

Food Handling Behaviors of Consumers When Grilling Poultry

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B.S., University of Tennessee at Knoxville, 2014

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Food, Nutrition, Dietetics and Health
College of Human Ecology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2017

Approved by:

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Abstract

Research has shown that many consumers do not use the proper food safety practices when cooking in the home. Although many studies have been conducted to observe the food safety behaviors and practices in a domestic home kitchen, the food safety behaviors of consumers when using an outside grill has not been vastly explored. The objective of this study was to gain insight on consumers' food safety practices and behaviors when preparing meat and poultry on an outdoor grill.

A nationwide survey of grilling consumers (n=1024) was conducted to evaluate the food handling behaviors of consumers who use an outdoor grill to prepare meat and poultry. The survey consisted of 50 questions based on the four core practices of food safety: clean, separate, cook, and chill. The results showed that there was low adherence to consumers not rinsing meat or poultry before preparation, separating utensils for raw and cooked meat, and using a thermometer to ensure doneness. Respondents who grilled poultry followed safer food handling practices than respondents who grilled meat.

An observational study (n=30) was conducted to observe consumers prepare poultry products on an outdoor grill. Participants were assessed on handwashing skills, cross contamination behavior, and how they determined the doneness of the poultry. This study illustrated that consumers were not washing their hands thoroughly, especially after handling packaging. Many consumers were observed contaminating surfaces or items in their kitchen after touching the raw poultry.

Consumers also failed to use clean utensils for the cooked poultry after using the utensil on raw poultry. Consumers used several methods to determine the doneness of the poultry. Visual cues such as looking at the appearance or color of the poultry was primarily used by consumers to

check if the poultry was fully cooked, followed by piercing or cutting the poultry open and using a thermometer. Thermometer use in this study was found to be higher than the usage in prior studies.

A separate study assessed poultry grilling recipes (n= 242) for a specified temperature of doneness and additional food safety information. Recipes from cookbooks, magazines, and online sources were evaluated. Over half of the recipes did not specify a temperature of doneness, but used time, visual or textural indications to determine doneness.

The findings of this research show that consumers could benefit from education to improve their food handling skills when preparing meat or poultry on an outdoor grill. Educational efforts should focus on proper handwashing procedures, how to reduce cross contamination and the importance of using a thermometer to ensure doneness.

Table of Contents

List of Figures	vii
List of Tables	viii
Acknowledgements.....	ix
Dedication.....	x
Chapter 1 - Literature Review.....	1
Introduction.....	1
Food Safety Attitudes and Perceptions of Consumers.....	2
Perceptions of the home as a location of foodborne illnesses.....	4
Consumer Food Safety: Knowledge and Food Handling Practices.....	5
Consumer Knowledge and Self-Reported Food Handling Practices	7
Handwashing.....	8
Cross-Contamination	9
Adequate Cooking	10
Self-Reporting Bias.....	11
Observed Behaviors of Consumers.....	12
Grilling Trends among Consumers.....	14
Food Safety Practices of Consumers When Grilling	15
Sources of Food Safety Information.....	17
Objectives	18
References.....	20
Chapter 2 - Self-Reported Food Handling Behaviors of Consumers While Grilling Poultry and Meat.....	33
Abstract.....	33
Introduction.....	34
Materials and Methods.....	36
Sample.....	36
Questionnaire	36
Data Analysis	38

Results.....	38
Clean	39
Separate.....	40
Cook.....	42
Chill.....	43
Discussion.....	44
Implications	49
References.....	58
Chapter 3 - Food Handling Behaviors of Consumers When Grilling Poultry	66
Abstract.....	66
Introduction.....	67
Methods	69
Subject Recruitment.....	69
Grilling Observation	69
Data Analysis	71
Results.....	71
Demographics	71
Grilling Environment and Area.....	71
Handwashing.....	72
Cross Contamination.....	73
Determination of Doneness.....	75
Endpoint Temperature.....	75
Discussion.....	77
References.....	81
Chapter 4 - Assessment of Determination of Doneness of Poultry Grilling Recipes.....	86
Abstract.....	86
Introduction.....	87
Methods	88
Results.....	89
Discussion.....	92
References.....	94

Chapter 5 - Summary	97
Appendix A - Grilling Screener and Survey (Chapter 2)	99
Appendix B - Observational Guide (Chapter 3)	136
Appendix C - Recipe Guide (Chapter 4).....	138

List of Figures

Figure 3-1:Techniques used by participants to determine the doneness of poultry..... 76

List of Tables

Table 1-1: USDA recommendations of safe minimum internal temperatures for meat products. .	7
Table 2-1: Demographic characteristics of U.S. consumers who use an outdoor grill to prepare raw meat or poultry (n=1024).	51
Table 2-2: Type of raw meat or poultry consumers prepared the last time they grilled on the outdoor grill (n=1024).	52
Table 2-3: Grilling area, usage, and skill of the respondents.	53
Table 2-4: Clean and separate food handling behaviors of respondents that grilled poultry by demographic characteristics (n=504).	54
Table 2-5: Cook and chill food handling behaviors of respondents that grilled poultry by demographic characteristics (n=504).	55
Table 2-6: Clean and separate food handling behaviors of respondents that grilled meat by demographic characteristics (n=520).	56
Table 2-7: Cook and chill food handling behaviors of respondents that grilled meat by demographic characteristics (n=520).	57
Table 3-1: Frequency of handwashing events at certain handwashing situations and cross-contamination behaviors (n=30).	74
Table 3-2: Endpoint temperatures of the poultry products	77
Table 4-1: Sources of recipes used in the study	90
Table 4-2: Specified temperatures of doneness within the recipe	90
Table 4-3: Specified temperatures of doneness within the recipe that contain more than one temperature.	91
Table 4-4: Number and percentage of recipes that included indicators of doneness (n=242).	91

Acknowledgements

As I complete this graduate journey, I would like to thank everyone who has contributed to making this experience one to remember. First and foremost, I would like to express my sincerest gratitude to my advisor, Dr. Marianne Swaney-Stueve for her support, guidance, and invaluable advice throughout my graduate career. I appreciate her contributions of time and expertise to make my thesis project successful. I am truly thankful for the excellent example she has provided as a successful, business savvy sensory scientist.

I would also like to thank my committee members, Dr. Mark Haub and Dr. Sandria Godwin, as well as Dr. Edgar Chamber IV for taking the time out of their busy schedules to provide valuable ideas, feedback, and direction throughout the development of my thesis work.

A very special thank you to my fellow sensory science graduate students who I have worked with and learned from along this journey. It has been an honor to work among such intelligent and hardworking students.

Lastly, I would like to thank my family and friends who have provided love and encouragement throughout this experience. Without their constant love and support, none of this would be possible.

Dedication

This thesis is dedicated to my parents who instilled in me the importance of education.

To the loving memory of my father, who I know is so proud of me and smiling down from
heaven.

To my mother, the strongest person I know, who gives me the strength to keep striving
for excellence.

Chapter 1 - Literature Review

Introduction

Each year, millions of people are affected by foodborne illnesses. Foodborne infections pose as a major public health problem and a great source of economic burden, costing the United States about \$15.5 million annually (Hoffmann, Maculloch, and Batz 2015). According to the Centers for Disease Control and Prevention, one in six people become victims of foodborne illnesses in the United States (CDC 2016). Of the 48 million people affected, there are an estimated 128,000 hospitalizations and 3,000 deaths due to foodborne illnesses (CDC 2016). Almost two million cases of foodborne infections are due to *Salmonellosis* and *Campylobacteriosis*, which are the two most common illnesses associated with raw or undercooked poultry (CDC 2016). Research has shown that consumers are not knowledgeable about proper food safety practices. Many consumers put themselves at risk of foodborne infections by falling victim to food safety misconceptions. Of the reported foodborne illnesses, twenty-five percent of the illnesses were a result of unsafe food handling behaviors of consumers in the home (McCabe-Sellers and Beatties 2004). Although many individuals recognize that food safety is a shared responsibility of the government, food manufacturers and the consumers themselves, consumers are lagging in following safe food handling practices (IFICF 2011). Because of the lack of awareness and knowledge of food safety information, many food safety organizations and agencies have increased the initiative to educate and improve the food safety practices of consumers. One of the top food safety objectives for the Healthy People 2020 organization is to increase the number of consumers that use proper food safety practices (Healthy People 2020). With foodborne illnesses from bacteria becoming more of a concern for

consumers, it is imperative that consumers are educated on how to prevent foodborne illnesses by using the proper food handling practices (IFICF 2012 and USDA 2016).

Food Safety Attitudes and Perceptions of Consumers

Many consumers misapprehend the origin and seriousness of foodborne illnesses (Bruhn and Schutz 1999). The frequency of foodborne illnesses and the complications associated with the illnesses are underestimated by many consumers (Bruhn and Schutz 1999 and Bruhn 1997). Because of this underestimation, consumers may not take the appropriate preventative measures to reduce their risk of food poisoning (Bruhn and Schutz 1999, Frewer et al. 1995, and Sammacro and Ripabelli 1997). In order to effectively reduce the incidences of foodborne illnesses, there needs to be an understanding of the current food safety perceptions and beliefs of consumers. Research has shown attitudes, beliefs, and perceptions can be related to the food handling behaviors of consumers (Shepherd 1995 and Fein, Jordan-Tin, and Levy 1995). In some cases, consumers' attitude can predict their behaviors (Saba and DiNatale 1999).

Perceptions of Risk and Responsibility

Generally, consumers are unaware about the critical risks that are associated with bacterial growth and contamination, which can ultimately result in foodborne infections (Redmond and Griffith 2003). According to the 2016 FDA Food Safety survey, only 33% of consumers in the USA believed that contamination of foods by microorganisms is a serious food safety problem. Some consumers do not believe that they are at a high risk of foodborne illness (IFICF 2012). Many consumers tend to think, "It won't happen to me" or "I've always done it this way and haven't gotten sick" (Byrd-Bredbenner et al 2013). Consumers also presume that they are at a higher risk of foodborne illness when someone else prepares the food rather than when they prepare food themselves (Byrd-Bredbenner et al. 2013, Redmond and Griffith 2003, and

Redmond 2002). Consumers suppose that their own personal risk to a lifestyle hazard such as food poisoning to be less when comparing themselves to other members of society (Verbeke et al 2006). A study in the United Kingdom performed by Redmond (2002) showed that 90% of consumers perceived the risk of food poisoning from food they prepared themselves to be very low. The study also indicated that 66% of consumers thought that they had full, or nearly full, control of their food safety when preparing food themselves. Due to optimistic bias, which causes a person to believe that they are at less risk to experience negative events, consumers believe that their risk of getting a foodborne illness is low compared to others (IFICF 2012). Consumers' attitudes of "low risk and high control" can make it difficult for consumers to be educated with the appropriate information (Fein, Jordan-Tin, and Levy 1995, Frewer et al. 1994, Weinstein 1987).

When preparing food in the home, consumers are thought to be responsible for safe food handling practices. Because consumers are the last line of defense in the food safety chain, they fail to recognize their role in the prevention of foodborne illnesses (Redmond and Griffith 2003, Byrd-Bredbenner et al. 2010, Kastner 1995, Koepl 1998). When consumers place little importance on their own responsibility, they are less likely to take protective steps when cooking in their homes (IFICF 2012). The belief that many foodborne infections are due to faults made earlier in the food safety chain, such as in the manufacturing process or retail, can cause consumers to put less responsibility on themselves to ensure that their food is safe (Spittler 2009, Fein Lin Levy 1995, Williamsom et al. 1992). A study in 1977, by Jones and Weimer, reported that consumers depended on government inspection to prevent contamination of bacteria on raw meat and poultry (Jones and Weimer 1977). Years later, data still indicate that consumers still greatly rely on the government to guarantee that their food is safe (IFICF 2012). The 2011 Food

and Health survey from the International Food Information Council Foundation found that more consumers agree that the government (71%), food manufactures (67%) and farmers/producers (58%) have the greatest responsibility for the safety of foods. Only 39% of consumers believed that the consumers themselves are ultimately responsible for the safety of their foods (IFICF 2011). Data concludes that many consumers remain ignorant to the fact that they also play a role in keeping food safe thus, reducing foodborne illnesses.

Perceptions of the home as a location of foodborne illnesses

The home is considered one of the primary locations where there is a substantial risk of foodborne illness (Byrd-Bredbenner et al. 2013). Recent analysis has shown that 9- 15% of foodborne illness outbreaks was the result of the consumption of food in the home (Gould et al. 2013, Gould et al. 2011). For most consumers, the home is where a considerable amount of food is prepared and eaten; therefore, the occurrences of food handling errors made in the home are increased (Byrd-Bredbenner et al. 2013 and Surujlal and Badrie 2003). Additionally, due to the multiple uses of home kitchens, they can be a primary location of bacterial contamination, which can increase the proliferation of pathogens and amplify the risk of acquiring a foodborne illness (Byrd-Bredbenner et al. 2013). Many consumers fail to believe that their handling behaviors while preparing food in their homes will lead to foodborne illness (Redmond and Griffith 2004). Consumers do not associate the risk of foodborne illnesses with their home because they do not think of their kitchen as being unsafe (Redmond, Griffith, and Peters 2000). Previous research by Williamson, Gravini, and Lawless (1992) uncovered that only 16% of consumers believed that the home was the most likely places for the mishandling of food. A more recent survey by Healthy People (2010) reported that 70% of the respondents did not think that it was extremely or very common for people in the United States to acquire a foodborne illness from the way food

is prepared in their homes (Cody and Hogue 2010). Similarly, the 2016 Food Safety Survey from the FDA showed that more than half of the respondents (54%) thought that it was more common to get food poisoning from food prepared from a restaurant rather than food prepared at home (USDA 2016). Since consumers believe that they have more control over the safety of food in their homes, they are more concerned with contracting a foodborne infection in other locations besides their home (Food and Drink Administration and Food Safety and Inspection Service 2000).

Consumer Food Safety: Knowledge and Food Handling Practices

The occurrence of foodborne illness is usually the result of improper handling, preparation, and storage of food (Redmond and Griffith 2003). To decrease the number of cases of foodborne illnesses that occur each year, consumers must be properly educated about safe food handling practices. Personal hygiene, cross contamination, and cooking procedures are the main focal points in many food safety education programs. In 1997, the Partnership for Food Safety Education launched a food safety campaign called FightBAC! to educate the public on consumer food safety (USDA 1997). The FightBAC! campaign educates consumers on the fundamentals of food safety based on four core practices: clean, separate, cook, and chill. More specifically, having good hygiene, refraining from cross-contamination, cooking food to the proper temperature, and storing foods at the appropriate temperature can reduce the risk of foodborne illness. If followed by consumers, the four FightBAC! food safety recommendations can reduce the risks of foodborne illnesses in the home. (PFSE 2016)

The first and most known food safety recommendation is clean. The “clean” step instructs consumers to wash their hands with soap and warm water for at least 20 seconds before, during,

and after food preparation. Consumers are also advised to clean food contact surfaces, kitchen equipment and utensils, and to also rinse fruits and vegetables. (PFSE 2016)

“Separate” refers to cross- contamination, which is the spread of harmful bacteria from one source to another. Consumers should separate raw and unwashed foods from cooked and ready to eat foods. This practice should not only be applied when preparing food but also when grocery shopping and storing food in a refrigerator. Consumers should also switch out or clean cutting boards and utensils that were used for raw meat or unwashed vegetables and fruits before using it for other cooked or ready to eat foods. (PFSE 2016)

Cooking food to a safe internal temperature is emphasized in the “cook” recommendation. The FightBac! campaign recommends that consumers thoroughly cook their food to the appropriate internal temperature in order to kill harmful bacteria. The USDA has recommended specific temperatures of doneness of most meat products. The recommended safe minimum internal temperature of meat products can be seen in Table 1. Poultry, particularly, should be cooked to an internal temperature of 165°F. The campaign is also a huge advocate for the use of food thermometers among consumers to ensure that the food has reached the accurate internal temperature. (PFSE 2016)

The last food safety step of the FightBAC! recommendations is chill. Chill specifies to refrigerate or freeze foods promptly to decelerate the growth of harmful bacteria. Specifically, cooked foods should always be stored at temperature of 40°F or less. Consumers are encouraged not to defrost foods at room temperature as well as to never let raw foods and leftovers sit in room temperature for more than 2 hours. (PFSE 2016)

Table 1-1: USDA recommendations of safe minimum internal temperatures for meat products.

Product	Minimum Internal Temperature and Rest Times
Beef, Pork, Veal & Lamb (Steaks, chops, roasts)	145 °F (62.8 °C) and allow to rest for at least 3 minutes
Ground meats	160 °F (71.1 °C)
Ham, fresh or smoked (uncooked)	145 °F (62.8 °C) and allow to rest for at least 3 minutes
Fully Cooked Ham (to reheat)	Reheat cooked hams packaged in USDA-inspected plants to 140 °F (60 °C) and all others to 165 °F (73.9 °C).
All Poultry (breasts, whole bird, legs, thighs, and wings, ground poultry, and stuffing)	165 °F (73.9 °C)
Eggs	160 °F (71.1 °C)
Fish & Shellfish	145 °F (62.8 °C)
Leftovers	165 °F (73.9 °C)
Casseroles	165 °F (73.9 °C)

Consumer Knowledge and Self-Reported Food Handling Practices

Numerous studies have demonstrated that food safety information among consumers is limited. Consumers lack complete knowledge of safe food handling practices (Bruhn and Schutz 1999 and Woodburn and Raab 1997). It has been said that knowledge is the prerequisite to safe food handling practices (Lum et al 2013). Eighty percent of unsafe food handling practices are due to a lack of knowledge and awareness (Daniels et al. 2001). A meta-analysis of 88 food safety studies, administered over 26 years in various countries, discovered that consumer’s food safety knowledge is not sufficient enough to make sure that the risk of foodborne illness is minimized when preparing and cooking food in the home (Griffith and Redmond 2003). Eighty percent of consumers believe that they are well informed about food safety, but 40% of consumers are unaware that they are using unsafe food handling practices (Griffith and Redmond 2003). Daniels et al. (2001) found that even consumers who considered themselves knowledgeable about safe food handling practices make errors when handling food. Although consumers may be

aware of safe food handling practices, some consumers may not always follow those practices when preparing food in their home. Consumer knowledge does not always correspond with consumer behavior (Ackerley 1994). There are disparities between the prevalence of knowledge and self-reported behaviors of consumers (Ackerley 1994). Consumers have more knowledge of food safety than they put into practice (Medeiros et al 2001).

Handwashing

Because the hands are a major vehicle for spreading germs, it is important that consumers wash their hands thoroughly before, during, and after food preparation to lower the risk of contracting a foodborne illness (Byrd-Bredbenner et al. 2013). Since hand washing is a familiar practice used to avoid getting sick or spreading germs, it is not a surprise that majority of consumers (75-100%) recognize that handwashing is an important food safety practice (Griffith and Redmond 2003). Most consumers report that they wash their hands with water and soap for 20 seconds before meal preparation and after handling raw meat (Kennedy et al. 2011, ADA and ConAgra 2011, Quick et al. 2013, and De Jong et al. 2008). Though most consumers are aware that hand washing is a necessary food handling practice, some consumers still do not wash their hands at the appropriate times when preparing food in the home. For instance, results from a food safety survey conducted by the American Dietetic Association and Conagra Foundation (1999) found that 44% of consumers consistently forgot to wash their hands properly before meal preparation. A national telephone survey administered by Altekruze et al. (1996) showed that while 86% of consumers knew that hand washing decreases the risk of foodborne illness, only 66% of consumers reported that they actually wash their hands after handling raw meat or poultry. Yang and others (1998) also reported that 20% of consumers do not wash their hands with soap after handling raw meat or chicken.

Despite data suggesting that most consumers know the accurate procedure for washing and drying hands, many consumers are not washing their hands correctly and thoroughly (Byrd-Bredbenner et al. 2013). About 20% of consumers in the United States, an estimated 40 million people, still lack knowledge of the correct hand washing and drying procedures (Griffith and Redmond 2003). A recent survey that assessed the awareness and knowledge of food safety recommendations among college students found that 72% of the college students could not identify the correct amount of time that is needed for hand washing after touching raw meat (McArthur et al. 2007). Furthermore, research by De Jong and others (2008) unveiled that 73-100% of consumers' hands, who reported that they washed their hands after handling raw poultry, were contaminated with *Campylobacter jejuni*.

Cross-Contamination

Cross-contamination among consumers during food preparation is a major food safety concern. Eighty-one to ninety percent of consumers know that it is better to use different chopping boards and utensils when preparing raw foods and cooked foods (Griffith 2001, Griffith et al 2001, Mathias 1999, Redmond 2002). A self-reported survey by the Research Triangle Institute (2000) found that 83% of consumers reported that they washed cutting boards that was used for raw meat or poultry with soap and/or bleach before using it again. Similarly, a recent study by Kosa et al. (2015) found that 97.1% of consumers washed or used separate dishes or utensils for preparing the next food product after preparing raw poultry in their homes.

However, there is still a considerable number of consumers who lack knowledge about preventing cross- contamination to reduce the risk of microbial contamination (Griffith and Redmond 2003). Studies have also revealed that up to 75% of consumers are not familiar with the term cross-contamination and the practices associated with the term (Griffith and Redmond

2003). Around 22% of consumers in the U.S. do not recognize the importance of using separate or thoroughly cleaned cutting boards, dishes, and utensils for raw food and cooked or ready to eat foods (Griffith and Redmond 2003). A study by Albrecht (1995) showed that 51% of consumers thought that a surface that was used to cut uncooked meat or poultry could also be used to prepare cooked meat or poultry

Adequate Cooking

The Fight Bac! recommendation that needs the most improvement among consumers is the “cook” recommendation (Byrd-Bredbenner et al. 2013). Many (72-92%) consumers know that eating undercooked meat is a leading cause of foodborne illnesses, but are cooking and eating meat that has not been heated to the proper endpoint temperature (Griffith and Redmond 2003). Healthy People 2020 reports that only 37% of consumers are cooking and heating foods to a suitable temperature that will kill harmful bacteria (Cody and Hogue 2003). A food safety survey conducted by the Academy of Nutrition and Dietetics (2011) found that only 31% of consumers thought that undercooking food was a common behavior that could cause food poisoning when cooking at home. (AND 2011). Altekruze and others (1999) found that 20% and 50% of consumers ate pink hamburgers and undercooked eggs, respectively. In addition, results from a survey by Nunnery (1997) showed that 28% of consumers consider a hamburger that is pink in the center to be cooked.

Consumers have been known to determine the doneness of meat subjectively by using appearance and color (Beddows 1983). Examining the appearance of meat or poultry is considered an unsafe practice that can result in undercooked meat (Snyder 1998). For example, a study conducted by Kennedy et al. (2011) found that 70% of chicken pieces that were deemed “done” by consumers, who visually inspected the chicken, were in fact undercooked and had

active *Campylobacter jejuni* cells. Regardless of consumers knowing that undercooked meat poses a high risk of acquiring a foodborne infection, a large proportion of consumers do not use a food thermometer to check the doneness of meat and poultry (Brewer and Rojas 2008, ADA 2011, Fein, Lando et al. 2011). Seventy-six percent of consumers reported that they did not regularly use a food thermometer to measure the doneness of meat and poultry (ADA 2000). A focus group study conducted by Koepl (1998) revealed that consumers feel that thermometers are difficult and inconvenient to use when cooking small pieces of meat or poultry (McCurdy et al. 2005). Many of the consumers also agreed that a thermometer is only needed when cooking large items such as turkeys or roasts (Koepl 1998). The participants felt that a thermometer was not needed if you have “experience” and that a thermometer does not guarantee safety when cooking foods. (Koepl 1998).

Moreover, consumers are also not knowledgeable about the specific endpoint temperatures of meat and poultry. A study by Cody and Hogue (2003) revealed that 68% of the respondents understood that undercooked meat can cause a foodborne illness, but only 9% of respondents could actually give the correct endpoint temperatures of cooked meat. These findings suggest that there are substantial gaps in consumers’ knowledge of the adequate cooking of foods (Bruhn and Schutz 1999, Albrecht 1995, and Cody and Hogue 2003).

Self-Reporting Bias

Self-reported behavior questions have been used in majority (92%) of consumer food safety studies (Griffith and Redmond 2003 and Patil 2004). Data from self-reported practice questions can provide valid information on awareness or knowledge about the proper behaviors, but cannot validate the actual behaviors of consumers (Griffith and Redmond 2003). Research that solely relies on self-reported data can be flawed because there is a difference between what people say

they do and what they actually do (Herzog 1996). Consumers' self-reported behaviors do not always correspond with the consumers' observed behaviors. (Levy 2008, Fein et al. 2011, and Mauhn et al. 2016). Consumers tend to exaggerate their reported behaviors due to social desirability bias (Levy 2008, Fein et al. 2011, and Maughan et al. 2016). Consumers can over-report "good behavior" or under-report "bad" or undesirable behavior to convey a positive image (Bowling 2000). Because of these inconsistencies in consumers' self-reported behavior and the actual behaviors of consumers, observational studies have been conducted to reduce the self-reporting bias.

Observed Behaviors of Consumers

Because of the fallibility of self-reported behavior, researchers have conducted observatory studies to assess the food safety handling procedures that consumers actually practice. Being that observational studies can be extremely time consuming and expensive, the sample size is usually not as large as when conducting quantitative studies (Boddy 2016). Though observational studies are not as common, they produce reliable and beneficial results. Observational research offers a real world aspect to research; thus, providing a better description of consumer behavior. The observed actions can accurately reflect the authentic behaviors of consumers rather than relying on second hand information from the consumer themselves (Anderson et al 2004, Herzog 1996, and Pyke and Agnew 1991).

Consumer food safety observational studies have previously taken place either in a controlled environment or in a natural environment. The consumer's kitchen at home is considered a natural environment, while a laboratory setting is considered a controlled environment (Redmond and Griffith 2003). Although, there are valid arguments for using each setting, research from

Redmond (2002) confirmed that there are no significant differences in the key food safety behaviors of consumers between the two types of locations.

Though few observational studies have been conducted to evaluate the food safety behaviors of consumers, the research remains consistent confirming that consumers do not follow proper food safety practices when preparing and cooking poultry in their homes. Inaccurate hand washing, cross contamination, undercooking poultry, no use or incorrect use of a meat thermometer and inadequate storage conditions are the major improper food safety and handling practices that have been observed by consumers in food safety studies (Maughn et al. 2016). Previous observational studies have verified that the self-reported behaviors of consumers are worse than their observed behavior. As an illustration, a study by Anderson and others (2014) that videotaped 99 consumers to assess their food handling behaviors found that 87% of consumers reported to wash their hands before meal preparation, but only 45% of consumers were observed washing their hands before preparing food. In addition, 30% of the consumers reported to owning a food thermometer but only 5% of consumers were observed using a thermometer to check the doneness of their meat. Likewise, 100% of participants in recent research by Mazengia et al. (2015) reported that they wash their hands prior to preparing a meal, but 80% did not wash their hands when observed. The average duration of hand washing was 13 seconds among the participants, which is less time than what is recommended by FightBac!. Similarly, Scott and Herbold (2010) found that the average length of time consumers used to wash their hands while being observed was 10 seconds. In the same study, only one household out of thirty was observed using a thermometer to check the temperature of meat. Another study with a sample size of 199 consumers observed 76% of consumers perform actions that would result in cross-contamination (Phang and Bruhn 2011). Only 40% of participants were observed washing their

cutting boards when switching to one preparation to another. Most cutting boards (81%) were washed with water alone, while merely 17% were washed with soap. Research by Sneed and others (2015) revealed that even with education intervention, consumers were still observed using unsafe food handling procedures that results in cross contamination. Furthermore, other observational studies have demonstrated comparable results of unsafe hand washing, cross contamination, and adequate cooking practices (Redmond, Griffith, Slader, and Humphrey 2004, Clayton and Griffith 2004, DeDonder et al. 2009, Hoelzl et al 2013, and Kendall et al. 2004, Abbot et al. 2009, Bruhn 2009, Kennedy et al. 2011).

Grilling Trends among Consumers

Grilling, also known as barbecuing, is one of the most primitive forms of cooking (Moss, R 2010). Grilling involves the use of direct heat or an open flame to cook food. For centuries, grilling has been a vital part of American culture (Moss, R 2010). It has become a favorite pastime and is thought to be a summertime tradition for many Americans. Not only is grilling about the food, but it is also about entertaining and spending time with family and friends.

Grilling or barbequing as a social event has shown an enduring power to bring people from all backgrounds together (Moss, R 2010).

Every other year, the Hearth, Patio, and Barbeque Association (HPBA), conducts a barbeque lifestyle, usage, and attitude online survey to discover trends about consumer grilling. According to the HPBA, 75% of households in the United States own a grill or smoker. Sixty-two percent and 53% of households own a gas grill or a charcoal grill, respectively (HPBA 2016). Ten percent of the consumers that own a grill or a smoker have an outdoor kitchen consisting of a top quality grill and premium furniture and lighting (HPBA 2016). Respondents of the survey often grilled at their primary residence or at a friends' or relatives' home (HPBA 2016). Although

more grilling is done in the summer months, 63% of consumers stated that they are using their grill year-round (HPBA 2016). Additionally, 43% of consumers reported to have grilled at least once during the winter months. The HPBA survey revealed that the top reasons consumers use a grill to prepare food are taste preferences, personal satisfaction, entertainment, and convenience (HPBA 2016). Hot dogs, steaks, burgers, and chicken parts were the foods that most consumers cooked on their grill. Surprisingly, not only are consumers using their grill to cook foods for dinner or lunch, 11% of grill owners have prepared breakfast on their grill as well (HPBA 2016). Correspondingly, a tailgating study conducted by Weber (2008) showed that grilling at tailgates has become significantly more popular than in previous years. Sixty-eight percent of tailgaters always grill at their tailgating parties and 90% consider grilling to be an important part of the tailgate. Moreover, tailgaters are now becoming more adventurous as they are cooking entire meals on the grill instead of just the main course. With more than half of the population in the United States using a grill more frequently, it is imperative that consumers know the proper food safety handling and practices to abide by when cooking food on a grill.

Food Safety Practices of Consumers When Grilling

Many studies have shown that many consumers do not use the proper food safety practices when cooking in the home. Although a plethora of studies have been conducted to assess the food safety practices in a domestic home kitchen, the food safety behaviors of consumers in an outside setting, such as outdoor grilling, has not been vastly explored. Because there is a difference in environment when cooking inside versus outside, there may be a contrast in food handling practices between the two settings. There might also be different factors that affect the behaviors and practices that consumers follow when grilling.

A national survey conducted by the American Dietetic Association and ConAgra Foods reported that people use poor food safety practices when grilling. Results of the survey revealed that the main food safety concern for grilling outdoors is cross-contamination (ADA and ConAgra Foods 2005). Forty-one percent of the survey participants do not use separate utensils for raw meat and cooked meat when grilling (ADA and ConAgra Foods 2005). One in four respondents of the survey stated that did not boil marinades or sauces before reusing them to baste cooked meats, which can increase the spread of bacteria. The survey also showed that 27% of consumers thaw their meat out on the counter or outside by the grilling station, which can cause the amount of microorganisms to grow rapidly (ADA and ConAgra Foods 2005). Not only are consumers not using the proper food safety practices when grilling, but consumers also are not knowledgeable on the endpoint temperatures of meat and poultry (ADA and ConAgra Foods 2005). The survey showed that 92% of grillers do not consistently use a meat thermometer to check the doneness of meats. Two thirds of the grillers did not know the proper endpoint internal temperature of hamburgers and 84% did not the correct temperature for chicken. However, many of the “hard core” grillers believed that they could determine if a piece of meat is done by its appearance and/or texture, which is not an accurate method to ensure that meat has been thoroughly cooked through. When handling leftovers, 25% of people believed that leftover food could sit out for more than two hours at 90°F before the food needs to be refrigerated. This is a food safety “don’t” as temperatures between 40°F and 140°F can double the amount of harmful bacteria (FSIS Danger zone).

A study by Bruhn (2014) addressed how consumers handled and prepared chicken in their homes. The participants were able to use one of the five methods, grilling, frying, oven roasting, boiling on the stovetop, or pressure-cooking, to prepare the chicken. Of the 33 participants that

used the grilling method to prepare the chicken, about half of the chickens were cooked to an internal temperature lower than 165°F. The grilling method resulted in the second highest percentage of undercooked chicken among the five methods. The findings from this study suggest that some consumers are not thoroughly cooking chicken when using a grill.

Recent research administered by Yavelak and others assessed the use of meat thermometers at college football tailgates through observation and interviews. Of the 523 participants, 350 did not use a thermometer to check the doneness of the meat. Only 34% of the 173 participants that did use a thermometer claimed to use a thermometer all the time and 65% used a thermometer for chicken.

Sources of Food Safety Information

Food safety studies have indicated that there is a need to improve consumers' knowledge of food safety and handling practices (Maughn et al 2016). Previous research has indicated that consumers get food safety information from many sources such as television, cookbooks, government publications, food labels, and health professionals (Bruhn et al 1992, Mathiasen 2004, Kornelis et al. 2007, and Griffith and Mathias 1994). Consumers tend to perceive information from print media as a more credible source than information from television (Bruhn 1998). For consumers, recipes, which can be found in cookbooks, magazines, and internet blogs, are common sources of cooking information. Cookbooks are “go to” references that consumers use to obtain food safety information (Buzby 1996). Even though cookbooks contain different cooking methods and techniques, there is little to no food safety information within the recipes (Griffith and Mathias 1994 and Maughan et al 2016). An in-depth review of cookbooks by Griffith and Mathias (1994) revealed that only 20% of the recipes included food safety information (Griffith and Mathias 1994.) Without food safety information within the recipe or in

cookbooks, there is some concern as to whether the dishes are being cooked to the recommended endpoint temperature. Despite the lack of food safety information in cookbooks, consumers, young and old, are interested and have a positive attitude toward learning about food safety (Quick et al. 2013, Abbot et al. 2012, Glanz et al. 1998, Yarrow et al. 2008).

Current research by Maughan and others (2016) demonstrated that the addition of food safety practices within a recipe could greatly improve food safety behaviors in consumers. Participants in the study were assigned to one of two groups, the control group, which received a recipe with no food safety instructions, or the test group, which received a recipe with food safety instructions. The test group performed significantly better than the control group in regards to food handling practices. The recipe with the incorporated food safety instructions increased the amount of hand washing and the use of the thermometer. Not only did the inclusion of the food safety information within the recipe increase safe handling behaviors, but the majority of the consumers reacted positively to them and found them easy to use. This study shows that adding food safety information to recipes or other cooking sources can produce change in the behaviors of consumers.

Objectives

Based on the review of literature, the food handling practices of consumers while grilling has not been thoroughly researched. Being that consumers are grilling more frequently throughout the year, it is important to know what food safety recommendations consumers are not following while grilling. The objectives of this study were to: 1) assess the food handling practices of consumers when grilling meat and poultry using a survey; 2) observe the food handling behaviors of consumers when using an outdoor grill to prepare poultry in their homes; and 3) evaluate grilling recipes based on the presence of food safety information within the recipe. The

finding of this study will allow educators and researchers effectively develop educational material targeted towards grilling consumers to promote safe food handling practices.

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Chapter 2 - Self-Reported Food Handling Behaviors of Consumers While Grilling Poultry and Meat

Abstract

Every year, 48 million people in the United States are affected by foodborne illnesses. Twenty-five percent of reported foodborne illnesses are due to unsafe food behaviors in the home. Foodborne infections derived from the home are the result of poor food handling practices such as inadequate hand washing, cross contamination, consuming undercooked meat or poultry, and improper storage conditions. Although substantial research on consumers' food handling practices in the home has been thoroughly conducted, few studies exploring consumers' food safety behaviors in an outside environment have been published. Recent research shows that consumers are grilling more frequently throughout the year; therefore, it is necessary to investigate the food safety practices of consumers when using an outdoor grill to prepare meat and poultry. A nationwide web survey of consumers who grill outdoors (n=1024) was conducted to approximate the percentage of consumers following the recommended food handling practices while grilling. The results showed that there was low adherence to not washing meat or poultry, using separate or clean utensils after flipping or turning the meat or poultry on the grill, and using a thermometer to determine doneness. Sixty-three percent of respondents washed the meat or poultry before grilling. Twenty-two percent reported washing utensils after turning or moving the poultry or meat on the grill, which can cause potential cross contamination. Consumers used a variety of techniques to determine the doneness of the meat or poultry, but only 25.6% of consumers used a thermometer. Results differed by some demographic characteristics. Woman and respondents who grilled poultry versus meat were more likely to follow safe food handling

practices. This survey indicates that food safety educators should focus strongly on cross contamination and thermometer use when designing food safety content for the grilling population.

Introduction

Foodborne illness is a major public health concern in the United States. Although preventable, there are an estimated 48 million cases of foodborne illnesses each year (CDC 2016). Foodborne infections are responsible for 128,000 hospitalizations and 3,000 deaths, costing the U.S approximately \$15.5 million dollars annually (CDC 2016, Gould et al 2011, Gould et al 2013). Nearly 25% of the reported cases of foodborne illnesses are due to consumers using unsafe food handling practices in the home (Mc Cabe-Sellers and Beatties 2004). Although individuals recognize that food safety is a shared responsibility of the government, food manufacturers and the consumers themselves, consumers are lagging in following safe food handling practices (IFICF 2011). Many consumers underestimate the risk of foodborne illnesses; therefore, they may not take the appropriate preventative measures to reduce the risk of food poisoning (Bruhn and Schutz 1999, Frewer et al. 1995, and Sammacro and Ripabelli 1997). Inaccurate hand washing, cross contamination, undercooking meat and poultry, and inadequate storage of foods are unsafe food handling practices that have been reported by consumers in previous food safety studies (Maughan et al. 2016, Redmond and Griffith 2003, and Byrd- Bredbenner et al. 2013). A lack of awareness and knowledge about food safety accounts for 80% of unsafe food handling practices of consumers (Daniels et al. 2001 and Lum et al. 2013). To educate consumers about safe food handling practices, the Partnership for Food Safety Education created the FightBAC! campaign. FightBAC! consists of four core recommendations for consumers to follow: Clean,

“Wash hands and surfaces often”; Separate, “Don’t cross-contaminate”; Cook, “Cook to the safe internal temperature”; and Chill, “Refrigerate promptly” (PFSE 2016).

While numerous studies have been conducted to evaluate the food safety behaviors and practices in a domestic home kitchen, the food safety behaviors of consumers in an outside environment, such as when using an outside grill, has not been thoroughly explored. The Hearth, Patio, and Barbeque Association reported that 75% of households in the United States own a grill or a smoker (HPBA 2016). The research also showed that consumers are now grilling year-round, as opposed to just grilling in the summer months (HPBA 2016). With more consumers grilling more frequently, it is imperative that research is conducted to understand what food safety practices are being used by consumers while grilling. A national telephone survey from the U.S. Food and Drug Administration found that 81% of consumers who use a grill to cook raw meat used a different plate or pan to remove food from the grill than what was used to carry the food to the grill (USDA 2016a). In contrast, a survey administered by the American Dietetic Association and ConAgra Foods (ADA and ConAgra Foods 2004) determined that people use poor food safety practices when grilling. When consumers were asked to grade themselves based on their food safety practices, 63% of the consumers gave themselves a grade of a B or lower. The survey showed that cross-contamination and the lack of the use of a thermometer were the main food safety concerns when consumers use an outdoor grill. Twenty-seven percent of the participants in the survey thawed their meat on the counter or outside by the grilling station, which can cause a rapid growth in bacteria (ADA and ConAgra Foods 2005). The survey also determined that 41% of the respondents do not use different utensils for raw meat and cooked meat while grilling. In addition, 92% of the grillers reported that they do not use a thermometer regularly to check the doneness of meat (ADA and ConAgra Foods 2004).

The objective of this study was to assess the food handling practices of consumers when grilling meat or poultry. The finding of this research will be beneficial, as it will demonstrate what food handling practices consumers are or are not following when preparing meat or poultry in an outside environment.

Materials and Methods

A nationwide, web based survey was conducted from February 24 to March 15, 2017 to collect information on the food handling behaviors of consumers who grill meat and poultry. The questionnaire was administered by Qualtrics, a private, web-based research software company. Approval was obtained from the Kansas State University Research Compliance Office, which houses the University's Institutional Review Board for Research Involving Human Subjects.

Sample

The survey was distributed nationwide through an online panel using Qualtrics Research Software. Panel members aged 18 years and older who had prepared meat or poultry using an outdoor grill within the past summer and fall months were granted access to complete the survey. A 70/30 ratio of men and women, respectively, was used to reflect the population of outdoor grilling consumer in the U.S. (HPBA 2016). A minimum of half of the respondents were required to have prepared poultry on an outdoor grill to assess if differences occur in the food handling behaviors when grilling poultry versus meat. The survey was equally distributed to the four regions of the United States assigned by the U.S. Census Bureau to be representative of the U.S. population (U.S. Census Bureau 2015).

Questionnaire

The questionnaire, shown in Appendix A, consisted of 50 questions separated into four different sections to assess the food handling behaviors of respondents who prepared meat (beef, pork,

lamb, and veal) or poultry (chicken, turkey, duck and other birds) on an outdoor grill. The first section asked respondents about their grilling environment, the type of poultry/meat that was grilled, and how the meat/poultry was prepared before grilling. This section also asked respondents how the meat or poultry was handled during certain steps of preparation, such as opening the package, seasoning or marinating, and moving on the grill. The second section was composed of questions about respondents' cleaning habits while preparing and grilling the meat/poultry for grilling. Respondents were asked if and how the grill grates were cleaned and how hands, utensils, and dishes were cleaned immediately after they were used to handle the raw meat/poultry. Questions concerning the determination of doneness, satisfaction of the grilled meat/poultry, and leftover were asked in the third section. The last section was comprised of demographic questions, which included sex, ethnicity, education, household income, and grilling usage, frequencies, and skills. The questionnaire was developed based on the four core practices of food safety from the Partnership for Food Safety Education: Clean, Separate, Cook, and Chill (PFSE 2016). Some questions from existing food safety surveys were used and/or modified to develop the survey instrument. Several questions were taken from Kosa and others (2015) and altered to make the questions applicable to outdoor grilling behaviors. Respondents were asked to answer the questions based on the last time they prepared meat or poultry on an outdoor grill.. Questionnaires were self-administered to all respondents. The survey items were multiple choice and forced choice to ensure that respondents answered all questions within the survey. Consent was obtained once the respondent continued the survey after being informed of the research topic, anonymity of data, and the ability to withdraw at any time. No personal identifiable information was collected from respondents. The survey was pilot tested for time estimation,

question comprehension, and clarity (n=50). Data collected from the pilot testing was not included in the final data. The survey took an average of 12 minutes to complete.

Data Analysis

Data were analyzed using XLSTAT software (Addinsoft, Inc. New York, NY) for Microsoft Excel. Descriptive analyses were conducted for all items in the survey. Cross tabulations and analysis of variance were performed to determine if differences between food-handling behaviors and demographic characteristics exist. For all analyses, a p-value less than or equal to 0.05 was indicative of a statistically significant difference.

Results

In total, data were collected from 1,024 respondents. Table 2-1 provides the demographic characteristics of the survey respondents. The sample included 743 males (72.6%) and 281 females (27.4%). The majority of respondents were Caucasian (77.4%), between 36 to 65 years of age (49.9%), and had at least some college education (74.9%). Annual household income was distributed with 21.6% of respondents earning less than \$25,000, 26.5% earning between \$25,000-\$49,000, 33.2% earning between \$50,000-\$99,000, and 18.7% earning over \$100,000 per year. Over half of the respondents (51.4%), did all the purchasing of groceries in their households.

Table 2-2 displays the type of meat (n=520) or poultry (n=504) that consumers prepared the last time they grilled. Chicken (46.1%) and beef (42.1%) accounted for most of the sample. For beef, steaks (46.2%) and ground beef patties (29.9%) were the specific pieces of meat that were prepared on a grill. Chicken parts such as breast, thighs, wings, and legs (89.6%) were the cuts of chicken mostly prepared by respondents the last time they grilled.

Table 2-3 provides the respondents' grilling area, usage and skill information. In general, most of the respondents (66.4%) used their grill all year long. During the grilling season for their area, most respondents (81.6%) grill a few times a month or more. Throughout the off season, when people do not typically grill, 28.4% of respondents still grill a few times a month and 25.7% only grill once every two to three months. The majority of respondents (85.4%) reported grilling at their primary residence the last time they grilled using a liquid propane gas grill (41.5%) or charcoal grill (40%). When asked to rate their grilling skills, most respondents rated themselves average or better (74.2%).

Clean

Twenty-three percent and 46.2% of consumers, respectively, did not wash the poultry or meat that was not ground, before preparation for grilling. Consumers who grilled meat were less likely to wash their meat than consumers who grilled poultry. As seen in table 2-6, respondents who grilled meat that were African American or Hispanic, 18 to 35 years of age, had a graduate, professional, or doctorate degree, and had a household income of \$100,000 or more were more likely to wash the meat.

Eighty-one percent of respondents who grilled poultry reported to have properly cleaned the dishes and utensils used to prepare the raw poultry by washing with soap, bleach, or a disinfectant and water, or by putting them in the dishwasher to be cleaned. Of those who grilled meat, 79.5% of the respondents reported to have properly clean the dishes and utensils. For both meat and poultry, about 19% of respondents rinsed or continued to use the dishes to prepare other foods, without washing them with soap and water first. Respondents who grilled poultry who were 36 years of age or older were more likely to properly clean the dishes or utensils after using them to handle raw poultry. Consumers who were male, between the ages of 18 and 35,

had an advanced degree, and earned \$100,000 or more annually were more likely not to wash utensils or dishes after they were used to handle raw meat.

Respondents were asked to report how they handled the raw meat and poultry, with bare hands, gloves, or utensils during particular situations while grilling. More respondents used their bare hands to open packaging (73.6%) and to season or marinate the meat/ poultry (58.8%). However, more respondents used a utensil to put the meat/poultry on the grill (58.8%), turn or move the meat/poultry on the grill (81.2%), and remove the meat/poultry from the grill (84.4%).

More respondents reported cleaning their bare hands, gloves or utensils immediately after opening the packaging (60.3%) and seasoning or marinating the raw meat/poultry (53.6%).

Twenty-one percent and 22.3%, of respondents respectively, did clean their hands, gloves, or utensils immediately after moving the poultry or meat on the grill. Respondents who grilled meat and were younger than sixty-five were significantly more likely to clean their hands, gloves, or utensils immediately after moving the meat on the grill. Respondents who grilled poultry that were thirty-six years of age or older and had some college education were less likely to immediately clean their hands, gloves, or utensils after moving the poultry on the grill.

Eighty-six percent of respondents cleaned the grates of the grill before grilling, and 61% of respondents cleaned the grates after grilling. Many respondents (95%) used a grill brush or a sturdy utensil on the grill during the cleaning process. Only 44.2% of the respondents cleaned the outside of the grill such as the side shelves and the handles after grilling.

Separate

While grocery shopping, 57.4% of respondents used the plastic bags found in the meat section of the store to separate meat and poultry from other foods. The majority of the respondents (81.6%) reported that the meat or poultry was bagged separately from other food at the checkout counter.

Of the consumers who thawed their poultry in the refrigerator (n=118), 26.3% responded to have placed the poultry on the top shelf, 32.2% on the middle shelf, 39.1% on the bottom shelf, and 3.4% stored the poultry in a drawer. Respondents who had a household income of \$25,000 to \$49,000 were more likely to store the poultry on the bottom shelf. For consumers who thawed meat in the refrigerator (n=90), 22.2% responded to have placed the meat on the top shelf, 50% on the middle shelf, 25.7% on the bottom shelf, and 2.2% stored the meat in a drawer.

Respondents that were younger than sixty-five were more likely to place the meat on the bottom shelf while thawing in the refrigerator.

Out of 644 respondents that used a cutting board or surface to prepare the raw poultry or meat, 73.2% (n=248) and 66.9% (n=204) of the respondents, respectively, cleaned the cutting board or surface by either washing with soap, bleach, or disinfectant or by putting it in the dishwasher to be cleaned before using it again to prepare other food or storing. Twenty-seven percent of respondents who grilled poultry and 31.5% who grilled meat rinsed or wiped the cutting board or surface before using it again or storing or continued to use the cutting board or surface without washing it to prepare other food. Respondents who grilled poultry that were male, 18 to 25 years of age, had an annual household income of \$100,000 or more, had a Bachelor's, graduate, professional or doctorate degree, and had less than average grilling skills were statistically less likely to wash the cutting board used for raw poultry before preparing the next food item or storing. Respondents that grill meat who were male, 18 to 35 years old, and had a household income of \$100,000 or more were less likely to properly clean the cutting used to prepare meat before storing or using it on another food item.

Ninety-one percent and 86.9%, respectively, transferred the cooked meat or poultry from the outdoor grill to the kitchen using a clean plate, pan, or dish. Female respondents who grilled

meat the last time they used an outdoor grill were statically more likely to use a clean plate to transfer the meat from the grill to the kitchen. For both poultry and meat, less than 11% of the consumers transferred the cooked meat using the same plate, pan, or dish that was used for the raw meat or poultry, which can pose a risk of contaminating the cooked meat or poultry.

Cook

Of the respondents who marinated the raw meat or poultry and reused the marinade (n=70), 43.6% (n=17) who grilled poultry and 22.6% (n= 7) who grilled meat, boiled the marinade that was used on raw poultry/meat before using it on cooked food items. Fifty-six percent of respondents who grilled poultry and 77.4% who grilled meat either heated the marinade, not to a boil, or did not reheat the marinade at all before using it on cooked foods. Respondents who grilled meat and were between the ages of 18-35 were more likely to boil the marinade that was used on raw meat before using the marinade on cooked foods. Respondents who grilled poultry with a graduate, professional, or doctorate degree were more likely to boil the marinade.

Overall, respondents used a variety of techniques to determine the doneness of the meat and poultry. The most used techniques among the respondents to determine the doneness of the meat and poultry were cutting the meat open (42.3% and 48.8%) and looking at the color of the meat (42.1% and 38.7). Twenty-eight percent of the respondents who grilled meat touched the meat for firmness. Twenty-eight percent of the respondents who grilled poultry checked that the juices ran clear. Twenty-three percent and 28.9%, respectively, used a thermometer to check the doneness of the meat or poultry the last time they grilled. Consumers who grilled poultry that were younger than 65, had an Associate's degree, a household income of \$100,000, and had a less than average grilling skill were less likely use a thermometer to check the doneness of the

poultry. Consumers who grilled meat that were males, aged 18-35, Hispanic, had a graduate, professional, or doctoral degree, and a household income of \$100,000 or more were less like to check the doneness of meat by using a thermometer.

Half of the respondents (50.1%) reported to have checked the doneness of only a few pieces of the meat/ poultry, while 22.3% checked every piece of the meat/poultry to ensure that all were cooked to the same level of doneness. Majority of the respondents (92.5%) were content with the doneness of each piece of meat/poultry, but 2.6% reported that some pieces were undercooked and 4.2% of respondents reported that there were overcooked pieces.

Chill

The Partnership for Food Safety Education (PFSE) recommends that consumers defrost foods in the refrigerator, in cold water that is changed often, or in the microwave to keep foods at a safe temperature (PFSE 2016). Fifty-three percent and 55.8% of respondents, respectively, properly thawed the meat or poultry. For respondents that incorrectly thawed the meat, 38.3% of respondents thawed the meat on a countertop, 4.2% thawed the meat in cold water that was rarely or never changed, and 4.6 % thawed the meat in warm or hot water. Respondents who grilled meat and were between 18-35 were less likely to thaw the meat correctly. For respondents that incorrectly thawed the poultry, 30.3% of respondents thawed the poultry on a countertop, 2.2% thawed the poultry in cold water that was rarely or never changed, and 11.0 % thawed the poultry in warm or hot water. Respondents who grilled poultry that were 65 or older, had a household income of \$50,000 to \$99,000, and had average or better than average grilling skills were more likely to thaw the poultry correctly.

When marinating and seasoning the raw poultry, 43.8% of the respondents let the poultry rest or marinate in the refrigerator, while 28.1% let the poultry rest on the countertop. Respondents who

grilled poultry that were between 18 to 35 years of age, had a high school diploma or less or a graduate, professional, or doctorate degree, and had less than average grilling skills were less likely to correctly rest or marinate the poultry in the refrigerator. Thirty-two percent of the respondents let the meat marinate in the refrigerator and 34.7% let the meat marinate on the countertop. Respondents who grilled meat and had a graduate, professional, or doctorate degree were more likely to let the meat rest or marinate on the countertop.

The USDA recommends that leftovers be stored in the refrigerator or freezer within 2 hours of removing from the heat source and eaten within 3-4 days to reduce bacterial growth (USDA 2016b). After grilling the poultry and meat, 81.1% and 73.5% of respondents who had leftovers, respectively, left them sitting at room temperature for no more than 2 hours. For both, meat and poultry, less than 1% let their leftovers sitting at a room temperature for two hours or more.

Discussion

This survey assessed the food handling practices of consumers when grilling meat or poultry. Demographic differences among consumer food handling practices were identified. Consistent with other food safety surveys, the finding of this study show that risky food handling behaviors are prevalent among consumers when grilling.

Despite most respondents reporting washing their hands with soap and water after handling raw meat or poultry, it is uncertain whether they followed the proper procedures for hand washing: washing hands with warm water and soap for at least 20 seconds. Similarly, most respondents reported following safe practices when using cutting boards, dishes, and utensils to prepare the raw meat or poultry, but it is unknown if the items were washed adequately. When opening a package with bare hands, 20.1% of respondents who grilled meat and 15.1% who grilled poultry

reported to not clean or wash their hands with soap and water. Previous research has shown that the outside of meat or poultry packages can be a vehicle for cross contamination (Burgess et al. 2005, Donelan et al. 2016, Kramer et al. 2000, and Patrick et al. 2010). Burgess et al. (2005) found that *Campylobacter* and *Salmonella* were present on the external packaging of raw meats. Therefore, it is recommended that consumers wash their hands thoroughly after touching a package of meat to reduce the spread of bacteria (Burgess et al. 2005, USDA 2016b).

Forty-three percent and 78% of respondents, respectively, reported to have washed raw meat or poultry before grilling. The USDA recommends that consumers do not wash raw meat or poultry to prevent splashing of contaminated water onto other foods, utensils, or kitchen surfaces (USDA 2013d and USDA 2016b). Rinsing meat and poultry can increase the likelihood of harmful bacteria being spread throughout the kitchen (Henley et al. 2016 and USDA 2013d). Research from Everis and Betts (2003) found that when washing poultry, droplets from of the contaminated water could travel 70 cm away from the sink or site of washing. Washing or rinsing raw meat or poultry does not remove pathogens, thus serves no purpose for food safety (Henley et al. 2016 and USDA 2013d).

Cross contamination is at the top of the list for food safety concerns during the grilling season. To prevent cross contamination, raw foods should always be separated from cooked or ready to eat foods (PFSE 2016). When storing raw meats or poultry, the Partnership for Food Safety Education advises consumers to store it in a sealed container or plastic bag on the bottom shelf of the refrigerator to prevent raw juices from leaking and contaminating other foods (PFSE 2016). Consistent with previous research from (Donelan et al. 2016, Koppel et al. 2015, and Kosa et al. 2015), few consumers stored the meat on the bottom shelf of the refrigerator. Although about one third of respondents stored the meat or poultry to be grilled correctly in the refrigerator, it is

not known if the meat or poultry was stored in a sealed container or plastic bag to further reduce the risk of contamination.

Consistent with previous research from the ADA and ConAgra Foods (2005), most respondents did not clean the utensil immediately after putting the meat on the grill and moving or flipping the meat/poultry. Using the same utensil, without washing or sanitizing, throughout the grilling process can pose a risk for cross contamination (Academy of Nutrition and Dietetics 2017 and PFSE 2017). It is not safe to use the same utensil used to put the raw meat or poultry on the grill to flip the meat. The utensil will be contaminated with bacteria from the raw meat or poultry; therefore, if used again without washing, it could contaminate the cooked portion of the meat or poultry. The USDA recommends that consumers do not use the same utensils for raw and cooked meats and poultry (USDA 2016b). Once a utensil has touched raw meat or poultry, it should be washed with soap before coming in contact with cooked or ready to eat foods (PFSE 2016). It is best to wash the utensil in between uses until the meat or poultry has been thoroughly cooked or to use two sets of utensils to reduce the occurrence of cross contamination. The same rule applies to dishes, as well. Eleven percent and 5.2% of respondents, respectively, reported transferring the cooked meat or poultry with the same dish used for the raw meat or poultry, which increases the risk of contracting a foodborne illness. Consumers should not use a dish that was previously used for raw meat or poultry for cooked meat, unless the plate has been washed in warm or hot soapy water first. Consumers should make sure to use separate plates for raw meat or poultry: one to bring the raw foods to the grill and another for taking cooked foods off the grill (Academy of Nutrition and Dietetics 2017, ADA and ConAgra Foods 2004 and PFSE 2017).

Although most consumers discarded the excess marinade that was used on raw meat and poultry, a few respondents incorrectly reused the marinade by not reheating the marinade before using it

on cooked foods. The PFSE recommends consumers to boil used marinade before applying it to cooked foods to destroy harmful bacteria or to reserve a portion of the unused marinade to use as a sauce (PFSE 2017). In addition, it is best to never use the same brush that was used to baste raw meat or poultry for cooked meats (Academy of Nutrition and Dietetics 2017, ADA and ConAgra Foods 2005, and Magoulas 2017).

Temperature plays a significant role in the safety of raw meats and poultry. To kill any pathogens that may be present, meat and poultry should be cooked thoroughly to a safe internal temperature (PFSE 2016, USDA 2015a, USDA 2015b, USDA 2013b and USDA 2016b). The USDA recommends all poultry be cooked to a safe minimum temperature of 73.9°C (165°F) (USDA 2015a). Cuts of beef, pork, veal, and lamb should be cooked to an internal temperature of 62.8°C (145°F) and ground meats, such as hamburgers, cooked to 71.1°C (160°F) (USDA 2015a). The only way to ensure that meat or poultry has been cooked to a safe minimum internal temperature and that all foodborne bacteria has been destroyed is by using a thermometer (ADA and ConAgra Foods 2005, USDA 2015b, and USDA 2016b). Previous research has shown that few consumers use a thermometer regularly to gauge the doneness of meats and poultry (Bruhn et al. 1999, Byrd-Bredbenner et al. 2013, ADA and ConAgra Foods 2004, Kosa et al. 2015, Kramer et al. 2000, Redmond and Griffith 2003 and USDA 2016a). Only about one fifth of respondents in this survey used a thermometer the last time they grilled to check if the meat or poultry was done, but it is not known if the meat or poultry was cooked to a safe internal temperature or if the thermometer was used correctly. Most respondents used a variety of techniques other than using a thermometer to check the doneness of the meat or poultry, such as looking at the color of the meat, cutting the meat open, checking that the juices ran clear, touching the meat for firmness, and using previous experience. As in this survey, consumers

have been known to rely on appearance and experience to determine the doneness of meat and poultry (Beddows 1983). Using subjective assessments of the doneness of meat and poultry is unsafe, as research (Hunt et al. 1995) has shown that hamburgers can turn brown in the middle before reaching a safe internal temperature (Synder 1998 and USDA 2015b). Similarly, a study conducted by Kennedy et al. (2011) found that 70% of chicken pieces that were deemed “done” by consumers, who visually inspected the chicken, was undercooked and had active *Campylobacter jejuni* cells. Focus groups conducted by Koepl (1998) revealed that consumers felt that a thermometer was inconvenient and was not needed when cooking small pieces of meat. Likewise, results from the 2016 Food Safety Survey reported that while 67% of respondents owned a thermometer, only 38% always used a thermometer for large items like roast, 19% for chicken parts, and 10% for hamburgers (USDA 2016a). Because many respondents in this study had not grilled large pieces of meat or poultry like whole birds or roasts, the last time they grilled, thermometer usage was high among the smaller pieces of meat. The results from this study could suggest that the number of consumers using a thermometer to check the doneness of smaller pieces of meat and poultry has increased.

Just as thermometers are used to ensure that foods have reached a safe temperature, they can also be used to make sure that foods have not been overcooked. In recent years, overcooked and charred meats have become a food safety concern (Lee et al. 2016). About 4% of respondents reported that the meat/poultry grilled was overcooked. Research has shown the use of direct heat of meat and poultry for an extended amount of time can activate dangerous chemical compounds such as polycyclic aromatic hydrocarbons and heterocyclic aromatic amines (Salmon et al. 2000 and Viegas et al. 2012). HCAs and PAHs are carcinogens that can change and damage DNA (National Cancer Institute 2015). Cooking method, temperature, and time are all factors that

influence the creation of HCAs and PCAs (Chung et al. 2011 and Viegas et al. 2012). Cooking methods such as grilling and frying tend to have higher concentrations of HCAs and PCAs (Chung et al. 2011, Salmon et al. 2000, and Viegas et al. 2012). To reduce the formation of HCAs and PAHs, the direct exposure of meat or poultry to an open flame for prolonged cooking times should be avoided (National Cancer Institute 2015).

There were a considerable number of respondents who thawed or marinated the meat/poultry on the countertop or in warm or hot water. Neither of these thawing methods are safe, as foods at a temperature between 4°C and 60°C (40°F and 140°F) can cause bacteria to multiply rapidly (PFSE 2017, USDA 2011, and USDA 2013a).

When handling leftovers, it is important to refrigerate or freeze foods promptly (PFSE 2017 and USDA 2013a). The majority of respondents refrigerated or froze their leftovers within two hours or less. Few respondents let the leftovers sit at room temperature for two hours or more. To slow the growth of harmful bacteria, the PFSE recommends that consumers chill leftovers at a temperature of 4°C (40°F) within two hours of sitting at room temperature or within one hour if the leftovers are sitting at temperatures above 32°C (90°F) (PFSE 2017).

Implications

The strengths of this present study consist of a nationwide survey design and a large sample size. Limitations of this study included the use of self-reported behaviors. Although self-reported behavior questions have been used in the majority of consumer food safety studies, self-reporting biases can be a potential source of error when conducting surveys (Herzog 1996 and Redmond and Griffith 2003). It is not known whether the reported behaviors reflect the actual behaviors of the respondents (Fein et al. 2011, Levy et al. 2008, Maughan et al. 2016, and Redmond and

Griffith 2003). Due to the social desirability bias, consumers tend to report behaviors that they perceive to be correct or “good” (Bowling 2000 and Lewis-Beck et al 2004). To reduce self-reporting biases in this study, respondents were instructed to answer the questions based on the last time they grilled meat or poultry to provoke responses about their actual behavior instead of their knowledge about food safety (Kosa et al. 2015).

This study provides additional information on the food handling practices of consumers when grilling meat or poultry. Overall, respondents who grilled poultry followed safer food handling practices, which can conclude that consumers are safer or being more cautious when grilling raw poultry. Also, women were significantly more likely to follow safe handling practices than men. Based on the statistical differences that were identified between demographics and safe food handling practices, the demographic groups that should be targeted for food safety education are men, young adults, lower middle-income consumers, and consumers with postgraduate degrees. Educational efforts should focus on not washing meat/poultry, cross contamination prevention when flipping or moving the meat/poultry on the grill and the importance of thermometer use. To promote safe handling of food while grilling, food safety content could be displayed on the packaging of grilling essentials, such as liquid propane tanks, charcoal bags, meat forks, or on a panel of the grill itself. Further research should be conducted to observe the actual behaviors of consumers while using an outdoor grill to determine if discrepancies exist between self-reported behavior and observed behavior.

Table 2-1: Demographic characteristics of U.S. consumers who used an outdoor grill to prepare raw meat or poultry (n=1024).

	<i>n</i>	%
Gender		
Male	743	72.6
Female	281	27.4
Age		
18-35	333	32.5
36-64	511	49.9
65+	180	17.6
Ethnicity		
Caucasian	793	77.4
African American	88	8.6
Hispanic	60	5.9
Asian	47	4.6
Native American	17	1.7
Other	19	1.9
Education		
Some high school or less	25	2.4
High school graduate or GED	232	22.7
Some college (no degree)	262	25.6
Associate's degree	112	10.9
Bachelor's degree	242	23.6
Graduate or professional degree	123	12.0
Doctoral degree	28	2.7
Household Income		
Less than \$25,000	221	21.6
\$25,000 to \$49,000	271	26.5
\$50,000 to \$99,000	340	33.2
\$100,000 or more	192	18.8

Table 2-2: Type of raw meat or poultry consumers prepared the last time they grilled on the outdoor grill (n=1024).

	<i>n</i>	%
Meat	520	50.8
Beef	432	42.2
Pork	73	7.1
Lamb or sheep	11	1.1
Veal	3	0.3
Other meat	1	0.1
Poultry	504	49.2
Chicken	472	46.1
Turkey	23	2.2
Duck or other birds	9	0.9

Table 2-3: Grilling area, usage, and skill of the respondents (n=1024).

	<i>n</i>	%
Grilling Area		
A grill with no side shelves or surface area to place plates or utensils.	268	26.2
A grill with side shelves or a surface area to place plates or utensils.	694	67.8
A grill with an outdoor kitchen with countertops.	45	4.4
A grill with an outdoor kitchen with countertops and a sink.	17	1.7
Grill Type		
Liquid Propane Grill	425	41.5
Natural Gas Grill	133	13.0
Charcoal Grill	410	40.0
Electric Grill	51	5.0
Ceramic Grill	5	0.5
Year-Round Grill Usage		
Yes	680	66.4
No	344	33.6
Grilling Skill		
Novice/Beginner	36	3.5
Basic skills	160	15.6
Average	401	39.2
Better than average	358	35.0
Expert	69	6.7

Table 2-4: Clean and separate food handling behaviors of respondents that grilled poultry by demographic characteristics (n=504).

Safe Food Handling Practices	Followed Safe Practices											
	Clean						Separate					
	Did not wash or rinse poultry†		Washed dishes and utensils used to prepare and handle raw poultry		Washed hands, gloves, or utensils immediately after turning or moving poultry on the grill		Stored poultry on the bottom shelf of the refrigerator during thawing ^a		Washed cutting board used for raw poultry before preparing next food item or storing ^b		Used a clean dish to remove and transfer cooked poultry from the grill	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Gender												
Male ¹	87	21.8	315	78.8	74	18.5	37	38.5	188	69.4	360	90.0
Female	27	26.0	91	87.5	30	28.8	8	36.4	60	88.2*	96	92.3
Age												
18-35	40	25.7	109	69.9*	38	24.4*	7	26.9	73	60.8*	134	85.9
36-64 ¹	59	22.8	217	83.8	51	19.7	29	27.5	128	77.1	242	93.4
65 and older	15	16.9	80	89.9	15	16.9	9	29.0	47	88.7*	80	89.9
Ethnicity												
Caucasian ¹	85	23.2	298	81.2	70	19.1	32	34.8	182	77.5	336	91.6
African American	7	13.0	47	87.0	15	27.8	4	57.1	27	62.8*	48	88.9
Hispanic	13	38.2	24	70.6	4	11.8	4	57.1	16	64.0	28	82.4
Asian	6	18.8	23	71.9	10	31.3	3	30.0	14	56.0*	29	90.6
Native American	0	0.0	2	66.7	2	66.7	0	0.0	1	33.3*	2	66.7
Other	3	21.4	12	85.7	3	21.4	2	100.0	8	100.0*	13	92.9
Education												
High School graduate, GED, or less	20	16.3	97	78.9	31	25.2	11	55.0	66	76.7*	107	87.0
Some college (no degree)	33	26.8	102	82.9	19	15.4*	13	36.1	61	81.3*	110	89.4
Associate's degree	15	29.4	44	86.3	9	17.6	6	40.0	30	90.9*	48	94.1
Bachelor's degree ¹	35	27.8	103	83.7	25	20.3	10	43.5	58	67.4	115	91.3
Graduate, professional, or doctoral degree	11	13.6	60	74.1	20	24.7	5	20.8	33	55.9	76	93.8
Household Income												
Less than \$25,000	21	20.0	88	83.8	24	22.9	6	33.3	50	73.5	92	87.6
\$25,000 to \$49,000	26	21.7	98	81.7	22	18.3	12	60.0*	57	73.1	111	92.5
\$50,000 to \$99,000 ¹	45	25.4	141	79.7	32	18.1	21	36.8	93	77.5	157	88.7
\$100,000 or more	22	21.6	79	77.5	26	25.5	6	36.1	48	65.8*	96	94.1
Grilling Skill												
Less than average	14	15.1	66	71.0	21	22.6	4	26.7	44	60.3*	80	86.0
Average ¹	53	26.4	164	81.6	40	19.9	21	41.2	101	78.3	180	89.6
Better than average	47	22.4	176	83.8	43	20.5	20	38.5	103	75.2	196	93.3
Total	114	22.6	406	80.6	104	20.6	45	38.1	248	73.2	456	90.5

¹ Referent group.

† Poultry that was not ground.

^a Only respondents who thawed the poultry in the refrigerator were allowed to answer this question (n=180)

^b Only respondents who used a cutting board to prepare the poultry were allowed to answer this question (n=339)

* Significantly different from the referent group, $p \leq 0.05$.

Table 2-5: Cook and chill food handling behaviors of respondents that grilled poultry by demographic characteristics (n=504).

Safe Food Handling Practices	Followed Safe Practices									
	Cook				Chill					
	Boiled marinade used on raw poultry before using it on cooked foods ^a		Used a thermometer to determine doneness of poultry		Thawed poultry in the refrigerator, microwave, or with cold water that was changed often ^b		Marinated/rested poultry in the refrigerator ^c		Refrigerated or froze leftovers within 2 hours	
	n	%	n	%	n	%	n	%	n	%
Gender										
Male ¹	14	41.2	117	29.3	125	55.6	145	41.7	329	82.3
Female	3	60.0	29	27.9	28	57.1	50	51.6	83	79.8
Age										
18-35	10	47.6	31	19.9	37	42.1*	51	35.2*	136	87.2
36-64 ¹	7	46.7	76	29.3	80	58.4	109	47.6	207	79.9
65 and older	0	0.0	39	43.8*	36	73.5*	35	49.3	69	77.5
Ethnicity										
Caucasian ¹	10	47.6	113	30.8	112	57.7	135	42.7	302	82.3
African American	1	11.1	14	25.9	14	46.7	28	52.8	43	79.6
Hispanic	2	50.0	5	14.7*	10	58.8	14	46.7	28	82.4
Asian	4	100.0	8	25.0	13	56.5	13	41.9	26	81.3
Native American	0	0.0	1	33.3	0	0.0	1	50.0	2	66.7*
Other	0	0.0	5	35.7	4	44.4	4	30.8	11	78.6
Education										
High School graduate, GED, or less	4	40.0	30	24.4	32	47.1	37	35.6	103	83.7
Some college (no degree)	1	16.8*	40	32.5	45	69.2	54	49.5	89	72.4
Associate's degree	0	0.0*	25	49.0*	19	67.9	25	54.4	36	70.6*
Bachelor's degree ¹	4	44.4	30	23.8	28	48.3	53	47.3	112	88.9
Graduate, professional, or doctoral degree	8	80.0*	21	25.9	29	52.7	26	35.1*	72	88.9
Household Income										
Less than \$25,000	4	36.4	37	35.2	28	50.9*	38	42.2	81	77.1
\$25,000 to \$49,000	3	27.3	36	30.0	30	51.0*	55	52.4	98	81.7
\$50,000 to \$99,000 ¹	1	20.0	50	28.3	65	63.1	62	39.5	144	81.4
\$100,000 or more	9	75.0	23	22.6*	30	52.6*	40	43.0	89	87.3
Grilling Skill										
Less than average	6	40.0	18	19.4	19	36.5*	34	19.5*	79	85.0
Average ¹	5	50.0	60	29.9	66	60.6	73	34.5	160	79.6
Better than average	6	42.9	68	32.4	68	60.2	88	25.9	173	82.4
Total	17	43.6	146	29.0	153	55.8	195	43.8	412	81.8

¹ Referent group.

^a Only respondents who reused excess marinade that was used on raw poultry were allowed to answer this question (n=39)

^b Only respondents who thawed the poultry were allowed to answer this question (n=274)

^c Only respondents who marinated or seasoned the poultry were allowed to answer this question (n= 445)

* Significantly different from the referent group, $p \leq 0.05$.

Table 2-6: Clean and separate food handling behaviors of respondents that grilled meat by demographic characteristics (n=520).

Safe Food Handling Practices	Followed Safe Practices											
	Clean						Separate					
	Did not wash or rinse meat [†]		Washed dishes and utensils used to prepare and handle raw meat		Washed hands, gloves, or utensils immediately after turning or moving meat on the grill	Stored meat on the bottom shelf of the refrigerator during thawing ^a		Washed cutting board used for raw meat before preparing next food item or storing ^b		Used a clean dish to remove and transfer cooked meat from the grill		
	n	%	n	%	n	%	n	%	n	%	n	%
Gender												
Male ¹	149	43.4	238	69.4	72	21.0	14	22.6	124	60.5	286	83.4
Female	91	51.4	160	90.4*	45	25.4	9	32.1	80	80*	166	93.8*
Age												
18-35	60	33.9*	115	64.8*	37	20.9	8	26.7	68	54.4*	145	81.9
36-64 ¹	125	49.6	211	83.7	67	26.6	11	28.2	100	72.5	224	88.9
65 and older	55	60.4	72	79.1	13	14.3*	4	19.1*	36	85.7*	83	91.2
Ethnicity												
Caucasian ¹	211	49.5	329	77.2	96	22.5	22	28.6	134	68.1	374	87.8
African American	9	26.5*	24	70.6	10	29.4	0	0.0	15	65.2	23	67.7
Hispanic	4	15.4*	22	84.6	6	23.1	0	0.0	14	70.0	23	88.5
Asian	7	46.7	9	60.0	3	20.0	0	0.0	6	60.0	15	100.0
Native American	7	50.0	11	78.6	2	14.3	0	0.0	4	50.0	13	92.9
Other	2	40.0	3	60.0	0	0.0	1	100.0	1	33.3	4	80.0
Education												
High School graduate, GED, or less	57	42.5	103	76.9	33	24.6	7	33.3	54	69.2	118	88.1
Some college (no degree)	76	54.7	110	79.1	31	22.3	5	27.8	52	69.3	122	87.8
Associate's degree	27	44.3	53	86.9	12	19.7	2	15.4	25	75.8	54	88.5
Bachelor's degree ¹	54	46.6	91	78.5	25	21.6	6	26.1	55	75.3	102	87.9
Graduate, professional, or doctoral degree	26	37.1*	41	58.6*	16	22.9	3	20.0	18	39.1*	56	80.0
Household Income												
Less than \$25,000	53	45.7	93	80.2	30	25.9	8	44.4	49	74.2	100	86.2
\$25,000 to \$49,000	60	39.7	118	78.2	31	20.5	8	34.8	60	68.2	136	90.1
\$50,000 to \$99,000 ¹	97	59.5	133	81.6	32	19.6	4	12.1	66	69.5	139	85.3
\$100,000 or more	30	33.3*	54	60.0*	24	23.7	3	18.8	29	51.8	77	85.6
Grilling Skill												
Less than average	43	41.8	71	68.9	23	22.3	1	6.7	39	60.9	82	79.6
Average ¹	94	47.0	160	80.0	46	23.0	8	22.2	80	69.0	178	89.0
Better than average	103	47.5	197	77.0	48	22.1	14	35.9	85	68.0	192	88.5
Total	240	46.2	398	76.5	117	22.5	23	25.6	204	66.9	452	86.9

¹ Referent group.

[†]Meat that was not ground.

^a Only respondents who thawed the meat in the refrigerator were allowed to answer this question (n=90)

^b Only respondents who used a cutting board to prepare the meat were allowed to answer this question (n=90)

* Significantly different from the referent group, $p \leq 0.05$.

Table 2-7: Cook and chill food handling behaviors of respondents that grilled meat by demographic characteristics (n=520).

Safe Food Handling Practices	Followed Safe Practices									
	Cook				Chill					
	Boiled marinade used on raw meat before using it on cooked foods ^a		Used a thermometer to determine doneness of meat		Thawed meat in the refrigerator, microwave, or with cold water that was changed often ^b		Marinated/rested meat in the refrigerator ^c		Refrigerated or froze leftovers within 2 hours	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Gender										
Male ¹	4	18.2	69	20.1	78	52.0	96	32.8	248	72.3
Female	3	33.3	50	28.3*	36	53.7	49	30.8	134	75.7
Age										
18-35	6	28.6*	35	19.8*	40	46.0*	42	24.9	134	75.7
36-64 ¹	1	14.3	62	24.6	51	56.7	82	37.3	185	73.4
65 and older	0	0.0*	22	24.2	23	57.5	21	33.3	63	69.2*
Ethnicity										
Caucasian ¹	5	23.8	96	22.5	95	54.6	115	31.6	315	73.9
African American	0	0.0	9	26.5	7	43.8	15	44.1	25	73.5
Hispanic	0	0.0	4	15.4*	6	46.2	10	41.8	19	73.1
Asian	2	66.7	4	26.7	4	57.1	2	14.3	9	60.0*
Native American	0	0.0	5	35.7	1	33.3	2	18.2	10	71.4
Other	0	0.0	1	20.0	1	25.0	1	20.0	4	80.0
Education										
High School graduate, GED, or less	4	44.4	33	24.6	28	50.0	41	35.7	103	76.9
Some college (no degree)	0	0.0	25	18.0	23	43.4	31	25.6	103	74.1
Associate's degree	0	0.0	18	29.5	16	64.0	23	41.8	38	62.3
Bachelor's degree ¹	2	25.0	33	28.5	28	60.9	37	37.0	87	75.0
Graduate, professional, or doctoral degree	1	14.3	10	14.3*	19	51.4	13	21.3*	51	72.9
Household Income										
Less than \$25,000	0	0.0	24	20.7	27	60.0	29	30.5	84	72.4
\$25,000 to \$49,000	4	36.4	36	23.8	30	48.4	49	36.0	112	74.2
\$50,000 to \$99,000 ¹	1	25.0	46	28.2	37	53.6	40	28.0	118	72.4
\$100,000 or more	2	25.0	13	14.4*	20	48.8	27	34.6	68	75.6
Grilling Skill										
Less than average	1	25.0	17	16.5	18	39.1	28	31.5	79	76.7
Average ¹	2	28.6	48	24.0	47	53.4	58	34.3	150	75.0
Better than average	4	20.0	54	24.9	49	59.0	59	30.4	153	70.5*
Total	7	22.6	119	22.9	114	52.5	145	32.1	382	73.5

¹ Referent group.

^a Only respondents who reused excess marinade that was used on raw meat were allowed to answer this question (n=31)

^b Only respondents who thawed the meat were allowed to answer this question (n=217)

^c Only respondents who marinated or seasoned the meat were allowed to answer this question (n= 452)

* Significantly different from the referent group, $p \leq 0.05$.

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Chapter 3 - Food Handling Behaviors of Consumers When Grilling

Poultry

Abstract

Following the proper food safety handling practices is the best way to prevent foodborne illnesses, such as Salmonellosis or Campylobacteriosis. Research has shown that consumers are using unsafe handling practices when cooking poultry. Though many studies have been conducted to assess the food handling behaviors of consumer through surveys, few studies have observed consumers to see how they handle food in their home. The purpose of this study was to observe and assess the food safety and handling practices behaviors of consumers when preparing poultry using an outdoor grill. Thirty participants from the Kansas City Metropolitan area were observed at their home while they prepared chicken quarters and turkey patties on an outdoor grill. Participants were assessed based on their handwashing and cross contamination behaviors, determination of doneness, and the endpoint temperature of the poultry products. The majority of the participants did not wash their hands thoroughly after handling the raw poultry. About 57% and 67% of participants, respectively, contaminated items or surfaces while preparing the chicken quarter and the turkey patties. Most participants did not use separate or clean utensils to remove the cooked poultry from the grill. Participants used several methods to determine the doneness of both poultry products by looking at the color of the meat, and cutting or piercing the meat being the most used techniques. Eighty percent of the chicken quarters were cooked to the proper temperature of 165°F or above, while 60% of the turkey patties were cooked to the correct temperature. The results from this study show that consumers are not using the proper food safety procedures when preparing poultry on a grill. There needs to be an increased initiative to promote safe handling practices of poultry among consumers.

Introduction

An estimated 48 million people in the United States experience foodborne illness each year causing 128,000 hospitalizations and 3,000 deaths (CDC 2016). Salmonella and Campylobacter, two of the most common foodborne bacteria associated with raw or undercooked poultry, respectively, are responsible for 1 million and 0.8 million-foodborne infections (CDC 2016). Because of its high incidence and the cost that it has imposed on society, foodborne illness is labeled as a major burden on public health (Bhaskar 2017). Although avoidable, the prevention of foodborne illness remains a challenge.

Because retail poultry contains a significant amount of harmful bacteria, consumers need to be cognizant of the risk associated with poultry when handling it raw (Zhao et al. 2001). The first line of defense to combat foodborne illness is consumer awareness and knowledge of good food safety practices (Redmond and Griffith 2003). Approximately 25% of foodborne infections in the United States are due to unsafe food handling practices in the home (McCabe-Sellers and Beattie 2004). During the preparation of food, consumers make many food-handling errors, thus increasing their risk of foodborne illness (Byrd-Bredbenner et al. 2013). Most cases of Salmonellosis and Campylobacteriosis are the result of poor food safety practices such as inadequate hand washing, consuming raw or undercooked poultry, cross contamination and, improper storage conditions and temperatures (Redmond and Griffith 2003).

Despite many studies being conducted to assess the food handling behaviors and practices in a domestic home kitchen, studies exploring the food handling behaviors of consumers when in an outside environment are limited. More consumers are starting to cook outdoors, such as when grilling and smoking (HPBA 2016). Research has shown that 66% of consumers use their grill year-round with 82% of consumers grilling a few times a month or more during the grilling

season (Terry 2017). With consumers grilling more frequently, it is important to investigate the food handling behaviors of consumers when preparing food on a grill.

A national telephone study administered by the U.S. Food and Drug Administration found that 81% of consumers practiced safe food handling by using a different plate or pan to carry food to the grill and to remove food from the grill (USDA 2016a). Conversely, a survey conducted by the American Dietetic Association and ConAgra Foods (2005) revealed that people use poor food safety practices when grilling. When consumers were asked to grade themselves based on their food safety practices when preparing food on a grill, 63% of the consumers gave themselves a grade of a B or lower. The survey found that cross-contamination was the main food safety concern when grilling outdoors. Forty-one percent of the survey participants reported not to use separate utensils for raw meat and cooked meat when grilling. Additionally, 92% of the respondents do not regularly use a thermometer to check the doneness of their meat.

Although there are food handling self-reported studies concerning outdoor grilling, few observational studies have been conducted researching grilling exclusively. Research that solely depends on self-reported data cannot be validated because of the difference in what consumers say and what consumers actually do (Herzog 1996 and Redmond and Griffith 2003). It is not truly known whether the practices reported by consumers are accurate (Levy 2008, Fein et al. 2011, and Maughan et al. 2016). Due to social desirability bias, consumers can over report “good” behaviors and under report “undesirable” behaviors (Bowling 2000). To reduce this bias, observational studies have been conducted to reflect the true practices and behaviors of consumers.

The purpose of this study was to observe the food handling practices of consumers when grilling poultry and to measure the internal endpoint temperature attained in those products.

Methods

Subject Recruitment

An observational study to observe the food handling behaviors of consumers when using an outdoor grill to prepare poultry in their home was conducted during the month of April of 2017. Thirty participants in the Kansas City metropolitan area were selected from the Sensory & Consumer Research Center database. The Sensory and Consumer Research Center specializes in conducting quantitative and qualitative consumer research, testing a wide range of food and consumer products. Compusense Cloud (Ontario, Canada), a web-based, sensory and consumer research collection and analysis software, was used to recruit and schedule the participants in this study. Participants were recruited based on the following qualifications: 1) had to have prepared chicken and burgers using an outdoor grill in the past 6-8 months, 2) have access to an outdoor grill, and 3) not have any food allergies or dietary restrictions that would prevent them from being able to grill poultry. Participants were told they were a part of research assessing consumers' grilling skills.

The study protocol was approved by the institutional review board at Kansas State University. All participants signed a consent form which provided information about the study and documented the agreement to participate in the study.

Grilling Observation

Observations were conducted at the participants' place of residence. For all observations, two researchers were present to conduct the study. Participants were assessed on their food handling practices including hand washing, cross contamination, determination of doneness, and endpoint

internal temperature of the poultry. Observers used the checklist shown in Appendix B to assess each participant. Participants were given one of four scores for the seasoning poultry and handling poultry handwashing situation: always (washed hands with soap and water at every opportunity), very often (missed one opportunity to wash hands with soap and water), seldom (missed several opportunities to wash hands with soap and water), and never (rinsed hands with only water or never washed hands with soap and water). Observations on cross contamination and determination of doneness were noted.

Participants were asked to prepare two poultry products on an outdoor grill: thigh-leg chicken quarters and turkey patties. Raw chicken quarters and a package of 1lb. raw ground turkey were supplied to all participants. Participants were asked to use their own ingredients or seasonings to prepare the poultry. No specific instructions were given on how to prepare or season the poultry, except to form patties or burgers with the ground turkey. The participants were not required to form a specific number of patties or burgers. Participants were instructed to prepare and season the poultry items one at a time. After each of the poultry products were prepared, participants were told that both products could be placed on the grill at the same time, if they preferred. Participants were instructed to remove the poultry from the heat source and to notify an observer once the poultry was finished cooking. Once participants stated that they were finished cooking the poultry product, the internal temperature was measured and recorded by an observer within no more than 1 minute of being removed from the grill. The internal temperature was measured using a digital food thermometer (model DFP450W, SYSCO Corporation). For the chicken quarters, the probe was inserted into the thickest part of the chicken and one temperature was recorded. When measuring the temperature of the turkey patties, the temperature of all the patties was taken. If all patties were removed from the grill at the same time, were 165°F or above, and

were within 5 degrees of each other, only the lowest temperature of the set was recorded. If patties were taken off the grill at separate times, then temperatures were recorded each time patties were taken off the grill. Also, if there were drastic temperature differences between the patties or if some patties were at the correct endpoint temperatures and some were not, more than one temperature was recorded. After the observation was complete, participants were debriefed about the true purpose of the study and given compensation for participating in the study.

Data Analysis

Data was compiled and analyzed with only basic statistics, including percentages and frequencies, due to the small sample size. Data was analyzed using Excel (Microsoft Corporation).

Results

Demographics

Of the 30 participants, 57% (n=17) were male and 43% (n=13) were female. All participants were Caucasian with 3.3% being in the 18-24 age range, 60% in the 24-44 age range, and 36.7% in the 45-64 age range. Over half of the subjects (53.3%) reported an annual household income of \$50,000 to \$99,000. Thirteen percent of the participants earned between \$25,000 and \$49,000 a year, while 33% earned above \$100,000 a year.

Grilling Environment and Area

Most of the observations were conducted in sunny or partly sunny weather conditions, with only 2 observations being conducted in rainy weather. Three participants used another source of light besides sunlight, such as patio or porch lighting, to grill due to the sun setting. The majority of the participants (83.3%) used a liquid propane grill, while 10% used a charcoal grill, and 6.6% used a natural gas grill. Nearly all subjects (n=27) used a grill that contained side shelves for

dishes and utensils. Two participants used a grill that did not have any side shelves, and one participant used a grill with an outdoor kitchen that included countertops.

Handwashing

According to the Partnership for Food Safety Education, proper handwashing is defined as washing hands with soap and water for at least 20 seconds. Before the preparation of the chicken quarters, two of the participants washed their hands with soap and water for the recommended time of 20 seconds. Twenty-three participants did wash their hands with soap and water, but not for 20 seconds or more. Five participants did not wash their hands at all before preparing the chicken. For the turkey patties, all subjects who washed their hands with soap and water (n=16), washed their hands for less than 20 seconds. Forty-seven percent (n=14) of the subjects either did not wash their hands at all or only rinsed their hands with water before preparing the turkey patties.

Sixty-seven percent and 70%, respectively, of the participants did not wash their hands or rinsed their hands with only water after handling the raw chicken quarter and ground turkey packaging. Of the 30% (n=9) of subjects who washed their hands with soap and water after handling the packaging, only 3.3 (n=1) washed their hands for 20 seconds or more. None of the subjects who washed their hands after handling chicken quarter packaging washed their hands for the recommended time.

After seasoning the chicken quarters, 23.3% of participants always washed their hands, 16.7% washed their hands very often, 3.3 seldom washed their hands, 13.3% rinsed their hands with water or did not wash their hands at all, and 43.3% did not touch poultry to season or did not season the chicken quarter. For the turkey patties, 12 participants always washed their hands, 11 washed their hands very often, 3 seldom washed their hands, and 4 of the participants rinsed their

hands with only water or never washed their hands after seasoning. Of the participants who washed their hands with soap and water when seasoning the chicken quarter and ground turkey, only 1 of the participants washed their hands for 20 seconds or more.

Twenty-one and 23 of the participants, respectively, always washed their hands or washed their hands very often with soap and water after handling the raw chicken quarters and the ground turkey. Two of the participants washed their hands for 20 seconds or more after handling the chicken quarter, and five participants washed their hands for 20 seconds or more after handling the ground turkey.

Cross Contamination

About 17% of the participants (n=5) washed the chicken quarter before preparing it for the grill. Over half of the participants contaminated items in their kitchen, such as seasoning bottles, countertops, cabinet handles, and utensils, when preparing both the chicken quarter (n=17) and the turkey patties (n=20). Twenty-three percent and 20% of participants, respectively, used a different or clean set of utensils to remove the chicken quarter and turkey patties from the grill. The majority of the participants (96.7%) used a different or clean dish to place the cooked poultry on after removing from the grill.

Table 3-1: Frequency of handwashing events at certain handwashing situations and cross-contamination behaviors (n=30).

Handwashing		Chicken Quarters		Turkey Patties	
		N	%	N	%
Initial Handwashing	Never/Rinsed hands with only water	5	16.7	14	46.7
	Washed hands with soap for ≥ 20 s	2	6.7	0	0.0
	Washed hands with soap for ≤ 20 s	23	76.7	16	53.3
After Handling Poultry Packaging	Never/Rinsed hands with only water	20	66.7	21	70.0
	Washed hands with soap for ≥ 20 s	0	0.0	1	3.3
	Washed hands with soap for ≤ 20 s	10	33.3	8	26.7
After Seasoning Poultry	Did not season/Did not touch poultry to season	13	43.3	9	30.0
	Never/Rinsed hands with only water	4	13.3	5	16.7
	Seldom	1	3.3	1	3.3
	Very Often	5	16.7	7	23.3
	Always	7	23.3	8	26.7
	Washed hands with soap for ≥ 20 s	1	3.3	1	3.3
	Washed hands with soap for ≤ 20 s	12	40.0	15	50.0
After Handling Poultry	Never/Rinsed hands with only water	5	16.7	4	13.3
	Seldom	4	13.3	3	10.0
	Very Often	10	33.3	11	36.7
	Always	11	36.7	12	40.0
	Washed hands with soap for ≥ 20 s	2	6.7	5	16.7
	Washed hands with soap for ≤ 20 s	23	76.7	21	70.0
Cross-Contamination					
	Rinsed raw chicken before preparation	5	16.7	N/A	N/A
	Contaminated items in the kitchen	17	56.7	20	66.7
	Used different or clean utensils to remove poultry from the grill	7	23.3	6	20.0
	Used different or clean dishes to remove poultry from the grill	29	96.7	27	90.0

Determination of Doneness

As shown in Figure 2, the participants used a variety of methods to determine the doneness of the poultry products. For the chicken quarters and turkey patties, looking at the color of the meat was the most used method to determine if the product was “done” or fully cooked (n = 28; 30), followed by piercing or cutting open the poultry (n= 20; 12), then using a thermometer (n= 15; 12). Forty-three percent and 33.3% of the participants, respectively, touched the chicken quarter or the turkey patty to test firmness, and 26.7% and 16.7% relied on time or used cooking time from a recipe as an indicator of doneness. Thirteen percent of the participants tasted the turkey patties to check if they were done and 13.3% checked that the juices ran clear to determine if the chicken quarter was done.

All participants who used a thermometer to ensure doneness of the chicken quarter used the thermometer properly by inserting the probe into the thickest part of the quarter. Of the participants who used a thermometer to check the doneness of the turkey patties (n=12), two participants correctly inserted the thermometer from the side of the patty and 10 participants inserted the thermometer from the top of the turkey patties.

Endpoint Temperature

As measured by the observer, 80% (n=24) of the chicken quarters were cooked to a safe internal temperature of 165°F or above and 20% (n=6) of the chicken quarters were cooked to a temperature below 165°F. For the turkey patties 40% (n=12) of the set of patties contained at least one patties that was cooked to a temperature below 165°F. Sixty percent of the set of patties contained patties that were all cooked to the proper temperature of 165°F or above. Of the patties

that were taken off the grill at the same time (n=25), three of the sets of patties contained patties that were cooked to the correct temperature and some that were not. Only two participants took the patties off the grill at two separate times.

Figure 3-1: Techniques used by participants to determine the doneness of the poultry products.

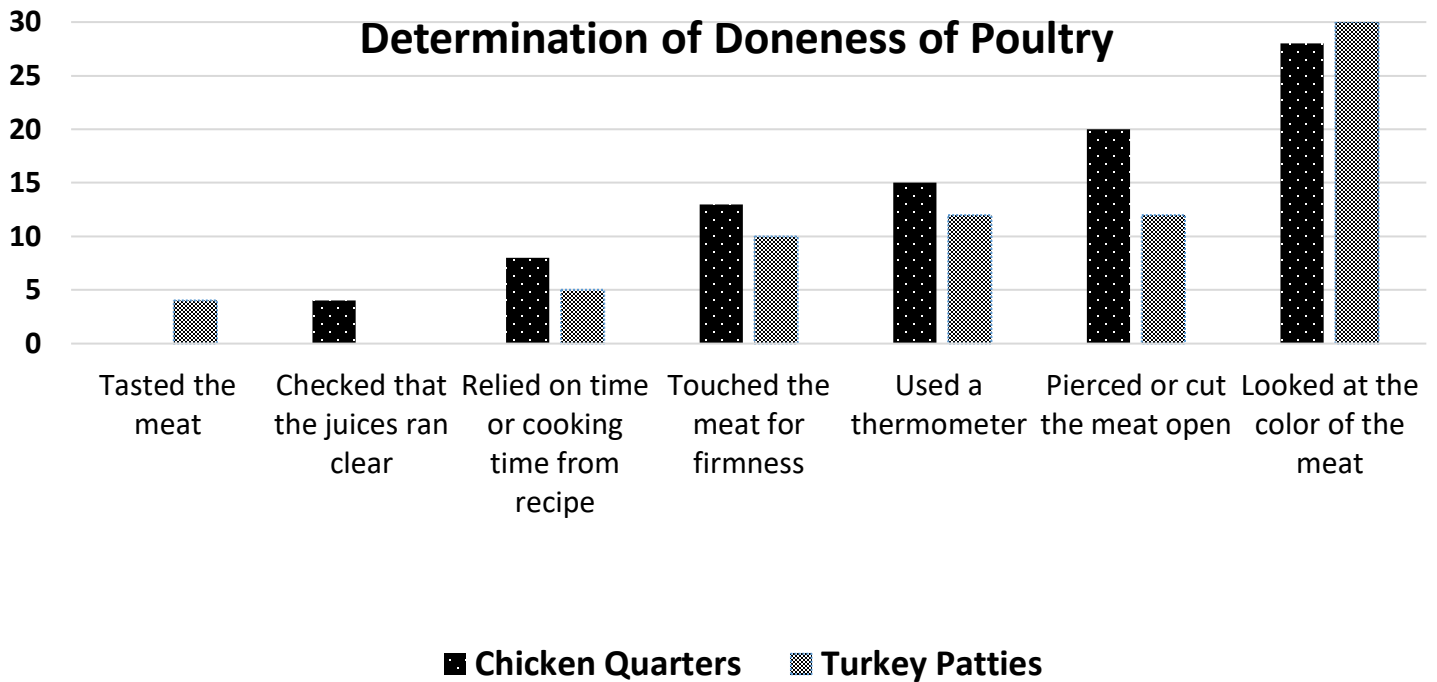


Table 3-2: Endpoint temperatures of the poultry products

Poultry	Endpoint Temperature	N	%
Chicken	Internal temperatures below 165°F	6	20
Quarters	Internal temperatures of 165°F or above	24	80
Turkey	One or more patties with internal temperature below 165°F	12	40
Patties	All patties with internal temperatures of 165°F or above	18	60

Discussion

The results of this study indicate that participants are not using safe food handling practices when grilling poultry. One sixth of the participants washed the chicken quarter before preparation, which the USDA deems as an unsafe practice. Washing poultry does not remove pathogens and can lead to the transfer of pathogens due to the splashing of contaminated water from the raw poultry on food or surfaces near the sink (Kosa et al. 2016, Everis and Betts 2003 and USDA 2013b).

Consistent with research from Sneed et al. (2015), Phang and Bruhn (2011), and Scott and Herbold (2010), proper hand washing was low among the participants. According to Fight BAC! guidelines, hand washing among the subjects in this study was inadequate in technique and duration (PFSE 2016). Consumers are advised to wash their hands with a cleaning agent for 20 seconds or more (USDA 2015), yet most participants either rinsed their hands with only water or washed their hands for less than 20 seconds. More subjects were observed washing their hands for 20 seconds or longer after handling the raw ground turkey. This can be attributed to subjects wanting to remove the turkey from their hands after forming the patties. Some participants did not wash their hands at all or wiped their hands on a dish towel or paper towel. Hand washing was especially low after handling the packaging. Microbiological testing has proved that pathogens such as Campylobacter and Salmonella are present on external packaging of retail

meats and poultry (Burgess et al. 2005). Because hands are a major vehicle for spreading harmful bacteria, it is very important to wash your hands thoroughly when handling raw poultry to reduce risk of foodborne illness. If not washed adequately and thoroughly, hands can still be contaminated with pathogens (De Jong et al. 2008).

Moreover, participants did not wash their hands directly after handling the raw poultry which resulted in cross contamination. Items that were contaminated by the participants included seasoning bottles, refrigerators, countertops, cabinet handles, door handles, dish towels, utensils, dishes, and trash cans. Consumers should be sure to sanitize all surfaces after preparation to prevent the transfer of pathogens.

Although nearly all the participants used a separate or clean dish to remove the poultry from the grill, many participants did not use separate or clean utensils. The USDA recommends that the consumers use separate utensils for raw and cooked meat. Using the same utensil for raw and cooked poultry could result in the transfer of bacteria to the cooked portion of the poultry. Once a utensil has been used on raw meat, it should be washed thoroughly before being used again on cooked meat (USDA 2016b).

Consistent with previous research (Maughan et al. 2016), participants used several techniques to determine the doneness of the poultry. Many participants used visual and textural indications such as looking at the color of the meat and cutting or piercing the meat. Examining the color and the appearance of meat to determine doneness is not safe as research has shown that meat that looks done could contain active cell of pathogens such as *Campylobacter* (Kennedy et al. 2011). The only way to ensure that poultry is fully cooked is to use a thermometer to check the doneness. More consumers used a thermometer to check the doneness of the chicken quarter than the turkey patties. This is consistent with previous research as studies have shown that

consumers are less likely to use a thermometer for smaller or thin such as burgers or patties (Maughan et al. 2016, USDA 2016, Kosa 2014, and Lando et al. 2012). While all participants used the thermometer correctly when checking the doneness of the chicken quarter, most participants incorrectly used the thermometer to ensure the doneness of the turkey patties. For turkey patties or burgers, the thermometer probe needs to be inserted into the side of patty to guarantee that the internal temperature throughout the patty has reached 165°F (USDA 2013a). Twenty percent of the chicken quarters and 40% of the turkey patty sets were not cooked to the correct temperature of 165°F, which is concerning. Of the participants who used a thermometer to check the doneness of the chicken quarters, only one of the chicken quarters was still not cooked to the proper temperature. This suggest that either the thermometer was malfunctioned or that the consumer did not know the proper endpoint temperature of poultry. Twelve sets of the turkey patties had at least one patty that did not reach a temperature of 165°F or above. This could be due to hot spots or unevenness of heat on the grill or consumers not checking the temperature of all patties, which was witnessed in 3 of the observations. For all other instances, color, appearance, texture, and time did not correctly determine if the chicken quarters or turkey patties were fully cooked.

Limitations of this study include a sample size and a lack of a representative sample. The finding of this study lacks the ability to be generalized to the grilling population. The subjectivity of the observer can also pose as a limitation. More observations will need to be conducted to provide validity of this research.

Finding of this research demonstrates that further education among consumers is needed. Efforts should focus on proper handwashing procedures and the risk of bacterial contamination when preparing poultry, especially after handling the external packaging of raw poultry product.

Education should also focus on the importance of using a thermometer to check the doneness of all poultry products and how to accurately use the thermometer to ensure poultry is fully cooked.

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Chapter 4 - Assessment of Determination of Doneness of Poultry

Grilling Recipes

Abstract

Research has shown that consumers use unsafe food handling practices when preparing poultry in the home, which can increase the risk of foodborne illness, such as Salmonellosis or Campylobacteriosis. Cookbooks and recipes are sources consumers use to obtain food safety information. Because consumers are grilling more frequently, it is vital that research pertaining to grilling be conducted. The objective of this study was to assess poultry grilling recipes to determine if food safety information concerning thermometer use was included within the recipe. Poultry grilling recipes (n=242) were collected from 53 cookbooks, 15 magazines, 12 websites, and 7 blogs. Forty-two percent of the recipes contained a specific temperature of doneness and only 51% of those recipes provided the correct internal temperature of 165°F, as recommended by the United States Department of Agriculture. About one third of the recipes specifically instructed consumers to use a thermometer to determine the doneness of the poultry. Ninety-five percent of recipes used cooking time as an indicator of doneness and over half of the recipes used visual measurements, such as color, to determine the doneness. The finding of this study showed that most recipes do not contain much food safety information within the recipe. Modifying recipes by adding food safety information could increase the use of proper food handling behaviors by consumers.

Introduction

Foodborne illness continues to be a major public health burden, causing significant morbidity and mortality at the national and global level (WHO 2015). In the United States alone, 48 million people are affected by foodborne illness annually (CDC 2016). Two of the most common causes of foodborne illnesses are Salmonella and Campylobacter, which are associated with raw and undercooked poultry (CDC 2016). Salmonellosis and Campylobacteriosis, combined, account for 1.8 million of foodborne infections in the United States (CDC 2016).

Many foodborne infections in the United States occur from improper food handling practices in the home (Byrd-Bredbenner et al. 2013). According to Healthy People 2020, cooking foods to a safe internal temperature is an area needing the most improvement among consumers (USDHHS 2010). Temperature plays an important role in the safety of foods, especially in poultry. The United States Department of Agriculture (USDA) recommends that all poultry, whole, pieces, and ground, be cooked to a minimum internal temperature of 165°F (USDA 2015a). Although consumers are aware that the greatest risk of foodborne infections is from undercooked foods, they continue not to use thermometers to determine doneness because of lack of knowledge or inconvenience (ADA and ConAgra Foods 2013, Fein et al. 2011, Kosa et al. 2014, Lando and Chen 2012). Alternatively, consumers use subjective measures, such as appearance, to determine the doneness of foods, which is unsafe (Kosa et al. 2014, USDA 2015b and Maughan 2016). Research has shown that there is a need to improve food-handling practices among consumers (Kosa et al 2016). Consumers obtain food safety information from many sources such as cookbooks, government publications, food labels, television, and health professionals (Maughan 2016, Godwin and Stone 2014, Kornelis et al. 2007, and Whatley et al. 2005). While cookbooks and recipes can be sources for cooking information for consumers, food safety information is not

prevalent within most recipes (Godwin et al 2016 and Griffith and others 1994). In the United States, grilling, or barbecuing, is a summertime tradition for many Americans. Chicken is one of the most common foods that consumers prepare on the grill (HPBA 2016). More consumers are starting to grill in the off-season or in the winter months. A survey conducted by Terry et al. (2017) found that 66% of consumers grill year-round. Research concerning food safety grilling information has not been thoroughly investigated. The objective of this study was to evaluate poultry grilling recipes based on the inclusion of temperature information, determination of doneness methods, and other food safety information.

Methods

Recipes that called for grilling poultry, chicken or turkey, with an outdoor grill were analyzed. Recipes from multiple sources, both online and in print were selected for analysis. The recipes were obtained from cookbooks, magazines (in print and online), websites, and blogs (personal and professional). Sources in print were found at the local public library or provided by friends and family. Online sources were found by searching “grilling poultry recipes” in the Google search engine. No more than three recipes were selected from one source.

Recipe Selection and Analysis

To gather recipes from cookbooks and magazines in print, the number of grilled poultry recipes were counted from the index. The term “grilled” was used to search for recipes in the index of printed sources. For sources with more than three poultry grilling recipes, a random number generator (random.org) was used to generate three numbers from one to the number of recipes that were in the source. The numbers generated were used to select the recipes in the order of which they were presented in the source. For example, if there were fifteen poultry grilling recipes in a cookbook, the number generator would produce three numbers from one to fifteen. If

the numbers generated were 2, 5, and 9, then the 2nd, 5th, and 9th recipes were selected for analysis. For online recipes or if an index was not available, the first three poultry grilling recipes that were viewed within the source were selected.

A checklist, Appendix C, was created to evaluate all recipes uniformly. Recipes were analyzed based on temperature information and determinants of doneness of the poultry specified within the recipe. Recipes were also assessed on correct thermometer usage. Any additional food safety information that was included in the recipe was also noted.

Results

In total, 242 recipes were analyzed from 87 sources. There were 208 chicken recipes and 34 turkey recipes. Recipes were collected from 53 cookbooks, 15 magazines (print and online), 12 websites, and 7 blogs. As shown in Table 4-1, more recipes were collected from print sources (n=59) than from online sources (n=28). The majority of the recipes collected were published after the year 2000.

Of the 242 recipes analyzed, 42% of the recipes had a specified endpoint temperature within the recipe and 51% of those recipes specified a correct temperature of 165°F, as seen in Table 4-2.

Nine percent, 8%, and 16% of the recipes that listed a specific temperature, respectively, instructed consumers to grill the poultry until the internal temperature reached 160°F, 175°F, and 180°F. About 26% of the recipes specified other temperatures and 9% had more than one temperature listed within the recipe.

To determine the doneness of the poultry, a little more than one third (n=84) of the recipes specifically instructed consumers to use a thermometer. Twenty-two percent (n=53) of the recipes indicated when to insert the thermometer into the poultry. The majority (83%) of those

recipes only instructed consumers to insert the thermometer at the end to check doneness and 15% (n=8) instructed to use the thermometer after a certain time and at the end of cooking. Fifty of the recipes specified where to insert the thermometer. Half (n=25) of the recipes provided a correct recommendation for location, 42% provided a partially correct location, and 8% provided an incorrect location.

Table 4-1: Sources of recipes used in the study

Source	Type	No. of Recipes	Type of Poultry		Year			
			Chicken	Turkey	1990-2000	2001-2010	2011-2016	No Year Available
Total		242	208	34	26	93	82	41
Print	Cookbooks	151	126	25	26	85	40	0
	Magazines	14	11	3	0	3	11	0
Internet	Websites	38	36	2	0	2	6	30
	Magazines	20	19	1	0	3	13	4
	Blogs	19	16	3	0	0	12	7

Table 4-2: Specified temperatures of doneness within the recipe

Temperature (°F)	N	%
No temperature specified	141	58.3
150	0	0.0
160	6	2.5
165	48	19.8
175	5	2.1
180	12	5.0
Other Temperatures	21	8.7
Multiple Temperatures	9	3.7
Total	242	100

Table 4-3: Specified temperatures of doneness within the recipe that contain more than one temperature

Temperature (°F)	N
150	0
160	3
165	3
175	3
180	4
Other Temperatures	4

Table 4-4: Number and percentage of recipes that included indicators of doneness (n=242)

Indicators of Doneness	N	%
Specified a temperature of doneness	101	42
Correct Temperature of Doneness	52	21
Specifically asked to use a thermometer	84	35
Specified when to use the thermometer	53	22
Specified the correct location to insert thermometer	25	10
Specified cooking time	230	95
Specified an outside color for determination of doneness	83	34
Asked to cut into or look at the inside of poultry	8	3
Specified to cook until the juices run clear	39	16
Included additional food safety information	26	11

Discussion

The results of this study concluded that most poultry grilling recipes do not contain temperature information or any additional food safety information. Many of the recipes relied on time and/or subjective measurements, such as appearance and color, to determine the doneness of the poultry rather than using a thermometer. The only way to ensure that poultry has been cooked to a safe internal temperature is by using a thermometer (USDA 2015). Using visual indicators to determine the doneness of poultry is an unsafe practice as it can result in undercooked poultry (Maughan et al. 2016); thus, increasing the risk of being infected by a foodborne illness. A study conducted by Kennedy et al. (2011) revealed chicken that was considered “done” by visual inspection of consumers was undercooked and contained active *Campylobacter jejuni* cells. About half of the recipes that specified a temperature provided the correct internal endpoint temperature of 165°F, based on USDA recommendations. Twenty-four percent of the recipes provided a temperature above 165°F, which although safe, could result in dry, overcooked poultry that may not be to the liking of the consumer. Recipes that provided partially correct thermometer locations often did not specify to insert the thermometer into the thickest part of the poultry or not to let the thermometer touch the bone. Being knowledgeable about the proper placement of a thermometer is very important. If the thermometer is inserted into the wrong location, the temperature readings will be inaccurate (USDA 2011).

The analysis of the recipes showed that consumers are not receiving the proper food safety information within recipes for preparing poultry on an outdoor grill. Although many of the cookbooks contained some food safety information, such as endpoint temperatures of poultry and other meats in the introduction or appendix of the book, it is not guaranteed that consumers will be aware of that information if they are not reading the whole book. Food safety information

should be added within the recipes to alter food safety behaviors of consumers. Research by Maughan et al. (2016) demonstrated that the addition of food safety instructions within a recipe greatly improved the food handling behaviors of consumers. The modification of recipes with the addition of food safety education could better the food-handling practices and increase thermometer use among consumers.

To further research, recipes should be tested to determine if the instructions given in the recipe would result in poultry that has been cooked to a safe internal temperature of 165°F. Microbial testing could also be conducted to ensure that poultry is safe to eat based on the instructions given in the recipe.

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Chapter 5 - Summary

Many cases of foodborne illness are the result of risky food handling behaviors. Following safe food handling practices is essential to preventing foodborne illnesses. The objectives of this research were to evaluate the food handling behaviors of consumers who grill outdoors through survey and observation and to assess poultry grilling recipes for food safety information.

To evaluate the food handling behaviors of consumers, quantitative and qualitative methods were used in this research. Using this approach in methodology allowed for the analysis of what consumers say they do and what consumers actually do when preparing food on an outdoor grill. Based on the findings of this research, the results of the survey and observations were similar in some respects. For example, both studies showed that majority of consumers used a variety of techniques to determine the doneness of meat and poultry with the most common methods being looking at the color of the meat or poultry, cutting open or piercing the meat or poultry, and using a thermometer. Additionally, in both studies, nearly all consumers used a clean plate or dish to remove the meat or poultry from the grill. This research illustrated that there were few discrepancies between what consumers say they do and what consumers actually do. The next steps to continue this research would be to conduct more observations to gain an ethnically diverse sample set to accurately represent the population in the United States. Observations in other cities should also be conducted to see if there is a difference in food handling behaviors in different regions in the U.S.

To assess poultry grilling recipes for food safety information, convenience sampling was used. This approach was used to mimic how consumers find recipes. Consumers find recipes that are accessible to them, whether they find the recipe online, in a magazine, or get them from friends and family. Although the findings of this study found more recipes with food safety information

than in previous studies, there is still a lack of food safety information within recipes. Authors and publishers of recipes should be cognizant of the determinants of doneness used within the recipe. The absence of the appropriate food safety information could result in consumers becoming sick because of foodborne illness. A recommendation to further this research would be to test the recipes that do not have a specified temperature to determine if the recipe would result in poultry that is safe to consume.

Overall, this research has shown that food safety education is needed, not only among consumers but among authors of recipe publications as well. Educational efforts should focus on thermometer use and how to reduce cross contamination when preparing raw meat or poultry.

Appendix A - Grilling Screener and Survey (Chapter 2)

Grilling Survey

Screener

Intro Thank you for participating in this survey. This survey asks about how you handle and prepare food items. The survey will take approximately 10-15 minutes to complete. Your participation in this study is completely voluntary. There are no risks associated with this survey. However, if you feel uncomfortable answering any questions, you can withdraw at any time. All of your responses will be kept confidential.

Page Break

Q1 What is your age?

- 17 or under (1)
- 18-35 (2)
- 36-64 (3)
- 65 and older (4)

Skip To: End of Block If What is your age? = 17 or under

Q2 What is your gender?

Male (1)

Female (2)

Page Break

Q3 Have you grilled meat or poultry on an outdoor grill in approximately the past 6-8 months?

Yes (1)

No (2)

Skip To: End of Block If Have you grilled meat or poultry on an outdoor grill in approximately the past 6-8 months? = No

Page Break

Q4 Thinking about the last time you prepared food on an outside grill, which of the following did you grill?

Beef (1)

Lamb (2)

Pork (3)

Turkey (4)

Veal (5)

Chicken (6)

Duck (7)

Q5 In which state do you currently reside?

▼ Alabama (1) ... I do not reside in the United States (53)

Page Break

Survey

QA In this survey, grilling is defined as "using an outdoor cooking apparatus that uses direct heat or fire to cook food in an OUTSIDE environment". Thinking about the last time you grilled meat/poultry on an outdoor grill, answer the following questions.

Page Break

Q1 What type of outdoor grill did you use the last time you grilled meat/poultry?

- Liquid Propane Grill (1)
 - Natural Gas Grill (2)
 - Charcoal Grill (3)
 - Electric Grill (4)
 - Ceramic Grill (5)
-

Q2 Where did you grill the last time you grilled meat or poultry?

- Tailgating (1)
 - Campground/camping (2)
 - Primary residence (3)
 - Secondary/Vacation Residence (4)
 - Other: Please Specify (5) _____
-

Q3 Which of the following statements best describes the grilling area at the last place you grilled meat or poultry?

- A grill with no side shelves or surface area to place plates or utensils. (1)
 - A grill with side shelves or a surface area to place plates or utensils. (2)
 - A grill with an outdoor kitchen with countertops. (3)
 - A grill with an outdoor kitchen with countertops and a sink. (4)
-

Q4 What type of lighting was used in the grilling area the last time you grilled meat/poultry?

- Natural sunlight (1)
 - Porch or patio lighting (2)
 - Flood or electric light/lamp (3)
 - Flashlight or lantern (4)
 - It was reasonably dark, but I did not use a light. (5)
 - Other: Please Specify (6) _____
-

Q5 Who purchased the food for the outdoor grill?

- I did (1)
- Someone else in the household (2)
- Someone else (3)

Skip To: Q8 If Who purchased the food for the outdoor grill? = Someone else in the household

Skip To: Q8 If Who purchased the food for the outdoor grill? = Someone else

Q6 Did you put your meat/poultry in one of the bags provided in the meat section of the store where you purchased your meat/poultry?

- Yes (1)
 - No (2)
 - I don't remember (3)
-

Q7 Was the meat/poultry bagged separately from other foods at the checkout counter?

- Yes (1)
 - No (2)
 - I don't remember (3)
-

Q8 How many people were you grilling for the last time you grilled?

- 1-2 people (1)
 - 3-4 people (2)
 - 5-6 people (3)
 - 7 or more people (4)
-

Page Break

Q9 Again, thinking about the last time you prepared meat or poultry on an outside grill, which of the following did you grill?

- Beef (1)
 - Lamb or sheep (2)
 - Pork (3)
 - Turkey (4)
 - Veal (5)
 - Chicken (6)
 - Duck or other birds (7)
 - Other meat: Please Specify (8)
-

Skip To: End of Block If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Beef

Skip To: End of Block If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Lamb or sheep

Skip To: End of Block If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Pork

Skip To: End of Block If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Other meat: Please Specify

Skip To: End of Block If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Veal

Display This Question:

If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Beef

Q9a What specific piece of beef did you prepare on the grill?

- Beef Brisket (1)
- Beef Ribs (2)
- Beef Steaks (3)
- Beef Roast (4)
- Beef Sirloin, loin, or tenderloins (5)
- Ground Beef (6)
- Other: Please Specify (7) _____

Display This Question:

If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Lamb or sheep

Q9b What specific piece of lamb or sheep did you prepare on the grill?

- Lamb steak or chops (1)
- Lamb Roast (2)
- Lamb Loin, sirloin, or tenderloin (3)
- Lamb Ribs (4)
- Lamb pieces such as breast or leg (5)
- Ground Lamb (6)
- Whole Lamb or Sheep (7)
- Other: Please Specify (8) _____

Display This Question:

If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Pork

Q9c What specific piece of pork did you prepare on the grill?

- Pork Ribs (1)
 - Pork Shoulder (2)
 - Pork chops or steak (3)
 - Pork Roast (4)
 - Ham (5)
 - Ground Pork (6)
 - Whole Pig (7)
 - Other: Please Specify (8) _____
-

Display This Question:

If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Turkey

Q9d What specific piece of turkey did you prepare on the grill?

- Whole Turkey (1)
 - Turkey parts such as breasts, thighs, wings, or legs (2)
 - Ground Turkey (3)
 - Other: Please Specify (4) _____
-

Display This Question:

If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Veal

Q9e What specific piece of veal did you prepare on the grill?

- Veal Ribs (1)
- Veal parts such as breasts or legs (2)
- Veal sirloin or loin (3)
- Veal Shoulder (4)
- Ground Veal (5)
- Other: Please Specify (6) _____

Display This Question:

If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Chicken

Q9f What specific piece of chicken did you prepare on the grill?

- Whole Chicken (1)
- Chicken parts such as breasts, thighs, wings, or legs (2)
- Ground Chicken (3)
- Other: Please Specify (4) _____

Display This Question:

If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Duck or other birds

Q9g What specific piece of duck or bird did you prepare on the grill?

- Whole Bird (1)
- Bird parts such as breasts, thighs, wings, or legs (2)
- Ground bird meat (3)

Display This Question:

If Again, thinking about the last time you prepared meat or poultry on an outside grill, which of th... = Other meat: Please Specify

Q9h What specific piece of meat did you prepare on the grill?

- Ribs (1)
- Steaks (2)
- Roast (3)
- Whole Animal (4)
- Ground (5)
- Other: Please Specify (6) _____

Q10 Did you have to thaw the meat/poultry you prepared on the grill?

- Yes (1)
- No, I cooked it frozen (2)
- No, it was not frozen (3)

Skip To: Q16 If Did you have to thaw the meat/poultry you prepared on the grill? = No, I cooked it frozen

Skip To: Q15 If Did you have to thaw the meat/poultry you prepared on the grill? = No, it was not frozen

Q11 How did you thaw the meat/poultry for grilling?

- Thawed on the countertop (1)
- Thawed in the refrigerator (2)
- Thawed with cold water that was changed often (3)
- Thawed with cold water that was rarely or never changed (4)
- Thawed in warm or hot water (5)
- Thawed in a microwave oven (6)
- Other: Please Specify (7) _____

Display This Question:

If How did you thaw the meat/poultry for grilling? = Thawed in the refrigerator

Q12 Where was the meat/poultry placed in the refrigerator?

- Top Shelf (1)
- A Middle Shelf (2)
- Bottom Shelf (3)
- A drawer (4)

Display This Question:

If How did you thaw the meat/poultry for grilling? != Thawed in the refrigerator

Q13 Did you place the meat or poultry in the refrigerator after thawing?

- No, I cooked it immediately. (1)
- No, I left it out until I cooked it. (2)
- Yes (3)

Skip To: Q16 If Did you place the meat or poultry in the refrigerator after thawing? = No, I cooked it immediately.

Skip To: Q12 If Did you place the meat or poultry in the refrigerator after thawing? = Yes

Display This Question:

If Did you place the meat or poultry in the refrigerator after thawing? = Yes

Q14 Where was the meat/poultry placed in the refrigerator after thawing?

- Top Shelf (1)
 - A Middle Shelf (2)
 - Bottom Shelf (3)
 - A drawer (4)
-

Q15 How long did you leave the meat or poultry out (not refrigerated or frozen) before you cooked it?

- Less than 30 minutes (1)
 - 31 minutes to an hour (2)
 - longer than 1 hour but less than 2 hours (3)
 - 2 to 4 hours (4)
 - more than 4 hours (5)
-

Page Break

Q16 Did you wash or rinse the meat/poultry before grilling?

- Yes (1)
 - No (2)
 - No, I used ground meat (3)
-

Q17 Did you use a cutting board or other surface to cut or prepare the raw meat/poultry?

- Yes (1)
- No (2)

Skip To: Q19 If Did you use a cutting board or other surface to cut or prepare the raw meat/poultry? = No

Q18 After cutting or preparing the raw meat/poultry what was the **next** thing you did with the cutting board?

- Continued to use it as is to prepare other food (1)
 - Rinsed or wiped it with water to clean it before using it again or storing it (2)
 - Washed it with soap and water to clean it before using it again or storing it (3)
 - Washed it with bleach or disinfectant to clean it before using it again or storing it (4)
 - Put it in the dishwasher to clean it before using it again or storing it (5)
 - Other: Please Specify (6) _____
-

Q19 Did you marinate or season the raw meat/poultry before grilling?

- Yes, I marinated the raw meat/poultry (1)
- Yes, I seasoned the raw meat/poultry (2)
- Yes, I seasoned and marinated the raw meat/poultry (3)
- No, I did not season or marinate the raw meat/poultry (4)

Skip To: Q24 If Did you marinate or season the raw meat/poultry before grilling? = No, I did not season or marinate the raw meat/poultry

Skip To: Q22 If Did you marinate or season the raw meat/poultry before grilling? = Yes, I seasoned the raw meat/poultry

Q20 After marinating the raw meat/poultry, what did you do with the excess marinade?

- Discarded excess marinade (1)
- Reused marinade (2)
- I did not have excess marinade (3)

Skip To: Q22 If After marinating the raw meat/poultry, what did you do with the excess marinade? = Discarded excess marinade

Skip To: Q22 If After marinating the raw meat/poultry, what did you do with the excess marinade? = I did not have excess marinade

Q21 How did you reuse the excess marinade?

- Boiled the marinade and used it on cooked meat/poultry (1)
 - Heated the marinade, but did not boil it, and used it on cooked meat/poultry or other foods as a sauce or dressing. (2)
 - Used the marinade as part of an uncooked sauce or dressing on other food (3)
 - Other: Please Specify (4) _____
-

Q22 Did you let the raw meat/poultry rest or marinate after seasoning or marinating?

- Yes, I let the raw meat/poultry rest or marinate on the counter. (1)
- Yes, I let the raw meat/poultry rest or marinate in the refrigerator. (2)
- No, I did not let the raw meat/poultry rest. (3)

Skip To: Q24 If Did you let the raw meat/poultry rest or marinate after seasoning or marinating? = Yes, I let the raw meat/poultry rest or marinate in the refrigerator.

Skip To: Q24 If Did you let the raw meat/poultry rest or marinate after seasoning or marinating? = No, I did not let the raw meat/poultry rest.

Display This Question:

If Did you let the raw meat/poultry rest or marinate after seasoning or marinating? = Yes, I let the raw meat/poultry rest or marinate on the counter.

Q23 How long did you let the raw meat/poultry rest or marinate on the countertop?

- Less than 30 minutes (1)
- 31 minutes to 1 hour (2)
- Longer than 1 hour but less than 2 hours (3)
- 2 to 4 hours (4)
- More than 4 hours (5)

Page Break

Q24 There are many times that food is handled during grilling and preparing for grilling. Please check how the raw meat/poultry was handled (touched) during each of the following times on the last occasion you grilled meat/poultry.

	Hands (bare) (1)	Fork/Spoon/Utensils (2)	Gloves on hands (3)	Other (4)	Did not do (5)
Opening package (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thawing (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Seasoning/marinating (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Putting on a plate/tray before grilling (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Putting on the grill (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Turning or moving on the grill (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Removing from the grill (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

QB Some people are obsessive cleaners and others are not. To put your other answers in context we need to know what kind of person you are and **what you really do, not what you think you should do**. Thus, we would like to know more about your cleaning habits while grilling or preparing the food for grilling. For the following questions, please tell us more about what you clean, or if you clean, during the grilling process.

Page Break

Q25 Did you clean the grates on your outdoor grill prior to grilling the meat?

- Yes (1)
- No (2)

Skip To: Q28 If Did you clean the grates on your outdoor grill prior to grilling the meat? = No

Page Break

Q26 How did you clean the grates on the grill prior to grilling?

- Cleaned without water or cleaner (1)
 - Rinsed grates with water. (2)
 - Cleaned grates with water and cleaner or a special formulated cleaner (3)
 - Other: Please Specify (4) _____
-

Q27 Did you use a grill brush or other sturdy utensil on the grill gates during the cleaning process?

Yes (1)

No (2)

Page Break

Q28 Did you clean and, if so, how did you clean your hands, utensils, or gloves immediately after you touched the meat/poultry at each situation?

	Did not Clean (1)	Wiped with disposable towel (2)	Wiped with reusable towel (3)	Washed with soap & water (4)	Did not do the choices given (5)
Opening package (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thawing (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Seasoning/marinating (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Putting on plate/tray before grilling (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Putting on the grill (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Turning or moving on the grill (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Removing from the grill (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Page Break

Q29 Did you clean the grates of the grill after grilling?

Yes (1)

No (2)

Q30 Did you clean the outside of the grill such as the handles and side shelves after grilling?

Yes (1)

No (2)

Page Break

QC Cooking the Meat

Now we have some questions about how you grill the meat, determine whether it is done, and how happy you are with your success.

Page Break

Q31 After putting the meat on the grill, what did you do with the dishes and utensils used to prepare and handle the raw meat?

- Continued to use as is to prepare other food (1)
 - Rinsed or wiped it with water (2)
 - Washed it with soap and water (3)
 - Washed it with bleach or disinfectant (4)
 - Put it in the dishwasher (5)
 - Rinsed or wiped it and put it in the dishwasher (6)
 - Washed it with bleach or disinfectant and put it in the dishwasher (7)
 - Other: Please Specify (8) _____
-

Q32 Check any factors that may have affected the methods you used to grill the meat/poultry.

- Weather changes (1)
- Running out of gas for the grill or an electrical outage (2)
- Not having the right utensil that you wanted to use (3)
- Other: Please Specify (4) _____
- I did not have any problems. (5)

Q33 Approximately, how long was the cooking time of the meat/poultry?

- 5-25 minutes (1)
 - 26-45 minutes (2)
 - 46-59 minutes (3)
 - 60-90 minutes (4)
 - 90 or more minutes (5)
-

Q34 How did you know that the meat was done and ready to eat? [Choose all that apply]

Looked at the color of the meat (2)

Touched the meat for firmness (3)

Checked that the juices ran clear (4)

Tasted the meat (5)

Relied on cooking time from recipe (6)

Cut the meat open (7)

Used a thermometer (1)

Other: Please Specify (8) _____

Page Break

Display This Question:

If How did you know that the meat was done and ready to eat? [Choose all that apply] = Looked at the color of the meat

Q35 When you looked at the color of the meat, how did you know it was done?

- The meat still had some pink color and was moist (1)
 - The meat was brown throughout and was moist (2)
 - The meat was brown throughout and was not moist (3)
 - Other: Please Specify (4) _____
-

Q36 Do you check a few pieces to check for doneness of the entire batch on the grill or do you check every piece for doneness.

- I check a few pieces because that way I can judge the other pieces (1)
 - I check every piece because everyone wants something different (2)
 - I check every piece because I want to be sure they are all the same. (3)
 - I only grilled one piece of meat/poultry (4)
-

Q37 Was all the meat you cooked supposed to be cooked to the same level of doneness?

- Yes (1)
 - No (2)
-

Q38 Were you happy with the doneness of each piece of meat after grilling?

- Yes everything was cooked just right. (1)
 - No, some were undercooked (2)
 - No, some were overcooked (3)
 - No, some were overcooked and some was undercooked (4)
-

Q39 How did you transfer the cooked meat from the outdoor grill to the kitchen?

- Transferred cooked meat with a clean plate, pan, or dish and utensils (1)
 - Transferred cooked meat with the same plate, pan, or dish and utensils you used for the raw meat (2)
 - I did not transfer cooked meat/poultry to the kitchen. (3)
 - Other: Please Specify (4) _____
-

Q40 After grilling the meat, how long were leftovers sitting at room temperature before putting them in the refrigerator or freezer?

- Less than 30 minutes (1)
- 31 minutes to 1 hour (2)
- Longer than 1 hour but less than 2 hours (3)
- 2 to 4 hours (4)
- More than 4 hours (5)
- I did not have or store leftovers. (6)

Skip To: QD If After grilling the meat, how long were leftovers sitting at room temperature before putting them... = I did not have or store leftovers.

Q41 How long did you store the leftover meat in the refrigerator before it was eaten?

- Less than 1 day (1)
- 1-2 days (2)
- 3-4 days (3)
- 5-6 days (4)
- 7 or more days (5)
- Did not eat the leftovers and were disposed of (6)
- Leftovers were stored in freezer (7)

Page Break

QD Demographics

Please answer all of the following questions as they describe you.

Page Break

Q42 What was your total household income before taxes during the past 12 months?

- Less than \$25,000 (1)
 - \$25,000 to \$49,000 (2)
 - \$50,000 to \$99,000 (3)
 - \$100,000 or more (4)
-

Q43 What is your ethnicity?

- Caucasian (1)
 - African American (2)
 - Hispanic (3)
 - Asian (4)
 - Native American (5)
 - Other: Please Specify (6) _____
-

Q44 Which statement best describes the highest level of education you have completed?

- Some high school or less (1)
- High school graduate or GED (2)
- Some college (no degree) (3)
- Associate's degree (4)
- Bachelor's degree (5)
- Graduate or professional degree (6)
- Doctoral degree (7)

Q45 Which statement below best describes the role you have in purchasing groceries for your household?

- All of the purchasing (1)
- Most of the purchasing (2)
- Some of the purchasing (3)
- Very little of the purchasing (4)
- None of the purchasing (5)

Page Break

Q46 What type of outdoor grill(s) do you own? [Choose all that apply]

- Liquid Propane Grill (1)
- Natural Gas Grill (2)
- Charcoal Grill (3)
- Electric Grill (4)
- Ceramic Grill (5)

Q47 How often do you use your outdoor grill during the main grilling season for your area?

- Multiple times a week (1)
 - A few times a month (2)
 - Once a month (3)
 - Once every 2-3 months (4)
 - Never (5)
-

Q48 How often do you use your outdoor grill during the off season (months when people typically do not grill in your area)?

- Multiple times a week (1)
 - A few times a month (2)
 - Once a month (3)
 - Once every 2-3 months (4)
 - Never (5)
-

Q49 I use my grill all year long?

Yes (1)

No (2)

Q50 How would you rate your grilling skills?

Novice/Beginner (1)

Basic skills (2)

Average (3)

Better than average (4)

Expert (5)

End of Block: Survey

Appendix B - Observational Guide (Chapter 3)

Observational Study Checklist

Participant #: _____

Weather:

Date & Time: _____

Grilling Factors	
Type of Grill	
Liquid Propane Grill	<input type="checkbox"/>
Natural Gas Grill	<input type="checkbox"/>
Charcoal Grill	<input type="checkbox"/>
Electric Grill	<input type="checkbox"/>
Ceramic Grill	<input type="checkbox"/>
Grilling Area	
A grill with no side shelves or surface area to place plates or utensils.	<input type="checkbox"/>
A grill with side shelves or surface area to place plates or utensils.	<input type="checkbox"/>
A grill with an outdoor kitchen with countertops.	<input type="checkbox"/>
A grill with an outdoor kitchen with countertops and a sink.	<input type="checkbox"/>
Lighting	
Natural sunlight	<input type="checkbox"/>
Porch or patio lighting	<input type="checkbox"/>
Flood or electric lamp/light	<input type="checkbox"/>
Flashlight or lantern	<input type="checkbox"/>
Cleanliness	
Were the grill grates clean? (free of debris)	<input type="checkbox"/>
Were the grill handle and shelves clean? (free of debris)	<input type="checkbox"/>

Handwashing with soap?? ≥ 20 Secs??	Frequency	Chicken	Frequency	Turkey
	Washed hands before preparing/cooking	Yes No		Yes No
Washed hands after handling packaging	Yes No		Yes No	
Washed the <u>poultry</u> before preparing/cooking	Yes No			
Washed hands after seasoning raw poultry (if touched poultry with bare hands)	Always Very Often Seldom Never		Always Very Often Seldom Never	
Washed hands after handling raw poultry	Always Very Often Seldom Never		Always Very Often Seldom Never	
Preparation Cross Contamination				
Were items (seasoning containers, etc.) contaminated	Yes No		Yes No	
Grilling Cross Contamination				
Used a <u>different or clean utensil (fork, tongs)</u> to remove poultry on the grill	Yes No		Yes No	

Used a <u>different or clean plate</u> to remove poultry from the grill	Yes No		Yes No	
Determination of Doneness		Chicken		Turkey
Looked at the color of the meat		<input type="checkbox"/>		<input type="checkbox"/>
Touched the meat for firmness		<input type="checkbox"/>		<input type="checkbox"/>
Checked that the juices ran clear		<input type="checkbox"/>		<input type="checkbox"/>
Tasted the meat		<input type="checkbox"/>		<input type="checkbox"/>
Relied on cooking time from recipe		<input type="checkbox"/>		<input type="checkbox"/>
Cut the meat open (or pierced)		<input type="checkbox"/>		<input type="checkbox"/>
Used a thermometer	Chicken: insert thermometer into the thickest part of the thigh or leg	<input type="checkbox"/>	Turkey: insert thermometer from the side of the patty	<input type="checkbox"/>
Temperature of Poultry				
Final Temperature		_____°F		_____°F

Appendix C - Recipe Guide (Chapter 4)

Name of Recipe _____

Date Published _____

Publication Type _____

Page Number _____

Contact Info _____

1) What poultry species is the recipe for?

1 = chicken 2 = turkey

2) What part of the bird is the recipe using?

1= breast 2= leg 3=thigh 4=wing 5= drumstick 6= whole 7= ground patties

1 2 3 4 5 6 7

4) Is a temperature of doneness specified?

1= yes 2=no (skip to 5)

4a) What temperature does the recipe suggest?

1= 150° 2= 160° 3= 165° 4= 175° 5= 180° 6= other

4b) Does the recipe specifically ask them to use a thermometer?

1 = Yes 2 = No (skip to 5)

4c) Does the recipe tell them when to insert the thermometer?

1 = yes 2 = No (skip to 4e)

4d) When did the recipe say to put the thermometer in the poultry?

1 = before cooking 2 = after a certain time 3 – at end to check doneness

4e) Does the recipe tell them where to insert the thermometer?

1 = Yes 2 = No (skip to 5)

4f) Is the location a correct recommendation?

1 = Yes 2 = No 3 = Partially (explain if this is chosen)

5) Is a cooking time specified?

1 = Yes 2 = No

6) Does the recipe specify an outside color for determining doneness?

1 = Yes 2 = No

7) Does the recipe ask the person to cut into or look at the inside of the poultry?

1 = Yes 2 = No (skip to 8)

7a) Does the recipe ask the person to cut into the poultry to see how tender it is?

1 = Yes 2 = No

7b) Does the recipe specify an inside color for determining doneness?

1 = Yes 2 = No

7c) Does the recipe tell the person to cook until the juices run clear?

1 = Yes 2 = No

8) Does the recipe include any additional food safety information?

1 = yes 2 = no

If yes, what is it?