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Assessing the Usage of Food Thermometers at American University Football Tailgates

ABSTRACT

Temporary food production settings such as festivals, community gatherings and tailgates often have little infrastructure for safe food handling practices. Many outdoor temporary events have been linked to foodborne illness outbreaks, but little is known about safe food handling practices specifically in tailgate settings. This research was designed to evaluate current food thermometer usage at university football tailgates, using a mixed-methods approach of observation and interview. Additional aims were to engage with participants around safe food handling and distribute food safety materials and evaluate this approach as an intervention. Trained data collectors from five U.S. universities collected baseline thermometer usage data, engaged participants with safe food handling messages, and returned to collect thermometer usage data. Just 33% of tailgaters reported using a food thermometer (n = 523). Follow-up observations revealed 56% of participants exhibited a change in behavior following the intervention (n = 39). The three most reported foods likely to be assessed with a thermometer were beef, pork, and chicken. Results provide insight on the need for food safety training and specific education for tailgaters. Targeting education efforts to this group can aid in reducing the risk of foodborne illness at temporary food settings.

INTRODUCTION

Approximately 48 million cases of foodborne illness occur in the United States every year, leading to problems such as financial loss, hospitalization, long-term health issues, and death *(5)*. According to outbreak data, produce accounts for 46% of foodborne illness, while meat and poultry products account for 22% *(15)*. The U.S. Centers for Disease Control and Prevention (CDC) attributes foodborne illness to five contributing factors, one of which is improper cooking. In food service settings, the United States Food and Drug Association (FDA)'s Model Food Code includes an end-point internal cooking temperature for meat and poultry products that will deliver a 6.5 to 7-log lethality of the most virulent pathogen likely in that product *(3, 17)*. These regulatory temperature requirements are commonly used as recommendations for safe endpoint

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cooking in consumer settings as well. The primary focus of this study was on meat and poultry, since these products are relevant to proper cooking temperatures and thermometer use in reducing the risk of foodborne illness and are potentially consumed raw or undercooked at temporary events.

Meat and poultry contain many pathogens that cause foodborne illness and that occur as natural flora in animal gastrointestinal (GI) tracts and hides. Shiga toxin-producing *Escherichia coli* (STEC) are commonly found in beef and have been known to cause serious GI illness in consumers who are young, old, or immunocompromised *(17)*. Raw poultry products can contain *Salmonella* spp. or *Campylobacter* spp., other human pathogens that can cause serious GI disease in individuals with weakened immune systems *(17)*. In whole cuts of meats, pathogens are most likely to be present on the surface of the meat; when these meats are ground or mechanically tenderized, the pathogen may internalize so as to be present in the center of the food product *(11, 17)*. In the United States, ground beef is the most consumed beef product, making up 62% of domestic beef consumption *(6)*. The potential for internalization highlights the importance of heating the meat to an internal temperature sufficient to reduce the pathogens and decrease the risk of foodborne illness.

Cooking food to the proper internal temperature is a practice that is not universally adopted by consumers around the world. Eating rare or undercooked beef is a cultural norm that varies in locations across the U.S. but is prevalent enough to warrant a consumer advisory section of the FDA's Model Food Code *(16, 17)*. Studies show that in consumers' homes, people rarely use thermometers to determine when their meat is fully cooked even when thermometers are owned and accessible *(4, 10, 14)*. When thermometers were used, most people were overcooking their meat, but others finished cooking before the target internal temperature was reached. The infrequency of thermometer use in consumer kitchens raises questions on their use at more temporary food preparation events.

Temporary events are defined here as non-permanent events where food is served to people without profit. These events include tailgates, community picnics, festivals, and other gatherings. In the United States, tailgates are informal events that take place in parking lots prior to large events where the attendees prepare and consume food outside, typically out of the back of a car or truck. Preparing risky foods at temporary events poses a particular risk for foodborne illness because of the lack of food safety infrastructure. Temporary events typically do not have proper hand washing facilities, training of food preparers, or storage conditions. Historically, foodborne illness outbreaks have been linked to consumption of food prepared at these types of events *(12, 16)*.

Successful interventions take more than knowledge into account, as knowledge is not the sole indicator of behavior change. Many behavior change models recognize attitudes, perception, opportunity, motivation, and social norms as precursors for intentions and behavior change *(1, 18)*. Additionally, targeted interventions resonate better with subjects than ones with generalized information *(8)*. Governmental agencies have released food safety information specific for temporary events such as tailgates, but little has been discovered about delivering these interventions in person.

This study aimed to assess the current use of food thermometers at American university football tailgates and use an intervention to provoke behavior change in those who do not already use a food thermometer. The hypothesis was that most tailgaters do not use food thermometers but that an in-person intervention could impact behaviors.

MATERIALS AND METHODS

An intervention was used to educate people grilling at university football tailgates on the importance of using a food thermometer when preparing food at temporary events. To evaluate the effectiveness of the intervention, two in-person structured surveys, including interviews and observations, were developed to determine food thermometer usage before and after delivery *(Fig. 1)*. The data collection included a mixed-methods approach of observation and surveying. Mixed-methods tactics incorporate multiple different qualitative and quantitative research tools to maximize the information received *(7)*. Surveying allowed collection of self-reported information from participants about past situations, and observation allowed collection of information on current food thermometer use without the bias associated with self-reporting.

Intervention development

The primary purpose of the intervention was to engage with people who were not already using a food thermometer while grilling. An active approach was taken in which participants were not only given the correct information and materials to change their behavior but also invited to participate in conversations about the importance of the subject. These conversations were not forced or scripted; rather, any participant could seek any further information of interest to them.

Distributed intervention materials were designed specifically for distribution to participants who did not currently use food thermometers. The packet included a food thermometer, an apron, and a cold drink holder, which were all chosen because of their functionality in tailgating situations as well as their ability to display food safety information for others to see. These visual materials contribute to the idea that other people are participating in the behavior and may draw others to participate in this social norm. Additionally, the packet included a 5 × 7" card with food safety information on using temperature and food thermometer use to

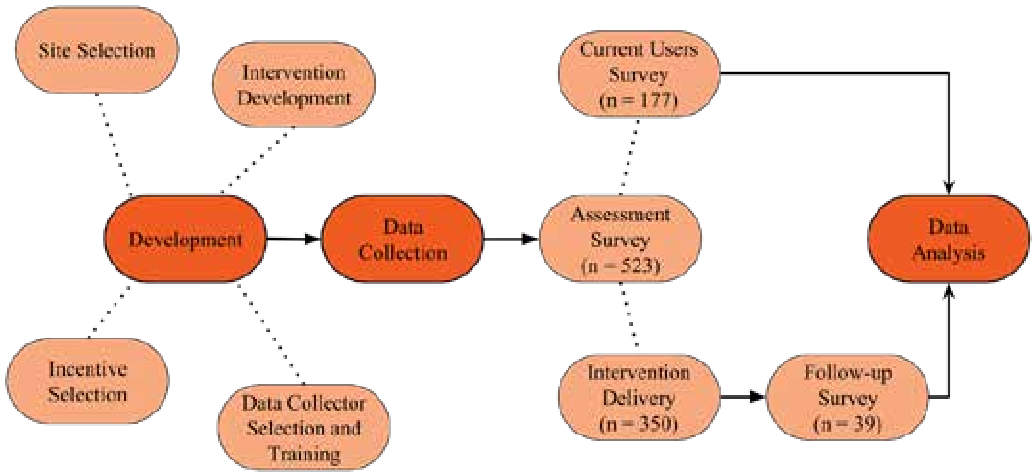

FIGURE 1. Flow diagram of study design, implementation and analysis

FIGURE 2. Food safety information intervention materials distributed following baseline assessment

indicate meat doneness *(Fig. 2)*. The food thermometer and food safety information provided an opportunity to practice food safe behavior, with the information presented in a way that highlighted the positive aspects of the behavior change and the control the participant has over cooking safe food.

Intervention evaluation

A pre-intervention assessment survey *(Fig. 3)* was developed to evaluate the use of food thermometers by participants. Data collectors followed a script of asking questions about food thermometer use, frequency of use, and use with specific food items. Participants were provided with a list of possible answers to simplify data analysis. Participants who reported not using a food thermometer became part of the intervention.

A post-intervention assessment was also employed to ask further questions about participants' food thermometer use. Answers to these questions included information regarding frequency of use, foods on which thermometers were used, and use at the time of follow up (which could be classified

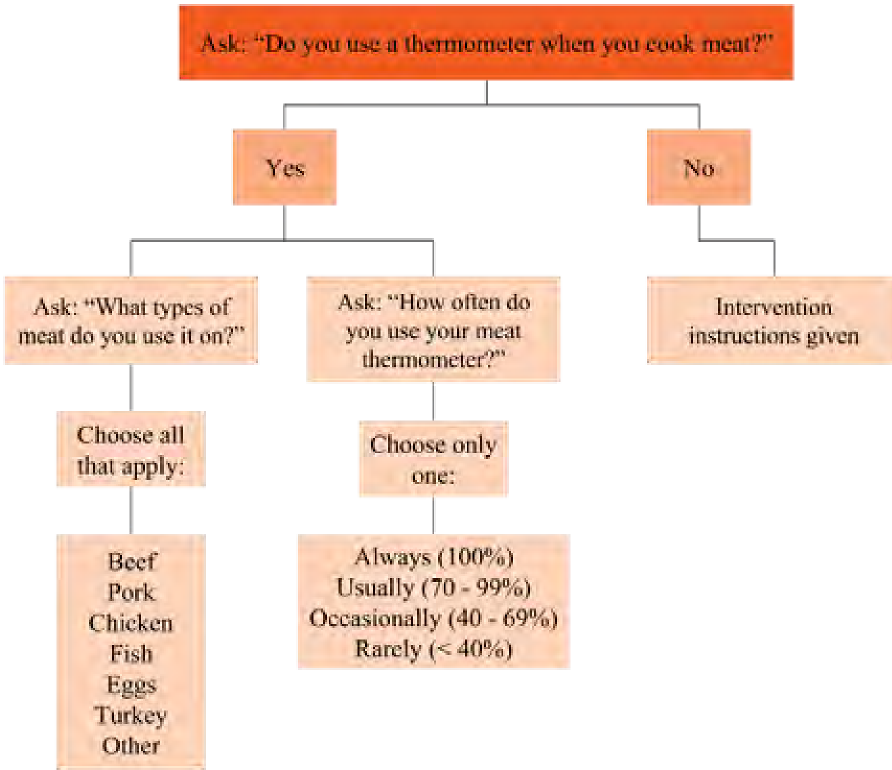

FIGURE 3. Baseline assessment survey questionnaire

as correct use, incorrect use, or no use). *Fig. 4* shows the sequence of the follow-up survey.

Survey results were collected with Google Forms (https://docs.google.com/forms; Alphabet Inc., Mountain View, CA, USA), with all questions appearing in quotations, worded exactly as they should be asked. This structure further standardized the interview, since a large number of data collectors with varying surveying experience were employed as data collectors. Surveys also implemented skip logic, a feature in which the answer to a question dictates what other questions are asked, allowing individuals to be surveyed only about instances that apply to them. Each survey began with volunteer and university name, for data collectors to answer before contact with participants. The university name was collected to later categorize responses by location.

Site selection

A convenience sample of participants at multiple universities was employed. Partner universities met the following criteria: (1) Participating in the grant providing project funds (2) having a recognized Food Science Club (FSC) through the Institute for Food Technologists Student Association and (3) having at least one collaborator willing to be in charge of the research at that institution. Five universities were recruited for this research: North Carolina State University (NCSU), Virginia Polytechnic Institute and State University (VT), Kansas State University (KSU), University of Nebraska at Lincoln (UNL), and Texas A&M University (TAMU). Researchers contacted both the grant collaborator and the FSC president at each university, and these individuals became the persons in charge (PIC) of the study at their university.

Data collector selection and training

Students were recruited from the FSC at each university, allowing many data collectors who already had knowledge about food science and food safety to participate. There was no cap on the number of data collectors; each PIC was able to recruit an adequate number to effectively cover their respective tailgates. Data collectors were required to be in groups of two or more students, to minimize the potential for misinformation that having only one person could cause.

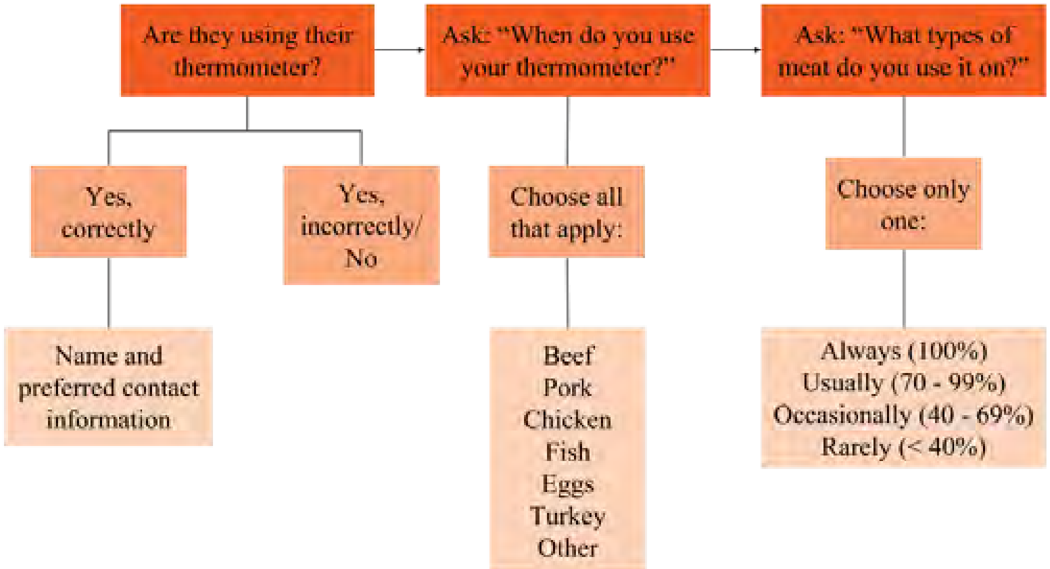

FIGURE 4. Post intervention survey and observation instrument

In an effort to standardize the surveying process, all data collectors were required to watch a training video (https://youtu.be/S2yjbW52TGI) prior to the start of data collection. This video included the following information: the goals of the project, the correct procedures for collecting the data, and the importance of the standardization of the process. Instructions were also produced in written form for data collectors as supplemental information.

Incentive

Incentives were incorporated in the research based on the idea that positive attitude formation and behavior change are related to the expectation of a favorable outcome *(1)*. All participants found correctly using the food thermometers they had been given were entered into a lottery for one big prize per university.

Data collection

Each university chose two non-consecutive home football tailgates for data collection. All data collectors from each university conducted all surveys and observations on the same designated day. At the first date, groups of data collectors approached participants who were actively preparing food, covering all areas of the tailgate. Data collectors first ensured that the participant was at least 18 years of age and then asked for consent to be included in a research study. If both conditions were met, data collectors administered the assessment survey in its entirety and were present to answer any questions that the participants may have had. Data collectors communicated that they would return to a home tailgate later in the season to follow up and gave instructions on how to be found during the follow up. The surveying continued until all intervention packets were distributed or until all areas of the tailgate were covered. Each school was given approximately 100 packets to distribute during the tailgate, but the number distributed varied by university with regard to the size of the tailgating event, the number of data collectors, and the number of tailgaters approached who already used food thermometers.

The follow up to the intervention was done at the second tailgate, unannounced to participants. Data collectors administered the follow-up survey and were responsible for assessing whether or not the participant who displayed their apron was (1) using their food thermometer and (2) using it correctly. Correct use, in this case, was defined as inserting the thermometer into the thickest part of the meat and making sure that the temperature reached the recommended internal temperature for that commodity. Previous studies have demonstrated that direct observation may impact behaviors, so the observation was performed without the knowledge of the participant to reduce the chance of their behavior changing as a result of observation *(13)*. If participants were using their food thermometers correctly, their information was collected for the incentive lottery. Data collection continued until all areas previously surveyed were observed. This approach was used to overcome limitations of self-reported data alone, which can be unre-

TABLE 1. Frequency of food thermometer use by current users

	Always		Usually		Occasionally		Rarely	
	100%		70–99%		40–69%		< 39%	
	n	%	n	%	n	%	n	%
Current users (n = 173)	60	35	55	32	42	24	16	9

liable because of social desirability bias *(19)*. Consumers' self-reported practices have also been shown to be different when compared to their observed behavior *(2, 9)*.

Analysis

Data collected was exported to Microsoft Excel 2011 for Mac (Seattle, WA, USA) for data analysis. Much of the analysis consisted of percentages of the whole participant population or subpopulations of participants.

One-way analysis of variance (ANOVA) was performed to identify significance of various factors in the study. All ANOVA tests were achieved using JMP Pro 12 software (SAS, Cary NC, USA). Significance for this study was defined as $P < 0.05$, or 95% confidence. Because of differences in number of participants per school, Tukey-Kramer Honestly Significant Difference (HSD) tests were completed as post-hoc tests to further detect significance among multiple subgroups within a variable.

RESULTS

Assessment survey

A total of 524 participants completed the pre-assessment. When asked about food thermometer usage, 33% of participants reported that they use a food thermometer when they cooked meat, and 67% of participants responded that they do not. Frequency of food thermometer usage by those who already use them (n = 173) is summarized in *Table 1*. When viewed by location, a significantly greater proportion of people reported using food thermometers at KSU than at VT, UNL, and TAMU *(Fig. 5)*. KSU also had a significantly greater proportion of current food thermometer users than the average among all participants, while VT and TAMU showed a significantly lower proportion of current food thermometer users than the participant average.

Additional data was collected from the subset of the initial sample that reported using food thermometers when cooking meat (n = 173). Commodities that the food thermometers were used on varied *(Table 2)*, with the three most frequently reported being beef, pork, and chicken. Other products included fish, turkey, eggs, and other (unspecified). Tailgaters chose all applicable commodities on which they use thermometers, so that the number of responses exceeded the number (173) of participants.

Table 2 also summarizes the location's effect on the type of meat that the food thermometer was being used on. At all 5 universities, the majority of people (> 50%) reported using their food thermometers on beef and pork, and at 4 of the 5 universities, the majority reported use on chicken. No school had the majority of its respondents using food thermometers on fish, turkey, or eggs.

Follow-up survey

Data collectors from all universities located a total of 39 participants to which to administer the follow-up survey. Of this population, 56% of participants were observed using their food thermometers correctly, as determined by the volunteer, 8% were observed using the food thermometer incorrectly, and 35.90% were observed not using their food thermometer. The breakdown of use at each study location is shown in *Fig. 6*.

All participants were asked what types of meats they use their food thermometers on. The foods included, in order of frequency of being reported, were beef (64%), pork (54%), chicken (46%), fish (10%), turkey (5%), eggs (3%), and other (3%). Frequency of food thermometer use after intervention is summarized in *Table 3*; when frequency was tested against correct use, the proportion of people who use food thermometers and report using them more than 40% of the time is significantly greater than the proportion of people who use a food thermometer and report using it only rarely. The number of people located per school was not consistent; therefore the data could not be analyzed for the significance of the effect of location on the results of the intervention.

Limitations

This project aimed to provide representative data for people grilling at university football games, but certain limitations should be taken into account with

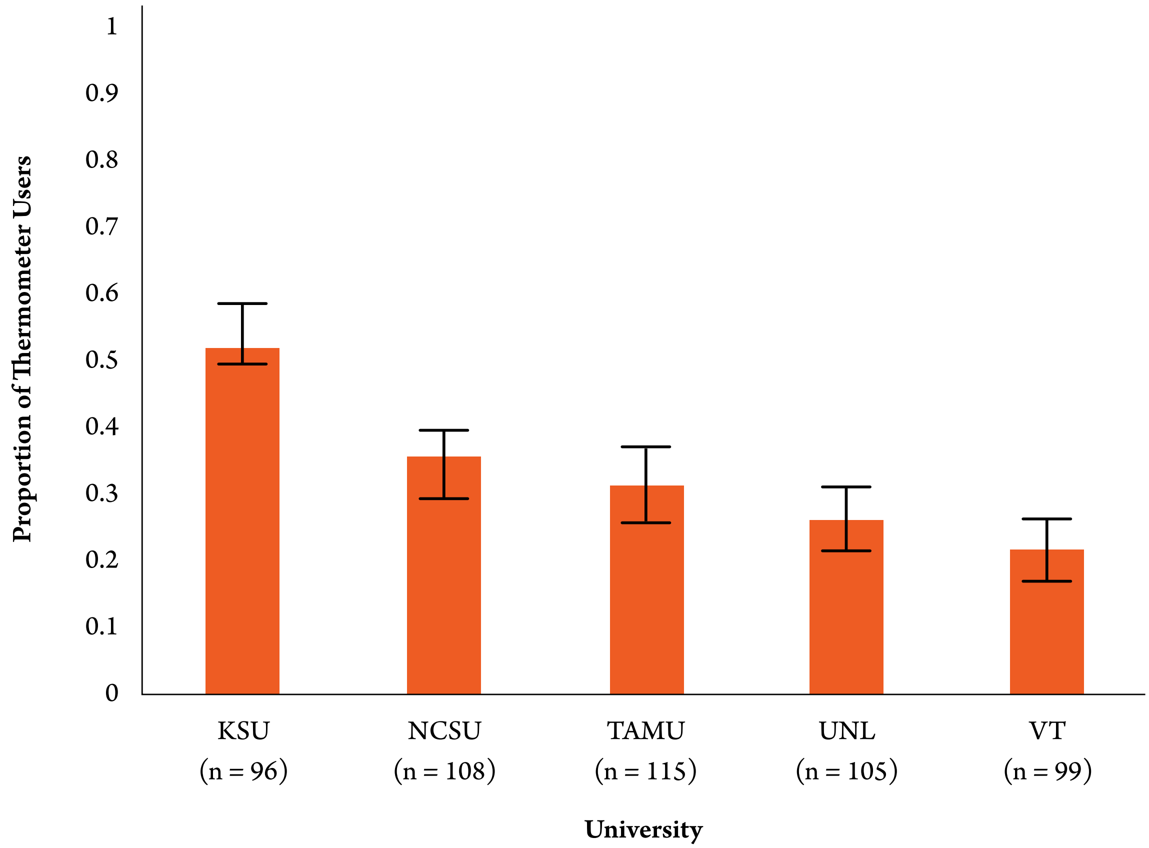

FIGURE 5. Proportion of participants at each study location who use food thermometers pre-intervention (n = 523)

TABLE 2. Food thermometer use on all applicable commodities by current users at each study location

	Overall use	Food thermometer use by location				
	(N = 173) n	KSU (N = 51) n	NCSU (N = 39) n	TAMU (N = 37) n	UNL (N = 26) n	VT (N = 20) n
Beef	125	43	23	27	16	16
Chicken	111	73	26	17	17	14
Pork	119	38	26	24	15	15
Fish	10	11	2	0	4	9
Turkey	9	7	1	0	2	0
Eggs	26	6	0	0	1	2
Other	4	1	2	0	1	0

regard to the conclusions. The schools chosen and the participants chosen at each school were done so by means of a convenience sample, which may not yield the most representative sample of those grilling at the events.

Data collectors approached only those who were displaying their apron during the follow-up survey, because the location of both participants and data collectors administering the survey could have changed since the initial data

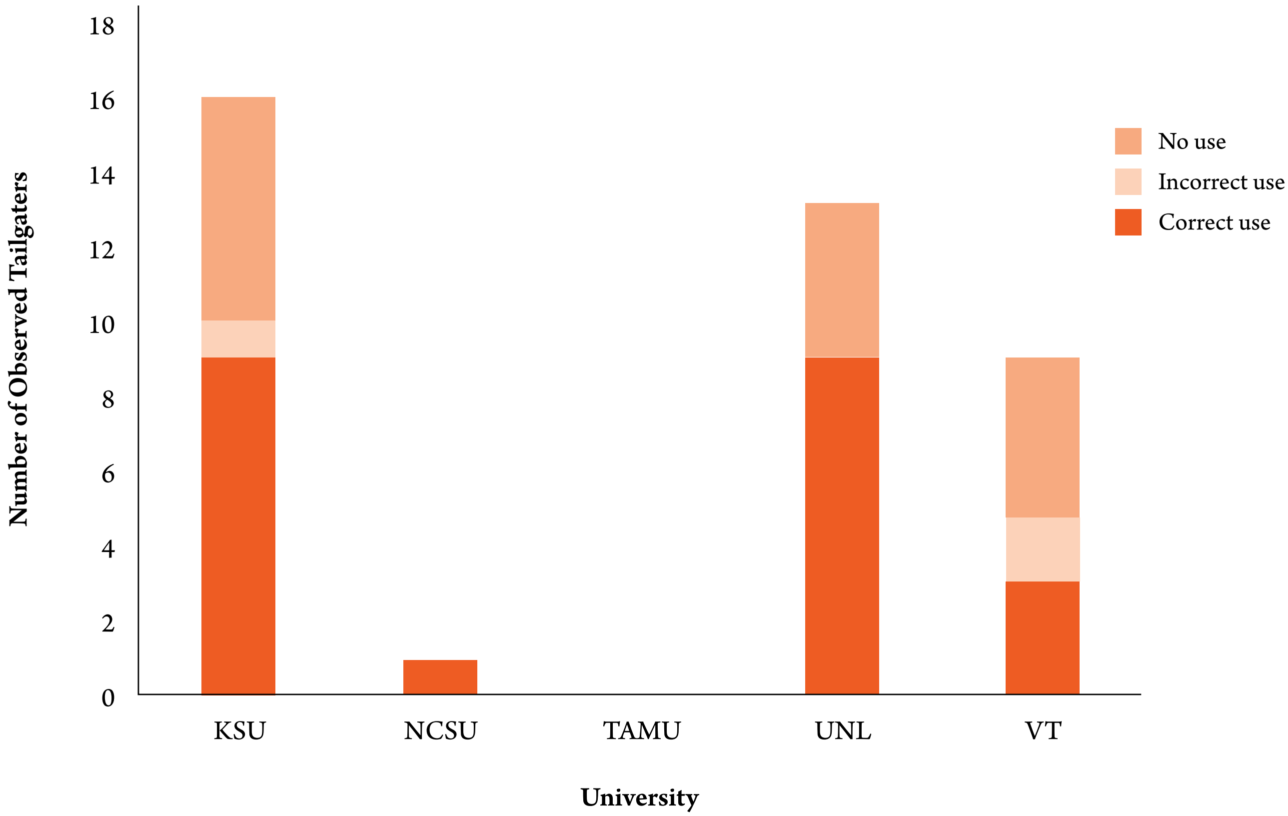

FIGURE 6. Post-intervention observed thermometer use at each study location (n = 39)

TABLE 3. Self-reported food thermometer frequency of use post-intervention

	Always		Usually		Occasionally		Rarely	
	100%		70–99%		40–69%		< 39%	
	n	%	n	%	n	%	n	%
Post-intervention participants (n = 39)	9	23	10	26	9	23	11	28

collection. This may give insight as to why participants were underrepresented in the follow-up study. Another source of underrepresentation may be the time of day when the tailgate occurred and the weather during the event, because grilling at tailgates is less common in the earlier hours of the day and in unfavorable weather. Finally, a portion of the follow-up data was observational, and there is a chance that tailgaters who were using their food thermometers during the event were not using them at the time of observation.

DISCUSSION

The results of this analysis give insight into the use of food thermometers at five similar temporary settings in different geographic regions of the United States, specifically during tailgates, and the efficacy of an in-person intervention. The assessment survey results support the hypothesis that the majority of people at these specific events do not use food thermometers while grilling. The information further illustrates that even those who already do use food thermometers use them on only certain food products.

Although beef, pork, and chicken are the most prevalent grilling products for tailgating, participants admitted not using their food thermometer on other commodities such as fish, eggs, and turkey even while in non-tailgating settings. Future efforts to increase the use of food thermometers in any setting should encourage use on all food products.

Data collected in the assessment survey showed a significant difference in food thermometer use by location, in that KSU had a significantly greater proportion of participants who were current food thermometer users, compared with UNL, VT, and TAMU, as well as a significantly greater proportion of food thermometer users than the mean of all participants in the study. In follow-up data, KSU yielded the greatest number of tailgaters located and was tied with UNL for the greatest number of participants observed using their thermometers correctly. This illustrates the event location's potential effect on consumers and demonstrates a need for location-specific food safety education at temporary events.

A major outcome from the follow-up observations and survey was that they showed that the proportion of people who were observed using food thermometers and reported using them over 40% of the time is significantly greater than the proportion of participants who were observed using a food thermometer and reported using it less than 39% of the time. Participants who responded to this survey were those who denied using a food thermometer during the assessment survey and were part of the intervention. This statistic illustrates the need for an effective intervention, because it suggests that people who use food thermometers use them often. If the number of consumers using food thermometers is attained, there may also be an automatic increase of the frequency of food thermometer use by those consumers.

Despite the limitation of locating only 11% of the intervention participants, a change of behavior was seen in the majority of participants post-intervention. Over half of the participants located for the follow-up survey were observed using their thermometers correctly. These observations were unannounced, so the thermometer use was unprompted by data collectors. Behavior change cannot be attributed solely to the in-person intervention, but these results support the hypothesis that giving participants the correct information and materials to practice food safety while grilling will generate an increase in thermometer use at university tailgates.

ACKNOWLEDGMENTS

The authors thank all FSC volunteer data collectors and the PIC from each university for their aid in data collection. All branded intervention materials were developed by the Jacht Ad Lab at the University of Nebraska at Lincoln.

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In Memory

Edmund A. Zottola

Dr. Edmund A. Zottola, Professor Emeritus of Food Microbiology, Department of Food Science and Nutrition at the University of Minnesota, passed away peacefully on October 4, 2017, from complications due to Alzheimer's disease.

Dr. Zottola was an actively engaged IAFP member and served with distinction in many capacities since joining the organization in 1966. He chaired and served on multiple committees and numerous awards juries and presented many scientific papers on food microbiology research during his 51 years as an IAFP member. For his many contributions to the field of food microbiology, he received the IAFP Elmer Marth Educator Award in 1988, The Robert F. Sherman Award in 1989 and was elected an inaugural Fellow of IAFP in 1998. He also was a Fellow of the Institute of Food Technologists (IFT). In addition, he received the IAFP President's Recognition Award in 2010, the GMA Food Safety Award in 2011 and became an Honorary Life member of IAFP in 2001. Dr. Zottola also served as Scientific Editor of *Food Protection Trends* from June 2004 until November 2007.

During his 31 years at the University of Minnesota, Dr. Zottola worked in Extension sharing his practical knowledge of microbiology with the food industry as well as teaching several courses in the department and mentoring graduate students. A prolific researcher and writer, he mentored more than 45 graduate students including 30 MS degree and 15 Ph.D. candidates. He was a beloved advisor who was always available to provide advice, counsel and assistance to his students. He encouraged them to present their research at the IAFP Annual Meetings where they successfully competed in graduate student paper competitions and, under his tutelage, received top honors on several occasions.

Today, his students hold prominent positions in all areas of food safety where they work to keep the food supply safe. Dr. Zottola was an excellent teacher, caring mentor and friend to his students as well as colleagues and had a profound impact on all of them. He will be sorely missed.