cooling Methods (CM) Compared	Main Effect of Covering Method	Mean of Covered (*SE*)*	Mean of Uncovered (*SE*)*	Main Effect of Amount of Chili in gallons	Mean of 3 gallon Amount (*SE*)*	Mean of 5 gallon Amount (*SE*)*	Interaction of Covering Method & Amount of Chili
CM9 & CM10 (12 in. diameter x 3 gallons chili) CM11 & CM12 (12 in. diameter x 5 gallons chili)	$F(1, 2) = 989.70$, $p = .001$	0.412 (0.005)	0.320 (0.003)	$F(1, 2) = 2027.63$, $p < .001$	0.276 (0.004)	0.456 (0.005)	$F(1, 2) = 108.97$, $p = .009$***

*Mean times are reported in days (1.000 = one day), *SE* = standard error.
** See Figure 1 for interaction profile plot.
*** See Figure 2 for interaction profile plot

Stainless steel foodservice pans: 12 in. widths x 20 in. lengths.
For cooling methods CM3 & CM4, compared with CM7 & CM8, a significant interaction effect was observed between covering method and depth of chili ($F(1, 8) = 5.52$, $p = .047$) (see Figure 1). Related pairwise t-tests for covering method revealed a significant difference between covered ($M = 0.16$, $SD = 0.02$) and uncovered ($M = 0.10$, $SD = 0.01$) cooling methods for 2 in. depths of chili ($t(8) = 8.54$, $p < .001$), and a significant difference in covering method between covered ($M = 0.20$, $SD = 0.02$) and uncovered ($M = 0.16$, $SD = 0.02$) cooling methods for 3 in. depths of chili ($t(8) = 5.96$, $p < .001$). Related pairwise t-tests for depth of chili revealed a significant difference between 2 in. depths of chili ($M = 0.16$, $SD = 0.02$) and 3 in. depths of chili ($M = 0.20$, $SD = 0.02$) for covered cooling methods ($t(8) = -5.00$, $p = .001$), and a significant difference between 2 in. depths of chili ($M = 0.10$, $SD = 0.01$) and 3 in. depths of chili ($M = 0.16$, $SD = 0.02$) for uncovered cooling methods ($t(8) = -14.83$, $p < .001$).

Aluminum stockpots and high-density polyethylene buckets: 12 in. diameters.
For cooling methods CM9 & CM10, compared with CM11 & CM12, a significant interaction effect was observed between covering method and depth of chili ($F(1, 2) = 108.97$, $p = .009$) (see Figure 2). Related pairwise t-tests for covering method revealed a significant difference between covered ($M = 0.31$, $SD = 0.01$) and uncovered ($M = 0.25$, $SD = 0.01$) cooling methods for 3 gallon amounts of chili ($t(2) = 19.98$, $p = .002$), and a significant difference in covering method between covered ($M = 0.52$, $SD = 0.01$) and uncovered ($M = 0.39$, $SD = 0.01$) cooling methods for 5 gallon amounts of chili ($t(2) = 24.26$, $p = .002$). Related pairwise t-tests for amount of chili revealed a significant difference between 3 gallon amounts of chili ($M = 0.31$, $SD = 0.01$) and 5 gallon amounts of chili ($M = 0.52$, $SD = 0.01$) for covered cooling methods ($t(2) = -33.50$, $p = .001$), and a significant difference between 3 gallon amounts of chili ($M = 0.25$, $SD = 0.01$) and 5 gallon amounts of chili ($M = 0.39$, $SD = 0.01$) for uncovered cooling methods ($t(2) = -46.70$, $p < .001$).

Analysis of chili cooled from 135ºF to 41ºF (see Table 4).
Stainless steel foodservice pans: 12 in. widths x 10 in. lengths.
For cooling methods CM1 & CM2, compared with CM5 & CM6, there was a significant main effect of covering method on cooling time ($F(1, 8) = 44.49$, $p < .001$). Covered containers ($M = 0.481$) took longer to cool than uncovered containers ($M = 0.341$). In addition, there was a significant main effect of the depth of chili on cooling time ($F(1, 8) = 127.06$, $p < .001$). Containers at 3 in. depths ($M = 0.483$) took longer to cool than containers at 2 in. depths ($M = 0.339$). No interaction effect was observed between covering method and depth of chili ($F(1, 8) = 0.74$, $p = .416$).

Stainless steel foodservice pans: 12 in. widths x 20 in. lengths.
For cooling methods CM3 & CM4, compared with CM7 & CM8, there was a significant main effect of covering method on cooling time ($F(1, 8) = 101.33$, $p < .001$). Covered containers ($M = 0.508$) took longer to cool than uncovered containers ($M = 0.347$). In addition, there was a significant main effect of the depth of chili on cooling time ($F(1, 8) = 103.69$, $p < .001$). Containers at 3 in. depths ($M = 0.498$) took longer to cool than containers at 2 in. depths ($M = 0.356$). No interaction effect was observed between covering method and depth of chili ($F(1, 8) = 2.84$, $p = .13$).

Table 4. Two-way (2x2) Repeated Measures ANOVA – Analysis of Data for Chili Cooled from 135 ºF to 41 ºF

Cooling Methods (CM) Compared	Main Effect of Covering Method	Mean of Covered (*SE*)*	Mean of Uncovered (*SE*)*	Main Effect of Depth of Chili	Mean of 2 in. Depth (*SE*)*	Mean of 3 in. Depth (*SE*)*	Interaction of Covering Method & Depth of Chili
CM1 & CM2 (12 in. x 10 in. x 2 in. chili depths) CM5 & CM6 (12 in. x 10 in. x 3 in. chili depths)	$F(1, 8) = 44.49$, $p < .001$	0.481 (0.015)	0.341 (0.009)	$F(1, 8) = 127.06$, $p < .001$	0.339 (0.010)	0.483 (0.009)	$F(1, 8) = 0.74$, $p = .416$
CM3 & CM4 (12 in. x 20 in. x 2 in. chili depths) CM7 & CM8 (12 in. x 20 in. x 3 in. chili depths)	$F(1, 8) = 101.33$, $p < .001$	0.508 (0.015)	0.347 (0.012)	$F(1, 8) = 103.69$, $p < .001$	0.356 (0.010)	0.498 (0.016)	$F(1, 8) = 2.84$, $p = .13$

Cooling Methods (CM) Compared	Main Effect of Covering Method	Mean of Covered (*SE*)*	Mean of Uncovered (*SE*)*	Main Effect of Amount of Chili in gallons	Mean of 3 gallon Amount (*SE*)*	Mean of 5 gallon Amount (*SE*)*	Interaction of Covering Method & Amount of Chili
CM9 & CM10 (12 in. diameter x 3 gallons chili) CM11 & CM12 (12 in. diameter x 5 gallons chili)	$F(1, 2) = 98.06$, $p = .01$	1.147 (0.022)	0.863 (0.017)	$F(1, 2) = 448.58$, $p = .002$	0.760 (0.023)	1.250 (0.009)	$F(1, 2) = 75.30$, $p = .013$**

*Mean times are reported in days (1.000 = one day), *SE* = standard error.
** See Figure 3 for interaction profile plot.

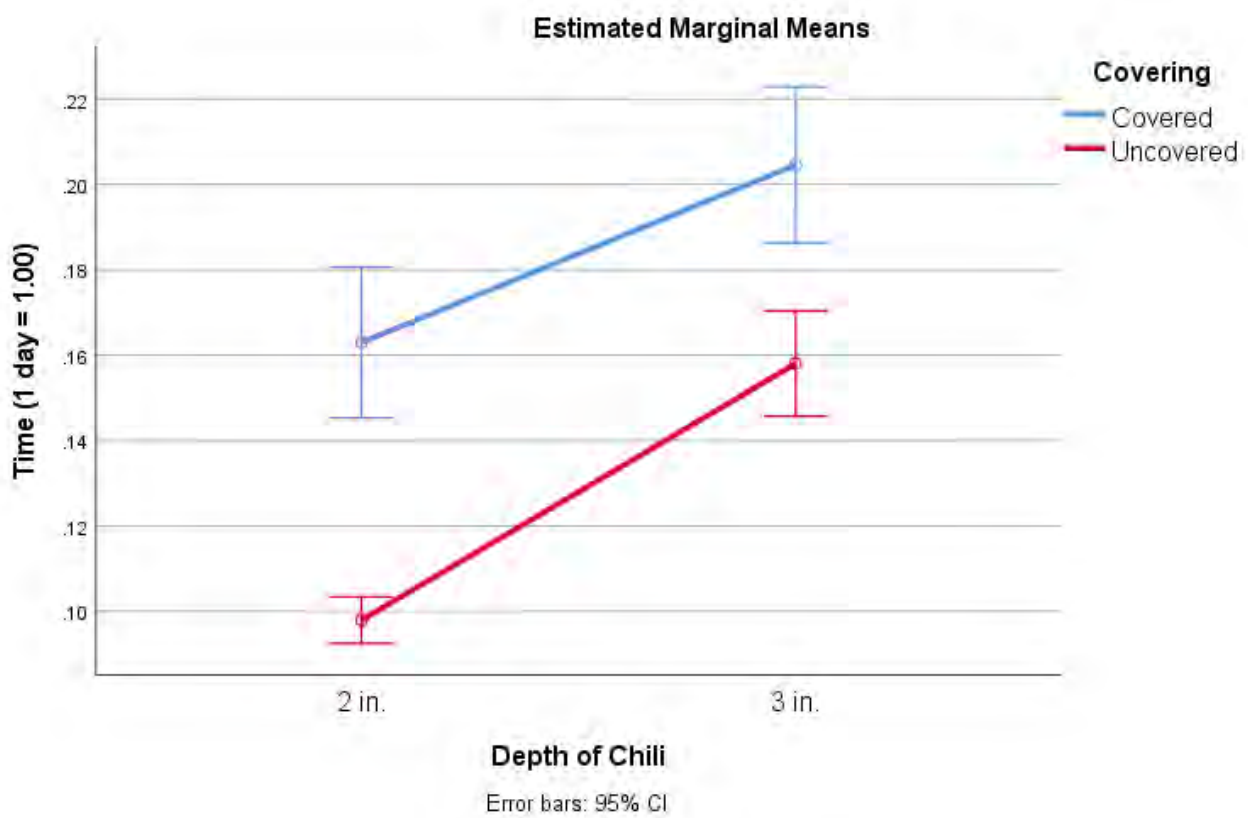


Figure 1. Interaction Profile Plot for Cooling Method 3 (Covered, 2 in.) and Cooling Method 4 (Uncovered, 2 in.); Compared to Cooling Method 7 (Covered, 3 in.) and Cooling Method 8 (Uncovered, 3 in.) for chili cooled from 135ºF to 70ºF.

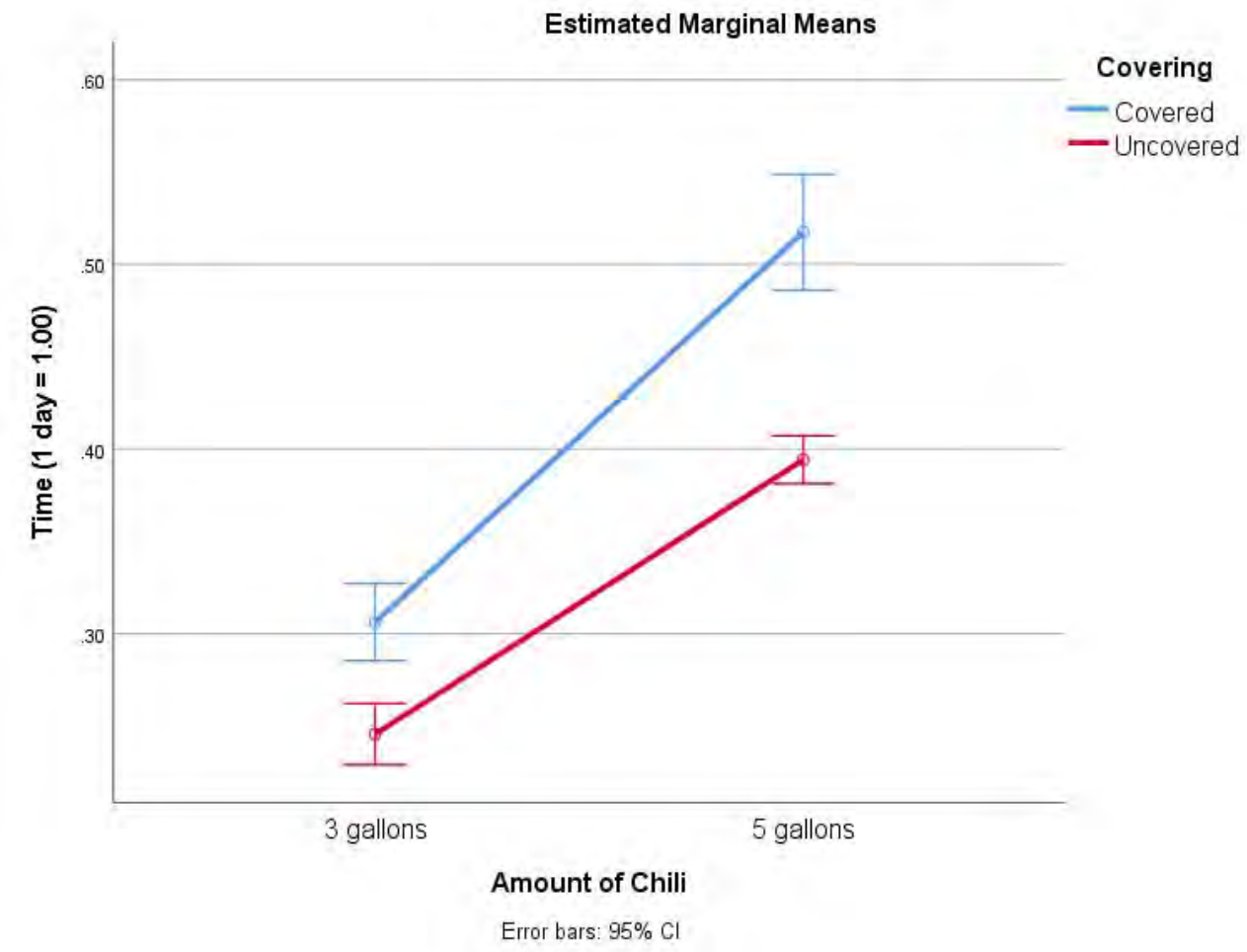


Figure 2. Interaction Profile Plot for Cooling Method 9 (Covered, 3 Gallons) & Cooling Method 10 (Uncovered, 3 Gallons); Compared to Cooling Method 11 (Covered, 5 Gallons) & Cooling Method 12 (Uncovered, 5 Gallons) for Chili Cooled from 135ºF to 70ºF.

Aluminum stockpots and high-density polyethylene buckets: 12 in. diameters.

For cooling methods CM9 & CM10, compared with CM11 & CM12, a significant interaction effect was observed between covering method and amount of chili ($F(1, 2) = 75.30$, $p = .013$) (see Figure 3). Related pairwise t-tests for covering method revealed a significant difference between covered ($M = 0.85$, $SD = 0.04$) and uncovered ($M = 0.68$, $SD = 0.04$) cooling methods for 3 gallon amounts of chili ($t(2) = 10.94$, $p = .008$), and a significant difference in covering method between covered ($M = 1.44$, $SD = 0.05$) and uncovered ($M = 1.05$, $SD = 0.02$) cooling methods for 5 gallon amounts of chili ($t(2) = 9.52$, $p = .011$). Related pairwise t-tests for amount of chili revealed a significant difference between 3 gallon amounts of chili ($M = 0.85$, $SD = 0.04$) and 5 gallon amounts of chili ($M = 1.45$, $SD = 0.05$) for covered cooling methods ($t(2) = -19.39$, $p = .003$), and a significant difference between 3 gallon amounts of chili ($M = 0.68$, $SD = 0.04$) and 5 gallon amounts of chili ($M = 1.05$, $SD = 0.02$) for uncovered cooling methods ($t(2) = -17.76$, $p = .003$).

SUMMARY OF RESULTS

While the FDA's recommendations of cooling food uncovered and reducing the depths/amounts of food products did improve the cooling processes, the 2017 FDA Food Code standards were still not met in this study. No cooling method tested in this study cooled chili from 135ºF (57ºC) to 70ºF (21ºC) within two hours and from 135ºF (57ºC) to 41ºF (5ºC) within a total of six hours or less.

The cooling method requiring the shortest cooling time from 135ºF to 41ºF (M = 6 hr 23 min, SD = 33 min) was the uncovered 12 in. x 20 in. stainless steel foodservice pan at a 2 in. food product depth (see Figure 4). The cooling method requiring the longest cooling time from 135ºF to 41ºF (M = 34 hr 47 min, SD = 1 hr 13 min) was the covered 5 gallons of chili in a high-density polyethylene bucket (see Figure 5), which is clearly an unacceptable cooling method that should never be considered for use in any type of foodservice operation.

Past studies have demonstrated that chili which was cooled uncovered in stainless steel foodservice pans at 2 in. depths in a walk-in freezer met FDA cooling time and temperature standards (Beardall et al., 2019a; Roberts et al., 2013; Watkins et al., 2016). However, available freezer space in school foodservice operations has been measured on average to be about 20% and this could be a barrier to cooling food in the freezer (Roberts et al., 2013). In addition, the safety and quality of frozen food normally stored in a walk-in freezer may be compromised if it is permitted to defrost while hot food products are cooling.

A prior study by Olds and Sneed (2005) explored ventilated cooling of chili con carne with beans using the following methods: (a) 12 in. x 10 in. stainless steel foodservice pans at 2 in. and 4 in. food product depths, cooled in a walk-in refrigerator; (b) 12 in. x 10 in. stainless steel foodservice pans at 2 in. and 4 in. food product depths, cooled in a blast chiller; (c) a stockpot containing 3 gallons of chili cooled in a

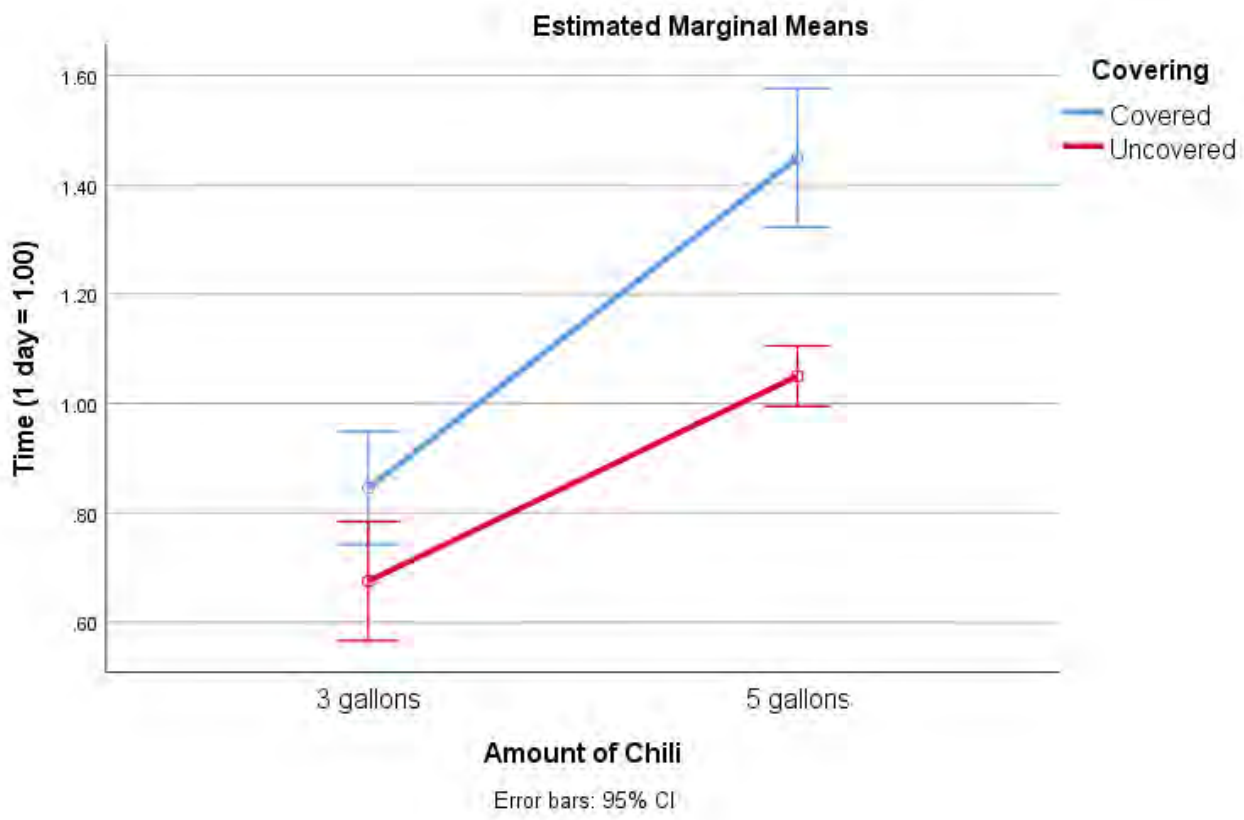


Figure 3. Interaction Profile Plot for Cooling Method 9 (Covered, 3 Gallons) & Cooling Method 10 (Uncovered, 3 Gallons); Compared to Cooling Method 11 (Covered, 5 Gallons) & Cooling Method 12 (Uncovered, 5 Gallons) for Chili Cooled from 135ºF to 41ºF.

walk-in refrigerator; and (d) a chill stick used in a stockpot containing 3 gallons of chili, while cooling in a walk-in refrigerator. The only methods that satisfied FDA Food Code cooling standards were those that utilized the blast chiller, which rapidly cooled chili at both 2 in. and 4 in. food product depths within the recommended times. Blast chillers are effective for rapidly cooling food products, but it has been estimated that only about 8% of onsite foodservice operations actually utilize them during food production (Krishnamurthy & Sneed, 2011). However, blast chillers can be prohibitively expensive to procure and thus may not be a feasible alternative for some onsite and retail foodservice operations, given the financial barriers (Olds et al., 2013).

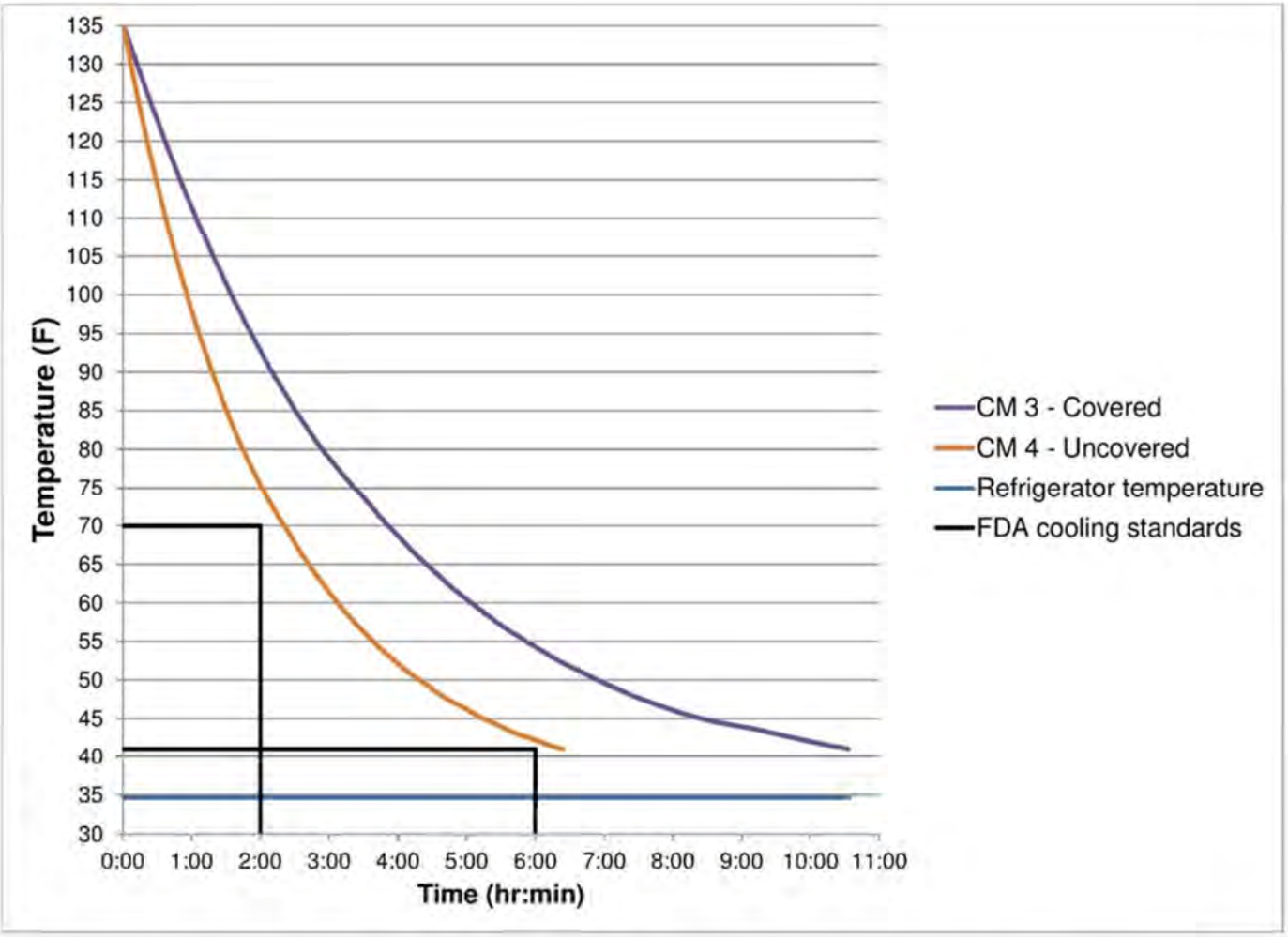
According to the 2017 FDA Food Code section, "Holding Hot Food Without Temperature Control," food held without temperature control should meet the performance standard of no more than 1 log growth of *C. perfringens* and *B. cereus* spores (FDA, 2017). Meeting FDA Food Code cooling standards helps to ensure that spore-forming bacteria such as *C. perfringens* and *B. cereus* do not multiply to unsafe levels and cause foodborne illness. *C. perfringens* spores can be found in chili, a food item commonly prepared and served in onsite foodservice operations (Blankenship, Craven, Leffler, & Custer, 1988; Krishnamurthy & Sneed, 2011). The 2017 FDA Food Code (§ 3-501.15) outlines acceptable cooling methods based upon the type of food product. These cooling methods include portioning food into shallow pans. This study demonstrated that chili cooled uncovered at 3 in. depths took longer to cool, as expected, than chili cooled uncovered at 2 in. depths. As shown in Table 2, chili cooled uncovered at 2 in. depths (cooling methods CM2 & CM4) only slightly exceeded Food Code standards. Further reduction of the depths of chili, while being cooled uncovered in a walk-in refrigerator, could potentially meet 2017 FDA Food Code cooling standards. If this was confirmed in a future research study, it could become a useful standard operating procedure for foodservice operations where walk-in freezers and blast chillers are not feasible options for cooling food.

CONCLUSIONS AND APPLICATIONS

The purpose of this research was to determine if practices commonly used to cool food produced in onsite foodservice operations would meet established 2017 U.S. FDA Food Code cooling standards.

The following conclusions were made based on the results of this study:

1. None of the cooling treatments tested in this study met 2017 FDA Food Code cooling standards.
2. For all cooling methods tested in this study, unventilated (covered) cooling methods took significantly longer to cool than ventilated (uncovered) cooling methods ($p < .05$).
3. For all cooling methods tested in this study on containers of identical widths and lengths, cooling methods with 3 in. depths of chili took significantly longer to cool than cooling methods with 2 in. depths ($p < .005$).
4. For all cooling methods tested in this study on containers of identical diameters, cooling methods with 5 gallon amounts of chili took significantly longer to cool than cooling methods with 3 gallon amounts of chili ($p < .005$).
5. Because FDA Food Code cooling standards were not met, the potential existed for spore-forming bacteria, such as *C. perfringens*, to multiply to unsafe levels.
6. Future research could help determine if cooling chili uncovered at depths less than 2 in. in a walk-in refrigerator would meet 2017 FDA Food Code cooling standards.



The FDA Food Code states that food shall be cooled from 135ºF to 70ºF within two hours and from 135ºF to 41ºF within a total of six hours (FDA, 2017).

Figure 4. Cooling Curves for Cooling Method 3 (Covered) and Cooling Method 4 (Uncovered); Both Utilizing a 12 in. x 20 in. x 2½ in. Foodservice Pan with a 2 in. Depth of Chili and Cooled in a Walk-in Refrigerator from 135ºF to 41ºF.

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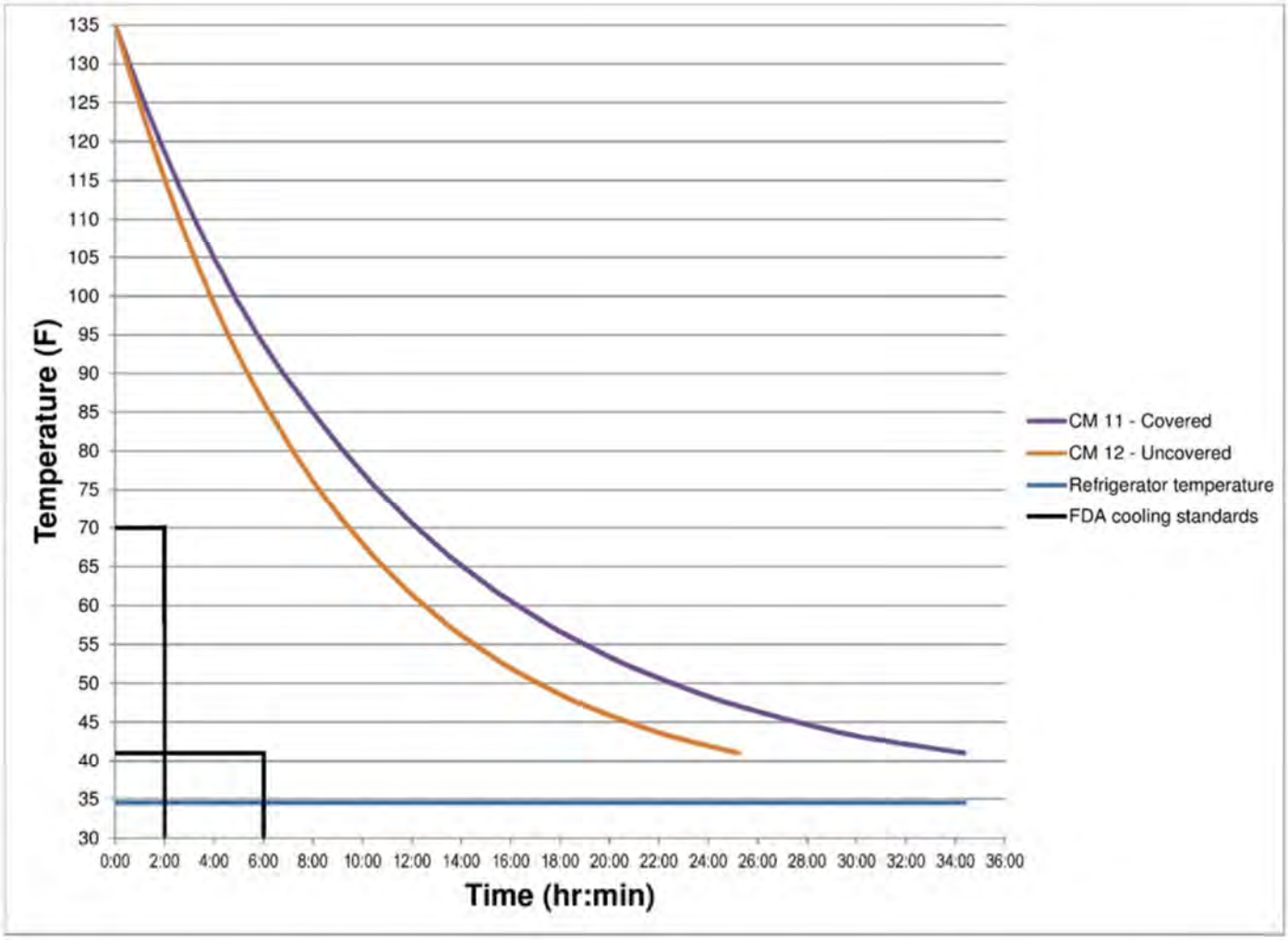

The FDA Food Code states that food shall be cooled from 135ºF to 70ºF within two hours and from 135ºF to 41ºF within a total of six hours (FDA, 2017).

Figure 5. Cooling Curves for Cooling Method 11 (Covered) and Cooling Method 12 (Uncovered); Both Utilizing a 12 in. Diameter x 13 in. HDPE Bucket with 5 Gallons of Chili and Cooled in a Walk-in Refrigerator from 135ºF to 41ºF.

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Research Contribution

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FOOD SAFETY NEEDS IN INDEPENDENTLY-OWNED CHINESE RESTAURANTS: FOOD SAFETY INSPECTORS' PERSPECTIVE

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ABSTRACT
The purpose of this study was to explore food safety inspectors' views on food safety needs of Chinese-speaking foodservice workers in independently-owned Chinese restaurants. Twenty-eight food safety inspectors completed a web-based questionnaire and identified language barriers and cultural differences as major challenges faced by inspectors when conducting food safety inspections. Critical and non-critical violations commonly observed during inspections were identified as improper cooling of foods and unclean non-food contact surfaces, respectively. Providing food safety training and educational tools in Chinese language was considered critical to improve food safety practices in Chinese restaurants.

Keywords: food safety, food safety inspections, foodservice, Chinese restaurants

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INTRODUCTION

Every year, contaminated food results in a number of illnesses and deaths in the United States. Annually, known disease-causing agents in food cause an estimated 9.4 million illnesses, 55,961 hospitalizations and 1,351 deaths. Furthermore, unknown disease-causing agents cause an additional 38.4 million illnesses, 71,878 hospitalizations and 1,686 deaths (Scallan, Griffin, Angulo, Tauxe, & Hoekstra, 2011a). In 2017, Americans spent approximately $798.7 million purchasing food away from home (National Restaurant Association, 2017). Yet, approximately 56% of foodborne illness outbreaks are associated with restaurants or delicatessens-including cafeterias and hotels (Centers for Disease Control and Prevention [CDC], 2017).

Furthermore, an alarming majority (60%) of these reported foodborne illnesses have been linked to preventable errors in food handling by foodservice employees (CDC, 2013). Contamination can occur at any point in the flow of food in foodservice establishments. Therefore, maintaining food safety is critical for the health and well-being of Americans. It has been estimated that foodborne illnesses cost consumers $51-78 billion in annual health-related costs (Scharff, 2012).

The demographic landscape of the U.S. has rapidly changed because of an increase in immigration and globalization. While, Hispanics are the largest minority in the U.S., Asians have become the fastest growing ethnic group in the U.S. from 2000-2015, increasing by 72% in 15 years. It was estimated that the Asian population will grow from 20.4 million in 2015 to 34.4 million by 2050 (Pew Research Center, 2017). This increase in diversity contributes to the increase in the number of ethnic restaurants (Mintel, 2014). Americans are becoming increasingly interested in tasting foods from different cultures. The most popular ethnic cuisines in the U.S. are Mexican, Italian, and Asian-primarily Chinese and Japanese (Lee, Hwang, & Mustapha, 2014).With the increasing number of ethnic restaurants; food handling practices in these establishments are a concern to food safety inspectors and consumers (Kwon, Roberts, Shanklin, Liu, & Yen, 2010).

Foodborne illness outbreaks have been associated with ethnic restaurants serving Asian, Italian, and Mexican foods. Foodborne illness data associated 2,727 cases of outbreaks to *Salmonella*, *Norovirus*, *Clostriduim perfringens*, *Campylobacter jejuni*, *Bacillus cereus*, and *E. coli O157:H7* in Mexican restaurants. While, 113 cases were associated to *Bacillus cereus*, *Norovirus*, *Camplylobacter jejuni*, *Staphylococcus aureus*, and *Campylobacte*r in Chinese restaurants. *Norovirus*, *Staphylococcus aureus*, *Bacillus cereus*, *Clostridium perfringens*, and *Salmonella enterica* were associated with 336 outbreaks in Italian restaurants and *Salmonella enterica*, *Norovirus*, *Bacillus cereus*, *Campylobacter jejuni*, and *Staphylococcus aureus* were associated with 298 outbreaks in Japanese restaurants (Lee et al. 2014). Kwon, Choi, Liu, and Lee (2012) assessed the frequency and type of food code violations in 156 Asian restaurants finding the top violation categories were hand hygiene, time & temperature abuse, storing practices, physical facility maintenance, and food contact surface maintenance & ware washing facilities. Furthermore, nearly 3 critical violations occurred per inspection.

The U.S. Food and Drug Administration (FDA, 2013a) identified five major risk factors that contribute to foodborne illness: (1) purchasing food from unsafe sources, (2) inadequate cooking of foods, (3) improper holding temperatures, (4) contaminated equipment, and (5) poor personal hygiene. These five major risk factors along with other factors are reviewed during food safety inspections. Food safety inspections are critical to ensuring foodservice establishments are following food safety and sanitation guidelines outlined by the Food Code, adopted by each state (FDA, 2013a). The Food Code "assists food control jurisdictions at all levels of government by providing them with a scientifically sound technical and legal basis for regulating the retail and food service segment of the industry (restaurants and grocery stores and institutions such as nursing homes)" (FDA, 2013b). The Food Code is updated every four years, but the FDA publishes supplements in the interim with updates. However, not all states follow the most recent Food Code, which could also explain the discrepancy in food handling practices in foodservice establishments and thus the incidences of foodborne illnesses.

Food safety inspections of retail foodservice establishments are conducted annually or more depending on the type of establishment and food safety history of the establishment, as well as availability of food safety inspectors (Iowa Department of Inspections & Appeals,

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2018). Increasing frequency of inspections and requiring food safety certification has been found to decrease rates of foodborne illness, and restaurants with established food safety procedures in place were able to do a better job of maintaining food safety than those restaurants that did not (Zablotsky Kufel et al. 2011). Newbold, McKeary, Hart, and Hall (2008) found no relationship between food safety compliance and increased inspection frequency, but suggested food safety inspections are an opportunity to educate food safety workers about food safety.

A review of restaurant inspections found that ethnic restaurants had more critical and non-critical violations, and more frequent food safety inspections than non-ethnic restaurants (Kwon, et. al, 2010). Significantly more violations were observed in ethnic restaurants for improper time and temperature control, improper maintenance of facility, inadequate prevention of contamination, poor hand hygiene, improper use of utensils, insufficient demonstration of food safety knowledge, and improper temperature control of food not considered potentially hazardous. It should be noted that each state categorizes critical and non-critical violations differently, however most follow the FDA Food Code guidelines. The FDA Food Code also calls "critical violations" "priority items" or "priority foundation items". Priority items are defined as "items with a quantifiable measure to show control of hazards such as cooking, reheating, cooling, and handwashing" (FDA, 2019). Examples of these include: not enough refrigeration equipment, lack of proper hand hygiene or not cooking food to the appropriate internal temperature (FDA, 2019). A review of critical violations of all restaurants from 2008-2010 in Jefferson County, Alabama found that characteristics of restaurants such as type of cuisine were associated with frequency of certain critical violations (Menachemi, Yeager, Taylor, Mcclure, & Outmet, 2012). The most common critical violations in Asian and Mexican restaurants were documenting procurement of food from approved/safe sources and Asian restaurants had a higher frequency of critical violations associated with cross-contamination than Mexican restaurants. Evaluation of food samples from these restaurants found that 35.7% of samples had detectable levels of *Staphylococus aureus* in both types of restaurants and 42.2% of food samples were received outside the temperature danger zone; suggesting a need for food safety education (Menachemi et al., 2012).

Among ethnic cuisines, Chinese cuisine has been identified as the most preferred ethnic cuisine in the U.S. followed by Mexican, Japanese, and Thai cuisine (Lee, Niode, Simonne, & Bruhn, 2012). There are more than 52,000 Chinese restaurants in the U.S., which is, perhaps twice the number of McDonald's restaurants (National Restaurant Association, 2017). The annual sales of Chinese restaurants reached over $20 billion in 2008, accounting for 5.0% of total food and drinks sales in the U.S. Due to the growth and expansion of the U.S. restaurant industry, Chinese restaurants have been facing competition from other types of restaurants, including other Asian restaurants - Indian, Japanese, Korean, Thai, and Vietnamese (Liu & Jang, 2008). However, Chinese cuisine still dominates the Asian restaurant market in the U.S. With the increasing popularity of Chinese food among consumers, maintaining safety of the food served at Chinese restaurants is critical for preventing incidences of foodborne illness. In an examination of restaurants in San Francisco; Satow, Inciardi, and Walllace (2009) found that sanitation levels in Chinese restaurants showed a wide degree of variability, with high and low sanitation standards, such as hand hygiene and food preparation issues.

Simonne, Nille, Evans, and Marshall (2004) suggested the increased incidence of foodborne illness originating from ethnic restaurants could be a result of food handler's unfamiliarity with proper handling practices of traditional ethnic ingredients (such as, chicken feet or fish heads), lack of knowledge about ethnic foods, and cultural barriers such as communication problems, low risk perception, or belief in handling food in foodservice establishments similar to the way it is handled at home. Cultural differences in food handling by the Chinese and Americans can also influence views on food safety practices in Chinese restaurants. Examining the role of Chinese culture and beliefs might help food safety inspectors conduct food safety inspections and communicate observed food safety risks to managers and workers in a culturally sensitive and effective manner. A study of Chinese restaurateurs found that courtesy, respect, and harmony were the top three Chinese cultural values (Liu, Kwon, Shanklin, Canter, & Webb, 2014).

Providing training and appropriate support (internal and external to the establishment) to Chinese restaurants is important. Though several studies have been conducted to identify food safety needs in Chinese restaurants from restaurant owners' and employees' perspective, little research has investigated the food safety inspector's perspective. Food safety inspectors play a critical role as a resource for food safety information in addition to performing routine health inspections, conducting food safety training programs and investigating suspected reports of foodborne illness (Pham, Jones, Sargeant, Marshall, & Dewey, 2010). In ethnic operations where limited training is provided by the operation, often the food safety inspector is one of the only forms of food safety education. This occurs when the inspector identifies an infraction and discussed the means to rectify or improve the food handling practice. Assessing the experiences of food safety inspectors when conducting food safety inspections in Chinese restaurants could assist in the development of appropriate approaches to educating Chinese-speaking foodservice workers about food safety. Which in turn, would potentially reduce the risk of a foodborne illness occurring in this type of operation due to improper food handling practices. The purpose of this study was to explore food safety inspectors' perceptions of the food safety needs of Chinese-speaking foodservice workers in independently-owned Chinese restaurants. The specific research objectives of the study were to:

1. Identify food safety violations that food safety inspectors have difficulty correcting in Chinese restaurants.
2. Detail food safety and sanitation practices in which Chinese restaurants need improvement.
3. Review cultural barriers food safety inspectors identify when conducting inspections in Chinese restaurants.

METHODS

Sample

Prior to the start of the study, IRB approval was obtained. A total of 45 Iowa Department of Inspections and Appeals (DIA) food safety inspectors with experience in conducting food safety inspections in independently-owned Chinese restaurants were contacted to participate in this study, of which 28 participated. The DIA has a joint state and local inspection program for restaurants and other establishments where food is served, such as schools, nursing homes, and hospitals.

Research Instrument

The web-based questionnaire consisted of 13 open-ended questions designed to elicit detailed information about participants' experiences with conducting food safety inspections, their observations of food safety practices, cultural barriers, and challenges faced when conducting food safety inspections in independently-owned Chinese restaurants. An open ended questionnaire was used to allow participants to describe their experiences and also simplify data analysis because the person responsible for data collection was a non-

native English speaker. The questionnaire was reviewed by experts (n = 3) in food safety and foodservice operations for content validity and pilot-tested with food safety inspectors (n = 2) for clarity and content. Food safety inspectors that participated in the pilot study were excluded from the main study. Feedback obtained from the pilot study was used to improve the questionnaire for clarity prior to collecting data (Appendix 1).

Data Collection

An invitation email containing the link to the questionnaire was sent to all participants (n = 45) listed in the mailing list provided by the DIA. Participants provided informed consent prior to participating in this study. Following recommendations by Dillman (2014), follow-up emails were sent at weeks one, two, and three to increase the response rate. Participants did not receive any incentive for their participation.

Data Analysis

Descriptive statistics were computed for the demographic questions using Statistical Package for Social Sciences (SPSS) version 22. Responses to each of the open-ended questions were entered into MS EXCEL. Two researchers independently analyzed each participant's responses following the same protocol (Merriam, 2009). The protocol included: 1) exploring the data by reading through the response several times; 2) independently coding the data by segmenting and labeling the text; 3) verifying the codes through an inter-rater reliability agreement check; 4) using codes to develop categories by aggregating similar codes; 5) and assessing and combining similar categories to develop themes (Merriam, 2009).

RESULTS AND DISCUSSION

Profile of Participants

Forty-five food safety inspectors were invited to participate in this study, of which 28 completed the questionnaire, for a response rate of 62.2%. Almost equal numbers of males (n = 15, 53.6%) and females (n = 13, 46.4%) were represented (Table 1). The majority of participants (n = 25, 85.7%) were between the ages of 31-60 years and obtained a Bachelor's degree (60.7%) (see, Appendix 1). Participants had an average of 10 years of experience conducting food safety inspections in independently-owned Chinese restaurants. The number of independently-owned Chinese restaurants inspected annually ranged from 2-31 restaurants with an average of 9.6 Chinese restaurants per inspector. An increase in the number of Chinese restaurants in the United States (National Restaurant Association, 2017) is reflected in the number of restaurants inspected by food safety inspectors.

Table 1. Demographic Profile of Food Safety Inspectors (n = 28)

Characteristics	*n*	%
Gender		
Female	13	46.4
Male	15	53.6
Age		
21-30 years	1	3.6
31-40 years	9	32.1
41-50 years	8	28.6
51-60 years	7	25.0
More than 60 years	3	10.7
Educational level		
Associates	5	17.9
Bachelors	17	60.7
Masters	3	10.7
Doctoral	-	-
Other	3	10.7

Food Safety in Independently-owned Chinese Restaurants

Table 2, presents themes and categories regarding food safety practices that food safety inspectors had difficulty correcting in independently-owned Chinese restaurants. Participants identified food safety practices commonly found in compliance with the Food Code were: cooking temperatures, holding temperature, date marking, monitoring employee health, purchasing from approved sources, and dishwashing. However, inspectors also identified the following food safety concerns: incorrect cooling methods of foods, improper holding temperatures of raw and cooked food (particularly buffets), poor general cleanliness, lack of pest control, incorrect dishwashing procedures, and lack of date marking of foods. Dishwashing and date marking were identified as being in compliance and also as concerns.

Cold holding temperatures was noted as a concern particularly when holding cold foods on buffets. In a study of cooling practices in 420 restaurants serving American, Italian, Mexican, or other cuisines, Brown et al. (2012) found, most restaurant managers (86%) reported having formal protocols for cooling of foods and 91% provided training to their employees about proper cooling. However, 39% of managers did not have cooling procedures that were tested for effectiveness, 41% did not monitor time and temperature during cooling, and 15% did not calibrate thermometers used for monitoring cooling temperatures. Non-adherence to proper cooling methods is a major concern. If managers do not monitor use of proper cooling procedures, it is likely employees are not practicing safe food handling practices either. While, few food safety inspectors found that certain practices in compliance with the Food Code such as date marking (n = 3), dishwashing procedures (n = 2); a higher number of participants listed the same practices as concerns suggesting that these practices were not commonly observed. The procedures that are of concern to food safety inspectors also correspond to the top five risk factors contributing to foodborne illness (FDA, 2006).

Critical violations that food safety inspectors had difficulty getting Chinese restaurant managers to correct were identified as: cooling foods properly, date marking, preventing cross contamination, holding foods at correct temperatures, adequate pest control practices, sanitizing food contact surfaces, hand hygiene practices (wearing gloves, avoiding bare hand contact, washing hands frequently when handling different foods), monitoring of employee health, proper storage of raw meat, and proper use of three-compartment sinks. Non-critical violations food safety inspectors had difficulty in getting Chinese restaurant managers to correct were identified as: inadequate or not cleaning of non-food contact surfaces, proper utensil storage, labeling of foods, use of test papers to check sanitizer concentration, covering food in storage, and thermometers usage. This is consistent with previous research (Kwon et al. 2010).

Food safety and sanitation issues that could be improved upon were identified as: general cleanliness of facility, staff food safety knowledge, holding food at correct temperatures, preventing cross contamination, and adequate sanitizing. Kwon et al. (2010) found that Asian, Mexican, or Latin American restaurants to have more food code violations associated with time and temperature abuse than non -ethnic restaurants. Other researchers have also reported time temperature abuse of foods in restaurants as a major issue (FDA, 2006; Walczak, 2000). Menachemi et al. (2012), also found that ethnic restaurants to have similar food safety and sanitation issues.

Cultural Issues and Cultural Barriers Identified During Inspections

Table 3 shows, in response to questions regarding cultural issues food safety inspectors faced when conducting food safety inspections in

Table 2. Themes/categories Inspectors have Difficulty Correcting (n = 28)			
Themes	**Categories**	***n***	**%**
Food safety practices in compliance*	Cooking foods to appropriate internal temperature	14	50.0
	Proper holding temperature	4	14.3
	Date marking of foods	3	10.7
	Awareness of the importance of employee health	2	7.1
	Purchasing foods from approved source	2	7.1
	Proper dish washing procedures	2	7.1
Food safety concerns*	Improper cooling of foods	10	35.7
	Improper cold holding temperature	9	32.1
	Lack of proper pest management,	6	21.4
	Improper dishwashing procedures	6	21.4
	Date marking	5	17.9
Critical violations*	Improper cooling of foods	9	32.1
	Inadequate date marking of foods	9	32.1
	Cross contamination	5	17.9
	Improper holding temperature	5	17.9
	Improper sanitizing	4	14.3
	Poor pest control	4	14.3
	Unclean food contact surfaces	3	10.7
	General unsafe food handling practices	2	7.1
	Poor employee health	2	7.1
	Improper storage of raw meat	1	3.6
	Improper or lack of use of three-	1	3.6
	compartment sink for sanitizing	1	3.6
Non-critical violations	Unclean non-food contact surfaces	16	57.1
	Improper utensil storage	1	3.6
	Inadequate or lack of labeling of foods	1	3.6
	Lack of testing sanitizer concentrations	1	3.6
	Leaving food uncovered during storage	1	3.6
	Lack of food thermometer use	1	3.6

* Inspectors identified more than 1 category within Theme

independently-owned Chinese restaurants; approximately 50% of participants identified that language barriers (n = 14) and cultural differences (n = 14) as challenges. Also identified were communication problems; lack of knowledge of the Food Code; time and financial constraints for food safety inspectors to train and educate foodservice workers. These findings are consistent with previous research on cultural barriers and ethnic restaurants (Simonne et al. 2004). Some food safety inspectors indicated that Chinese-speaking foodservice workers tended to be conservative in their views on handling their business and did not like to be told what to do. Other participants stated, workers followed traditional food handling practices native to their culture, had low risk perception, were frugal (reused storage containers for food storage such as cardboard boxes, plastic containers that previously contained non-food items), and hid themselves or their poor food handling practices from the food safety inspector. Inspectors also described how foodservice employees showed no respect to food safety inspectors, and because most of the restaurants were family-owned restaurants they lacked restaurant management skills which can impact food handling behaviors.

Research on Chinese cultural values and beliefs found that trust (believing others actions are in interest of one's betterment), reciprocity (responding to positive actions of others with positive actions which help continuing and building relationships), face (maintaining dignity or prestige in society), time (importance of using time efficiently in tasks that are perceived as important), harmony (maintaining peaceful relationships with those around), hierarchy (a system where ranked above others based on status and/or authority), power distance (the extent to which less powerful members of an organization accept and expect that power is distributed unequally), and long-term orientation (willingness to forsake short-term success or materials to prepare for the future) to influence Chinese business practices (Fan, 2000; Kuo-Shu, 1987; Matthews, 2000; Rokeach, 1973). Mock and DeFranco (1999) found that Chinese workers preferred resolution of issues in an "implicit and mild" manner which could explain why food safety inspectors perceived Chinese restaurant workers were hiding themselves or their food handling practices from inspectors; this could also be to save "face/ reputation" (Linsk & Sitaramaiah, 2000). Respect and saving face were identified as important by Chinese restaurant owners to encourage cooperation and compliance with food safety inspector recommendations (Liu & Kwon, 2013). Rudder (2006) also found that language barriers, lack of knowledge and understanding of food safety concepts to be major challenges to practicing food safety in ethnic food retail businesses. Food safety inspectors (n = 17) believed cultural differences could also be addressed by providing food safety training and training materials in Chinese. For example, the training material could assist to educate regarding appropriate cultural norms in the United States versus in the Chinese culture.

CONCLUSIONS AND APPLICATIONS

The purpose of this study was to explore food safety inspectors' perceptions of the food safety needs of Chinese-speaking foodservice workers in independently-owned Chinese restaurants. A web-based questionnaire was utilized in this exploratory study. Results of this

Table 3. Cultural Issues and Barriers Identified during Food Safety Inspections (n = 28)	
Themes	**Categories**
Cultural Issues*	Language barriers *"Language is a huge issue, if someone is not there who speaks English I have a hard time communicating."* Conservativeness of Chinese culture *"I feel that, as a woman, the male owners do not take what I say as requirements"* Low risk perception *"Risk perception varies on leaving food at ambient temperature. Example leaving previously cooked meat and egg rolls out of refrigeration for extended periods of time and not time marking and discarding"* Frugality *"Sometimes, I see reuse of a shopping bag as a food storage bag"* Hiding the truth about actual food handling practices or themselves from food safety inspectors *"A particular facility had numerous critical violations during an inspection (hot water turned off, cross contamination, cold hold temps above required temperature, dish machine out, sanitizer out, bleach sanitizer in an orange juice bottle, etc). Items were fixed when I was there. I came back to do a re-check 2 weeks later and many of the violations were the same as when I was there before"* Gaining trust and respect of Chinese restaurant workers *"…. say to me....all Chinese restaurants are like this....you are too picky"*
Challenges or barriers*	Language barriers *"Language barrier, failure to understand the seriousness of violations....sometimes unless I can produce a dead person....they will not believe me"* Cultural differences *"Chinese restaurants do not understand the risk level of certain food safety issues, because it was not seen as an issue in their country"* Communication problems *"They speak only enough English to take customers' orders, etc. No understanding of English language beyond that"* Lack of knowledge about the Food Code *…"not maintaining compliance with code-say we've worked through a violation and it has been corrected, but then you go back for a recheck and they have reverted to non-compliance again"* Time constraints during inspections to explain food safety issues, financial constraints *" ….there isn't enough time to explain in detail all the impacts of poor food handling practices…."*

* Inspectors identified more than 1 category within theme

study showed food safety violations which food safety inspectors have difficulty correcting in Chinese restaurants. Additionally, findings identified food safety and sanitation practices in which Chinese restaurants need improvement. This study identified that many challenges food safety inspectors faced when conducting food safety inspections in independently-owned Chinese restaurants of which language and cultural barriers were identified as major challenges. Language barriers impacted communication with Chinese foodservice workers leading to difficulty in conveying food safety messages on-site, explaining the rationale for food safety practices that needed corrections, and conducting training.

Due to limited research related to food safety needs of Chinese-speaking foodservice workers in independently-owned Chinese restaurants, this study fills the research gap by presenting the perceptions of food safety inspectors. Results could aid food safety educators when developing educational tools to tailor training to issues identified by food safety inspectors. However, the onus of ensuring food safety does not lie only with food safety inspectors. Foodservice managers and foodservice workers must work together with food safety inspectors to improve food safety in their restaurants.

To improve food safety knowledge, attitudes, and practices of Chinese -speaking foodservice workers food safety inspectors suggested foodservice workers complete a food safety course and/or obtain a food safety certification. Inspectors also recommended providing training and training materials to restaurant managers and food handlers in the Chinese language, such as videos, posters, and picture cards with food safety information in Chinese. The inspectors recommended training be conducted by a trained instructor as well as on-going on-the-job maintenance training be conducted by the restaurant manager. An additional resources could be to provide a Chinese training handbook which can serve as a one-stop resource for food safety information, and the use of other resources such as the FDA Oral Culture Learner Project training materials (FDA, 2015). These underscore the importance of using training tools in the native language and that are visual-based. These suggested visual aids are an inexpensive educational tool and have been shown to be effective in other foodservice settings (Reynolds & Rajagopal, 2017).

Rajagopal (2012, 2013) found that visual-based food safety training helpful in improving food safety knowledge scores of Spanish-speaking foodservice workers. Also, participants suggested explaining the importance of food safety with science-based information so it makes "sense", and this will help food safety inspectors from being perceived as "trouble makers". Similar approaches were suggested for addressing cultural differences. While cultural differences are difficult to address and given the limited resources and time available to food safety inspectors; providing training and tools in Chinese language were considered to be main ways of addressing cultural issues and improve food safety practices of Chinese-speaking foodservice workers in Chinese restaurants. As access to training materials is often scare due to limited funds and time, and further compounded due to limited understanding of proper food safety practices by managers (Rudder, 2006), the food safety inspector is often the most valuable intervention tool.

It is important that in addition to food safety training and conducting food safety inspections, food safety inspectors should also consider

the role of culture on food handling practices. This can be achieved by providing food safety inspectors some training on cultural sensitivity, introducing a brief overview of dominant cultures in the U.S., and identify strategies to interact successfully with ethnic foodservice workers. For example, food safety inspectors can earn trust by interacting with Chinese-foodservice workers informally for 5-10 minutes before beginning the inspection or learning some Chinese words (such as hello, how are you) to "break the ice".

Findings could also help food safety researchers and Extension educators develop food safety training and educational materials that consider the role of the Chinese culture. Educators can also consider the role of food safety culture (Arendt & Sneed, 2008; Griffith et al., 2010; Powell et al., 2011; Reynolds & Rajagopal, 2017; Ungku Fatimah et al., 2013; Yiannas, 2008) of Chinese restaurants as a person's culture may influence their food safety behaviors. Foodservice educators can utilize the findings of this study to teach foodservice management students about culture and its influence on food safety.

There are several limitations to this study. First, this study was conducted in one state and results may not be generalized to other parts of the U.S. or other types of ethnic restaurants, as each culture is unique. Additionally, advanced statistical analysis was not possible, though future research with a larger sample could assist with this. While, the sample size in this study was small; the information obtained in this study provided an account of the needs of Chinese-speaking foodservice workers in independently-owned Chinese restaurants from a different viewpoint, as opposed to self-reported food safety behaviors which have been found to not accurately represent actual behaviors (FDA, 2009; Strohbehn, Paez, Sneed, & Meyer, 2008).

Future research could explore the development and assessment of Chinese language food safety training with Chinese-speaking foodservice workers. Most food safety inspectors mentioned the importance of training in Chinese language and also the use of visual-based training. Future research could explore the effectiveness of visual-based training on attitudes, knowledge, and practices of Chinese-speaking foodservice workers. Furthermore, additional research should be conducted to assess food inspector's perspectives on other ethnic restaurants to provide a different perspective. Finally, future research should investigate longitudinal effects of food inspector's food safety education interventions on restaurant food inspections. However, this study is the first known study that provided an opportunity to explore food safety inspectors' perceptions of food safety practices in independently-owned Chinese restaurants.

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Appendix 1. Questionnaire for Food Safety Inspectors

The following questions aim to obtain feedback about your experiences as a food safety inspector when conducting food safety inspections in independently-owned Chinese restaurants in Iowa with the goal of developing food safety training materials for educating Chinese foodservice workers. We realize that not all independently-owned Chinese restaurants are the same, but we intend to explore food safety needs in general in independently-owned Chinese restaurants in the state of Iowa.

1. How many years have you been conducting food safety inspections in Iowa restaurants? (use drop down menu)
   _____ year(s)

2. How many of those years have you conducted food safety inspections in independently-owned Chinese restaurants in Iowa? (use drop down menu)
   _____ year(s)

3. What is the average number of independently-owned Chinese restaurants you inspect every year? (Pull down menu to be added here).

4. During food safety inspections which top five food safety practices do you observe are in compliance with the Food Code in independently-owned Chinese restaurants?

5. Based on your experience with conducting food safety inspections, what are your top five food safety concerns in independently-owned Chinese restaurants?

6. What challenges or barriers (in terms of food safety, personnel, etc) do you face when conducting food safety inspections at independently-owned Chinese restaurants?

7. In your experience, which critical violations and non-critical violations do independently-owned Chinese restaurants have difficulty in correcting after they have been identified during a food safety inspection?
   Critical violations:
   Non-critical violations:

8. Describe an experience (contentious experience and/or leading to shut down of restaurant) you had when conducting a food safety inspection in an independently-owned Chinese restaurant?

9. Based on your experiences with conducting food safety inspections, what food safety and sanitation practices do you think independently-owned Chinese restaurants could improve upon?

10. In your opinion, what type/s of food safety training tools (e.g. posters, demonstrations, etc.) would be helpful to educate Chinese-speaking foodservice workers about safe food handling practices in independently-owned Chinese restaurants?

11. What suggestions do you have for improving the following among Chinese-speaking foodservice workers in independently-owned Chinese restaurants?
    Food safety attitudes (e.g. the importance of food safety, learning about food safety, etc.):
    Food safety knowledge (e.g. time and temperature control, personal hygiene, etc.):
    Food safety practices (e.g. glove, handwashing, etc.):

12. What cultural issues (food safety attitudes, risk perception, language, etc) do you face when conducting food safety inspections in independently-owned Chinese restaurants? You can also provide examples to elaborate.

13. In your opinion, how could these cultural issues be addressed (in terms of training provided to Chinese-speaking foodservice workers and/or food safety inspector about conducting food safety inspections in ethnic restaurants, support for food safety inspectors and/or Chinese-speaking foodservice workers) to improve food safety in independently-owned Chinese restaurants?

Demographic questions

What is your age?

□ 21- 30 years □ 31-40 years □ 41-50 years □ 51-60 years

□ more than 60 years

What is your gender?

□ Female □ Male

What is the highest educational degree attained?

- □ Associates
- □ Bachelors
- □ Masters
- □ Doctoral
- □ Other (please specify _____)

Which county/counties are under your jurisdiction for food safety inspections?

May I call you if I have follow-up questions? Please provide your contact information below (optional)

Phone_____ Email_____

Thank you for your participation!

Research Contribution

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EXPLORING RESTAURANT SERVICE SABOTAGE BEHAVIORS IN THE U.S.

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ABSTRACT
Service sabotage refers to employee's deliberate actions that negatively influence the delivery of service or service standards. Extent literature asserts that service sabotage is prevalent, costly, and detrimental in the service industry. However, the expression of service sabotage may vary drastically depending on the industry because service sabotage behaviors are context-specific. Therefore, the purpose of the study was to explore prevalent restaurant service sabotage behaviors. A total of 419 non-managerial front-of-house frontline employees in full-service restaurants in the U.S. were recruited from an online restaurant employee panel. Results show that 80.4% of the respondents had sabotaged restaurant service at least once a year, and eight out of 39 types of restaurant service sabotage behaviors were conducted by 51.7% or more of the research participants. Among identified restaurant sabotage behaviors, complaining about customers with colleagues was the most prevalent, followed by passive-aggressive sabotage behaviors. According to the cluster analysis, service saboteurs tend to be younger, and a larger proportion of them work in fine-dining restaurants (30.9%). This study yielded practical insights for restaurant managers to effectively manage service sabotage and provided a foundation for restaurant service sabotage scale development in future research.

Keywords: restaurant, service sabotage, cluster analysis

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INTRODUCTION

Traditionally, employees' behaviors have been considered positive and compliant with organizational norms (Ackroyd & Thompson, 1999). However, negative employee behaviors have been identified and researched over time, including workplace deviant behaviors (Robinson & Bennett, 1995), antisocial behaviors (Giacalone & Greenberg, 1997), dysfunctional behaviors (Griffin, O'Leary-Kelly, & Collins, 1998), and organizational misbehaviors (Ackroyd & Thompson, 1999). These researchers have shown that some employees intentionally engage in negative behaviors that affect the organization, people within it, or both. Although researchers use different labels to describe such negative workplace behaviors, it is generally agreed that these misconducts may cause direct or indirect damages to the organization or its members.

The characteristics of the restaurant industry, the uniqueness of restaurant service, and the extensive interactions between frontline employees and customers all contribute to the urgent need to better understand and manage restaurant service sabotage. However, restaurant service sabotage has not been studied extensively, while service sabotage behaviors have been studied in overall hospitality organizations (Harris & Ogbonna, 2012), call centers (Skarlicki et al., 2008), and hotels (Yeşiltaş & Tuna, 2018). Furthermore, service sabotage behaviors are context-specific, that is, service sabotage behaviors occurring in call centers (e.g., deliberately transferring the call to the wrong department) (Skarlicki et al., 2008) or in hotels (e.g., intentionally changing guest room temperature and setting the alarm clocks) (Harris & Ogbonna, 2009) can be different from those taking place in restaurants.

Recently, *service sabotage* has drawn attention in various sectors of the service industry (Harris & Ogbonna, 2012; Lee & Ok, 2014; Skarlicki, van Jaarsveld, & Walker, 2008; Yeşiltaş & Tuna, 2018). Service sabotage refers to employee's deliberate actions that intentionally and negatively influence the delivery of service or service standards (Harris & Ogbonna, 2002). The prevalence of service sabotage in the hospitality industry is high, and nearly 100% of frontline employees stated that they had witnessed service sabotage behaviors in the workplace (Harris & Ogbonna, 2002). The financial cost of service sabotage is estimated to reach billions of dollars every year accounting for the damage due to service sabotage as well as prevention and correction of such behaviors (Fagbohungbe, Akinbode, & Ayodeji, 2012; Harris, 2012). Furthermore, service sabotage has a strong and negative influence on service quality and the rapport between employees and customers, resulting in decreased customer satisfaction (Harris & Ogbonna, 2006). In short, service sabotage is prevalent, costly, and detrimental in the service industry; therefore, managing service sabotage in various service industries including the restaurant industry is critically important.

The restaurant industry has negative images among job seekers because of high levels of job stress, long work hours, and relatively low pay (Zhao & Ghiselli, 2016). The phenomenon is even worse for frontline employees who provide service to customers directly. The paradox lies in the fact that while the work environment is unfavorable for frontline employees, their performance is essential to the customers' dining experience (Gounaris & Boukis, 2013; Spinelli & Canavos, 2000). Another unique characteristic of restaurant service is the inseparability of production and consumption (Parasuraman, Zeithaml, & Berry, 1988), as there is almost no lapse in time between production and consumption of service.

Providing service to customers in restaurants requires extensive face-to-face communications including both verbal and nonverbal interactions. However, it is not uncommon to find frontline employees being abused by difficult customers (Skarlicki, et. al, 2008), and revenge against abusive customers was one of the major drivers for service saboteurs (Harris & Ogbonna, 2012). Front-of-house frontline employees provide service to customers throughout the dining period, and prolonged service contacts along with challenging customers increase the likelihood of service sabotage (Harris & Ogbonna, 2002). To sum up, the purpose of the study was to explore service sabotage behaviors in the U.S. restaurant industry.

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Specific objectives were to:

1. Identify prevalent restaurant service sabotage behaviors in the U.S., and
2. Evaluate the differences between restaurant service saboteurs and non-saboteurs.

LITERATURE REVIEW

The Concept of Service Sabotage

Harris and Ogbonna (2002) defined service sabotage as "organizational member behaviors that are intentionally designed negatively to affect service" (p. 166). Researchers have used various terms to describe negative employee behaviors depending on the focal point of such actions. For example, workplace deviance focuses on interpersonal and organizational deviance (Bennett & Robinson, 2000). While service sabotage is one example of negative organizational employee behavior; it is conceptually different from previously studied scales, and it is unknown how different it is from the other negative employee behaviors, such as workplace deviance.

In actuality, service sabotage should not be seen as another term for the general concept of workplace deviance, nor is it merely a subcategory within it. Sabotage behaviors are explicitly intended to cause harm, whereas deviance focuses on violating norms (Ambrose, Seabright, & Schminke, 2002). Therefore, service sabotage and workplace deviance are conceptually different. Furthermore, a more detailed look at the definition of service sabotage clarifies that service sabotage happens for a reason. Service sabotage is derived from organizational members' intention (Harris & Ogbonna, 2002, 2006, 2009, 2012), and this intentionality sets service sabotage apart from the common service failure.

Service failure refers to service performance that falls below customers' expectations (Hoffman & Bateson, 1997), and it is typically not deliberate. While service sabotage is different from service failure in terms of the deliberate nature of such an action, service sabotage and service failure behaviors may be difficult to distinguish from the customer's perspective. For instance, service staff may provide false information about the menu due to lack of knowledge or inadequate training (i.e., service failure), but service saboteurs may intentionally mislead customers by providing incorrect information. It is, therefore, plausible that frontline employees disguise service sabotage as service failure in front of customers to evade punishment. Perhaps, frontline employees who intentionally spilled drinks on customers' backs but immediately apologized for their accidental clumsiness may be viewed as service failure, when in fact it could be service sabotage (Harris & Ogbonna, 2002).

Investigation of critical incidents of restaurant service sabotage behaviors yielded different types of restaurant service sabotage behaviors (Tao, 2017). A total of 243 critical incidents were identified through Tao's in-depth individual interviews with restaurant frontline employees, revealing four types of service sabotage behaviors: acting *passive-aggressive, targeting customers, targeting colleagues,* and *targeting restaurants*. Unlike Tao's categorization of service sabotage behaviors mainly based on the targets of such behaviors, Browning (2008) used seriousness (minor–serious) and whether the event targets customers (indirectly–directly) as two dimensions to categorize service sabotage behaviors in adventure tourism and hospitality organizations. Although the typologies and study settings may be different, the targets seem to be of importance in the service sabotage literature.

In summary, service sabotage is conceptually different from other negative employee behaviors, and service sabotage and service failure can be difficult to differentiate, particularly from the customer's viewpoint. Service saboteurs may intentionally conceal their misbehaviors to avoid being caught or punished, and therefore, it is challenging for others to identify service sabotage and even more so to effectively manage service sabotage.

The Impact of Service Sabotage on the Restaurant Industry

It was estimated that the sales at U.S. restaurants increased to $863 billion with a workforce of 15.3 million employees in 2019 (National Restaurant Association, 2019). Researchers estimate that service sabotage costs firms billions of dollars every year (Fagbohungbe et al., 2012; Harris, 2012), which is clearly a heavy burden on the industry. Furthermore, 85% of frontline employees reported engaging in service sabotage, and nearly 100% of them have witnessed service sabotage in their workplace (Harris & Ogbonna, 2002). If this estimate remains valid today, considering the large workforce in the U.S. restaurant industry, the number of service saboteurs (often frontline employees) can be substantial, and the subsequent negative effect of service sabotage could be devastating.

In the contemporary hospitality industry, marketers rely heavily on online reviews on web-based opinion platforms and social networking sites, such as Yelp.com and Facebook. Popularity of social networking makes the service saboteurs, especially thrill-seeking saboteurs (Harris & Ogbonna, 2009) to be more problematic. Today's young customers are extremely involved in sharing their experience online, and some employees also readily share a part of their work days online using postings, photos, or videos. For example, two Domino's Pizza employees filmed themselves tampering with a customer's food in the kitchen and uploaded the video to social media; this video clip went viral on the internet in a short time (Clifford, 2009). Millions of customers viewed the video and expressed how disgusted they were through comments within a few days, and Domino's Pizza faced a public relations crisis. This single incident of service sabotage that deliberately violated multiple hygiene codes illustrated how service sabotage is capable of endangering the reputation of a restaurant brand with only a few clicks.

Service sabotage has profound impacts on multiple areas in an organization, including personnel, service quality, and labor performance (Harris & Ogbonna, 2002, 2006). Moreover, working conditions in restaurants, including prolonged service contacts (Harris & Ogbonna, 2002), a high level of job stress (Harris & Ogbonna, 2012), emotional dissonance (Lee & Ok, 2014), and mistreatment from customers (Skarlicki et al., 2008), contribute to the likelihood of employee service sabotage. However, it is challenging for managers to effectively identify and prevent restaurant service sabotage behaviors because it can be difficult to distinguish between service sabotage and service failure. As the connotation of restaurant service sabotage remains unclear to scholars and practitioners, further investigation is needed.

METHODS

Sample Selection

The target population was non-managerial front-of-house frontline employees (e.g., waiter/waitress, host/hostess, or bartender) in full-service restaurants in the U.S. Employees working in both chain and independently-owned restaurants were invited via an online survey company (Qualtrics) to cover a broader spectrum of restaurant service sabotage behaviors. However, employees in limited-service restaurants were excluded from the study sample because of limited customer-employee interactions. The target sample size was set at 400 with the intent to recruit participants with more socio-demographic diversity to identify current trends of restaurant service sabotage behaviors.

Instrument Development

The instrument consisted of four major parts, including questions pertaining to eligibility to take the survey (Part A), work characteristics (Part B), restaurant service sabotage (Part C), and demographics (Part D). Part A inquired if the survey participant was over the age of 18, employed in a full-service restaurant in the U.S. as a frontline service provider with less than 50% of supervisory responsibility. Part B asked survey participants about the type of restaurants they work for (e.g., chain or independently-owned restaurant), restaurant segment, their position, hours of work per week, tenure with current employer, and average amount of tips received.

To better gauge restaurant service sabotage behaviors, a set of 39 items were listed in Part C (Tao, 2017). Tao applied critical incident techniques to analyze 243 potential service sabotage incidents from the in-depth individual interviews with non-managerial frontline employees in the U.S. A total of 29 service sabotage behaviors were identified in addition to the other 10 items adapted from the previous literature (Tao, 2017). Questions in Part C started with the probe, "*I have intentionally*" followed by each behavioral item, such as "*acted rudely toward customers*" and "*stopped serving food earlier than regular hours*." Participants were instructed to rate on a 7-point behavior frequency scale, ranging from 1 (never) to 7 (daily). Participants could also choose the "not applicable" option, if that particular item was not applicable due to his/her position. The rationale was that service sabotage behaviors could be very context-specific and varied in the way of expression. A host/hostess may not have the same opportunity to sabotage service as a waiter/waitress due to the essence of the job. By differentiating between "never" (i.e., respondents could have engaged in service sabotage, but chose not to) and "not applicable" (i.e., respondents could not engage in service sabotage due to job nature), it was anticipated to attain more insightful results from participants. To ensure the data quality, two attention check questions were included in the middle of the survey. After the instrument was developed, a panel of experts consisting of six professors and three senior managers in the restaurant industry reviewed it for content validity, and the survey instrument was converted to an online format using the Qualtrics survey system.

The online instrument was pilot-tested using a panel of 30 non-managerial frontline employees in full-service restaurants to assess inter-item reliability and usability of the survey instrument. The Cronbach's alpha coefficient of the 39-item scale was .94, showing high internal consistency of the instrument. However, no respondent admitted to have "served contaminated food." After consulting the foodservice and service quality experts, the verbiage of this item was altered to "served unsanitary food" to ensure content validity and usability prior to main data collection.

Data Collection and Analysis

Permission was obtained from Kansas State University's Institutional Review Board prior to data collection. Participants were recruited from an online restaurant employee panel by hiring an online research firm, Qualtrics. A cover letter stating the purpose of the study was displayed on the first page of the online survey. Anyone who was not qualified to complete the survey or failed to pass the attention check questions was excluded from the survey. Moreover, survey responses completed in less than one third of the average time for completing the pilot study were removed to ensure data quality. Data collection was conducted between May 31 and June 8, 2017 and completed when the target sample size of 400 completed responses was attained.

Descriptive statistics and reliability tests were performed for data analysis using IBM SPSS Version 24. Cluster analysis was also used to discover the heterogeneity among participants. Following the two-step approach, hierarchical cluster analysis using Ward's method with squared Euclidian distance was performed first to determine the appropriate number of clusters prior to executing the k-means procedure (Meyers, Gamst, & Guarino, 2013). Furthermore, a series of t-test and chi-square analysis was applied to assess if the differences between the clusters were statistically significant. The statistical significance was set at the .05 level for inferential statistics.

RESULTS AND DISCUSSION

Characteristics of Survey Participants

Approximately 6,000 online panel members from the restaurant employee panel were randomly selected by the online research company (Qualtrics) to receive survey invitations with a URL linked to the online survey. Of those, 3,232 individuals accessed the first page of the survey (response rate = 53.9%). After that, the researcher screened out or excluded 2,813 participants because they (a) did not provide consent to enter the survey (n = 228), (b) were under 18 years of age (n = 9), (c) were not employed in the U.S. (n = 719), (d) did not work as a frontline employee (n = 709), (e) had more than 50% supervisory responsibilities (n = 774), (f) did not work in full-service restaurants (n = 342), (g) did not pass the attention check questions (n = 25), or (h) never finished the survey (n = 7). Therefore, 419 usable responses were included for data analysis.

Survey participants' characteristics are summarized in Table 1. The majority of participants were between 18 and 29 years old (n = 252, 60.1%) and female (n = 355, 84.7%). The ratio of female participants is slightly higher than that reported in the U.S. Bureau of Labor Statistics, where 70.0% of servers and 80.8% of hostesses were female (U.S. Department of Labor, 2016). A vast majority of participants were Caucasians (n = 366, 87.4%), and most had some college education (n = 176, 42.0%). In addition, the majority of participants had worked for their current employers for three years or less (n = 281, 67.4%) in casual dining restaurants, e.g., T.G.I. Friday's (n = 325, 77.6%). Only 22.4% of the participants (n = 94) worked for the fine dining restaurants, e.g., Ruth's Chris Steak House, and more than half of the participants worked at chain restaurants (n = 222, 53%). In terms of work characteristics, around three quarters of the participants were wait staff (n = 318, 75.9%), receiving an average tip amount between 16% and 20% of sales (n = 190, 45.3%). A significant number of participants worked more than 20 hours every week (n = 340, 81.2%).

Prevalent Restaurant Service Sabotage Behaviors

Means, standard deviations, and participation rates of the 39 restaurant service sabotage behaviors are summarized in Table 2. The mean scores of the top 10 most frequent behavioral items ranged from 2.23 to 4.10 on a 7-point behavior frequency scale. Of those, "complained about customers with colleagues" was rated the highest (4.10 ± 2.07) with 15.5% of the participants doing this on a daily basis, 15.3% weekly, 13.1% monthly, 22.4% several times a year, with only 19.6% of the respondents never doing this. This behavior initially seemed as if it might not directly affect the delivery of service. However, if someone recorded the conflict and shared the video on social networking sites, a single incident can devastate the restaurant's reputation (Whitley, 2012). On the other hand, even if a customer is unaware of intentional complaints by the saboteur, this behavior may lead to decreased service quality. In addition to "complained about customers with colleagues," it is notable that the following two most prevalent service sabotage behaviors were also toward customers, including "made fun of a customer or group of

Table 1. Characteristics of Survey Participants (n = 419)

Characteristic	n	%
Age		
18 – 29 years	252	60.1
30 – 39 years	98	23.4
40 – 49 years	45	10.7
50 – 59 years	19	4.5
60 years or older	5	1.2
Gender		
Female	355	84.7
Male	61	14.6
Prefer not to disclose	3	0.7
Ethnicity[a]		
White / Caucasian	366	87.4
African American	25	6.0
Hispanic	24	5.7
Asian	12	2.9
Native American	13	3.1
Pacific Islander	3	0.7
Other	4	1.0
Education		
Less than high school degree	5	1.2
High school diploma or GED	112	26.7
Some college	176	42.0
Associate's degree	53	12.6
Bachelor's degree	65	15.5
Advanced or professional degree beyond college degree	8	1.9
Years with current employer[b]		
3 or less	281	67.4
4 – 6 years	85	20.4
7 – 9 years	22	5.3
10 – 12 years	16	3.8
13 years or more	13	3.1

[a]The total number of responses exceeds 419 due to multiple responses.
[b]The total number of responses is less than 419 due to missing data.

customers behind their back" (2.79 ± 1.95) and "lied to customers" (2.52 ± 1.66). In other words, service sabotage behaviors toward organization members (i.e., colleagues and managers) or the organization itself (i.e., restaurant) are less prevalent in the current study, indicating that properly managing service sabotage behaviors toward customers should be the restaurant manager's priority.

Service Sabotage Can Sometimes Benefit Customers

Not all of the top 10 most prevalent restaurant service sabotage behaviors were deemed detrimental to customers. In fact, some service sabotage behaviors benefited customers but hurt the restaurant profitability. Some examples included "under-charged customers" (2.32 ± 1.57) and "given out free food and/or beverages without authorization" (2.28 ± 1.51). For example, an IHOP server was arrested for giving away free drinks that were worth $3,000 to customers, and he claimed himself as the "modern day Robin Hood" (Hafner, 2016). This type of service sabotage behavior can be deemed as larceny, stealing the money that belongs to the restaurants and benefitting customers. A plausible explanation is that the IHOP server may receive higher amount of tips from the customers and may develop better employee-customer rapport, although his behavior of giving out free drinks negatively influence the restaurants' profitability and service standards. Harris and Ogbonna (2006) identified the negative association between service sabotage and employee-customer rapport, yet we suspect that this relationship may not be generalized to the service sabotage behaviors that are actually benefiting customers, such as under-charging customers or giving out free food/beverages without authorization.

Types of Restaurant Service Sabotage Behaviors

Recent media coverages of service sabotage (Hilaire, 2017) revealed service sabotage behaviors pertaining to intentional contamination. However, results of this study did not include such behaviors as frequently as other sabotage behaviors. Participants reported "given or served with unclean utensils" ranked 28th and "served unsanitary food" ranked 37th among the 39 items presented in the survey. This finding implies that saboteurs tend to engage in minor and indirect (to customers) sabotage behaviors in restaurants, which is consistent with previous research (Browning, 2008).

The majority of prevalent restaurant service sabotage behaviors were characterized as *passive-aggressive*; that is, an indirect expression of hostility that conveys aggressive feelings through passive means such as malicious compliance (Johnson & Klee, 2007). Although the authors were unable to ascertain the specific underlying psychological reasons for passive-aggressive behaviors due to the limitation of quantitative data collected, several restaurant service sabotage behaviors identified in this study appeared to fit the description of passive-aggression. Some of these examples are *I have intentionally* "completed the bare minimum amount of side jobs," "withheld some information from customers," "provided the bare minimum amount of customer service," and "spent too much time fantasizing, daydreaming, and/or playing with cell phone instead of working." Passive-aggressive sabotage behaviors are mostly indirect and minor (Browning, 2008), and it can be challenging for customers, colleagues, or managers to identify (Harris & Ogbonna, 2002). Therefore, it may be very difficult to identify such service sabotage behaviors and to take corrective actions. Even if managers detect passive-aggressive sabotage behaviors, they may face the dilemma of taking severe corrective actions against such subtle sabotage behaviors considering the hefty cost of employee turnover in the hospitality industry (Tracey & Hinkin, 2008).

Participation Rate of Restaurant Service Saboteurs

Another notable finding in regards to restaurant service sabotage behaviors is the percentage of respondents who reported that they had participated in the behavior at least once a year, which is termed as the participation rate by Bennett and Robinson (2000). The participation rates of the top 10 most prevalent service sabotage behavior items ranged from 42.7% to 80.4%. Over 80% of participants reported that they have intentionally "complained about customers with colleagues" (80.4%). Further, more than half of the respondents reported that, at least once a year, they have "completed the bare minimum amount of side jobs" (57.0%), "made fun of a customer or group of customers behind their back" (56.2%), "lied to customers" (55.4%), "withheld some information from customers" (52.8%), "given out free food and/or beverages without authorization" (52.0%), "under-charged customers" (51.9%), and "provided the bare minimum amount of customer service" (51.7%). These eight sabotage behaviors with greater than 50% participation rate account for one fifth of all behavior items.

Compared to Harris and Ogbonna's study (2006) which identified service sabotage behaviors that respondents *have heard about*, prevalent restaurant service sabotage behaviors identified in this study reflect what respondents *intentionally have done* in their workplace. Our data, therefore, provide a more precise estimate for service sabotage behaviors as well as service failure that may be attributable to sabotage behaviors in the restaurant industry. Similar to the 85% of customer-contact employees in hotels and restaurants engaging in at least one service sabotage behavior in 2002 (Harris &

Table 2. Means, Standard Deviations, and Participation Rates of Restaurant Service Sabotage Behaviors (n = 419)				
Rank of items based on means.	*I have intentionally…*	**M[a]**	**SD**	**Participation Rate[b]**
1.	Complained about customers with colleagues	4.10	2.07	80.4
2.	Made fun of a customer or group of customers behind their back	2.79	1.95	56.2
3.	Lied to customers	2.52	1.66	55.4
4.	Completed the bare minimum amount of side jobs	2.50	1.62	57.0
5.	Withheld some information from customers	2.40	1.62	52.8
6.	Under-charged customers	2.32	1.57	51.9
7.	Rushed customers	2.31	1.65	47.6
8.	Given out free food and/or beverages without authorization	2.28	1.51	52.0
9.	Provided the bare minimum amount of customer service	2.24	1.50	51.7
10.	Spent too much time fantasizing, daydreaming, and/or playing with cell phone instead of working	2.23	1.72	42.7
11.	Treated customers sarcastically	2.07	1.55	41.8
12.	Not checked a customer's ID when selling alcoholic beverages	1.91	1.54	32.4
13.	Snuck foods and/or beverages out of the restaurant	1.88	1.50	32.1
14.	Neglected to follow my supervisor's instructions	1.87	1.31	37.6
15.	Simplified and/or omitted service procedures without authorization	1.85	1.44	33.6
16.	Taken extra time for breaks	1.84	1.42	32.1
17.	Told a customer that I fixed something but didn't fix it	1.84	1.27	37.9
18.	Acted rudely toward customers	1.76	1.21	36.4
19.	Made customers wait longer than usual	1.73	1.26	31.8
20.	Ignored customers	1.68	1.22	30.4
21.	Put a customer on hold for a long period of time when taking reservations or to-go orders	1.64	1.23	29.2
22.	Created drama about colleagues	1.57	1.09	29.2
23.	Disregarded food and/or beverage quality standards	1.54	1.21	22.1
24.	Used illegal drugs before and/or during shifts	1.54	1.42	15.8
25.	Dragged out work in order to get overtime	1.48	1.09	20.2
26.	Stopped serving food earlier than regular hours	1.47	1.07	20.7
27.	Yelled at customers and/or colleagues	1.42	0.90	23.3
28.	Given or served with unclean utensils	1.33	0.96	13.9
29.	Encouraged other employees to dislike a colleague	1.32	0.89	15.2
30.	Argued with other wait staff to serve customers who tip well	1.31	0.88	14.2
31.	Adhered to rules excessively to delay the service to customers	1.27	0.80	13.6
32.	Entered wrong orders to eat and/or drink them later	1.25	0.84	11.1
33.	Hung up on a customer when taking reservations or to-go orders	1.21	0.80	8.5
34.	Disconnected a phone call when taking reservations or to-go orders	1.20	0.70	10.1
35.	Stormed out the restaurant	1.19	0.59	12.6
36.	Not shown up at work without notice (i.e., no call, no show)	1.15	0.45	12.5
37.	Served unsanitary food	1.14	0.63	5.8
38.	Over-charged customers	1.13	0.54	8.0
39.	Asked my colleagues to withdraw from providing high quality service to customers	1.10	0.55	4.5

[a]Response ranged from 1 (never) to 7 (daily).
[b]Percentage of respondents who indicated that they had participated in the behavior at least once a year.

Ogbonna, 2002), the current study reveals that 80.4% of restaurant frontline employees sabotaged service in 2017. The percentage of participation in service sabotage has not changed drastically in the past 15 years, implying that these behaviors are still prevalent and restaurant managers need to engage in preventing, correcting, and managing service sabotage behaviors among their employees.

Cluster Analysis

Cluster analysis was conducted to gain a better understanding of individuals who engage in service sabotage behaviors. Results from the dendrogram of hierarchical cluster analysis indicate that a two- or three-cluster resolution may be appropriate. Both two- and three-cluster resolutions were analyzed by the k-means procedure afterwards, and convergence was reached in 25 iterations. The two-cluster resolution was deemed better because the distribution of samples in the 3-cluster resolution was highly uneven. Furthermore, results show that the two clustered groups differed significantly on all 39 restaurant service sabotage behavior items ($p < .001$), except for "not shown up at work without notice (i.e., no call, no show)."

As shown in Table 3, Cluster 1 consists of 97 participants while Cluster 2 contains 233. The ratings for restaurant service sabotage behavior items were relatively higher in Cluster 1 compared to Cluster 2, ranging from 1.14 to 5.82 on a 7-point behavior frequency scale. In other words, participants in Cluster 1 have a greater propensity to engage in service sabotage (i.e., *restaurant service saboteurs*). Results from the t-test show that mean differences in restaurant service sabotage items were significant for all variables, except for "not

Table 3. Means and Mean Differences of Clusters

Rank of items based on mean differences.		Mean[a]			
	I have intentionally…	Cluster 1 (n = 97)	Cluster 2 (n = 233)	Mean Difference	*t*-value
1.	Complained about customers with colleagues	5.82	3.13	2.70	15.51***
2.	Made fun of a customer or group of customers behind their back	4.47	1.89	2.58	12.82***
3.	Rushed customers	3.80	1.60	2.20	11.81***
4.	Lied to customers	3.95	1.82	2.13	12.00***
5.	Completed the bare minimum amount of side jobs	3.86	1.88	1.98	11.81***
6.	Neglected to follow my supervisor's instructions	3.25	1.30	1.95	12.35***
7.	Withheld some information from customers	3.70	1.76	1.94	10.89***
8.	Spent too much time fantasizing, daydreaming, and/or playing with cell phone instead of working	3.54	1.61	1.93	8.75***
9.	Provided the bare minimum amount of customer service	3.46	1.62	1.85	10.67***
10.	Simplified and/or omitted service procedures without authorization	3.07	1.28	1.79	9.57***
11.	Given out free food and/or beverages without authorization	3.44	1.74	1.71	10.12***
12.	Told a customer that I fixed something but didn't fix it	3.01	1.33	1.68	10.54***
13.	Snuck foods and/or beverages out of the restaurant	3.02	1.36	1.66	8.30***
14.	Under-charged customers	3.40	1.81	1.59	8.58***
15.	Not checked a customer's ID when selling alcoholic beverages	2.95	1.46	1.49	7.23***
16.	Taken extra time for breaks	2.79	1.44	1.36	7.05***
17.	Disregarded food and/or beverage quality standards	2.52	1.16	1.35	7.30***
18.	Made customers wait longer than usual	2.57	1.30	1.26	7.51***
19.	Treated customers sarcastically	2.79	1.55	1.25	6.84***
20.	Ignored customers	2.46	1.24	1.22	7.78***
21.	Acted rudely toward customers	2.45	1.35	1.10	7.07***
22.	Put a customer on hold for a long period of time when taking reservations or to-go orders	2.32	1.31	1.01	5.44***
23.	Used illegal drugs before and/or during shifts	2.18	1.26	0.92	4.30***
24.	Yelled at customers and/or colleagues	2.00	1.15	0.85	6.22***
25.	Dragged out work in order to get overtime	2.05	1.26	0.79	4.89***
26.	Created drama about colleagues	2.10	1.33	0.77	5.12***
27.	Given or served with unclean utensils	1.89	1.12	0.76	4.86***
28.	Encouraged other employees to dislike a colleague	1.84	1.11	0.72	5.11***
29.	Adhered to rules excessively to delay the service to customers	1.76	1.06	0.71	5.34***
30.	Argued with other wait staff to serve customers who tip well	1.77	1.11	0.67	4.85***
31.	Stopped serving food earlier than regular hours	1.82	1.36	0.46	3.17**
32.	Hung up on a customer when taking reservations or to-go orders	1.53	1.06	0.46	3.29**
33.	Served unsanitary food	1.46	1.02	0.44	3.93***
34.	Disconnected a phone call when taking reservations or to-go orders	1.43	1.09	0.35	3.10**
35.	Asked my colleagues to withdraw from providing high quality service to customers	1.36	1.02	0.34	3.26**
36.	Entered wrong orders to eat and/or drink them later	1.47	1.17	0.31	2.43*
37.	Stormed out the restaurant	1.35	1.13	0.22	2.74**
38.	Over-charged customers	1.27	1.06	0.21	2.37*
39.	Not shown up at work without notice (i.e., no call, no show)	1.14	1.17	-0.03	-0.50

[a]Response ranged from 1 (never) to 7 (daily); * $p < .05$ (two-tailed); ** $p < .01$ (two-tailed); *** $p < .001$ (two-tailed)

shown up at work without notice (i.e., no call, no show)." Items with larger mean differences (i.e., top five among the 39 items) were "complained about customers with colleagues" (mean difference = 2.70), "made fun of a customer or group of customers behind their back" (mean difference = 2.58) "rushed customers" (mean difference = 2.20), "lied to customers" (mean difference = 2.13), and "completed the bare minimum amount of side jobs" (mean difference = 1.98), showing that restaurant service saboteurs behave quite differently compared to their counterpart.

In terms of participants' demographics, there was a significant difference in age between Cluster 1 and Cluster 2 ($t_{225.283} = -2.009$, $p < .05$). The average age for Cluster 1 was 2.1 years younger than the average age of those in Cluster 2. This finding shows that restaurant service saboteurs tend to be relatively younger which is consistent with previous literature in the call center setting (Skarlicki et al., 2008). Moreover, there was a significant association between clusters and restaurant segments. Cluster 1 and Cluster 2 had different proportions of workplaces between casual-dining restaurants and fine -dining restaurants ($c^2(1) = 4.834$, $p < .05$). It is interesting to note that 30.9% of respondents in Cluster 1 (i.e., *restaurant service saboteurs*) work in fine-dining restaurants which is higher than Cluster 2 (19.7%). Most of the times, customers expect to receive higher service quality in fine-dining restaurants; however, this counter-intuitive finding may be due to the prolonged service contacts as reported in the previous research (Harris & Ogbonna, 2002).

CONCLUSIONS AND APPLICATIONS

The purpose of this research was to explore prevalent restaurant service sabotage behaviors. Descriptive statistics revealed that restaurant service sabotage behaviors, especially passive-aggressive behaviors were prevalent. Service sabotage behaviors toward customers occurred more often than those toward colleagues, managers, and restaurant itself among the prevalent behavioral items. The majority (80.4%) of respondents admitted that they engaged in one or more restaurant service sabotage behaviors at least once a year. Eight different restaurant service sabotage behavior items were committed by more than half of the respondents. Furthermore, the two clustered groups were identified by using hierarchical and k-mean cluster analyses. Restaurant service saboteurs tend to be younger, and a larger proportion of saboteurs work in fine-dining restaurants compared to those who had lower propensity to engage in service sabotage.

As service sabotage behaviors vary depending on the context, restaurant managers may not be fully aware of how the behavior is exhibited. This study provides a comprehensive list of 39 restaurant service sabotage behaviors for the managers' reference. Of those, restaurant managers should pay close attention to the prevalent service sabotage behaviors to effectively detect and manage them. Moreover, restaurant managers should address passive-aggressive service sabotage behaviors in the early phase although they are more indirect (i.e., toward customers) and minor in nature, making it hard to be detected. However, passive aggression may become direct and more severe if proper supervision and management are absent. Informing frontline employees that managers are aware of such behaviors and they will not be tolerated may deter employees from engaging in these negative behaviors.

Besides practical applications addressed above, researchers may apply findings from this study as a foundation to develop a valid scale to measure restaurant service sabotage and attain more insights of this prevalent, costly, and yet, critical phenomenon in the restaurant industry. The list of 39 restaurant service sabotage items may be used as the item pool when conducting the future research in restaurant sabotage service.

The study should be interpreted with caution due to the following limitations. Restaurant service sabotage is a sensitive topic in the workplace. Past literature cautioned the effect of social desirability bias when studying service sabotage (Harris & Ogbonna, 2002). While one cannot guarantee that data from this study are free from the social desirability bias, participants in the current study were recruited from an online panel where they could access the online survey anonymously to minimize the impact of social desirability bias. This practice assured a less stressful environment when taking the survey. Further, data in this study were collected from frontline employees in full-service restaurants in the U.S. where tipping is a social norm. Therefore, the results from this study may not be generalizable to other restaurant segments (e.g., quick service or fast casual) or to other regions where tipping is not required or expected. Finally, the authors were unable to identify the underlying psychological reasons for displaying passive-aggressive sabotage behaviors due to the nature of the quantitative data collected in the current study. Future studies may apply qualitative methods to gain a better understanding of the passive-aggressive sabotage behaviors.

The essence of the study was exploratory with the purpose of identifying prevalent restaurant service sabotage behaviors in the U.S. This is an initial effort to elicit more research toward this important yet understudied issue existing in the U.S. restaurant industry. In this sense, the aim of the study was achieved, and future researchers should continue exploring ways to correctly measure restaurant service sabotage behaviors and developing strategies to discourage employees from engaging service sabotage behaviors.

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Research Contribution

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EDUCATIONAL AFFORDANCES OF GOOGLE GLASS AS A NEW INSTRUCTIONAL PLATFORM FOR FOODSERVICE TRAINING

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ABSTRACT
Foodservice training delivered through wearable computers is a new type of instructional delivery method, yet little is known about how it impacts training outcomes. Three educational properties of a wearable computer-based foodservice training platform were compared to traditional, strictly video-based, classroom training. Results showed the efficiency of using the wearable computer as an on-the-job training method, as participants required less than 50% of the time to view and execute the training and food handling tasks compared to the strictly video-based group. Food industry stakeholders should weigh the costs and benefits of using wearable computers when considering upgrading existing training methods.

Keywords: wearable computers; foodservice training; food safety training; smart glasses

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INTRODUCTION

Many companies struggle to ensure their employees are properly trained and perform their prescribed job duties. It is estimated that in 2012 corporations spent more than $164 billion in training, much of which failed to lead to changes in individual job performance (Miller, 2013). Effective training of front-line personnel is foundational to foodservice and has been shown to boost both employee efficiency and their confidence in the workplace (Aguinis & Kraiger, 2009).

Foodservice owners and managers train their workers on tasks and procedures through different methods and forms of instruction. When designing training programs, attention must be given to the selection of the most effective instructional media, as it can impact learning outcomes and training transfer (Tonhäuser, Büker, Tonh, & Laura, 2016). A review of food safety training methodologies found that videos were the most commonly used audiovisual resource, followed by posters, slides, illustrations, flip charts, music, and interactive media (Medeiros, Cavalli, Salay, & Proença, 2011). However, improvements in the affordability and design of advanced training technologies have made computer-based training among the most popular instructional media in the foodservice industry (Mandabach, 2007).

Computer-based training provides a flexible learning platform where the employee can self-navigate through the content at their own pace (Pintauro, Krahl, Buzzell, & Chamberlain, 2005), saving on costs for dedicated trainers during normal shifts (Singh, Kim, & Feinstein, 2011). Self-navigation through training may increase motivation to learn through providing foodservice workers greater individual autonomy for their own learning (Hall, 2015). Computer-based training can minimize variation in peer-to-peer training as well as inaccuracies and/or employee deviations from established job procedures (Hall, 2015).

Costly, high turnover rates drive the need for effective and efficient training to ensure consistent product quality and safety. Employee turnover rates in the fast food industry average 150% (Spencer, 2018). Replacing low paying, high turnover jobs, such as that commonly associated with the food industry, costs employers an average of 16% of an employee's annual wages (Boushey & Glynn, 2012). Because many computer-based training mediums are novel, they have been shown to arouse increased employee interest in routine training content (Fredricks, Blumenfeld, & Paris, 2004). A study of 96 healthcare workers enrolled in safety training found computer-based training motivated employees to a greater extent than videos or routine lectures (Rodgers & Withrow-Thorton, 2005).

While advantageous in some regards, there are several drawbacks to computer-based training, including cost concerns (Hall, 2015) and its overall impact on learning compared to other types of instructional media. Some foodservice companies may be hesitant to invest in novel technologies that may become obsolete in a few years (Tanyeri, 2018). Concerning learning outcomes, a study comparing lecture-based to computer-assisted, interactive food safety training found both methods were equally effective at increasing food safety knowledge (Costello, Gaddis, Tamplin, & Morris, 1997). Behnke and Ghiselli (2004) found no significant differences in knowledge retention scores across two groups that received menu training through either a face-to-face lecture or computer. These studies are in line with Reiser's (2001) finding that the type of instructional media has historically had minimal impact on improving the effectiveness of instructional practices. From a theoretical perspective, the instructional media serves as simply a carrier of information and thus is unlikely to have a dramatic effect on the efficiency of the learning process (Clark, 1983, 1994).

Most of the aforementioned studies, however, are concerned with what might now be called traditional, computer-assisted methods. A new type of instructional media involves the use of wearable devices which deliver step-by-step instruction while the trainee performs the action. Wearable computers are increasingly being used in the manufacturing and foodservice industry (della Cavo, 2014). A wearable computer can be defined as a "fully functional, self-powered, self-contained computer that is worn on the body… [that] provides access to information" (Caudell & Barfield, 2001, p. 6). Wearable computers may take the form of smart glasses or virtual reality headsets. This technology carries a unique set of educational properties or features (Table 1). Wearable computers such as smart glasses can provide hands free training that could affect how efficiently training is viewed and executed, potentially affecting training expenses for companies. A new paradigm is emerging that suggests greater organizational outcomes can be achieved by educating workers through computer-based training and augmenting worker performance with the assistance of smart glasses (Abraham & Annunziata, 2017; Noone & Coulter, 2012). These plausible benefits

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Table 1: Educational Properties of Wearable Computers as a Training Delivery Method	
Positives	**Negatives**
In situ contextual information	Overreliance on wearable technology
Recording	Familiarization with the technology
Simulation	Small interface
Communication	Privacy
Engagement	Cost
First-person view	Technical Problems
Hands free access to information	Legal Issues
In situ guidance	Development of software
Feedback	Processing power
Efficiency	Distraction
Presence	
Distribution	
Freed up spaces	
Gamification	

Adapted from Bower and Sturman (2015)

must be weighed against some of the potential drawbacks associated with wearable computers as an educational tool (Table 1).

To date, little is known of the impact of wearable computers on the food industry or its functionality in a training situation. Understanding the functionality and limitations of using wearable computers for training purposes can help food industry stakeholders make better informed decisions about whether to supplant existing instructional delivery methods with new technology. The objective of this study was to understand properties of wearable computer-based foodservice training in comparison with a more traditional, strictly video-based training platform. This study looked at the properties of efficiency, hands-free access to information, and freed-up space in the work environment. Efficiency was evaluated, while hands-free access to information and freed-up space in the work environment were addressed.

METHODS

Participants

Prior to data collection, approval was obtained by the University of Arkansas' Institutional Review Board for human subjects. To recruit participants, the study was posted in campus news emails sent out to students, faculty, and staff of the university. No affiliation with the university was necessary for study participation. Recruiting was conducted on a rolling "as-needed" basis, and participants were told the purpose of the study was to understand how food handler training affects food handling outcomes. Individuals were pre-screened for any food allergies, food intolerances, or predisposition to Obsessive-Compulsive Disorder related to excessive handwashing behavior (Pellegrino, Crandall, & Seo, 2015). Participants were balanced across the two treatment groups by age, gender, foodservice experience, and their familiarity with technology usage. To determine technology usage, participants were given a list of common, interactive technologies, which included smart watches, tablets, mobile phones, computers, and digital games among others (Agbatogun, 2013). Participants were asked how often they used each type of technology on a three-point scale, "1 = Never", "2 = Sometimes", "3 = Frequently." Adding up the total score yielded technology usage for each participant.

Research Instruments

The wearable computer used in this study was Glass, Enterprise Edition (Google, 2018a) (Figure 1). Glass is worn by the user like a pair of eye glasses, and an optical display located in the user's field of vision shows training content. Users navigate through the training content through voice commands or a scroll pad embedded in the side frame. Using voice commands poses a potential decreased risk of cross contamination in comparison to using the scroll pad.

A team of professional videographers filmed the training content for both treatment groups, and a university theater student with prior acting experience served as the food handler. All training content was filmed in a commercial kitchen. The training included when and how to wash hands and a procedural learning task of making a sandwich. These tasks were selected because: (a) poor personal hygiene such as lack of handwashing is associated with an increased risk of foodborne illness transmission and foodborne illness outbreaks (Food and Drug Administration, 2010; Todd et al., 2010), b.) low handwashing compliance is often observed among food handlers (Food and Drug Administration [FDA], 2018), and c.) procedural learning is integral in the foodservice industry in which food handlers must remember to prepare food products with ingredients in a specific order and/or arrangement.

Handwashing training for both treatment groups utilized the same footage taken from the third-person, or observer perspective. This would be equivalent to watching a peer wash hands. Handwashing steps were based on Centers for Disease Control and Prevention (CDC) recommendations and included wetting the hands, adding soap, 20 seconds of lathering, rinsing the hands, drying the hands, and turning off the water with a paper towel (CDC, 2015). Participants were shown four events of when to wash hands: (a) handwashing before touching food; (b) after cleaning; (c) after handling pre-cooked, processed meat, but before handling vegetables, and (d) after touching money. These events were chosen, in part, due to mandates in the 2017 FDA Food Code regarding washing hands before engaging in food preparation and after events that could contaminate the hands (FDA, 2017). The researchers recognized that handling ready-to-eat pre-cooked meat may not constitute a hand contamination event. This event was used in the preliminary pilot study and could not be edited out by the researchers given the nature of the Glass software configuration. However, the event may be analogous to training procedures on avoiding cross contamination of allergens or for religious food handling procedures such as halal, kosher, etc.

For the procedural learning task, photo stills for the Glass training were extracted from video footage obtained simultaneously as that used for the strictly video-based training. Photo stills were obtained using a GoPro HERO4 which captures the first-person, or actor perspective (Figure 2). This would be like watching oneself perform a

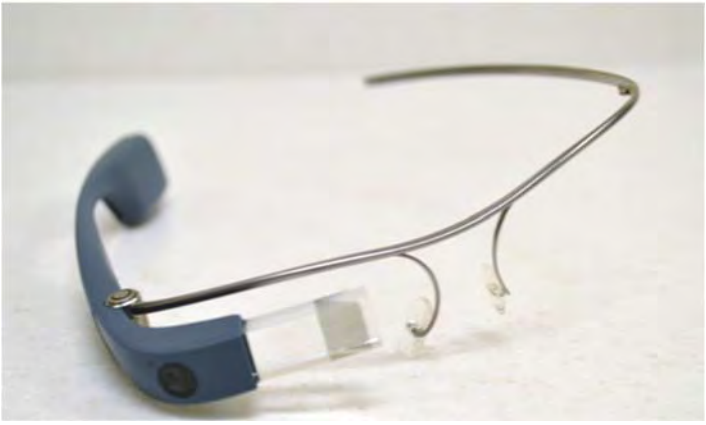

Figure 1: The Wearable Computer Used in the Study.

task from a bird's eye view. The video footage used for the sandwich making with the strictly video-based training was captured from the third-person perspective. The sandwich training for both training groups included placing ten food items in a specific arrangement on a piece of bread marked as a 2x2 grid.

Procedures

Participants in both training groups were told they were being trained to make a sandwich and that handwashing was important. While both groups executed the training content, overall time to wash hands and make the sandwich was recorded. Time was calculated as total time required to both view and execute the handwashing training. For the Glass group, viewing and execution occurred simultaneously, while for the video group viewing and executing the training were two separate events, i.e. in the classroom (viewing) and in the testing area (execution). For the video group, time to traverse between the classroom and testing area was not included in the calculations. Adherence to the CDC six handwashing steps and lathering time were recorded. Lathering times less than 20 seconds were recorded as a missed step in the handwashing process. Participants were surveyed on whether they had received food safety training prior to the study and duration and type of foodservice experience, if applicable. Then participants were debriefed and compensated with a $20 gift card.

Video training group

Participants in the strictly video-based training group viewed the four-minute training video from eight feet away with a 25-inch screen. To control for differences in instructional media display, the video size was calibrated to correspond with the Glass display which is analogous to watching a 25 inch television from eight feet away (Google, 2018b). Immediately afterwards, participants were ushered into the testing area with sandwich materials arranged in a similar manner as seen in the training video and available handwashing facilities. To minimize experimenter error, the same researcher was used to give and assess the training. Approximate time between training viewing and execution was two minutes. Then participants were told to make a sandwich based on the training they had just received.

Glass training group

In the testing area with handwashing facilities and sandwich materials arranged in a similar manner as the training, participants were provided an instruction sheet created by the training software developer. This gave information on how to go through the training step-by-step using voice activation and/or manually swiping and tapping a scroll pad embedded in the temple of the glasses to advance to the next step in the training sequence. Participants were allowed to familiarize themselves with device functionality by going through a deli slicer cleaning module until they felt comfortable. No deli slicer was present and participants were shown this training for the sole purpose of learning how to progress stepwise through the training. To control for navigation type and assess hands free access to information, participants were encouraged to advance to the next training step by voice activation by saying, "next step" out loud. However, some participants were not comfortable relying solely on voice commands, necessitating usage of the scroll pad. After becoming familiar with Glass, participants were reminded by the researcher to complete the training by simultaneously making the sandwich as instructed by the device.

Analytical Procedure

Thirty participants were recruited and an equal ratio of men to women were placed in each training group (5 men and 10 women) (Table 2). Average age of the Glass group and strictly video-based training group was 32.1 years (SD = 12.4, range: 19-60) and 30.0 years (SD = 11.5, range: 20-60), respectively. This closely mirrors the median age of food preparation workers in the U.S. (31.5 years) (Data USA, 2016). There was no significant difference between training groups in age [$t(28) = .49$, $p = 0.62$], technology use [$t(28) = .14$, $p = 0.89$], or foodservice experience [$\chi^2(1) = .13$, $p = 0.72$]. Data was analyzed using SPSS version 24.

Figure 2: Comparison of Sandwich Training between Training Methods. First-person Perspective Photo Stills were Used for the Wearable Computer Training (Left) and a Third-person Perspective Video was Used in the Video Training (Right).

Table 2: Demographic Characteristics of the Wearable Computer and Video Training Groups

		Wearable Computer	Video
Age (average, years)		32.1 ± 12.4	30.0 ± 11.5
Gender	Male	5	5
	Female	10	10
Food service experience (years)	None	8	7
	<1	2	3
	1-3	2	1
	4-7	2	4
	8+	1	-
Type of food service experience	Restaurant	4	3
	Cafeteria	1	2
	Catering	-	1
	Other	-	-
	Multiple	2	2
Prior food safety training	Yes	7	6
	No	8	9

RESULTS

Average time to view and execute the sandwich and handwashing training for the Glass and strictly video-based training group was 4 minutes 15 seconds (SD = 33 seconds) and 6 minutes 43 seconds (SD = 36 seconds), respectively. All participants in the Glass group made the sandwich in the exact way informed by the training, receiving an average score of 10 out of a possible 10. Average sandwich score in the strictly video-based group was 5.1 (SD = 2.3, range = 2-10). All participants washed hands both times as designated in the training. Average lathering time before making the sandwich for the Glass and strictly video-based training groups was 24.5 seconds (SD = 7.2, range = 12-43) and 19.7 seconds (SD = 8.7, range = 3-37), respectively. Average lathering time before handling vegetables after touching pre-cooked, processed meat for the Glass and strictly video-based training groups was 19.8 seconds (SD = 8.8, range = 0-30) and 21.3 seconds (SD = 8.7, range = 3-45), respectively. There was no significant difference between the training groups in lathering times for before making the sandwich [$t(28) = 1.63$, $p = 0.11$] and before handling vegetables after touching pre-cooked, processed meat [$t(28) = -.48$, $p = 0.64$].

DISCUSSION

The purpose of the study was to explore the educational properties of wearable computers that included efficiency, hands free access to information, and freed up spaces in the work environment. Efficiency was evaluated, while hands- free access to information and freed-up space in the work environment were addressed. The strictly video-based training group required over 50% more time to receive and execute the training compared to the Glass group [6 minutes 43 seconds (SD =36 seconds) compared to 4 minutes 15 seconds (SD = 33 seconds)]. Wearable computers such as smart glasses show potential to expedite and to impact food handler training positively. However, more research is needed that determines whether this potential is realized across a diverse workforce with different comfort levels in learning and using new technology (Ravichandran, Cichy, Powers, & Kirby, 2015). Recent labor trends indicate more older workers are being employed in the foodservice industry (Patton, 2018). Older foodservice workers have expressed frustration with computer-based training and may require one-on-one assistance that increases the overall cost of training (Ravichandran et al., 2015).

Having access to the training material through hands-free voice activation or manual scrolling allowed some participants in the Glass group to receive on-the-job training. A study that assessed hygiene of food contact surfaces in a catering establishment found 19.4% of surfaces that included cutting boards, meat slicers, and countertops were considered dirty (>100 CFU/25 cm^2) (Garayoa, Díez-Leturia, Bes-Rastrollo, García-Jalón, & Vitas, 2014). This highlights the advantages of hands-free access to training content through voice activation, which could decrease the risk of cross contamination between food, food contact surfaces, and the instructional media. Concerning freed-up space in the work environment, foodservice kitchens may face space limitations, as smaller work areas allow food handlers quick access to ingredients. Additionally, some tasks such as properly cleaning food equipment may require more than a poster on a wall to explain the procedure properly, rendering paper-based training manuals impractical.

CONCLUSIONS AND APPLICATIONS

Foodservice owners and managers have a need to train employees quickly and effectively, given high turnover and the resulting training costs. While the type of instructional media may not have significant effects on learning outcomes, it does offer different properties, uses, and conveniences. The present study examined three properties offered by wearable computers in juxtaposing Glass and strictly video-based training. This information could benefit foodservice stakeholders conducting cost-benefit analysis on whether to modernize training programs by utilizing wearable computers.

The cost of wearable computers compared to more traditional forms of instructional media should be considered in light of the possibility of time savings. While computer-based training allows employers to save money through decreasing the need for paper manuals (Hall II, 2015) this must be weighed against the cost of using the technology. The smart glasses used in the study cost between $1200-$1400 per pair, though renting the devices remains a potential costing option for foodservice entities. As with any piece of equipment, foodservice entities would need to consider the device's durability and maintenance needs balanced against the possibility of it being damaged or stolen. One device has the capacity to train an unlimited number of workers one at a time (limited by battery life). As implied, training multiple workers simultaneously would necessitate multiple devices, which would also drive up training costs.

More research is needed that compares the time required to design and execute training with wearable computers compared to strictly video-based methods or paper-based training manuals. Creating a workflow and embedding video instructions in the smart glasses ranged from 2-3 hours. While the researchers did not time participants on how long it took them to learn how to operate the smart glasses, this time cost of computer-based training should also be examined.

The experiment had several limitations. The study was a laboratory experiment, and future research should assess wearable computer use in the context of an operational foodservice environment. Qualitative research with industry stakeholders on the advantages and disadvantages of using wearable technology to train workers would provide needed perspectives to supplement the present study's findings. The study was limited to 15 participants per group, and future studies should compare trainings with a larger sample size. Additionally, the exact number of participants in the Glass group that used voice activation or manually scrolling was not determined, but rather only that a portion of participants fell into either category. Future research should seek to better understand the factors that influence the preferred choice for completing training. Future studies could also compare and quantify cross contamination events between using solely voice activation or manually scrolling.

The researchers were mindful of the impact an observer may have on an employee performing a behavior, commonly known as the Hawthorne effect (Latham, 2012). The researchers endeavored to minimize the impact of the Hawthorne effect by utilizing the same experimenter for both the wearable computer and strictly video-based training groups. In addition, the efficiency of both trainings was measured, rather than focusing solely on the compliance with handwashing behavior which has been shown to be inflated by the presence of an observer (Srigley, Furness, Baker, & Gardam, 2014). Time to become familiar with and learn how to operate the smart glasses was not recorded by the researchers and future studies should measure this input.

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