The Effect of a Basic Food Safety Intervention on Food Safety Knowledge in U.S. Young Adults: An Intervention Trial

by

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ABSTRACT

The true number of food borne illness occurrences that stem from the home is largely unknown, but researchers believe the number is much greater than represented in national data. The focus on food safety has generally been directed at food service establishments, which have made great strides at improving the methods of how their food is prepared. However, that same drive for proper food safety education is lacking in home kitchens, where the majority of food is prepared. Young adults are among some of the riskiest food preparers, and limited research and education methods have been tested on this vulnerable population. This study examined the effect of a basic food safety intervention on consumer food safety knowledge in young adults in the United States (U.S.) over a week period. The study had a pre/post survey design, where participants answered a survey, watched a short 10-minute video, and then recompleted the same survey a week later. Ninety-one participants age 18-29 years completed the initial food safety knowledge questionnaire. Twenty-six of those participants completed both the pre- and post-intervention food safety knowledge questionnaires. A paired t-test was used to analyze changes in questionnaire scores pre/post intervention. The majority of participants were female (78.9%), Arizona State University (ASU) students (78.0%), did not have any formal food safety education (58.2%), prepared a minimum of one meal per week from home (96.7%), and had completed 0-1 college nutrition courses (64.8%). The average overall score for all participants who completed the initial questionnaire was 62.6%. For those that took both the initial questionnaire and the follow up questionnaire (n=26), their scores shifted from 66.8% to 65.5% after the intervention. Scores increased

significantly only for one question post-intervention: 38.5% (n=10) to 53.8% (n=14) for the safest method for cooling a large pot of hot soup ($p = 0.050$). This was the first study of its kind to test a video intervention in attempts to increase food safety knowledge in young adults, and additional studies must be done to solidify the results of this study. Other means of education should be explored as well to determine the best way of reaching this population and others.

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CHAPTER 1

INTRODUCTION

It is estimated that one in every six Americans experience food borne illness each year, which leads to the hospitalization of at least 56,000 and the death of 1,300 (Byrd-Bredbenner, Berning, Martin-Biggers, & Quick, 2013; Scallan et al., 2011). Therefore, it is likely that everyone will experience food borne illness at least once in their life. Food borne illness outbreaks have been documented for decades, but substantial measures have only been taken in food service establishments to eliminate this nationwide issue. Although commercial establishments have made strides to reduce food borne illness and have been effective in doing so, education to the general public has lacked.

While experts have reached the consensus that far more food borne illness occurrences happen within the home than are reported, many consumers do not view their home as a risky place (Bryan, 1988; Byrd-Bredbenner et al., 2013; Byrd-Bredbenner, Maurer, Wheatley, Cottone, & Clancy, 2007a; Byrd-Bredbenner, Maurer, Wheatley, Cottone, & Clancy, 2007b; Food and Agriculture Organization of the United Nations & World Health Organization, 2002; Kennedy et al., 2005; Knabel, 1995; Maurer, Byrd-Bredbenner, Wheatley, Cottone, & Clancy, 2008; McArthur, Holbert, & Forsythe, 2006; Redmond & Griffith, 2009; Spittler, 2009; Worsfold & Griffin, 1997). Many consumers also report that they do not believe their current way of preparing food is problematic (Murray et al., 2017; Phang & Bruhn, 2011; Shapiro, Porticella, Jiang, & Gravani, 2011). If experts can help consumers understand the degree of power they have in their kitchens to prevent illness, behavior change can occur. Although there is a general consensus that

food safety knowledge is lacking in homes, limited studies have been published on food safety knowledge in this population.

Researchers have found that certain populations are more likely than others to engage in risky food handling behaviors. These populations include: young adults (ages 18 to 29 years), men, and individuals with education beyond high school (Abbot, Policastro, Bruhn, Schaffner, & Byrd-Bredbenner, 2012; Altekruse, Yang, Timbo, & Angulo, 1999; Fein, Jordon Lin, & Levy, 1995; Klontz, Timbo, Fein, & Levy, 1995; United States Department of Agriculture, Food Safety and Inspection Service, 1998; Williamson, Gravani, & Lawless, 1992). Although young adults are not typically an at-risk group unless immunocompromised or pregnant, it is vital that they know how to properly handle food. Many young adults currently, or will in the future, care for at risk groups such as infants, young children, and the elderly. Many individuals from this group also work, or will work, in the food service industry. Researchers hypothesize that young adults may engage in risky food handling practices because of a lack of food safety education, poor role models, and a lack of experience in the kitchen (Abbot et al., 2012; Altekruse, Street, Fein, & Levy,1996). Over the past few decades, school home economic classes have been cut from the curriculum. These courses taught students the basic food safety principles needed to prepare foods safely (Abbot et al., 2012; Beard, 1991; United States Department of Agriculture & Food and Drug Administration, 1998). Due to American families living more and more on-the-go, convenience foods are frequently relied upon. Consequently, this has reduced the amount of opportunities for children to learn safe food practices through observations at home. These missed educational

opportunities while growing up have left the majority of young adults lacking basic food safety fundamentals, as well as the knowledge required to defend themselves and their families against foodborne illness (Abbot et al., 2012; Altekruse, Yang, Timbo, & Angulo, 1999; Beard, 1991; Durant, 2002; Knabel, 1995; Partnership for Food Safety Education, 1998; United States Department of Agriculture and Food and Drug Administration, 1991; United States Department of Agriculture, Food Safety and Inspection Service, 2002; Williamson et al., 1992). Intervention programs can aid consumers in highlighting safety issues within their own kitchens.

Presently, there are only a few studies that have tested the food safety knowledge of young adults. Even fewer studies have tested an educational food safety intervention on this population. Considering that educational food safety interventions are most effective when the intervention is tailored to a specific population (Abbot et al., 2012; Altekruse et al., 1999; Medeiros, Hillers, Kendall, & Mason, 2001; Nayga, 1996), the researchers have customized an intervention to fit this populations specific needs. The present study tests the efficacy of an educational intervention for improving food safety knowledge. Participants in the study benefit from a possible increase in food safety knowledge, and experts benefit by testing new intervention methods that can later be shared.

PURPOSE OF THE STUDY

This study examined the effect of a basic food safety intervention on consumer food safety knowledge in U.S. young adults over a week period. The study had a pre/post

survey design, where participants answered a survey, watched a video, and then recompleted the same survey a week later.

HYPOTHESIS

H: A basic food safety intervention will improve consumer food safety knowledge in U.S. young adults after one week.

DEFINITIONS

- **Food Borne Illness:** Sickness caused by food contaminated with bacteria, viruses, parasites, or toxins. This study will focus on two of the most prevalent food borne diseases, Norovirus and *Salmonella* (United States Department of Agriculture, 2015a).
- **Food Safety:** Properly handling, preparing, and storing food, in ways that aim to prevent food borne illness (United States Department of Agriculture, 2015a).
- **Food Safety Knowledge:** The ability to define food borne illness, and comprehend what it means to properly handle, prepare, and store foods (United States Department of Health and Human Services, 2018).

DELIMITATIONS

- Limited to narrow response set
- Use of closed-ended responses in surveys rather than open-ended responses
- Study population: Healthy young adults, ages 18-29 years old

LIMITATIONS

- Use of a convenience sample
- Participants self-reported data via questionnaires
- Possible response bias due to participants guessing expected outcome
- Small sample size

CHAPTER 2

REVIEW OF LITERATURE

Introduction

The following literature review focuses on research relating to food borne illness in young adults. This review contains information about common food borne illnesses, food safety techniques, and food safety education methods. A few food borne pathogens are discussed, along with common misconceptions regarding food safety, ways to prevent food borne disease, and a review of previously tested food safety education methods. The goal of the literature review was to identify the latest research on food borne diseases and food safety, and pinpoint areas needing further research. This extensive review establishes that need for food safety knowledge testing and the need for alternative methods of educating young adults, leading to the development of this study. The current study testing a basic video intervention on food safety knowledge in young adults will add to the current research in food safety.

Food Borne Illness

Most common food borne illnesses in the United States. *Salmonella* spp. and Norovirus are two of the most prominent and deadly food borne diseases. From 1998 to 2008 in the United States, 9 to 15% of all reported food borne illness outbreaks were traced back to home kitchens, with over a third of these illnesses being linked to Norovirus and *Salmonella* (Byrd-Bredbenner et al., 2013; Gould et al., 2013). Painter et al. analyzed food borne illness outbreak data in the United States from 1998-2008 (2013).

Of all the illnesses observed, Norovirus caused the most outbreaks (1,419), and outbreak-associated illness (41,257), which was far higher than the median for all illnesses (Painter et al., 2013). In order to be deemed a food borne disease outbreak, two or more illnesses must be caused by the consumption of one common food. Therefore, if someone does not report the illness, or if they themselves are the only one to get sick, the situation would not be deemed an outbreak. Thus, there is the potential that the number of illnesses caused by food borne diseases is much greater than it appears.

The Centers for Disease Control and Prevention (CDC) takes responsibility for collecting all food borne disease outbreak data from all health departments across the United States (Hall et al., 2013). FoodNet expands the activities of the CDC, USDA, FDA, with the goal of identifying, controlling, and preventing food borne disease hazards. FoodNet oversees these organizations and produces national estimates on specific food borne diseases in the United States. According to FoodNet, significant progress has been made towards decreasing food borne illness caused by common pathogens, except *Salmonella* (Byrd-Bredbenner et al., 2013; Centers for Disease Control and Prevention, 2019). While this decline in overall food borne illness is great news, the rate is still higher than Healthy People 2020 goals (Byrd-Bredbenner et al., 2013; United States Department of Health and Human Services, 2018). There was an average of 15.0 confirmed *Salmonella* spp. cases per 100,000 people reported from 2006-2008, which was used as the baseline to set the Healthy People 2020 target of 11.4 cases per 100,000 people (United States Department of Health and Human Services, 2018). In 2015, laboratory confirmed *Salmonella* spp. cases sat at 15.7 cases per 100,000 people (United

States Department of Health and Human Services, 2018), demonstrating that *Salmonella* spp. infection rates are not on the decline. It is important to determine the source of a food borne illness occurrence, so individuals can be more cautious when handling those items.

Painter et al. highlighted 17 food commodities where food borne illness could arise (2013). Researchers discovered that more illnesses were associated with leafy vegetables (22%) than any other commodity. Next followed dairy (14%), fruits-nuts (12%), and poultry (10%) (Painter et al., 2013). While leafy vegetables lead to the most illnesses, poultry accounted for the most deaths (19%). Of the 278 deaths that were due to poultry products, the majority were found to be caused by *Listeria monocytogenes* and *Salmonella* spp. bacteria. Dairy accounted for 10% of deaths, vine-stalk vegetables for 7%, fruit and nuts for 6%, and leafy vegetables for 6%. Pasteurization, the process of mildly heating foods in order to prolong shelf life and kill pathogens, is common in dairy products. This process has greatly decreased the risk of illness from dairy foods, but these foods can still be contaminated after pasteurization occurs, or if pasteurization was not executed properly (Olsen et al., 2004; Painter et al., 2013). The majority of illnesses due to bacteria were related to dairy (18%), poultry (18%), and beef (13%) products. The majority of illnesses caused by viruses were due to leafy vegetables (35%), fruits and nuts (15%), and dairy (12%) products (Painter et al., 2013). Overall, the majority of food borne illness had a plant commodity as the vehicle, while the majority of food borne deaths occurred from animal commodities.

The facts presented by Painter et al. must be viewed as estimations. They observed phenomena from outbreak cases, not every individual case of food borne illness. Studies of sporadic cases would enhance the data presented. This research indicates that emphasis must be placed on preventing contamination of produce and poultry to reduce disease.

Populations at greatest risk. Certain groups have shown to mishandle food more often than others. Those most likely to make food handling errors include men, adults younger than 30 years old, adults older than 64 years, and those who have at least some post-secondary education (Byrd-Bredbenner et al., 2007b; Christensen et al., 2005; Fein et al, 2011; Fischer et al, 2006; Jevsnik, Hlebec, & Raspor, 2008; Patil, Cates, & Morales, 2005; Redmond & Griffith, 2003). Over half of American consumers report that they consume raw cookie dough (made with raw eggs), a quarter consume raw fish, one-fifth consume undercooked hamburgers, two-fifths consume raw eggs, and an eighth consume raw oysters (Byrd-Bredbenner et al., 2007c; Fein et al., 2011). As people are placing themselves at risk for food borne illness, it must be questioned whether a lack of food safety education could be a reason.

Fisher and colleagues claim, "People who prepare food least frequently...are...the most dangerous cooks" (Fischer, Frewer, & Nauta, 2006). Fischer and Frewer speculated that more educated individuals tend to worry less and may feel more confident with the way they prepare food (2008). Past research shows that food safety knowledge in young adults is typically low (Abbot, Byrd-Bredbrenner, Schaffner, Bruhn, & Blalock, 2009; Burke, Young, & Papadopoulos, 2016; Byrd-Bredbenner et al., 2007c; Ferk, Calder, &

Camire, 2016; Green & Knechtges, 2015). Even those individuals who are at highest risk for contracting a food borne illness may never be taught food safety education. This is concerning considering food preparation and eating are a part of everyday life.

A cross-sectional survey issued by Byrd-Bredbenner et al. assessed young adults self-reported risky eating behaviors (2008). There were 4,343 participants who completed the survey, and each participant marked which foods they consume on a randomized list of safe to eat and risky to eat foods. Each risky food item marked received one point, and the sum of all points was calculated for each participant, with a possible score range of 0-27 points. The mean score was 5.1±3.6, demonstrating that young adults eat risky foods (Byrd-Bredbenner et al., 2008). Males scored over one point higher than females, with males reporting an average of 5.9±4.3 risky foods, and females reporting an average of 4.7±3.1 foods. Researchers also found those who viewed food poisoning as a personal threat were less likely to eat risky foods (3.1±0.8) (Byrd-Bredbenner et al., 2008). This study clearly demonstrates that young adults are consuming risky foods, and that improving food safety knowledge may reduce the amount of risky food behaviors in this population.

Certain groups of people are considered at high-risk for food borne illness and are more prone to infection than the general population. Not only are these people more susceptible to food borne illness, but they also will likely be sicker longer or require hospitalization, and have a greater chance for death, as compared to others (United States Food and Drug Administration, 2018a). These groups include pregnant women, young children, older adults, and those with weakened immune systems (e.g. transplant patients,

cancer patients, those with HIV/AIDS, or those with diabetes). Women are more likely to contract a food borne disease during pregnancy because their immune system is altered. Pathogens can cross the placenta and attack the baby's underdeveloped immune system, putting them at great risk as well (United States Food and Drug Administration, 2018b). Young children's immune systems are still developing and thus they are at high-risk for disease.

For the opposite reason, older adults are at higher risk for disease. Their immune system and other body processes are on the decline and function slower, thus not being as quick to fight off pathogens like food borne disease (United States Food and Drug Administration, 2018b). Also, this population tends to have developed more chronic diseases and take medications that can weaken the immune system. Stomach acid plays an important role in killing bacteria in the gastrointestinal tract. As individuals age, stomach acid production declines, leaving them more defenseless against invasion. Individuals undergoing medical treatment for various diseases like cancer, HIV/AIDS, diabetes, or transplants, are more susceptible to food borne illness and infection (United States Food and Drug Administration, 2018b). The treatment process, medications, and a decreased immune system puts them at greater risk. Diabetes can also lead to gastroparesis, thus providing more time and opportunity for diseases to multiply. Hyperglycemia triggers localized pyloric contraction and inhibits antral contraction, therefore causing delayed gastric emptying (Fraser, Horowitz, & Den, 1991). For those with uncontrolled diabetes, this poses a significant problem.

Extra caution must be taken when preparing foods for these high-risk groups. Luckily, research shows that knowledge of the groups at highest risk for food borne illness predicts greater compliance to proper food handling recommendations (Abbot et al., 2009). As young adults are thinking about starting a family and raising young children, proper food safety education will help them keep healthy during those vulnerable times.

Food Safety

The importance. It is estimated that 1 in every 6 Americans experience food borne illness each year, which leads to the hospitalization of at least 56,000 and death of 1,300 (Byrd-Bredbenner et al., 2013; Scallan et al., 2011). As explained in the last section, food borne illness is a major issue within homes in the United States. Experts in the field of food safety and disease prevention have focused on commercial kitchens because health codes can be regulated by the government. Only a few studies have assessed sanitation practices in home kitchens.

Byrd-Bredbenner, Abbot, and Schaffner modified a home kitchen research instrument to allow individuals to evaluate the safety of their own home kitchens (2010). The tool was adapted from inspection procedures used in food service facilities (Byrd-Bredbenner et al., 2007b). Food service, food microbiology, and nutrition experts, along with a registered environmental health specialist and a licensed sanitarian, analyzed and refined the tool for use in home kitchens (Byrd-Bredbenner et al., 2010a). The instrument encompassed two main parts, where Part A assessed the kitchen area and personal

hygiene, and Part B assessed the individual's basic food safety knowledge. Participants were able to grade their own kitchens and add up the number of food safety violations from Part A. A description was provided for each point illustrating why that practice is unsafe, and suggestions on how to improve the situation were provided (Byrd-Bredbenner et al., 2010a). The number of points accrued correlated to a letter grade (e.g. 7-9 points received a grade of "C"). For the second part of the survey, Part B, food safety knowledge was assessed, and each point scored correlated to a greater food safety knowledge.

Ages of participants in this study ranged from 18 to 53 years old, with a mean age of 21.7±6.0 years. The mean score for part A was 10.1±2.5 (maximum score possible was 14). The mean score for food safety knowledge was 4.2±1.0 (maximum score possible was 5) (Byrd-Bredbenner et al., 2010). Participants (n=275) reported that the study increased their awareness of their behaviors in the kitchen, and that the brief food safety knowledge check (Part B) helped them to learn more food safe techniques to improve their behaviors. More interest, higher retention rates, and higher incidences of adopting the practice can result from tools such as this where individuals are allowed to evaluate their own practices and surroundings (Kreuter & Wray, 2003). In this study, overall Part A grades ranged from "B" to "F," demonstrating that all participants can make more food safe decisions in regard to their environment (Byrd-Bredbenner et al., 2010a). It is also important to note that the mean age for this study was 21.7±6.0 years old, encompassing a large number of young adults. While the majority of the food safety violations observed in adults could be fixed easily and inexpensively, research has revealed a general lack of

knowledge among consumers regarding how to improve practices in their own kitchens (Abbot et al., 2009; Byrd-Bredbenner et al., 2007c; Byrd-Bredbenner et al., 2010a). Further research is needed to discover the best methods to provide individuals with the knowledge they need to live healthier, safer lives.

According to experts, homes are one of the primary locations where food borne illness cases emerge (Bryan, 1988; Byrd-Bredbenner et al., 2013; Byrd-Bredbenner et al., 2007a; Byrd-Bredbenner et al., 2007b; Food and Agriculture Organization of the United Nations & World Health Organization, 2002; Kennedy et al., 2005; Knabel, 1995; Maurer et al., 2008; McArthur et al., 2006; Redmond & Griffith, 2009; Spittler, 2009). However, numerous consumers do not believe their homes to be a dangerous place for foodborne diseases (Byrd-Bredbenner et al., 2013; Worsfold & Griffin, 1997). In 2011, the Food Marketing Institute studied grocery shopper trends, and discovered that only 8% of consumers thought foodborne illness was likely to occur in homes. This was a drop from 2005, where 18% of consumers reported that they believed foodborne illness was likely to occur in homes (Byrd-Bredbenner et al., 2013; Food Marketing Institute, 2011). Twelve percent of consumers believe it is very common for people to acquire a food borne illness at home (Byrd-Bredbenner et al., 2013; Food Marketing Institute, 2011); yet in 2011, only 7% of consumers who thought they acquired a food borne illness believed home prepared foods to be the reason (Brewer & Rojas, 2008; Byrd-Bredbenner et al., 2013). As mentioned earlier, home acquired food borne illness is likely highly underreported. Individuals do not recognize that their health risk is in their own hands when preparing foods at home.

Many consumers do not realize that poor food safety practices at home reverse the effort made by handlers earlier in the food chain to keep their food safe (Beard, 1991; Byrd-Bredbenner et al., 2013; Kennedy et al., 2005). Studies have concluded that the only reason a consumer chooses to practice quality food safety skills is when they perceive a significant risk; for example, when they fear making others sick, others are watching, or when they are handling raw poultry (Clayton, Griffith, & Price, 2003; Levy, Choiniere, & Fein, 2008; Mullan & Wong, 2009). Once individuals realize that they play an essential role in ensuring the safety of themselves and others, they can take a proactive role in preventing food borne illnesses.

Common misconceptions of food safety. Nobody can force consumers to prepare meals a certain way at home; and because of this, education is lacking in this area. Not only is there not a big effort to educate, but there is some resistance to learning. There is a multitude of reasons consumers give to explain poor food safety practices. One common consumer response to illness and food safety is that food producers and manufacturers should control the risks before food is offered at stores (Brewer & Rojas, 2008; Byrd-Bredbenner, et al., 2013). Many consumers report that they do not think their current way of preparing food is problematic (Murray, et al., 2017; Phang & Bruhn, 2011; Shapiro et al., 2011). If experts could help consumers understand the degree of power they have in their kitchens, behavior change can occur.

One concern is that many people, including those at higher risk, do not perceive themselves or their family members to be susceptible to food borne illness (Buffer, Kendall, Medeiros, Schroeder, & Sofos, 2013; Byrd-Bredbenner et al., 2013), and

consider their risk of food borne illness lower than that of others (Byrd-Bredbenner et al., 2013; Frewer, Shephard, & Sparks, 1994). Another misconception is that hot foods need to reach room temperature before being refrigerated (Bruhn & Schultz, 1999; Byrd-Bredbenner, et al., 2013). Potentially hazardous foods (foods that need refrigerated) should be chilled as soon as possible after preparation in order to reach a safe temperature (40˚F or below) within four hours. More specifically, foods should be cooled below 70˚F in two hours or less, and then cooled from 70˚F to 40˚F or below in an additional two hours or less (Brown et al., 2012). The goal is to decrease the length of time that the food remains in the temperature danger zone (41˚F-135˚F), where pathogens in food can grow rapidly (Brown et al., 2012). Washing raw poultry to remove "germs" still remains a common phenomenon (Byrd-Bredbenner et al., 2013; Henley, Stein, & Quinlan, 2012). Washing raw meat or poultry in a sink spreads bacteria to the sink, faucet, counter tops, other food, towels, and the handler. Splashing water can contaminate up to three feet around the sink with bacteria (Gravely, 2016). This can lead to cross-contamination and illness. It is recommended to transfer raw meats and poultry directly to the cooking pan because cooking foods to the proper temperatures will kill any bacteria in the food. There are many misconceptions when it comes to food safety. Proper education can help alleviate some of the confusion and debunk the myths surrounding proper food handling and storage.

Proper hygiene. One proven method for decreasing the risk of infection by particular viruses and other infectious agents is to simply wash your hands (Aiello, Coulborn, Perez, & Larson, 2008; Bloomfield, Aiello, Cookson, O'Boyle, & Larson,

2007; Curtis & Cairncross, 2003; Ejemot-Nwadiaro, Ehiri, Meremikwu, & Critchley, 2008; Larson & Aiello, 2001). Hand washing is a crucial component of good hygiene when it comes to preparing food. Proper hand washing before handling food is essential to prevent the spread of bacteria, microorganisms, sweat, dead skin cells, and dirt that may be residing on the hands (Todd et al., 2010). The efficiency of hand washing depends on two major factors: how well the hands are being washed (duration, soap, friction) and how often they are being washed. More specifically, the removal of microbes depends on the following factors: the type and amount of microbial or organic material on the hands, the level of minerals present in the water, the length of time spent washing, the type and quantity of soap used, the level of friction created by vigorously rubbing the hands together, and the degree to which the hidden crevasses of the hand (subungual area beneath the nails, knuckles, between fingers) are cleansed and rinsed (Todd et al., 2010). One of the most important components of hand washing is the friction caused by rubbing the hands together, especially those "forgotten" places like the thumbs, fingertips, nails, and the spaces between the fingers where microbes are prone to reside (Todd et al., 2010). It is important that home cooks understand the dangers of not washing one's hands before touching foods.

Most people understand that washing their hands is important when preparing food. However, many people either do not know the proper way to wash their hands or fail to actually practice effective hand washing when in the kitchen (Fischer et al., 2007). Redmond and Griffith conducted a meta-analysis of studies analyzing hand washing behaviors both in the United States and the United Kingdom (2003). They discovered that

one in five individuals were not aware of how to properly wash and dry their hands (Redmond & Griffith, 2003). Another study by Bryd-Bredbenner et al., found that while 97% of young adult respondents rated their food safety knowledge as fair or better, 60% of them failed to wash their hands with soap and water after handling raw poultry (2007c). So, although individuals may understand the importance of hand washing, they may have never been educated on the proper methods or may not practice these methods in their homes.

Proper cooking temperatures: Cook. According to Healthy People 2020, the biggest area for food safety improvement is while cooking. Only 37% of consumers heat foods properly to a temperature high enough to kill harmful pathogens (United States Department of Health and Human Services, 2018). Prevention surveillance figures illustrate that approximately half of all food borne illness outbreaks are related to temperature violations, and half are related to cleanliness (Byrd-Bredbenner et al., 2010a; Lynch, Painter, Woodruff, & Braden, 2006). In a burger cooking study conducted by Phang and Bruhn, only 4% of participants used a thermometer to check for doneness (2011). The majority of consumers do not realize color is not a good indicator of whether or not a food is cooked thoroughly. Researchers conducted a study to test the efficiency of consumers judging when chicken was fully cooked by visual inspection. Seventy percent of the chicken that consumers viewed as "done" had not reached the proper cooking temperature to kill off harmful bacteria, and the chicken still contained active *C. jejuni* cells (Bergsma, Fischer, van Asselt, Zwietering, & de Jong, 2007; Kennedy et al., 2011). Many consumers report frustration with trying to remember the proper cooking

temperatures, resulting in them avoiding thermometers all together (Abbot et al., 2012). Due to thermometers seldom being used on televised cooking shows, and color being recommended as a way to check food doneness, consumers may be led to believe that only inexperienced cooks would use a thermometer (Fein et al., 2011). Proper education on the importance of using thermometers and how to utilize them properly is necessary to prevent food borne disease and decrease the stigma that may be associated with them.

Poultry (whole or ground chicken, turkey, duck), stuffed meat, poultry, seafood, or pasta, stuffing made with meat, poultry, or fish, and dishes made with time-temperature control (TCS) foods such as meat, poultry, fish, soy products, dairy products, eggs, baked potatoes, sprouts, and cut fruits and vegetables, should be cooked to a minimum temperature of 165˚F for a minimum of 15 seconds. This will ensure that the food is safe from food borne illness (ServSafe National Restaurant Association, 2012). Ground beef or pork should be cooked to an internal temperature of 160˚F (USDA Food Safety, 2015). Steaks or chops of beef, veal, pork, and lamb, all seafood, and cooked eggs that will be served immediately, should be cooked to a minimum internal temperature of 145˚F for a minimum of 15 seconds (ServSafe National Restaurant Association, 2012). It is essential to cook foods to the proper internal temperatures because all harmful pathogens in the foods would be killed, and the food would be safe to eat.

Proper storage techniques: Chill. Refrigerators play an important role in temperature control. Studies have revealed that many refrigerators in use exceed the recommended temperature of 40˚F. This has been shown not only in the U.S., but also the U. K., Ireland, Australia, and New Zealand (Byrd-Bredbenner, 2007a; Gilbert et al.,

2007; Griffin, Worsfold, & Mitchell, 1998; Jackson, Blair, McDowell, Kennedy, & Bolton, 2007; Kennedy et al., 2005; Medeiros, Kendall, Hillers, Chen, & DiMascola, 2001; Mitakakis et al., 2004; Redmond & Griffith, 2009; Worsfold & Griffin, 1997). Not only are refrigerators not being cooled properly, but they may also be too full. Tightly packed refrigerators limit air flow and can pose a cross-contamination risk (Byrd-Bredbenner et al., 2007a). If cold air cannot be distributed through the refrigerator properly, certain areas may be in the temperature danger zone where pathogens multiply rapidly. The warmest part of the refrigerator is the door, therefore perishable foods should not be stored there. The door storage temperature fluctuates more than the rest of the refrigerator (United States Department of Agriculture, 2015b). The organization of the refrigerator is important as well. Kosa, Cates, Bradley, Chambers, and Godwin surveyed 1,504 U.S. adults and discovered that only 17.5% of participants put raw poultry in a sealed container on the bottom shelf of the refrigerator when storing it (2015). To prevent cross-contamination from raw juices dripping onto other foods, all raw meat, poultry, and seafood must be stored in a sealed container on a lower shelf than all ready to eat foods (United States Department of Agriculture, 2015b). This will prevent foods like lettuce from becoming a food borne pathogen vehicle.

Consumers encounter many cooling risks at home, but they also can take the risk with them to work or school. Two-thirds of workers report that they store their lunches in the refrigerator at work. However, half of workers also report leaving perishable food at room temperature for more than two hours (American Dietetic Association & ConAgra Foods, 2011). The packed lunches children bring to school may pose "chill" food safety

risks as well, as they are often left at room temperature for hours (Hudson & Walley, 2009). It is imperative that cooling and refrigeration safety training reaches consumers so that they can prevent themselves and their families from unnecessary risk.

Cross-contamination prevention: Clean, separate. Home kitchens serve many purposes and are not simply a place for food preparation and storage (Byrd-Bredbenner et al., 2007a; Byrd-Bredbenner et al., 2013; Redmond & Griffith, 2009). For example, researchers have found that purses that have been placed on kitchen countertops had previously been on restroom floors (Byrd-Bredbenner et al., 2007a; Byrd-Bredbenner et al., 2013). Pets, old newspapers, house plants, and dirty laundry are regularly found in home kitchens, among other items (Byrd-Bredbenner et al., 2007a; Byrd-Bredbenner et al., 2013; Redmond & Griffith, 2009). Kitchen sinks are used for a multitude of things, such as: hand washing, produce washing, dishwashing, bathing children and pets, laundry, and wetting mops. Dripping raw meat, raw unwashed produce, and ready-to-eat foods are regularly found in home refrigerators. Home kitchens provide the potential for an array of pathogens to invade, spread to foods, proliferate, and lead to illness (Byrd-Bredbenner et al., 2013). Cleaning kitchen surfaces well after multipurpose use and keeping household products away from food is essential to prevent the spread of dangerous microorganisms.

The purpose of keeping "clean" is to prevent cross contamination. The transfer of disease-causing microorganisms from one surface, item, or food to another is called cross contamination (Byrd-Bredbenner et al., 2013; World Health Organization, 2006). Dishcloths and sponges, for example, quickly become microbe vehicles and can transfer

bacteria throughout the kitchen to hands, surfaces, and equipment (Byrd-Bredbenner et al., 2013; Enriquez, Enriquez-Gordillo, Kennedy, & Gerba, 1997; Erdogrul & Erbilir, 2005; Haysom & Sharp, 2005; Hilton & Austin, 2000; Redmond & Griffith, 2009; Rossi, Scapin, & Tondo, 2013; Safefood, 2012). Reusable lunch boxes and bags pose a food safety threat when they are improperly cleaned with a used dishcloth (Hudson & Walley, 2009). The purpose of separating certain foods is to prevent cross-contamination. Kitchen equipment, such as utensils and cutting boards, are major cross contamination routes (Byrd-Bredbenner et al., 2013; De Jong, Verhoeff-Bakkenes, Nauta, & de Jonge, 2008). By keeping raw meat, poultry, and seafood, away from ready-to-eat foods like salads and cooked meats, the possibly of pathogens being transferred can be reduced (Byrd-Bredbenner et al., 2013). Recently, a new vehicle of cross-contamination has come into play, with the introduction of reusable grocery bags.

Williams, Gerba, Maxwell, and Sinclair found that one in three consumers report using reusable grocery bags for multiple activities, such as going to the gym or carrying toys (2011). This is a point of concern considering that 75% of consumers use these same bags to transport raw meat and groceries (Williams et al., 2011). The researchers also found bacterial growth, including fecal coliforms, in every reusable bag they tested from consumers outside of a grocery store (Williams et al., 2011). It is important to note that the researchers also tested new reusable bags and traditional plastic bags where no bacteria were found. Pathogens can effectively be killed by washing reusable bags, however only 3% of consumers reported that they wash them regularly (Williams et al., 2011). In 2010, an outbreak of Norovirus within a girls' soccer team was traced back to a

reusable grocery bag (Repp & Keene, 2012). By encouraging consumers to wash their reusable bags regularly, food borne illness transfer can be prevented.

Young adults who share living spaces with other young adults could be at greater risk of food borne illness. Shared kitchen spaces can amplify the risk of food borne illness, unless everyone sharing the space diligently cleans and sanitizes the area. By spreading knowledge and awareness throughout the young adult community, safe practices can multiply amongst roommates and friend networks.

Education Methods

Barriers to change habits. Many consumers do not view their current food preparation methods to be hazardous (Glanz, Rimer, & Viswanath, 2008). For many people, preparing food is a habitual behavior that is often repeated (Fischer et al., 2006). Changing an individual's method of preparing a dish, whether it be washing their hands differently after touching an ingredient or using a thermometer to check for doneness, can be very challenging.

Many consumers like to deflect responsibly onto those higher in the production chain, believing that food safety risks are a producers' problem rather than their own (Brewer & Rojas, 2008; Ipsos-Reid Corporation, 2004). Due to this, consumers may not believe that they have a part in preventing food borne illness at home (Kennedy et al., 2011). Some consumers express concerns that developing a new food behavior may change the taste of their favorite foods (Fischer et al., 2007). This is a major barrier to change considering that the biggest influence on food choices is taste (International Food

Information Council Foundation, 2016). Individuals need to be taught how to reach the same flavor profile in their favorite dishes from healthier, safer methods.

Few people believe that home cooked meals are a common cause of food borne illness (Brewer and Rojas, 2008). According to Redmond and Griffith, most (90%) people report that their food borne illness risk is low from foods that they have prepared at home (2004). When consumers have already established a firm belief that their kitchens are currently safe from food borne illness, it is difficult to motivate for change (Glanz et al., 2008). It may be difficult to convince individuals that they play an active role in food borne illness prevention, but meeting consumers where they are at and working from there is a good place to start.

Intervention methods & development. A few studies have tested different methods of educating the public about food safety, through a variety of means. In 2004, Unusan developed readings and questionnaires to test a food safety intervention using email and hand-out formats (2007). The course focused on five topics: practicing good personal hygiene, cooking foods adequately, avoiding cross-contamination, avoiding food poisoning, and avoiding food from unsafe sources (Unusan, 2007). This study was conducted over a period of two weeks, and participants self-selected which group they would like to participate in, either education via email or education via hand-out. Researchers developed a 34-question questionnaire based on previous survey data (Altekruse, Street, Fein, & Levy, 1996; Fein et al., 1995; Knight, Jackson, Bain, & Eldemire-Shearer, 2003; Schafer, Schafer, Bultena, & Hoiberg, 1993; Unusan, 2007).

The questionnaire covered demographic characteristics as well as Likert type scale questions covering the five topics mentioned earlier.

A paired t-test was used to analyze each of the two groups. Cronbach' alpha values were used to analyze the inter-term reliability of the final scores, which showed that the questionnaire practiced good internal consistency reliability (Unusan, 2007). The total sample had 68 participants, with 34 participants in each group. The majority of respondents were males, aged 25-35 years of age, and lived in households of three to five people (Unusan, 2007). Of the 25 food hygiene questions analyzed, the email group improved significantly from the pre-intervention to the post-intervention for 11 questions. These questions asked about food handler hygiene, existence of microorganisms and insecticides/pesticides in foods, food labeling, refrigeration temperatures, proper thawing methods, cross contamination, and food poisoning (Unusan, 2007). Only one significant change occurred in the hand-out group. Respondents who completed the food safety educational intervention via email reported that they were more satisfied with their education method (Unusan, 2007). Perceptions of the volume learned, course content, motivation on the topic, and education delivery method, were significantly statistically different between the two groups. This study has shown that it can be feasible to offer an effective food safety educational intervention in a distance learning format and provides a potential model for future food safety education interventions.

Teaching consumers about the level of control they have over their own kitchens and finding the proper motivation methods to help them actually make a change are key. Abbot et al. sought to gather the appropriate data to characterize the young adult

population and identify what intervention methods would resonate best with that group (2012). This study was completed over three stages. Stage one consisted of an online survey sent to college students (n=4,343) across the United States. The survey asked questions that were used to analyze food safety knowledge, behaviors, and the psychosocial factors of this population. Stage two involved a smaller (n=154) subsample of participants and the actual food safety practices of these young adults were observed. Stage three brought together the results of stage one and two to formulate and implement a food safety media campaign on the college campuses. The campaign was then evaluated by comparing data from a pre-test (issued 2-4 weeks before campaign initiation) and a post-test (issued one week after the campaign ended). This campaign created by Abbot et al. was structured under the theory of planned behavior and the theory of reasoned action (Ajzen, 1991; Montano, Kasprzyk, & Taplin, 2002). These theories help to provide insight into why people do the things that they do and helps decipher the best way to influence behavior for this particular group.

The campaign was built in three phases: focus groups with college students, expert discussions, and campaign material creation. The focus groups (n=53, split into 15 groups) started with the moderator summarizing the stage one and two findings. Participants were then asked to pinpoint barriers that may make them stray away from applying safe food handling behaviors. They also were asked how they prefer to receive food safety information (Abbot et al., 2012). Overall, participants felt that the campaign should be built with their generation in mind and focus on only a few topics relevant to them. They also mentioned a need for clear examples of how to improve current

behaviors. The second phase of the campaign involved collecting the expertise of a few members (n=7) in the field of food safety education, for example the U.S. Department of Agriculture Cooperative Extension nutrition and food safety specialists (Abbot et al., 2012). The experts received a summary of the results from stages one and two of the study a few weeks before they were asked to participate. The experts decided on which messages would be most effective for this population in the campaign, resulting with the following topics: hand washing, food thermometer use, safe refrigeration temperature range, and how to properly store and reheat leftovers. Researchers then pulled together the information from the first two phases of the campaign to create their campaign plan.

Researchers, with the help of a graphic designer, created the content, slogans, and materials to be used in the campaign. Four themes were used for the campaign: Clean, Cook, Chill, and Leftovers. Each week of the campaign focused on one theme, and materials were distributed across the college campuses (cartoon videos on the college television station, radio skits on the campus radio station, student newspaper advertisements, posters in high traffic areas, table tents on dining hall tables, Facebook flyers, and email announcements sent via email listservs) (Abbot et al., 2012). Events were also hosted on campus each week, where that week's theme was on display for students to learn more about the topic, engage in hands-on learning, and receive magnets with that week's food safety tips on them.

A pre-test (issued 2-4 weeks before program initiation) and post-test (the week directly after the campaign) were conducted to test the effectiveness of the campaign for food safety learning. An eight question, multiple choice questionnaire was used to

evaluate knowledge gained, with one point being issued for each correct answer (maximum score possible was eight points). The 607 participants who completed the pre and post campaign questionnaires had a mean age of 19.86±1.52 years, with the majority of participants having never taken a nutrition course (82%) or completed any food safety certifications (92%) (Abbot et al., 2012). Scores increased from 3.29±1.61 on the pre-test to 4.17±1.84 on the post-test ($p<0.0001$). This complex study gives insight into how young adults enrolled at college campuses prefer to learn and provides suggestions on how to best educate them on food safety topics.

Attempting to target "everyone" through an educational intervention isn't always the most effective. Tailoring and personalizing an intervention towards one group has shown to have the bests results (Abbot et al., 2012; Byrd-Bredbenner, Abbot, & Quick, 2010; Contento et al., 1995; DiClemente, Crosby, & Kegler, 2009; Glanz et al., 2008; Hoffman et al., 2005; Samuel et al., 2007). Few food safety interventions have targeted young adults specifically (Abbot et al., 2012). There is a plethora of opportunity for research in this population.

Byrd-Bredbenner et al. questionnaire. In 2007, Byrd-Bredbenner et al. decided to establish a valid, reliable, comprehensive questionnaire to assess food safety knowledge. Before then, only a few questionnaires covering this topic were used, none of which were criterion-referenced or comprehensive (Byrd-Bredbenner et al., 2007d). In order to develop and execute education efforts, a valid, reliable questionnaire was needed. The researchers developed the knowledge questionnaire using a seven-stage process. The first stage used published reports from 1991-2001 and a panel of seven

experts in the field of food safety and sanitation. The previous reports and panel of experts identified components of food safety that are essential to protect consumer health. In the second stage, Byrd-Bredbenner et al. assembled a bank of objective questions for the questionnaire, covering the topics of: cross-contamination prevention/disinfection procedures; groups at greatest risk for food borne illness and foods that increase the risk of food borne disease; safe times/temperatures for cooking/storing foods; and food borne pathogens (2007d). During stage three, the initial bank of questions (101 questions) was reviewed by the panel of experts.

During their review, the experts selected the most appropriate questions and identified ways to improve question phrasing, with the purpose of avoiding ambiguity. They also made sure all questions were mutually exclusive, kept to the scope of study, and were complete in breadth and depth. Expert reviewers also assessed each question's content validity in relation to the category it was assigned. The questionnaire was refined further by removing questions with difficulty levels less than 15% or greater than 85% because they were deemed too easy or too difficult (Byrd-Bredbenner et al., 2007d). Even with further refinements, the questions related to food borne pathogens continued to be regarded as too difficult. To preserve and better control for participants guessing on these questions, the panel decided to add the answer choice "don't know," even though this option would be scored be incorrect.

The final food safety knowledge questionnaire built by Byrd-Bredbenner et al., had a total of 39 questions (2007d). Thirty-three multiple choice questions with four or five answer options, one true/false question, and five dichotomous questions with a series

of answer options. According to the Flesch-Kincaid Grade Level score, the questionnaire is written at a 7th-grade reading level. The reliability of the food safety knowledge test was 0.92, calculated from Livingston's Coefficient for criterion-referenced tests, using a passing score of 50% (Byrd-Bredbenner et al., 2007d). Overall, the questionnaire meets or exceeds standards of reliability and validity (Byrd-Bredbenner et al., 2007d). This questionnaire was created specifically to test baseline food safety knowledge as well as measure any increase in knowledge after an educational intervention.

Previous use of the Byrd-Bredbenner et al. questionnaire. A few studies seeking to determine the level of food safety knowledge in a population or to evaluate the use of a food safety intervention have used the Byrd-Bredbenner et al. validated questionnaire. Researchers in one study wanted to test undergraduate students' safe food handling knowledge, attitudes, and behaviors and see if there were any demographic-based variations in the baseline data. These researchers also set out to test the effectiveness of a social marketing campaign and to evaluate its effectiveness on increasing safe food handling knowledge and practices among college students (Policastro, Byrd-Bredbenner, Maurer, & Kinney, 2007; Stein, Dirks, & Quinlan, 2009). The food safety knowledge, attitudes, and behaviors of undergraduate students (n =1,122) were collected on an urban college campus using the previously piloted Byrd-Bredbenner et al. survey tool. Data showed that while students reported high levels of confidence in their ability to engage in safe food handling practices, their knowledge and self-reported behaviors indicated that they were not actually engaging in safe food handling practices (Stein, Dirks, & Quinlan, 2009). Student participants were particularly lacking

knowledge when it came to proper temperatures for cooking, reheating, and refrigerating foods. The data was further analyzed to discover food safety knowledge and practice differences between demographic groups. An email message with a link to the online survey was sent to all undergraduate students (n = 12,000) through university administration.

Nine of the questions addressed respondent attitudes regarding safe food handling. Overall, respondents reported a high level of confidence in their ability to handle food safely. Results indicated that 87% of students felt they could cook ground beef to appropriate temperatures, 92% felt they could always wash their hands before eating or preparing food and 82% felt they could do this even when in a hurry, 89% felt they could cook poultry to appropriate temperatures, 93% felt they could refrigerate leftovers within 2 hours, and 91% felt they could reheat leftovers to an appropriate temperature (Stein et al., 2009). However, only 51% felt they could use a thermometer to check for proper cooking temperature when preparing ground beef. This could be due to not owning a food thermometer, or not knowing how to properly use one. Four questions addressed self-reported behaviors regarding safe food handling. When asked to rate their own food safety skills, 65% rated themselves as either excellent (11%) or good (54%). Thirty-nine percent reported never checking the temperature of their refrigerator (Stein et al., 2009). Only 52% of respondents reported that they always wash their hands before preparing food, but 71% reported that they always wash their hands after going to the bathroom.

The materials for the four-week social marketing campaign were previously developed and piloted by researchers at Rutgers University (Policastro et al., 2007; Stein et al., 2009) to specifically address food handling issues that they had identified in a college undergraduate population. A new theme was introduced on campus each week and an event was advertised and held on campus to highlight that week's theme. The post campaign survey included 35 total questions, including five regarding participant demographics, nine items to measure knowledge, eight items to measure attitude, five items to measure self-reported behavior and behavioral intention, and eight items to measure campaign awareness and participation. Two statistically significant ($p < 0.05$) changes in attitude after the campaign included more students reporting that they could always wash their hands before preparing food and that they could check refrigerator temperatures. Researchers were able to determine that at a minimum, 66% of respondents reported seeing some element of campaign promotional efforts (Stein et al., 2009). The results of this study indicate a continued need to educate young adults to improve knowledge of food safety and hygiene. The results of this study also indicate that direct emails and posters may be an effective method for reaching this population.

Ferk, Calder, and Camire utilized the Byrd-Brenner et al. food safety knowledge questionnaire (FSKQ) to analyze the food safety knowledge of University of Maine students (2016). The researchers added their own demographic questions to the FSKQ, entered them all into Survey Monkey (online survey management website), and distributed the questionnaire via the University of Maine's email system. Ferk et al. scored each participant's (n=104) responses to the 39 knowledge questions in accordance

with the procedures outlined by Byrd-Bredbenner et al. (2007d). The data from this study was analyzed using Microsoft Excel 2007 and SYSTAT 12 for Windows software. Independent analysis of variance (ANOVA) tests were conducted to determine differences between demographic data and the scores on the FSKQ (Ferk et al., 2016). Chi-square tests were used to establish associations between categorical variables. The significance level was set at $P \leq 0.05$.

The majority of participants in this study were between 18-21 years old (71%), were female (68%), and prepared at least one meal a month from home (92%). Almost half of respondents (46%) reported preparing ten or more meals a month for themselves (Ferk et al., 2016). Eighty percent of respondents reported searching the internet for their food safety information. Their parents (54%), cookbooks (51%), and government agency websites (33%), were also common sources of food safety information. The mean score for the study was 53±11.9 out of 89 possible points (Ferk et al., 2016). Therefore, the average score was 60%. In general, the participants with the highest scores in this study were females, ages 22-26, who lived off campus, and had previously taken a college level food safety or food preparation course (Ferk et al., 2016). About two-thirds of respondents incorrectly answered questions about how to properly clean and sanitize kitchen counters and sinks. The correct temperature for freezers and refrigerators were also commonly missed, 80% and 52%, respectively. Only 17% of participants were able to identify the safest method for cooling a large pot of hot soup (Ferk et al., 2016). More than half of participants (57.3%) knew that touching other foods after touching raw chicken could cause *Salmonella* cross contamination (Ferk et al., 2016). This study was

able to highlight many areas where food safety knowledge is lacking in this population. However, no intervention was tested to improve these scores.

A similar study by Burke, Young, and Papadopoulos, tested food safety knowledge in Canadian young adults (2016). The researchers also sought to identify ways that this population prefers to receive food safety education. Participants were 19-29 years old and were asked to participate in an online food safety survey via social media or email. The questionnaire used was developed and adapted from online Canadian government-run public food safety materials and the previously validated food safety questionnaire created by Byrd-Bredbenner et al. (Burke et al., 2016; Byrd-Bredbenner et al., 2007d). The questionnaire consisted of nine participant demographic questions, fifteen food preparation knowledge questions, five food safety information source questions, and four high risk activity questions, for a total of 33 questions. The data was collected using Qualtrics and downloaded to Apple Numbers (Apple Inc., California) for descriptive analysis of the results. Multivariable logistic regression modeling was used to analysis the association between demographic variables of participants and their overall food preparation knowledge score (Burke et al., 2016). After 27 surveys being excluded due to age criteria, a final dataset of 307 responses remained.

The overall average food safety preparation knowledge score was 59.1% (Burke et al., 2016). The vast majority of participants (97.7%, n=300) knew that separate cutting boards should be used for raw and ready to eat foods. Less than half (43.0%, n=132) of participants reported that they regularly use a thermometer to check the internal temperature of meats, know the correct safe internal temperature of chicken (38.8%,

n=119), or could identify the temperature danger zone for optimal bacterial growth (40.7%, n=125) (Burke et al., 2016). There is a lot of room for improvement with these food safety scores. Participants selected that their family and friends (n=222), the Internet (n=210), and the food safety websites ran by the federal government (n=105), were there top sources for food safety information (Burke et al., 2016). More than half of participants (53.4%, n=164) stated that they do not want to receive food safety information over social media. When asked what would make them more interested and motivated about receiving food safety information, participants responded with specific topics, in-recipe information, social media sites or apps, educational classes or programs, and videos (Burke et al., 2016). This data concludes that although past research has shown that social media could be an effective tool in spreading food safety knowledge (James, Albrecht, Litchfield, & Weishaar, 2013; Mayer & Harrison, 2012), young adults may be more interested in other approaches.

Much like Ferk et al., and Burke et al., Green and Knechtges set out to identify areas of strengths and weaknesses in regard to food safety in young adults. Green and Knechtges studied undergraduate college students enrolled in a health course. Seven-hundred eighty-six students (mean age 18.9±1.14) voluntarily participated in the study. The survey consisted of 24 questions, 21 of which came from the validated Byrd-Bredbenner et al. survey tool (Byrd-Bredbenner et al., 2007d; Green & Knechtges, 2015). The first three questions asked participants to rank where most of their food is prepared, chose a food safety issue that would be most beneficial for young adults to know, and to rate their perceived risk for food borne illness. Each correct answer on the following 21

questions adapted from the Byrd-Bredbenner et al. survey was given one point, with the exception of one question. One question had four correct answers, which was given four points. Therefore, a perfect score on the questionnaire was 24 points (Green & Knechtges, 2015). Qualtrics and SPSS 19.0 were used to analyze the data. Descriptive statistics displayed demographic characteristics and were used to identify food safety knowledge mean scores. Mean scores on the survey were compared across demographic variables and analyzed with independent sample *t*-tests and analysis of variance.

Most of the young adults in this survey (72%) believe that they are either "unlikely" or "very unlikely" to be at risk for food borne illness. The mean questionnaire score was 10.23±4.13, out of a possible 24 points (Green & Knechtges, 2015). Participants scored the lowest when asked about which food borne disease pathogens are associated with which common foods. Participants were most familiar with *Salmonella* as compared to other disease pathogens, but yet less than half (47%) of participants could identify "raw chicken" as a common food containing *Salmonella*, or how to make a food safe that may contain *Salmonella* (44%) (Green & Knechtges, 2015). The overall food safety knowledge scores were low in this study. This study builds upon past knowledge of the importance of food safety education in young adults' lives. Being that this population consistency has scored low on food safety questionnaires, new and innovative techniques must be developed to educate them.

Conclusion

Food borne pathogens remain a significant problem in home kitchens. A few studies have tested different methods of educating young adults on food safety topics

(Abbot et al., 2012; Burke et al., 2016; Ferk et al., 2016; Green & Knechtges, 2015; Stein et al., 2009; Unusan, 2007), but none to date have tested the effectiveness of a short video-intervention. Being that a short educational video is a timely, feasible, easily-distributable method of educating this population, it is imperative that this study be completed. The results of the current study will help build upon previous research, illustrate where consumer food safety knowledge currently stands, and evaluate the effectiveness of a new educational intervention.

CHAPTER 3

METHODS

Participants & Recruitment

Healthy young adults (18-29 years old) who cook a meal at least once a week from home were recruited from a large college campus email listserv and from flyers with a link to the study posted on Facebook (see Appendix C for recruitment flyer). The majority of participants had no formal food safety education (ServSafe certification, food handler's card, etc.). Recruitment took place from May 2018-November 2018. All subjects were issued written consent before receiving the initial questionnaire and educational intervention via Qualtrics (see Appendix D for consent form). With the written consent, subjects were given a description of the study including the trial length, possible risks and benefits, how data will remain confidential, and the contact information of the researchers. Researchers were available for consult to answer any questions and to provide more detailed trial information. The study was deemed exempt by the Institutional Review Board (IRB) of Arizona State University (see Appendix A for IRB exemption).

Study Design

The study was conducted over seven months, from May 2018 to November 2018. The study followed a quasi-experimental design. Of the 105 people to complete the initial questionnaire, 14 were excluded due to age criteria. Of the 91 participants who completed the initial questionnaire, 65 participants either did not complete the follow up questionnaire (n=53), were excluded due to age criteria (n=2), or did not list their email

address on the follow up questionnaire so their data could not be linked (n=10). This resulted in a total of 26 participants being included in the pre/post intervention group. Each subject was instructed to complete the initial questionnaire via email, and then watch the provided video directly after. The video was compiled from various government agency video clips on food safety. The video clips used were produced by the USDA and eFoodhandlers Inc. Participants were asked to maintain their usual lifestyle throughout the 1-week trial. Participants were issued the post-intervention questionnaire one week after the initial questionnaire and intervention via email. To encourage completion of the follow-up questionnaire, five reminder follow-up emails were sent to participants during data collection who had completed the initial questionnaire but had not completed the follow-up questionnaire.

Video Intervention

The educational intervention consisted of a series of video clips pieced together by the researchers. The researchers searched for appropriate educational videos on YouTube, using key words such as, "temperature danger zone," "cross contamination prevention," and "USDA." Videos were chosen based on credibility, content, and time length. Video clips were selected from the USDA and eFoodhandlers Inc., and cover cross contamination prevention, proper hand washing, proper cooking temperatures, and proper food storage. The video intervention is 10 minutes and 16 seconds long (see Appendix F for video link).

Questionnaire Data

A pre/post questionnaire was collected to observe current food safety knowledge in homes, and possible knowledge changes post-intervention. A modified version of a previously created, comprehensive, criterion-referenced questionnaire was used. The original questionnaire (Byrd-Bredbenner et al., 2007d), was modified to correlate with video content and to reduce the time requirement of participants (see Appendix G for full Byrd-Bredbenner et al. questionnaire). The original survey was composed of 39 questions that covered five topics: cross contamination prevention/sanitation procedures, safe times/temperatures for cooking/storing food, foods that increase risk of foodborne disease, groups at greatest risk for foodborne disease, and common sources of foodborne disease pathogens. The modified questionnaire focused on three major topics: cross contamination prevention/sanitation procedures, safe times/temperatures for cooking/storing food, and common sources of foodborne disease pathogens. Thirty-nine questions were reduced to 19, with one point being issued per correct answer. Therefore, a score of 100% was given for 19 correct answers. See Appendix E for full questionnaire.

Statistical Analysis

The dependent variable in this study was the food safety knowledge questionnaire scores, and the independent variable was the intervention educational video. Statistical analyses were performed using IBM SPSS Statistics 24. All data were tested for normality and transformed if necessary. To assess differences between pre- and post-intervention questionnaire scores, a paired t-test was used. Descriptive statistics were used to compare demographic characteristics. Data was presented as mean±SD. A p-value of <0.05 was used to indicate a significant difference.

CHAPTER 4

RESULTS

Respondent Demographics

The initial questionnaire was distributed through a variety of means. Multiple professors from the university sent the research flyer to their students, reaching young adults from all different backgrounds (Nutrition, Exercise, Business, etc.). The research flyer was also distributed via a social media site. Out of all the people offered to participate in the study, 105 completed the initial questionnaire. After 14 being excluded due to age criteria, a final dataset of 91 resulted. The mean age was 23 ± 3 years. The respondents were predominantly female 78.9% (n=71), and ASU students 78.0% (n=71). The majority of participants did not have any formal food safety education 58.2% (n=53) and prepared a minimum of one meal per week from home 96.7% (n=87). The number of college nutrition courses completed varied from 42.9% (n=39) never taking a college nutrition course, to 23.1% (n=21) majoring in nutrition.

Table 1

Demographic Characteristics of Questionnaire Respondents (n = 91)

Demographic	**Study Population, n (%)**
Age (years)	
18-29, mean 23.67	91 (100)
Gender	
Male	19 (21.1)
Female	71 (78.9)
Current ASU Student	
Yes	71 (78.0)
No	20 (22.0)

Number of College Level Nutrition Classes Completed	
0	39 (42.9)
1	20 (22.0)
2+ classes	11 (12.1)
Majored in Nutrition	21 (23.1)
Formal Food Service Education Completed (ex. Food Handler's Card, ServSafe Certification)	
Yes	38 (41.8)
No	53 (58.2)
Prepares a Meal at Least Once a Week from Home	
Yes	87 (96.7)
No	3 (3.3)

The demographic distribution was similar for the follow-up questionnaire as well. Of the 105 participants that were sent follow-up questionnaires, 28 completed the follow-up questionnaire for a response rate of 26.7%. This response rate is comparable to a similar study by Stein et al. (2009). Two participants were excluded due to age criteria. The mean age was 23.9 ± 3.1 years. The respondents were primarily female 76.0% (n=19), and ASU students 65.4% (n=17). About two thirds (65.4%) of responders reported having no formal food safety education. The majority (92.3%) stated that they prepare at least one meal from home each week and have never completed a college nutrition course (65.4%).

Table 2

Demographic Characteristics of Questionnaire Respondents Participating in the Follow-Up Testing (n=26)

Demographic	**Study Population, n (%)**
Age (years)	
17-29, mean 23.9	26 (100)

Gender	
Male	6 (24)
Female	19 (76)
Current ASU Student	
Yes	17 (65.4)
No	9 (34.6)
Number of College Level Nutrition Classes Completed	
0	17 (65.4)
1	2 (7.7)
2+ classes	2 (7.7)
Majored in Nutrition	5 (19.2)
Formal Food Service Education Completed (ex. Food Handler's Card, ServSafe Certification)	
Yes	9 (34.6)
No	17 (65.4)
Prepares a Meal at Least Once a Week from Home	
Yes	24 (92.3)
No	2 (7.7)

Cross Contamination Prevention & Disinfection Procedures

The average overall cross-contamination prevention and disinfection score among the initial questionnaire participants was 61.6%. Just over half of the respondents (53.0%, n=44) recognized the best way to wash fresh produce, and 86.7% (n=72) of participants identified the best methods to avoid cutting board cross contamination in the kitchen. About two-thirds (65.2%, n=54) of participants identified the two safest ways to wash dishes, and also correctly identified (67.5%, n=56) when kitchen counters should be washed, rinsed, and sanitized. The majority of participants fell short (31.3%, n=26) when answering how often the kitchen sink drain should be sanitized, however, they demonstrated awareness (76.3%, n=61) when asked about the most hygienic way to wash

their hands. Half of respondents (51.4%, n=41) answered correctly when asked what should not be done when storing raw meats in the refrigerator.

The average overall cross-contamination prevention and disinfection score for the participants who completed both the initial and follow-up questionnaires lowered modestly from 62.1% to 60.4%. Correct response rates dropped after the intervention for how to properly wash produce, from 61.5% (n=16) to 42.3% (n=11). Scores remained the same for identifying the best methods to avoid cutting board cross contamination (84.6%, n=22), and for identifying the safest ways to wash dishes (73.1%, n=19). Scores increased from 65.4% (n=17) to 80.8% (n=21) for identifying when kitchen counters should be washed, rinsed, and sanitized. The recommended frequency of cleaning the kitchen sink drain to prevent food poisoning remains uncertain among participants, with correct scores moving from 19.2% (n=5) to 23.1% (n=6) post-intervention. Scores dropped for which hand washing method is most hygienic, from 73.1% (n=19) to 61.5% (n=16), and remained constant for the proper storage recommendations of meats in the refrigerator, at 57.7% (n=15).

Safe Times & Temperatures for Cooking & Storing Food

The average total score for safe times and temperatures for cooking and storing food among the initial questionnaire group was 62.0%. Participants struggled to identify the recommended freezer temperature to prevent food poisoning, with 32.5% (n=26) answering correctly. Most participants (86.3%, n=69) answered correctly when asked what to do with meats in their freezer after the electricity went off for an extended period of time. About two-thirds of respondents knew the correct cooking temperature for

ground beef (67.5%, n=54), and the maximum temperature refrigerators should be held at to preserve the safety of foods (68.9%, n=51). When answering what minimum temperature all foods were considered safe to eat at, 51.4% (n=38) of respondents answered correctly. The majority of participants answered correctly for the proper method for checking doneness of hamburgers (90.4%, n=66), and the least safe method for thawing a frozen roast (73.0%, n=54). Less than half of participants recognized the safest method for cooling a large pot of soup (35.1%, n=26), and which food is least likely to cause food poisoning (47.2%, n=34). Most participants (68.1%, n=49) know that chilling or freezing foods does not kill harmful germs that may be present in them.

The average safe times and temperatures for cooking and storing food score for the participants who completed both the initial and follow-up questionnaires shifted from 67.8% to 66.7%. Correct response rates increased from 30.8% (n=8) to 34.6% (n=9) for the recommended freezer temperature, and remained constant (92.3%, n=24) for what to do with meats in your freezer after the electricity went off for an extended period of time. Respondent scores decreased for the recommended cooking temperature for ground beef from 80.8% (n=21) to 73.1% (n=19), and for the maximum recommended refrigerator temperature, from 69.2% (n=18) to 61.5% (n=16). Scores increased from 64.0% (n=16) to 72.0% (n=18) for the proper internal cooking temperature for all foods to be considered safe, and remained the same (96.0%, n=24) for the best method for testing the doneness of hamburgers. Scores also remained the same (76.0%, n=19) for recognizing the least safe method for thawing a frozen roast. Scores increased significantly from 38.5% (n=10) to 53.8% (n=14) for the safest method for cooling a large pot of hot soup

(p = 0.050). However, scores decreased from 76.9% (n=20) to 65.4% (n=17) for acknowledging that chilling and freezing does not eliminate harmful germs in food. Scores also decreased from 53.8% (n=14) to 42.3% (n=11) regarding which food is least likely to cause food poisoning.

Common Food Sources of Food Borne Disease Pathogens

The average overall score for the common food sources of foodborne disease pathogens among the total initial questionnaire group was 68.7%. The majority of participants recognized how a food containing salmonella can become safe (54.2%, n=39), and how salmonella bacteria can spread via a food handler (83.1%, n=59).

The average common food sources of foodborne disease pathogens score for the participants who completed both the initial and follow-up questionnaires remained consistent at 78.6%. Scores increased from 69.2% (n=18) to 73.1% (n=19) for how a food containing salmonella can become safe and decreased from 88.0% (n=22) to 84.0% (n=21) for how salmonella bacteria can be spread by food handlers.

Table 3

Correct Responses to Pre-Intervention Food Safety Knowledge Questions (n=91)

Survey Question	**# Correct Responses (%)**
Cross-contamination Prevention/Disinfection Procedures Scale	
1. The best way to keep from getting food poisoning from fresh fruits and vegetables is to wash them with:	44 (53.0)
2. After you have used a cutting board to slice raw meat, chicken, or fish and need to cut other foods, which of these is the best way to prevent food poisoning?	72 (86.7)
3. To prevent food poisoning, the best way to wash dishes is to:	54 (65.2)

4. When should kitchen counters be washed, rinsed, and sanitized?	56 (67.5)
5. To prevent food poisoning, how often should the kitchen sink drain in your home be sanitized?	26 (31.3)
6. Which is the most hygienic way to wash your hands?	61 (76.3)
7. Which should not be done when storing raw meat, fish, or poultry in the refrigerator?	41 (51.3)
Safe Times/Temperatures for Cooking/Storing Food Scale	
8. What is the recommended freezer temperature for preventing food poisoning?	26 (32.5)
9. Imagine that your electricity went off and the meat, chicken, and/or seafood in your freezer thawed and felt warm. To prevent food poisoning, what should you do?	69 (86.3)
10. For ground beef to be safe to eat, it needs to be cooked until its internal temperature reaches:	54 (67.5)
11. What is the maximum temperature refrigerators should be to preserve the safety of foods?	51 (68.9)
12. All foods are considered safe when cooked to an internal temperature of:	38 (51.4)
13. Which method is the most accurate way of determining whether hamburgers are cooked enough to prevent food poisoning?	66 (90.4)
14. What is the least safe method for thawing a frozen roast?	54 (73.0)
15. What is the safest method for cooling a large pot of hot soup?	26 (35.1)
16. Chilling or freezing eliminates harmful germs in food.	49 (68.1)
17. Which food is least likely to cause food poisoning?	34 (47.2)
Common Food Sources of Foodborne Disease Pathogens	
18. Salmonella bacteria can cause food poisoning. How can a food be made safe if it has salmonella in it?	39 (54.2)

19. You may contaminate the next food you touch with salmonella bacteria if you don't wash your hands after touching:	59 (83.1)
Average Correct Score:	**62.6%**
Mean Score (out of 19):	**10.1 ± 4.8**

Table 4

Correct Responses to Pre-Post Intervention Food Safety Knowledge Questions (n=26)

Survey Question	**# Correct Responses (%)**	
	Pre	Post
1. The best way to keep from getting food poisoning from fresh fruits and vegetables is to wash them with:	16 (61.5)	11 (42.3)
2. After you have used a cutting board to slice raw meat, chicken, or fish and need to cut other foods, which of these is the best way to prevent food poisoning?	22 (84.6)	22 (84.6)
3. To prevent food poisoning, the best way to wash dishes is to:	19 (73.1)	19 (73.1)
4. When should kitchen counters be washed, rinsed, and sanitized?	17 (65.4)	21 (80.8)
5. To prevent food poisoning, how often should the kitchen sink drain in your home be sanitized?	5 (19.2)	6 (23.1)
6. Which is the most hygienic way to wash your hands?	19 (73.1)	16 (61.5)
7. Which should not be done when storing raw meat, fish, or poultry in the refrigerator?	15 (57.7)	15 (57.1)
8. What is the recommended freezer temperature for preventing food poisoning?	8 (30.8)	9 (34.6)
9. Imagine that your electricity went off and the meat, chicken, and/or	24 (92.3)	24 (92.3)

seafood in your freezer thawed and felt warm. To prevent food poisoning, what should you do?		
10. For ground beef to be safe to eat, it needs to be cooked until its internal temperature reaches:	21 (80.8)	19 (73.1)
11. What is the maximum temperature refrigerators should be to preserve the safety of foods?	18 (69.2)	16 (61.5)
12. All foods are considered safe when cooked to an internal temperature of:	16 (64.0)	18 (72.0)
13. Which method is the most accurate way of determining whether hamburgers are cooked enough to prevent food poisoning?	24 (96.0)	24 (96.0)
14. What is the least safe method for thawing a frozen roast?	19 (76.0)	19 (76.0)
15. What is the safest method for cooling a large pot of hot soup?	10 (38.5)	14 (53.8)
16. Chilling or freezing eliminates harmful germs in food.	20 (76.9)	17 (65.4)
17. Which food is least likely to cause food poisoning?	14 (53.8)	11 (42.3)
18. Salmonella bacteria can cause food poisoning. How can a food be made safe if it has salmonella in it?	18 (69.2)	19 (73.1)
19. You may contaminate the next food you touch with salmonella bacteria if you don't wash your hands after touching:	22 (88.0)	21 (84.0)
Average Correct Score:	**66.9%**	**65.6%**
Mean Score (out of 19):	**12.6 ± 3.0**	**12.4 ± 2.6**

Total Scores

The average overall score for all participants who completed the initial questionnaire was 62.6%. For those that took both the initial questionnaire and the follow

up questionnaire, their scores shifted from 66.8% to 65.5% after the intervention. A paired t-test was used to compare pre-intervention and post-intervention scores among participants ($p = 0.556$). Initial questionnaire participants scored under 50% for 4 out of the 19 food safety questions.

Scores did not significantly differ between genders for the initial questionnaire group (n=91). When comparing the mean scores of those who have not completed any college nutrition courses to those that majored in nutrition, food safety knowledge scores were significantly higher for those that majored in nutrition ($p=0.048$). The same relationship was noticed when comparing participants who have completed one college nutrition course to those that have majored in nutrition ($p=0.023$). Scores were also significantly higher for participants who have had previous formal food safety education compared to those who had not ($p=0.005$). The group with the highest mean scores were nutrition majors who have also had formal food safety education in the past (13.6±3.8). This group answered over four more questions correctly when compared to those who have never taken a college nutrition course or had any formal food safety education (9.5±4.3) ($p=0.002$).

Table 5

Initial Questionnaire Comparisons* (n=91)

Question	**Response**	**N**	**Mean Score**
Gender	Male	19	9.1±4.79
	Female	71	10.3±4.8
Number of Nutrition Courses Completed	None	39	9.6±4.1
	1 class	20	8.7±4.7
	2+ classes	11	10.2±5.8

	Majored in Nutrition	21	12.3±5.2
Formal Food Safety Education	Yes	38	11.8±4.5
	No	53	8.9±4.7
Nutrition & Food Safety Education	Nutrition Major & Has Had Formal Food Safety Education	16	13.6±3.8
	Never Have Completed a College Nutrition Course & Has No Formal Food Safety Education	31	9.5±4.3

*Maximum score possible= 19. Scores did not differ significantly by any categorization.

CHAPTER 5

DISCUSSION

Score Comparisons

This study provides insight on the level of food safety knowledge young adults have. Participants scored well in several different areas. On the initial questionnaire, 86.7% (n=72) of participants were able to identify the best methods for avoiding cutting board cross-contamination. Other studies that have used this validated questionnaire had similar findings. Ferk et al., who conducted their questionnaire with university students in 2016, found that 81.8% (n=84) of students knew the best methods to avoid cross contamination of cutting boards. Green and Knechtges also conducted their questionnaire in undergraduate students and had 67% (n=517) of respondents answer correctly in 2015. Scores seem to be on the rise for this topic. Scores increased in the pre/post questionnaire group from 65.4% (n=17) to 80.8% (n=21) for identifying when kitchen counters should be washed, rinsed, and sanitized. So, after the video intervention, 15.4% of participants were able to improve their scores. Not as many respondents in the Ferk et al. study scored as well, with 58.7% (n=61) choosing the correct answer (2015). When asked what to do with meats in their freezer after a prolonged power outage, both the initial questionnaire participants (86.3%, n=69), and the pre/post questionnaire participants (92.3%, n=24) scored high. Only 64.4% (n=67) of participants in the Ferk et al. study answered correctly for that question (2016).

Participants also scored very high for the best method for testing the doneness of hamburgers, with 90.4% (n=66) of initial questionnaire participants and 96.0% of

pre/post questionnaire participants answering correctly. Scores were not nearly as high for this question in other studies, with participants scoring 67.3% (n=70) correct (Ferk et al., 2016) and 53% (n=403) correct (Green & Knechtges, 2015). Only 43.0% (n=132) answered correctly in a similar study where participants were asked how to test the doneness of meats (Burke et al., 2016). Knowledge about the importance of thermometers is definitely improving. Although knowledge is increasing, more research needs to be done to see if thermometers are actually being used in this population, and if they are being used correctly.

Scores were high (83.1%, n=59) for how salmonella can be spread by a food handler in the initial questionnaire group. Due to outbreak news on television and on social media outlets, this population has likely seen food borne illness outbreak warnings and precautions to prepare foods safely while online. This could possibly account for higher scores is this population as compared to another, but further research would need to be done. With that being said, this study only asked questions about salmonella, a relatively well-known food borne disease. Other studies have shown that individuals tended to have the lowest scores when asked about what foods are likely to carry specific pathogens (Byrd-Bredbenner et al., 2007d; Ferk et al, 2016; Green & Knechtges, 2015). On Byrd-Bredbenner et al.'s original questionnaire, the answer choice "don't know" was chosen for 45-72% of responses for questions related to foodborne pathogens (2007d). Further research into the knowledge of specific pathogens would shed light on whether or not this topic is showing true improvement or not.

While participants scored high on multiple questions, there were also a few they struggled with. The majority of initial questionnaire participants were unsure of how often the kitchen sink should be sanitized, with only 31.3% (n=26) answering correctly. Ferk et al. participants scored comparably with 32.7% of them answering correctly (2016). While scores started low for the safest method to cool a large pot of hot soup, they increased significantly from 38.5% (n=10) to 53.8% (n=14) (p=0.050). Not even a quarter of participants answered this question correctly when asked in similar studies over the past few years (Burke et al., 2016; Ferk et al., 2016; Green & Knechtges, 2015). Researchers, Green and Knechtges, also asked their participants to select the recommended freezer temperature, with only 13.0% (n=97) selecting the correct response (2015). Scores were much higher in the current study, with 32.5% of initial questionnaire respondents selecting the correct answer. Although participants had a few less than desirable scores, it is clear that scores on these questions seem to be improving over time when comparing homogeneous studies. The current study demonstrates a need for further education regarding the cleaning and sanitation of sinks, recommended freezer temperatures, how to cool large amounts of food, and foods that are likely to cause food poisoning.

Scores did not significantly differ between genders for the initial questionnaire group (n=91). However, in similar studies, females scored significantly higher than their male counterparts on food safety questionnaires (Burke et al., 2016; Ferk et al., 2016; Green & Knechtges, 2015). The initial questionnaire participants majoring in nutrition scored significantly higher than those who had not completed any college nutrition

classes (p=0.048) and those that had only completed one college nutrition class (p=0.023). Nutrition students are required to complete several biology and food science courses throughout their education that cover a wide variety of food safety topics (Arizona State University, 2019). The data from the present study demonstrates that these students tend to have a stronger knowledge base on food safety topics. Initial questionnaire participants having previous formal food safety education also scored significantly higher (p=0.005) than those with no formal food safety education. This demonstrates that programs issuing Food Handler's Cards and ServSafe Certifications are likely effective at educating this population. However, even those with previous food safety education scored 11.8±4.5 on average (out of 19), therefore there is plenty of room for improvement.

The group with the highest mean scores on the initial questionnaire were nutrition majors who have also had formal food safety education in the past. It is expected that individuals with the most food safety education experiences would score the highest on the questionnaire. Those that have completed formal food safety and nutrition education (n=16) answered 71.5% (13.6±3.8) of questions correctly on the initial questionnaire, whereas those without any college nutrition education or formal food safety education answered 50.0% (9.5±4.3) of questions correctly. This shows that there is not only room for growth in the group with less education on this topic, but also for those that are more experienced.

Certification Score Comparison

ServSafe is an industry leader in food safety certification. ServSafe provides a basic food safety course and exam for individuals looking to get their food handlers certificate. This allows an individual to begin work in the food service industry and have the tools to protect the public from food borne illness. The course is 60-90 minutes long and can be taken online or in-person lead by a ServSafe food handler instructor (ServSafe National Restaurant Association, 2019). After completion of the course, participants take a 40-question exam, and must get a 75% or higher to pass. There is no time limit for the exam and each person is allowed three attempts to score a 75% or higher (ServSafe National Restaurant Association, 2019). For the present study, individuals took a 19-question questionnaire, watched a 10-minute training video, and then took the same 19-question questionnaire one week later. The average score on the questionnaire post-intervention was 65.5%. The educational interventions and questions asked are not identical between these sources and cannot be compared directly. However, it is interesting to note that the study participants are not far from a passing score on a food safety certification test, with much less education provided. Although it is also important to note that this could be due to some participants (34.6%, n=9) having had formal food safety education in the past (ex. Food Handler's Card or ServSafe Certification).

Education Methods

While other studies have tested food safety knowledge in young adults, no studies to date have tested a video intervention. This study sought to find if a short video intervention was an effective way of improving this population's knowledge over time.

From this study alone, it cannot be confirmed that video interventions are effective in this population. As almost all food service organizations (restaurants, schools, hospitals, etc.) utilize videos to educate their employees on food safety, it raises the question if these methods should be reevaluated. The video used in this study was compiled from videos offered by the USDA (and a short clip from eFoodhandlers Inc.) online to the public. According to the results of the current study, we must ask, is this the best way to educate the public?

Limitations and Future Research

Participation in this study was completely voluntary and there were no incentives provided to participants other than a possible increase in food safety knowledge. With that being said, those who have no interest in food safety may have been underrepresented. The current study was conducted using a convenience sample and relied on self-reported data via questionnaires. Being that the questionnaires were distributed online and there was nobody observing participants while they completed the study, it is possible that participants did not actually watch the intervention video. Participants could have clicked past the video and "finished" the questionnaire without watching it at all or could have been distracted with other things while the video was running on their device. There is also the possibly of response bias due to participants guessing the expected outcome or researching the correct answers while filling out the questionnaires. A larger sample size would likely provide better understanding of whether or not this intervention method is effective. The response rate of 26.7% of initial questionnaire participants completing the follow-up questionnaire was comparable to a

similar study by Stein et al. (2009). Previous studies have tested food safety knowledge, but also asked participants if they actually practiced food safety in their lives. They found that while some knowledge is there, the behavior is not always practiced (Patil, Cates, & Morales, 2005).

Home economic classes have been on the decline in secondary schools, which may pose a threat to food safety education in this population. A recent Australian study found that food safety knowledge scores were higher on a questionnaire for participants who have taken home economic courses during secondary school as compared to those who did not (Worsley, Wang, Yeatman, Byrne, & Wijayaratne, 2016). That study consisted of two questionnaires, with the mean ages being 43.6 years old and 45.9 years old. This supports the idea that the skills and information learned from these classes likely had a long-term impact on participant knowledge. Future researchers should look into hands-on food safety training, to see if that is a viable option for educating the public. By working on practicing food safety first hand and learning by doing, it may have a more profound impact on the public's behavior, just as home economic classes have in the past.

Qualitative Segment

The present study was able to ignite conversation on the topic of food safety. One participant, after emailing the researchers to inquire more about a topic discussed during the video, stated "Thank you … this survey is [going to] change my life." The participant wanted to clarify that you should never wash raw poultry in a sink, due to cross-contamination. This study was able to change one participant's behavior for the better, if

not more. By simply educating the public on the topic of food safety, individuals can take proactive steps to keep themselves and others safe.

CHAPTER 6

CONCLUSION

The aim of this study was to discover if a basic video food safety intervention was an effective means of educating young adults about food safety. The results from the current study suggest that a video intervention may not be the best education method. Food safety scores did not significantly improve pre- to post-intervention overall with one exception: scores for the 'safest method to cool a large pot of hot soup' did improve significantly. Just over half of respondents answered that question correctly compared to 38.5% pre-intervention. This study highlighted key areas where food safety knowledge is lacking in this population. Further education is imperative on the topics of sink cleaning and sanitation, recommended refrigerator and freezer temperatures, proper cooling methods for foods, and what foods are at highest risk for food borne disease. This was the first study of its kind to evaluate the effectiveness of a brief video as a food safety educational tool in this population; thus, more research is needed to confirm these results. The current study did have limitations, however, including a small sample size, use of a convenience sample, participant self-reported data, and possible response bias due to guessing. Further research is needed in this area to decipher if videos are an effective learning tool, identify barriers to the success of this method, and detect any retention differences as time elapses. Researchers should aim for a larger, more representative sample in future studies. In the future, educational videos may become a viable and economical method of distributing food safety information to vulnerable populations. As

health professionals are encouraging people to cook more from home and eat more fresh foods, safe handling instructions must accompany the message.

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APPENDIX A

ASU IRB APPROVAL

EXEMPTION GRANTED

Carol Johnston
Nutrition
602/827-2265
CAROL.JOHNSTON@asu.edu

Dear Carol Johnston:

On 5/1/2018 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	The effect of a basic food safety intervention on food safety knowledge in US young adults: An intervention trial
Investigator:	Carol Johnston
IRB ID:	STUDY00008161
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• text for listserv, Category: Recruitment Materials; • flyer, Category: Recruitment Materials; • qualtrics survey, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • protocol, Category: IRB Protocol; • survey consent, Category: Consent Form;

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 5/1/2018.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

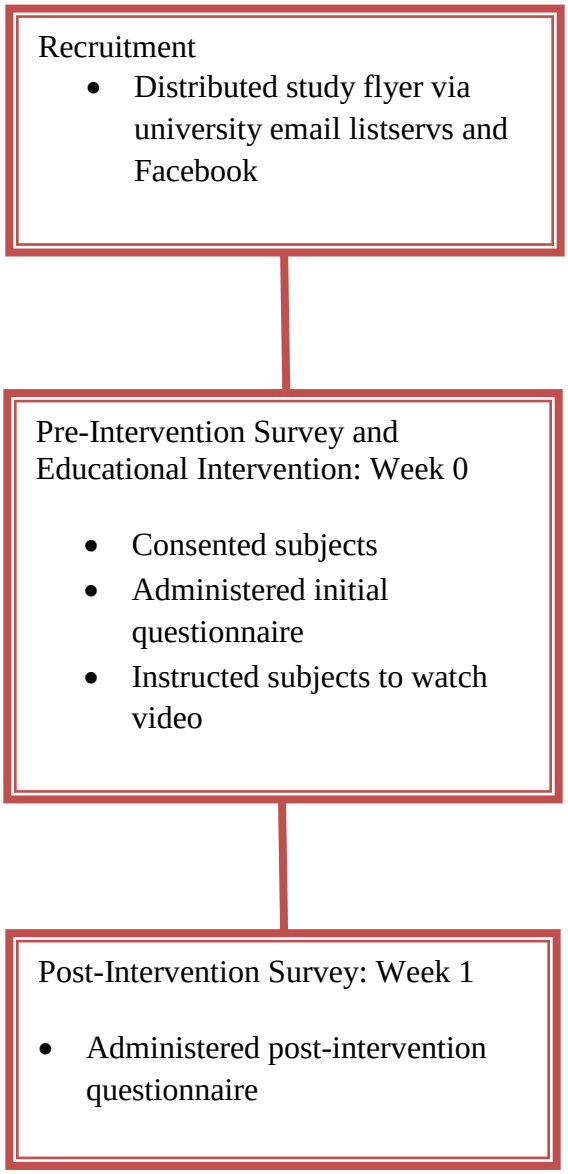
Sincerely,

IRB Administrator

cc: Brooke Clifford

APPENDIX B

STUDY FLOW CHART


Recruitment
Distributed study flyer via university email listservs and Facebook
Pre-Intervention Survey and Educational Intervention: Week 0
Consented subjects
Administered initial questionnaire
Instructed subjects to watch video
Post-Intervention Survey: Week 1
Administered post-intervention questionnaire

APPENDIX C

RECRUITMENT FLYER

School of Nutrition & Health Promotion
ARIZONA STATE UNIVERSITY

ASU Nutrition Research Study: Food Safety

The Nutrition program at ASU is recruiting healthy young adults for a research study involving two online questionnaires and a short, online video intervention.

Participants must be 18-29 years old, and prepare at least one meal per week from home.

Interested in participating? Please visit:

https://asuhealthpromotion.co1.qualtrics.com/jfe/form/SV_9zqKLU4grrXcb3f

Participation is voluntary

APPENDIX D

CONSENT STATEMENT

I am a graduate student under the direction of Dr. Johnston in the College of Health Solutions at Arizona State University. I am conducting a research study to examine the effect of a basic food safety intervention on consumer food safety knowledge in US young adults, over a week period.

I am inviting your participation, which will involve answering a 25-question survey and watching a short, 10-minute educational video. A second survey will be sent to your email address after one week for you to complete. Each survey should take about 10 minutes to complete. You have the right not to answer any question, and to stop participation at any time.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. Participants must be 18-29 years old; prepare at least one meal per week from home; and have no formal nutrition training or food safety education.

By participating in this study, one may benefit from an increase in food safety knowledge. Your responses to the survey will be used to assess food safety knowledge in consumers and test possible methods for improvement, if needed. There are no foreseeable risks or discomforts to your participation.

Email contact information will be used to link surveys, and email lists will be destroyed once the two surveys are connected to maintain confidentiality. Your responses will be anonymous. The results of this study may be used in reports, presentations, or publications but your name will not be used. Results will only be shared in the aggregate form.

If you have any questions concerning the research study, please contact the research team at: (602) 827-2265, or email at carol.johnston@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

By clicking "I consent" below you are agreeing to be part of the study.

- I consent
- I do not consent, and I wish to exit the study

APPENDIX E

INITIAL QUESTIONNAIRE

Please enter your email address.

Notice:
Email contact information will not be linked to data sheets, and email lists will be destroyed once the two surveys are connected to maintain confidentiality. Your responses will be anonymous. The results of this study may be used in reports, presentations, or publications but your name will not be used. Results will only be shared in the aggregate form.

What is your age?

Are you currently a student at ASU?

- [ ] Yes
- [ ] No

Have you ever taken a nutrition class in college? Select the best answer.

- ○ Never
- ○ One class
- ○ Two or more classes
- ○ Majored in Nutrition

Do you have any formal food safety education (ex. Food Handler's Card, ServSafe Certification)?

- ○ Yes
- ○ No

What is your gender?

- ○ Male
- ○ Female

Do you prepare a meal at home at least once a week?

- ○ Yes
- ○ No

The best way to keep from getting food poisoning from fresh fruits and vegetables is to wash them with

- regular soap.
- hot water.
- anti-bacterial soap.
- an anti-bacterial sponge.
- **cool running water.**

After you have used a cutting board to slice raw meat, chicken, or fish and need to cut other foods, which of these is the best way to prevent food poisoning?

Choice 1: wipe the cutting board off with a paper towel
Choice 2: rinse the cutting board under very hot water
Choice 3: turn the board over and use the other side
Choice 4: wash the cutting board with hot soapy water and rinse
Choice 5: set the cutting board aside and use a different cutting board to cut other foods

- Choice 1 or 3
- Choice 2, 3, or 5
- Choice 3 or 4
- **Choice 4 or 5**
- All of the choices

To prevent food poisoning, the best way to wash dishes is to:

Choice 1: wash and dry them in an automatic dishwasher
Choice 2: soak them in the sink for several hours and then wash them in the same water
Choice 3: hand-wash them right after the meal and then let them air-dry
Choice 4: hand-wash them right after the meal and then dry them with a dish towel

- Choice 1 or 2
- **Choice 1 or 3**
- Choice 2 or 4

- Choice 3 or 4
- Any choice is fine as long as the dishes look clean

When should kitchen counters be washed, rinsed, and sanitized?

- after each use
- when you begin working with another type of food
- at 4-hour intervals if the counter is in constant use
- **all of the above**

To prevent food poisoning, how often should the kitchen sink drain in your home be sanitized?

- **daily**
- weekly
- monthly
- only when food is going to be thawed or washed in the sink

Which is the most hygienic way to wash your hands?

- apply sanitizer, run water, rub hands together for 20 seconds, rinse hands, dry hands, rub on an antiseptic hand lotion
- apply soap, rub hands together for 20 seconds, rinse hands under water, dry hands, apply sanitizer
- **run water, moisten hands, apply soap, rub hands together for 20 seconds, rinse hands, dry hands**
- run water, moisten hands, apply sanitizer, rub hands together for 20 seconds, rinse hands, dry hands, rub on antiseptic hand lotion

Which should not be done when storing raw meat, fish, or poultry in the refrigerator?

- place it in the coldest part of the refrigerator.
- set it in a larger container before refrigerating.
- place it on the lowest shelf in the refrigerator.
- leave it in the package it came in
- **all should be done when storing raw meat, fish, or poultry**

What is the recommended freezer temperature for preventing food poisoning?

- **0 degrees F(-18 degrees C)**
- 18 degrees F (-8 degrees C)
- 24 degrees F (-4 degrees C)
- 32 degrees F (0 degrees C)

Imagine that your electricity went off and the meat, chicken, and/or seafood in your freezer thawed and felt warm. To prevent food poisoning, what should you do?

- **throw them away**
- cook them right away
- see how they smell or look before deciding what to do
- immediately re-freeze until solidly frozen, then cook them

For ground beef to be safe to eat, it needs to be cooked until its internal temperature reaches

- 90 degrees F (32 degrees C)
- 125 degrees F (52 degrees C)
- **160 degrees F (71 degrees C)**
- 250 degrees F (121 degrees C)

What is the maximum temperature refrigerators should be to preserve the safety of foods?

- 0 degrees F (-18 degrees C)
- 25 degrees F (-4 degrees C)
- **40 degrees F (4 degrees C)**
- 45 degrees F (7 degrees C)
- 60 degrees F (16 degrees C)

All foods are considered safe when cooked to a minimal internal temperature of

- 130 degrees F (54 degrees C)
- 140 degrees F (60 degrees C)
- 150 degrees F (66 degrees C)
- **165 degrees F (74 degrees C)**

Which method is the most accurate way of determining whether hamburgers are cooked enough to prevent food poisoning?

- cut one to check the color of the meat inside
- check the color of the juice to be sure it is not pink
- **measure the temperature with a food thermometer**
- check the texture or firmness of the meat
- measure the length of time the hamburgers cook

What is the least safe method for thawing a frozen roast?

- leave it in the refrigerator until it is thawed
- **leave it on the kitchen counter until it is thawed**
- put it in the microwave oven set to automatic defrost
- put it under running water for 1 hour

What is the safest method for cooling a large pot of hot soup?

- **put the soup in a shallow pan and refrigerate it right away**
- place the cooking pot filled with soup in the refrigerator right away
- transfer the soup to a clean, deep pot before refrigerating it
- leave it on the counter until it cools to room temperature, then refrigerate it
- add ice cubes to the soup

Chilling or freezing eliminates harmful germs in food.

- True
- **False**

Which food is least likely to cause food poisoning?

- slices of cantaloupe left on the counter overnight
- baked potato that was left on the kitchen counter overnight
- leftover turkey eaten cold
- **chocolate cake that was left on the kitchen counter overnight**

Salmonella bacteria can cause food poisoning. How can a food be made safe if it has salmonella in it?

- **cook it thoroughly**
- wash it under extremely hot running water
- freeze it for at least 3 days
- the food cannot be made safe

You may contaminate the next food you touch with salmonella bacteria if you don't wash your hands after touching:

- raw pork
- raw sprouts and lettuce
- raw beef
- **raw chicken**

APPENDIX F

VIDEO INTERVENTION LINK

Link to intervention video posted on YouTube: https://youtu.be/9icBFqYT4yE

APPENDIX G

BYRD-BREDBENNER ET AL. QUESTIONNAIRE (2007D)

Cross Contamination Prevention/Disinfection Procedures Scale

1. The best way to keep from getting food poisoning from fresh fruits and vegetables is to wash them with
() regular soap.
() hot water.
() anti-bacterial soap.
() an anti-bacterial sponge.
() cool running water.

2. After you have used a cutting board to slice raw meat, chicken, or fish and need to cut other foods, which of these is the best way to prevent food poisoning?
Choice 1: wipe the cutting board off with a paper towel
Choice 2: rinse the cutting board under very hot water
Choice 3: turn the board over and use the other side
Choice 4: wash the cutting board with hot soapy water and rinse
Choice 5: set the cutting board aside and use a different cutting board to cut other foods
() Choice 1 or 3
() Choice 2, 3, or 5
() Choice 3 or 4
() Choice 4 or 5
() All of the choices

3. To prevent food poisoning, the best way to wash dishes is to:
Choice 1: wash and dry them in an automatic dishwasher
Choice 2: soak them in the sink for several hours and then wash them in the same water
Choice 3: hand-wash them right after the meal and then let them air-dry
Choice 4: hand-wash them right after the meal and then dry them with a dish towel
() Choice 1 or 2
() Choice 1 or 3
() Choice 2 or 4
() Choice 3 or 4
() Any choice is fine as long as the dishes look clean

4. When should kitchen counters be washed, rinsed, and sanitized?
() after each use
() when you begin working with another type of food
() at 4-hour intervals if the counter is in constant use
() all of the above

5. Which procedure for cleaning kitchen counters is most likely to prevent food poisoning?
() spray with a strong sanitizing solution
() wash with a detergent, rinse, then wipe with a sanitizing solution

() wipe with a sanitizing solution, then rinse with clean water and wipe dry
() brush off any dirt or food pieces, then wipe with sanitizing solution

6. To prevent food poisoning, how often should the kitchen sink drain in your home be sanitized?
() daily
() weekly
() monthly
() only when food is going to be thawed or washed in the sink

7. Which is the most hygienic way to wash your hands?
() apply sanitizer, run water, rub hands together for 20 seconds, rinse hands, dry hands, rub on an antiseptic hand lotion
() apply soap, rub hands together for 20 seconds, rinse hands under water, dry hands, apply sanitizer
() run water, moisten hands, apply soap, rub hands together for 20 seconds, rinse hands, dry hands
() run water, moisten hands, apply sanitizer, rub hands together for 20 seconds, rinse hands, dry hands, rub on antiseptic hand lotion

8. If you have a sore on the back of your hand, should you prepare food for other people?
() Yes, if it isn't infected.
() Yes, if you put a bandage on it.
() Yes, if you wear a glove.
() Yes, if you bandage the sore and wear a glove.
() No, you should not prepare food until the sore heals.

9. Which should not be done when storing raw meat, fish, or poultry in the refrigerator?
() place it in the coldest part of the refrigerator.
() set it in a larger container before refrigerating.
() place it on the lowest shelf in the refrigerator.
() leave it in the package it came in
() all should be done when storing raw meat, fish, or poultry

10. To prevent food poisoning, which of these individuals should not prepare food for other people? (Check all that apply)
[] a person with diarrhea
[] a person with severe acne
[] a person with bandaged burns on his or her hands that are covered with gloves
[] a person with a fever
[] a person with unexplained itching
[] a person who smokes
[] a person with a sore throat
[] a person with a cold

[] a person with vomiting
[] person with HIV
[] none of these individuals

11. When preparing food, you should wash your hands after touching which of these? (Check all that apply)
[] your face
[] clean pots and pans
[] utensils that are being used to prepare food
[] fresh fruit
[] dishes that came out of the dishwasher
[] a pimple
[] clean countertop
[] clothing
[] none of these foods

Safe Times/Temperatures for Cooking/Storing Food Scale

1. Which practice is most likely to cause food poisoning?
() leaving stuffing in a cooked turkey until it cools to room temperature
() stuffing turkeys just before cooking them
() cooking turkeys until the stuffing reaches 165◦ F
() removing the giblet bag before cooking a turkey

2. When is it safest to place refrigerated foods in your cart when grocery shopping?
() early in the shopping trip
() about halfway through the shopping trip
() near the end of the shopping trip
() at the very end of the shopping trip, just before checking out
() it doesn't matter when I place them in the cart

3. What is the recommended freezer temperature for preventing food poisoning?
() 18 ◦F(−8 ◦C)
() 0 ◦F(−18 ◦C)
() 24 ◦F(−4 ◦C)
() 32 ◦F(0 ◦C)

4. Imagine that your electricity went off and the meat, chicken, and/or seafood in your freezer thawed and felt warm. To prevent food poisoning, what should you do?
() throw them away
() cook them right away
() see how they smell or look before deciding what to do
() immediately re-freeze until solidly frozen, then cook them

5. Which of the following is considered the most important way to prevent food poisoning?
() spray for pests in the kitchen area at least every week
() rarely or never serve leftovers
() keep foods refrigerated until it's time to cook or serve them
() clean kitchen counters with sanitizing solutions weekly

6. For ground beef to be safe to eat, it needs to be cooked until its internal temperature reaches
() 90 ◦F(32 ◦C)
() 125 ◦F(52 ◦C)
() 160 ◦F(71 ◦C)
() 250 ◦F (121 ◦C)

7. What is the maximum temperature refrigerators should be to preserve the safety of foods?
() 0 ◦F(−18 ◦C)
() 25 ◦F(−4 ◦C)
() 40 ◦F(4 ◦C)
() 45 ◦F(7 ◦C)
() 60 ◦F(16 ◦C)

8. If a family member is going to be several hours late for a hot meal, how should you store the meal to keep it safe until this person is ready to eat it?
() store it in the refrigerator and reheat it when the person is ready to eat it
() store it in on the kitchen counter until the person is ready to eat it
() store it in a cool oven until the person is ready to eat it
() store it in a warm oven until the person is ready to eat it

9. All foods are considered safe when cooked to an internal temperature of
() 130 ◦F(54 ◦C)
() 140 ◦F(60 ◦C)
() 150 ◦F(66 ◦C)
() 165 ◦F(74 ◦C)

10. Which method is the most accurate way of determining whether hamburgers are cooked enough to prevent food poisoning?
() cut one to check the color of the meat inside
() check the color of the juice to be sure it is not pink
() measure the temperature with a food thermometer
() check the texture or firmness of the meat
() measure the length of time the hamburgers cook

11. Which food does not need to be refrigerated to prevent food poisoning?
() fresh fruit salad
() roasted ears of corn on the cob
() open box of raisins
() chocolate pudding
() an open can of green beans

12. To prevent food poisoning, how long should leftover foods be heated?
() until they are boiling hot
() just until they are hot, but not too hot to eat right away
() just until they are at least room temperature
() reheating isn't necessary

13. What is the least safe method for thawing a frozen roast?
() leave it in the refrigerator until it is thawed
() leave it on the kitchen counter until it is thawed
() put it in a microwave oven set to automatic defrost
() put it in under running water for 1 hour

14. What is the safest method for cooling a large pot of hot soup?
() put the soup in a shallow pan and refrigerate it right away
() place the cooking pot filled with soup in the refrigerator right away
() transfer the soup to clean, deep pot before refrigerating it
() leave it on the counter until it cools to room temperature, then refrigerate it
() add ice cubes to the soup

Foods that Increase Risk of Foodborne Disease Scale

1. Chilling or freezing eliminates harmful germs in food.
() true
() false

2. Which food is least likely to cause food poisoning?
() slices of cantaloupe left on the counter overnight
() baked potato that was left on the kitchen counter overnight
() leftover turkey eaten cold
() chocolate cake that was left on the kitchen counter overnight

3. Eating which of these foods will increase a person's risk of food poisoning? (Check all that apply).
[] Raw oysters, clams, or mussels
[] Home canned beans, carrots, peas or potatoes right from the jar
[] Unpasteurized milk
[] Rare hamburgers

[] Leftover soup reheated until warm, but not boiling
[] Fried eggs with a runny or soft yolk
[] Raw homemade cookie dough or cake batter
[] Grilled steak served on the same plate that held raw steak without washing the plate
[] Sushi
[] Food right from the refrigerator that feels warm
[] Meat cooked medium-well
[] Unpasteurized fruit juice
[] Cooked shellfish that have unopened shells
[] Sliced melon
[] Foods prepared in a kitchen with a pet present
[] Fresh fruit salad stored at room temperature
[] Frozen foods with frost build up on the package
[] Food stored in a cabinet beside oven
[] Fresh raw milk cheese
[] Soft food like jelly or sour cream after scraping off mold
[] Soft scrambled eggs
[] Raw sprouts (alfalfa, clover, radish)
[] Commercially canned vegetables right out the can without re-heating them
[] Picnic foods that were stored at room temperature for more than 2 hours
[] Box of rice that does not show a USDA inspection stamp
[] none of these foods

Groups at Greatest Risk for Foodborne Disease Scale

1. People should be especially careful about not eating raw seafood, if they have
() diabetes.
() HIV infection.
() cancer.
() any of these diseases.

2. Which foods do pregnant women, infants, and children not need to avoid?
() soft cheeses, cold smoked fish, cold deli salads
() hot dogs and lunchmeats that have not been reheated
() raw or undercooked eggs
() canned vegetables, pasteurized fruit juice
() These individual do not need to avoid any type of food

3. Compared to most people, which of these individuals are more likely to get sick or seriously ill from harmful germs in food? (Check all that apply)
[] preschool children
[] teenagers
[] pregnant women
[] older people (age 60 and over)

[] people who are HIV positive
[] cancer patients
[] people who frequently eat at restaurants or get take-out food often
[] none of these individuals

Common Food Sources of Foodborne Disease Pathogens

1. Salmonella bacteria can cause food poisoning. How can a food be made safe if it has salmonella in it?
() cook it thoroughly
() wash it under extremely hot running water
() freeze it for at least 3 days
() the food cannot be made safe
() don't know

2. Staph (Staphylococcus) bacteria that cause food poisoning are most likely associated with which food?
() contaminated water from unfiltered mountain streams and lakes
() food prepared by cooks with their bare hands and then left at room temperature
() undercooked pork, especially bacon
() raw or undercooked eggs and poultry
() don't know

3. Botulism is a disease that is most likely associated with which food?
() canned foods
() food prepared by cooks with their bare hands and then left at room temperature
() undercooked pork, especially bacon
() raw eggs, or raw or undercooked poultry
() don't know

4. Listeria bacteria are most likely associated with which food?
() home canned foods
() raw or undercooked beef
() deli meats
() raw eggs and poultry
() don't know

5. Harmful E. coli bacteria are most likely associated with which food?
() raw or undercooked pork
() sliced lunch meat
() soft cheeses like Brie
() raw or undercooked beef
() don't know

6. Trichinosis is most likely associated with which food?
() deli meats
() raw or undercooked pork
() soft cheeses like Brie
() raw or undercooked beef
() don't know

7. Campylobacter bacteria are most likely associated with which food?
() canned food
() raw or undercooked pork
() raw or undercooked poultry
() raw or undercooked beef
() don't know

8. You may contaminate the next food you touch with salmonella bacteria if you don't wash your hands after touching:
() raw pork.
() raw sprouts and lettuce.
() raw beef.
() raw chicken.
() don't know