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Characterization of Food Safety Knowledge, Attitudes, and Behaviors of Adolescents in East Tennessee

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To the Graduate Council:

I am submitting herewith a thesis written by Ashley S. Pedigo entitled "Characterization of Food Safety Knowledge, Attitudes, and Behaviors of Adolescents in East Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Food Science and Technology.

F. Ann Draughon, Major Professor

We have read this thesis and recommend its acceptance:

Agricola Odoi, Arnold M. Saxton, Doris H. D'Souza

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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**Characterization of Food Safety Knowledge, Attitudes,
and Behaviors of Adolescents in East Tennessee**

A Thesis Presented for
the Master of Science Degree
The University of Tennessee, Knoxville

Ashley S. Pedigo
May 2008

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Abstract

Educational research suggests that middle school is an ideal time to teach food safety since adolescents are in the process of setting life-long behaviors and are, therefore, more likely to synthesize new food safety knowledge into positive behaviors.

The objectives of this study were to: 1) Describe the baseline food safety knowledge and attitudes/ behaviors of 7th grade students in East Tennessee 2) determine the relationship with geographic location, socioeconomic status, race, and gender; and 3) compare the current data (Study 2) to a previous study (Study 1) that pre-tested 7th grade students prior to an education intervention.

A 40-item survey was administered to 232 students in 12 schools chosen using a weighted, stratified random sample. A hierarchical model was used to obtain least squares means at the school and student levels. To compare Studies 1 and 2, independent sample t-tests and chi-square analysis were applied to determine significant differences in food safety knowledge or attitudes/behaviors between the populations.

Study 2 results showed that 63% knew the importance of hand-washing, but only 50% reported 'always' washing their hands before eating or preparing food; 50% reported 'always' following temperature directions, but 85% did not know how to determine if a hamburger was cooked properly. No statistical difference was found in food safety knowledge for all variables except race, where Asian/Pacific students scored lower ($p=0.0005$). Males ($p=0.0133$) and Asian/Pacific students ($p=0.0033$) reported

riskier food handling behaviors. No significant differences ($p < 0.05$) were found between Study 1 and 2 in food safety knowledge or attitudes/behaviors.

Hand-washing and use of proper temperatures, as well as differences in behavior within gender and some ethnic groups should be focal points in adolescent food safety education. These results suggest that some differences in knowledge and behaviors are less pronounced in adolescents than those found in similar studies with adults. The results of the comparison between adolescent studies suggest that the food safety curriculum targeted to adolescents of Study 1 would likely be effective at raising student knowledge and improving students' food handling behaviors in a larger population of 7th grade students.

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Chapter One: Review of Food Safety Education Literature

Introduction

Foodborne illness continues to be a major cause of economic burden, human suffering, and death in the United States (DHHS, 1999). The Centers for Disease Control and Prevention report that an estimated 76 million illnesses and 5,000 deaths are attributed to foodborne illness each year (Mead et al., 1999). Disturbingly, a significant proportion of foodborne illnesses may be attributed to improper food preparation and hygiene by consumers (Redmond and Griffith, 2003; Bean and Griffin, 1990). In fact, greater than 20% of illness may occur due to mishandling by consumers (Olsen et al., 2000). Several studies have emphasized the importance of the consumer as the “final line of defense” in the prevention of foodborne illness because they comprise the final step in the food preparation process (Redmond and Griffith, 2003; Zhang and Penner, 1999; Fein et al., 1995). Concern about the consumer’s role in food protection has increased attention on food safety education. As a result, the Healthy People 2010 initiative, which reports that 71% of meals and 78% of snacks are prepared by consumers, has identified increasing the proportion of consumers who follow key food safety practices as 1 of its 7 food safety objectives (DHHS, 2008). This emphasis on improving consumer food safety practices has prompted considerable research in food safety education interventions focused on consumer knowledge and behaviors.

Food Safety Knowledge

In 1997, the partnership for Food Safety Education launched the Fight BAC!TM campaign to teach consumers about safe food handling (USDA, 1997). The campaign focuses on four messages, which are *clean*: wash hands and surfaces often, *separate*: don’t cross-contaminate, *cook*: cook to proper temperature, and *chill*: refrigerate

promptly. Medeiros et al. (2001) also recommended that consumer food safety education should focus on hand washing, cooking practices, avoiding cross-contamination, and keeping food at safe temperatures, as well as, avoiding food from unsafe sources. They also suggested that incidence of foodborne illnesses should be a primary determinant in establishing the focus of food safety. Thus, poor personal hygiene, is associated with 10 million cases of foodborne illness/year, and cooking and cross-contamination practices, which are associated with 3.4 million cases of foodborne illness/year, should receive the most attention in food safety programs (Medeiros et al., 2001). Many studies have identified gaps in or a lack of knowledge in many of these focal areas of food safety education (Bryd-Redbenner et al., 2007; Meer and Misner, 2000; Bruhn and Shutz, 1999; Woodburn and Raab, 1997; Altekruise et al., 1996; Albrecht, 1995). Redmond and Griffith (2003) stated that although levels of adult consumer knowledge determined in food safety surveys have differed, a majority reviewed in their study concluded that adult consumer knowledge of food safety is inadequate and requires improvement. In fact, their study estimated the following proportions of U.S. adult consumers lacked knowledge of key food safety practices: hand-washing and drying, 14-21%; separation of raw and cooked meats during food preparation, 20-22 %; refrigeration temperatures, 40-56 %; and correct heating temperature, 80-93 % (Redmond and Griffith, 2003).

Disconnect Between Knowledge and Behavior

Despite the reported lack of knowledge of food safety practices in scientific literature, the majority of adult consumers (80%) think they are adequately informed regarding food safety (Bruhn and Shutz, 1999). Of greater concern are disconnects observed between food safety knowledge and reported safe behaviors of adult consumers.

Albrecht (1995) indicated that adult consumers did not clearly understand or implement safe food handling practices for which knowledge was exhibited. Albrecht's study with 426 adults found that 88 % demonstrated knowledge of preventive cross contamination practices, but only 75 % reported implementing those practices (Albrecht, 1995). Patil et al. (2005) also reported that adult consumer knowledge of safe handling practices does not correspond with reported use of the practices, suggesting that knowledge is a poor indicator of actual behavior. Their meta-analysis from 20 studies reported a 10 % difference between knowledge and self-reported behavior of hand-washing/hygiene practices, and 18.2 % difference in preventive cross-contamination practices (Patil et al., 2005). Altekruise et al. (1996) also reported similar results with 1620 adult consumers in hand-washing practices: 86 % of adult consumers demonstrated knowledge, but only 66% reported washing their hands after handling raw meat. In the same study, results in cross-contamination practices were: 80 % knew to separate raw and cooked foods, but 67% reported not using a clean cutting board between foods (Altekruise et al, 1996). Other studies have reported comparable results for hygiene/hand-washing and preventive cross-contamination practices (Byrd-Bredbenner et al., 2007; Garayoa et al., 2006; Redmond and Griffith, 2000).

Validity of self-reported behaviors

Redmond and Griffith (2003) suggested that self-reported behavior may provide valid information on awareness or indirect knowledge about "correct" behaviors rather than precise information on actual behaviors. Social scientists have suggested that participants may claim to perform the perceived "correct" behaviors in order to convey a positive image (Bowling, 2000). Despite the tendency to inflate the performance of food

safety behaviors, several studies have suggested that reported unsafe practices and misunderstandings about safe food handling exist with respect to many factors, like hygiene/hand-washing and cross contamination, that are known to contribute to food borne illness. In fact, one survey indicated that unsafe food hygiene practices were reported by one third of the respondents (Altekruse et al., 1996).

Comparison of observed behavior with self-reported behavior and knowledge

With the validity and reliability of self-reported behaviors under question, a few researchers have compared food safety knowledge with both reported behaviors and observed behaviors. Anderson et al. (2004) videotaped 99 adult participants in the U.S. handling food in their homes and concluded that consumers are repeatedly making food-handling errors in their homes and thus, increasing their risk of foodborne illness. Their study found that 79 % demonstrated knowledge of hand washing practices and 87% self-reported washing their hands before food preparation, but only 45 % were observed washing hands before handling food (Anderson et al., 2004). Likewise, they found that 97 % of consumers demonstrated knowledge of preventive cross-contamination practices, but 98 % were observed cross-contaminating from raw meat to ready-to-eat food due to improper cleaning and sanitizing of hands and surfaces (Anderson et al., 2004). Their study also found that 30 % reported owning a food thermometer, but only 5 % were observed using a thermometer to determine the “doneness” of their meat (Anderson et al., 2004). The results of that study show that the proportions of consumers who report safely handling foods are substantially higher than those who were actually observed implementing safe food handling practices. Data from an Australian study also revealed differences between reported behaviors on a questionnaire and behaviors observed via

video monitoring for safe food handling and hygiene practices (Jay et al., 1999). Because of such discrepancies between knowledge, reported behaviors, and actual behavior, researchers have concluded that knowledge of food safety practices does not always result in the correct execution of food safety behaviors (Anderson et al., 2004; Redmond and Griffith, 2003; Jay et al., 1999).

The Effect of Food Safety Attitudes/Perceptions on Behaviors

It has been suggested that consumer attitudes and perceptions of foodborne illness may contribute to awareness, concern, and knowledge of food safety issues, which may lead to increased preventive food safety behaviors (Fein et al., 1995; Redmond and Griffith, 2003). Experts believe that most cases of foodborne disease are caused by consumer-prepared food (IFT, 1995). However, Fein et al. (1995) state that there is a misperception of the nature of foodborne illness and the most likely place where the problem food was prepared. Their study with participants from two telephone surveys (1988 and 1993) found that most respondents perceived foodborne illness to be a minor sickness characterized by gastrointestinal upset without fever that comes on within a day of eating contaminated food, most likely a flesh food from a restaurant (Fein et al., 1995). In two U.S. studies, only 16 % (Williamson et al, 1992) to 23 % (Woodburn and Raab, 1997) of consumers were found to perceive their homes as likely places to acquire a foodborne illness. Redmond and Griffith (2003) found similar results in a review of United Kingdom studies with 9 to 35 % of consumers regarding the home as a likely source of food poisoning.

Optimistic bias and perception of food safety risks

It may be that many misperceptions about food safety, including the home as a common source, may stem from an underlying attitude and perception known as optimistic bias. Several researchers have investigated optimistic bias, where consumers believe they are less likely to suffer food poisoning than other people, and its effects on the implementation of preventive food safety behaviors (Parry et al., 2004; Redmond and Griffith, 2003; Weinstein and Lyon, 1999). These researchers found that consumers perceive that risk of foodborne illness from self-prepared food was very low, with Redmond and Griffith (2003) reporting as high as 90 % of consumers demonstrating this perception. Redmond and Griffith (2003) also reported in their review that 66 % of consumers thought they had full or nearly full control of their safety of food and 84 % perceived their personal responsibility for food safety to be high. These results indicate that while perceived threat or risk of foodborne illness is low, self efficacy (i.e. the perception that one can have some effect on the outcome of the risk), was high.

The Health Belief Model on food safety perceptions and the relationship with behavior

In an application of the Health Belief model to predict food safety actions, Schafer et al. (1993) found that participants who perceived unsafe food as a personal threat, who had higher self efficacy, and who exhibited high health motivation were significantly more likely to implement safe food handling behavior. Analysis of data from two Food and Drug Administration (FDA) surveys (1988 and 1993) revealed that consumers who believed they had experienced a foodborne illness had an elevated awareness of foodborne pathogens, indicated concern about food safety issues, demonstrated a higher perception of foodborne illness and risk, and presented superior

scores on knowledge of food safety behaviors (Fein et al., 1995). Likewise, consumers from Kentucky who perceived higher food safety risks, including the likelihood of becoming sick and the source of foodborne illness, exhibited safer food handling behaviors (Roseman and Kurzynske, 2006). Since consumers' attitudes and perceptions toward food safety may affect safe food handling behaviors, researchers will likely continue to focus on areas of low or misperception, like the home as a source of foodborne illness, to attempt to increase perceived personal threat and awareness of food safety issues.

Food Safety Knowledge and Behavior Population Differences

For effective food safety education and risk communication to encourage safe food handling practices, behavioral differences between various subpopulations must be understood (McIntosh et al., 1994). Several studies have found food handling practices to differ by gender, ethnicity, age, income, and other demographic characteristics (Patil et al., 2005; Altekruise, 1996; Klontz et al., 1995). Gender differences in various food handling practices have been reported in many studies. Overall, studies find that safer food practices are reported by women than men (Patil et al., 2004; Li-Cohen and Bruhn, 2002; Klontz et al., 1995). From a national telephone survey with 1,415 participants, Altekruise (1995) found that women significantly demonstrated more knowledge of hand-washing practices and implemented significantly safer food handling practices than men in the areas of hygiene and cross-contamination. An Arizona survey with 222 participants produced similar results with women demonstrating significantly higher food safety knowledge and reporting safe food preparation and handling behaviors (Meer and Misner, 2000). In self-reported food safety behaviors, Patil et al. (2004) found that men

reported significantly higher incidences of consumption of raw/undercooked ground beef and poor hygienic practices than women. Several other studies have found similar results with men reporting less safe behaviors than women in a variety of food handling practices: men seldom or never washed fruits and vegetables (Li-Cohen and Bruhn, 2002); 23.9 % of men did not adequately wash hands after handling raw meat (Roseman and Kurzynske, 2006).

Relationships of Race, Education level, Socioeconomic Status, Geographic location

Research in food safety knowledge and behaviors has focused on a variety of other demographic characteristics like race, socioeconomic status or income, education level, and geographic location. Meer and Misner (2000) found that Caucasians scored significantly higher ($p < 0.001$) in food safety knowledge than Hispanics, but no significant differences were found among other ethnic groups, including: African Americans, Asian/Pacific, or Native Americans. Likewise, a FoodNet survey from 1996 to 1997 of 7,493 consumers found that Hispanics were more likely to engage in fewer safe food handling behaviors, such as washing hands and cutting boards after handling raw meat, than other ethnic groups (Shiferaw et al., 2000). However, Patil et al. (2005) found that the difference in good hygiene between Caucasians and Hispanics was not significant, but that African Americans and Asian reported significantly higher use than Caucasians or Hispanics. In a study of consumers in Kentucky, Caucasian responders were found to be less likely to wash their hands after handling raw meat than were other races (Roseman and Kurzynske, 2006). Despite the varying results of differences among ethnic groups between studies, overall research suggests that race does play a role in

determining food safety knowledge and behaviors of consumers (Meer and Misner, 2000; Shiferaw et al., 2000).

Consumer education level, which is typically divided into greater or less than 12 years of education, has also been found to be important when analyzing food safety knowledge and behaviors. It has been reported that knowledge of good hygiene increases with education, but actual hand-washing practices did not differ by educational status (Altekruse et al., 1996). That study also reported that while knowledge of adequate cooking increased with education level, the practices of serving or consuming adequately cooked foods (i.e. hamburgers that were medium or well done) decreases with education (Altekruse et al., 1996). Meer and Misner (2000) reported similar results in food safety knowledge, with participants of the highest education level (i.e. greater than 12 yrs.) scoring significantly higher, but found that there was no significant differences seen in food safety behavior scores or the likelihood of consuming high risk foods among the different education levels. Several other studies have reported an inverse relationship between safe food handling behaviors and education, with the highest educated consumers engaging in the riskiest behaviors, especially in regards to consumption of adequately cooked meats (Roseman and Kurzynske, 2006; Li-Cohen and Bruhn, 2002; Shiferaw et al., 2000; Klontz et al., 1995). Patil et al. (2005) reported that for individuals without a high school education, reported use of safe food handling behaviors exceeded demonstrated knowledge on those practices by 33%; conversely, for individuals with greater than a high school education, knowledge exceeded reported use by 31.9%. The pattern of food safety knowledge and behaviors within education levels found in previous

research indicates that this characteristic should be seriously considered when designing education and risk communication efforts for consumers.

Some research has observed the relationship between food safety knowledge, attitudes, and behaviors with socioeconomic status or income levels of consumers. Patil et al. (2005) found that high-income individuals (>\$50,000 annual household income) reported greater consumption of unsafe foods, less knowledge of hygiene, and poorer cross-contamination practices. Other studies have reported that higher-income households (ranging from: >50,000 to >99,999) are more likely to practice unsafe food handling practices (Li-Cohen and Bruhn, 2002; Klontz et al., 1995; Williamson et al., 1992). However, Roseman and Kurzynske (2006) found that consumer with household incomes greater than \$75,000 were more likely to use safe refrigeration and cooling techniques than other demographic groups. They also reported that consumers with the lowest (<\$12,500) and highest (>\$75,000) were the most confident in the nation's food supply, but an analysis between food safety perceptions and behaviors found that consumers who were very or somewhat confident in the food supply were more likely to practice unsafe behaviors (Roseman and Kurzynske, 2006).

The effect of geographic location of residence on food safety knowledge and behaviors has received little attention in research. Patil et al. (2005) found that individuals residing in metropolitan areas or cities reported the highest consumption of raw or undercooked ground beef. They also found that use of preventive cross-contamination practices was poorest in the rural Mountain area (Patil et al., 2005). Other studies report that consumers from urban areas tend to have lower food safety knowledge scores than those from rural areas (Shiferaw et al. 2000; Albrecht, 1995). An Arizona

study between two metropolitan counties with different core cities (Phoenix and Tucson) revealed a difference approaching significance in food safety practices (Meer and Misner, 2000). The results from these studies suggest that location of residence may somewhat be related to food safety knowledge and/or behaviors of consumers.

Throughout food safety knowledge and behavior research, no demographic group consistently outperformed another in every safe handling practice. Overall, food safety behavior differences according to gender, race, socioeconomic level, and other demographic characteristics do exist and can be helpful in tailoring education and risk communication efforts to target groups.

Food Safety Knowledge and Behaviors by Age

The association of frequent food preparation and gender with safe practices suggests that food handling skills may be acquired through factors related to training, experience preparing food, or maturation (Tauxe et al., 1987). These factors are most likely correlated with an increase in age, thus several studies have included age in their analysis of food safety knowledge and behaviors. Altekruze et al. (1996) found that unsafe practices were reported more often by adults 18 to 29 years of age, particularly in regards to implementation of preventive cross-contamination practices. Other studies have reported similar results, with consumers ranging from 18-25 reporting the most risky food handling behaviors (Roseman and Kurzynske, 2006; Patil et al., 2005; Li-Cohen and Bruhn, 2002). Likewise, studies have reported that older consumers (ranging from 35 and older to 50 and older) report safer behaviors than younger consumers. Interestingly, Altekruze et al. (1996) reported that while safe practices did increase with age, knowledge of food hygiene practices did not. The disparity between knowledge and

self-reported practices may relate to food handling experience, which may be lacking in young adults (Tauxe et al., 1987).

Recently, studies have begun to focus on young adults, mostly college or high school students. Many of the same gaps in knowledge and disconnects between behavior that are found with adult consumers in previous studies in the food safety education focal areas of good hygiene, adequate cooking, and preventive cross-contamination practices were found among young consumers (Byrd-Bredbenner et al., 2007; Garayoa et al., 2005; Unklesbay et al., 1998). Also, in studies among college students ranging from 18 to 27 years old, female students were found to outperform males on knowledge, reported practices, and attitudes towards food safety (Byrd-Bredbenner et al., 2007; Garayoa et al., 2005; Unklesbay et al., 1998). Additionally, Unklesbay et al. (1998) found that students of both genders who had enrolled in a college course that included food safety information had significantly higher attitude and practice scores than students who had not. However, Byrd-Bredbenner et al. (2007) found that number of nutrition, microbiology, and food science courses were not significantly related to food safety knowledge or behavior. However, they did report that 84 % of their sample prepared at least one meal every week. These results imply that some exposure in food safety or experience in food handling practices may lead to increased safer behaviors. Also, studies with college students reveal that many of the disconnects between knowledge and behaviors and some of the differences among demographic groups have already been established by the college years.

Food Safety Education of Adolescents

Despite a consensus in the public health community that learning safe food-handling habits at an early age benefits health in the short and long term, many adolescents (5th – 8th grade) have not received adequate education on the topic of food safety (USDA, 1998). With the increase of pathogenic microbes (Byrd-Bredbenner et al., 2007) and the changes in eating habits of Americans, today's youth are more at risk of contracting a foodborne illness than previous generations (Coulston, 1999; ADA, 1997). It has been suggested that adolescents have had limited opportunities to learn about safe food handling for at least two reasons: changes in the education system have resulted in the reduction or elimination of courses and curricula in family and consumer sciences where food safety was once taught (USDA, 1998; Beard, 1991); and increasing numbers of working mothers and growing reliance on convenience, take out, and restaurant foods have decreased opportunities for adolescents to learn safe food handling through observation (USDA, 1998; Kastner, 1995). Researchers suggest that the most effective food safety education is tailored toward changing those behaviors which are most likely to result in foodborne illnesses: cook, clean, chill, and separate (Medeiros et al, 2001). The success of these interventions depends upon alignment of educational strategies with specific needs of the targeted demographic groups that will motivate them to practice safer food handling.

Richards et al. (2008) suggests that middle school is an ideal time to teach food safety since adolescents are in the process of setting life-long behaviors and are, therefore, more likely to synthesize new food safety knowledge in a way that will lead to the development of life-long behaviors. Haapala and Probart (2004) also agree that there

is a need for food safety education among adolescents and that the school setting would be an effective place to reach young consumers. Their study with 178 middle school students found that this group had only a fair level of food safety knowledge regarding the food safety education focal points (cook, clean, chill, and separate) with 72 % answering correctly. Likewise, Richards et al. (2008) reported that in their study of 233 7th grade students, 51 % demonstrated correct food safety knowledge. They also found disconnects between knowledge and behavior with 73 % of students reporting desirable food safety attitudes and behaviors (Richards et al., 2008). Haapala and Probart (2004) revealed the same disconnect. Their study also highlighted the finding that no significant difference in food safety knowledge or behavior was indicated between genders, whereas, similar studies with adults overwhelmingly report that females score higher than males (Haapala and Probart, 2004). The study also suggested that the lack of gender difference may be consistent with the finding that boys and girls participated equally in meal and snack preparation at home (Haapala and Probart, 2004). These results, along with government initiatives, support the need for further study of food safety knowledge, attitudes, and behaviors among adolescents to improve consumer education efforts and, ultimately, have positive effects on changing consumer food safety behaviors.

Purpose of This Study

Without baseline data, it is difficult to develop and implement effective education efforts (Contento et al., 2002). Constructing a baseline of food safety knowledge, attitudes, and behaviors for various demographic groups is vital for determining the specific educational strategies that will motivate consumers to practice safer food handling.

In this research, adolescents are targeted for several reasons: educational research has shown that it is the best time for establishing life-long, healthy behaviors; many have begun preparing meals or working in food service; and adolescents are currently an understudied population in food safety knowledge and behaviors. Many factors can affect knowledge and attitudes toward food safety and subsequent behaviors. Research has highlighted demographics like gender, race, geographic location of residence (urban, suburban, rural), socioeconomic status, and food handling experience as possible determinants.

The objectives of this study were to: 1) develop a rigorous statistical sampling method to allow for the collection of data on the food safety knowledge, attitudes, and behaviors of 7th grade students in East Tennessee; 2) analyze that data to construct a baseline and identify gaps in food safety knowledge, attitudes, and behaviors; and 3) determine the relationships with variables such as geographic location, socioeconomic status, gender, and food handling experience. The results of this study will allow researchers and educators to more effectively develop and implement food safety education materials for this age group, as well as target specific populations in need of educational interventions.

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**Chapter Two: Characterization of Food Safety Knowledge,
Attitudes, and Behaviors of Adolescents in East Tennessee**

Abstract

Educational interventions can improve food safety knowledge and behaviors if they are aligned with specific needs of target groups. Establishing a baseline for food safety knowledge in adolescents is important because it is understudied in this group, and research shows adolescence is an ideal time to establish life-long behaviors.

The objectives of this study were to: 1) develop a statistical sampling method to measure food safety knowledge and behaviors of 7th grade students in East Tennessee; 2) identify gaps in food safety knowledge and behaviors; and 3) determine the relationships with geographic location, socioeconomic status, race, and gender.

A 40-item survey assessing food safety knowledge and behaviors was administered to 232 students in 12 schools chosen using a weighted, stratified random sample. A hierarchical model was used to obtain least squares means at the school and student levels.

Results showed that 63% knew the importance of hand-washing, but only 50% reported 'always' washing their hands before eating or preparing food; 50% reported 'always' following temperature directions, but 85% did not know how to determine if a hamburger was cooked properly, and 74% did not know how to safely thaw meat. No statistical difference was found in food safety knowledge for all variables except race, where Asian/Pacific students scored lower ($p=0.0005$). Males ($p=0.0133$) and Asian/Pacific students ($p=0.0033$) reported riskier food handling behaviors.

Hand-washing and use of proper temperatures, as well as differences in behavior within gender and some ethnic groups should be focal points in adolescent food safety

education. These results suggest that some differences in knowledge and behaviors are less pronounced in adolescents than those found in similar studies with adults. With limited food handling experience and fewer relationships with demographic factors, dissemination of knowledge and development of safe behaviors through adolescent education may prove successful in improving consumer food safety.

Introduction

It has been estimated that greater than 20% of foodborne illnesses may occur due to mishandling by consumers (Olsen et al., 2000). Several studies have emphasized the importance of the consumer as the “final line of defense” in the prevention of foodborne illness because they comprise the final step in the food preparation process (Redmond and Griffith, 2003; Fein et al., 1995; Zhang and Penner, 1999). Concern about the consumer’s role in food protection has increased attention on food safety education. As a result, the Healthy People 2010 initiative, which reports that 71% of meals and 78% of snacks are prepared by consumers, has identified increasing the proportion of consumers who follow key food safety practices as one of its seven food safety objectives (DHHS, 2008). This emphasis on improving consumer food safety practices has prompted considerable research in food safety education interventions focused on consumer knowledge and behaviors.

Researchers suggest that for effective food safety education and risk communication to encourage safe food handling practices, behavioral differences between various subpopulations must be understood (McIntosh et al., 1994). Several studies have found food handling practices to differ by gender, ethnicity, age, income, and other demographic characteristics (Patil et al., 2005; Altekuse, 1996; Klontz et al., 1995). Overall, studies find that safer food practices are reported by women than men; (Patil et al., 2004; Li-Cohen and Bruhn, 2002; Klontz et al., 1995). While results of differences among ethnic groups between studies have greatly varied, overall research suggests that race may play some role in determining food safety knowledge and behaviors of consumers (Roseman and Kurzynske, 2006; Patil et al, 2005; Meer and

Misner, 2000; Shiferaw et al., 2000). Several studies have reported an inverse relationship between safe food handling behaviors and education, with the highest educated consumers engaging in the riskiest behaviors, especially in regards to consumption of adequately cooked meats (Roseman and Kurzynske, 2006; Patil et al., 2005; Li-Cohen and Bruhn, 2002; Shiferaw et al., 2000; Klontz et al., 1995). Some research has observed the relationship between food safety knowledge, attitudes, and behaviors with socioeconomic status or income levels of consumers. Many studies have found that high-income adults (>\$50,000 annual household income) reported greater consumption of unsafe foods, less knowledge of hygiene, and more likely cross-contamination practices (Patil et al., 2005; Li-Cohen and Bruhn, 2002; Klontz et al., 1995; Williamson et al., 1992). The effect of geographic location of residence on food safety knowledge and behaviors has received little attention in research. Patil et al. (2005) found that individuals residing in metropolitan areas or cities reported the highest consumption of raw or undercooked ground beef and that use of preventive cross-contamination practices was poorest in the rural mountain area (Patil et al., 2005). Other studies report that consumers from urban areas tend to have lower food safety knowledge scores than those from rural areas (Shiferaw et al. 2000; Albrecht, 1995).

The association of frequent food preparation and gender with safe practices suggests that food handling skills may be acquired through factors related to training, experience preparing food, or maturation (Tauxe et al., 1987). Many studies found that unsafe practices were reported more often by adults 18 to 29 years of age, particularly in regards to implementation of preventive cross-contamination practices (Roseman and Kurzynske, 2006; Patil et al., 2005; Li-Cohen and Bruhn, 2002; Altekruse et al. 1996).

Interestingly, Altekruse et al. (1996) reported that while safe practices did increase with age, knowledge of food hygiene practices did not. The disparity between knowledge and self-reported practices may relate to food handling experience, which may be lacking in young adults (Tauxe et al., 1987).

Throughout food safety knowledge and behavior research, no demographic group consistently outperformed another in every safe handling practice. Overall, food safety behavior differences according to gender, race, socioeconomic level, and other demographic characteristics do exist and can be helpful in tailoring education and risk communication efforts to target groups.

Recently, studies have begun to focus on young adults, mostly college or high school students. Many of the same gaps in knowledge and disconnects between behaviors that are found with adult consumers in the areas of good hygiene, adequate cooking, and preventive cross-contamination practices were found among young consumers (Byrd-Bredbenner et al., 2007; Garayoa et al., 2005; Unklesbay et al., 1998). These studies concluded that some exposure in food safety or experience in food handling practices may lead to increased safer behaviors. Also, research with college students reveals that some of the differences among demographic groups with adult consumers have already been established by the college years.

Despite a consensus in the public health community that learning safe food-handling habits at an early age benefits health in the short and long term, many adolescents (5th – 8th grade) have not received adequate education on the topic of food safety (USDA, 1998). Some researchers contend that with the increase of contamination of food with pathogenic microbes (Byrd-Bredbenner et al, 2007) and the changes in

eating habits of Americans, today's youth are more at risk of experiencing a foodborne illness than previous generations (Coulston, 1999; ADA, 1997). Adolescents are targeted for food safety educational research because many have begun or will soon begin preparing meals or working in food service, and they are currently an understudied population in food safety knowledge and behaviors. Richards et al. (2008) suggests that middle school is an ideal time to teach food safety since adolescents are in the process of setting life-long behaviors and are, therefore, more likely to synthesize new food safety knowledge in a way that will lead to the development of safer life-long behaviors.

Effective educational interventions for adolescents can lead to improved food safety habits, but the success of these interventions depends upon alignment of educational strategies with specific needs of the targeted demographic group. Research suggests that without baseline data, it is difficult to develop and implement effective education efforts (Contento et al., 2002). Constructing a baseline of food safety knowledge, attitudes, and behaviors for various demographic groups is vital for determining the specific educational strategies that will motivate adolescents to practice safer food handling.

The objectives of this study were to: 1) develop a rigorous statistical sampling method to allow for the collection of data on the food safety knowledge, attitudes, and behaviors of 7th grade students in East Tennessee; 2) analyze that data to construct a baseline and identify gaps in food safety knowledge, attitudes, and behaviors; and 3) ascertain the relationship of variables such as geographic location, socioeconomic status (SES), gender, and food handling experience with food safety knowledge, attitudes, and behaviors.

Materials and Methods

Study Design. Participants in the study were 7th grade students attending East Tennessee schools chosen through a proportionally weighted, random sample stratified by U.S. Census Bureau Standard Metropolitan Areas (SMA) classification of the county in which the school is located. The 2006 SMA Data Book describes the general concept of a Metropolitan or Micropolitan statistical area as “a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core”. Counties that were not defined by this method were assigned the classification “Other” by the investigator. Within the Metropolitan area classification, counties were further stratified by the principal city (Knoxville, Chattanooga, or Tri-Cities) to ensure a proportionally weighted sample according to percentage of students in that area. The random number generator command in Microsoft Excel was used to randomly select a total of 15 schools (7 Metropolitan, 4 Micropolitan, and 4 schools from the Other SMA) from the possible 193 East TN schools that housed a 7th grade to contact for participation. A minimum of three schools per SMA was applied to ensure replication within the sample. The rigor of this methodology allowed the results to be generalized to the entire 7th grade population in East TN (24,701 students).

Questionnaire development. The study instrument, administered as 40 item questionnaire assessing food safety knowledge, attitudes and behaviors, was adapted from an instrument developed and validated as part of a larger research project (Richards et al., In Press). This survey consisted of 20 multiple-choice knowledge questions, 11 true/false and 9 Likert-scale (1- Never, 4-Always) questions assessing attitudes and behavior.

Assessment items were written to measure specific food safety learning objectives that were appropriate for adolescent learners. These learning objectives were identified by the Tennessee Food Safety Task Force and a panel of food safety and microbiology experts from the University of Tennessee's Department of Food Science and Technology. The instrument was evaluated by an independent testing expert and field tested by a group of similar seventh grade students at a middle school not selected in this study for reliability and validity ($\alpha=0.868$) prior to its use. A 5 item demographic questionnaire assessing gender, race, and food handling experience was administered concurrently. (See Appendix 1 for a copy of the assessment).

Participation and Data Collection. Access to study participants was gained through the support and cooperation of administrators and teachers of participating schools.

Informed consent/assent letters were given to students and their parents or guardians to determine participation. All surveys were prepared by the investigator and shipped to the sites to reduce the likelihood of misadministration. Teachers at the test site collected all consent forms from participating students in their classrooms, administered the 20-25 minute survey, and shipped them directly to the investigator. Students received a pencil and coupon donated by a local food company and, in some cases, extra class credit as incentives for participation.

Data Analyses. Surveys were scored by the University of Tennessee Office of Information and Technology Test Scanning and Scoring department. Individual student assessment scores were considered outliers and removed from the data set under the following conditions: (1) the entire assessment was not finished, or (2) student responses

were “offline” on the scantron sheet giving too few or too many answers on the answer form.

Item analyses by question were completed by aggregating and sorting data in Microsoft Excel to describe the participants’ responses and determine baseline knowledge and attitudes/behaviors for food safety measures in this survey. All statistical analyses were completed using SAS (version 9.1, Cary, NC). The study participants were characterized by gender, race, socioeconomic status (SES), geographic location of residence, and food handling experience using the frequency procedure. Contingency table analysis with the exact test was used to determine significant differences in food safety knowledge or attitudes/behaviors between genders.

Mean knowledge scores were obtained by totaling the 20 knowledge questions, while attitude/behavior mean scores were determined by adding the 11 true/false and 9 Likert scale (never, rarely, sometimes, always) behaviors for each subject. Total knowledge and attitudes and behavior scores were normalized to 100 with a possible range of scores of 0 to 100. A hierarchical model with geographic location (SMA) and SES at the school level and gender and race at the student level was used to obtain least squares means to measure the relationships of these demographic variables with food safety knowledge or attitudes/ behaviors total scores of adolescents in this study. Mean separation and differences of least squares means by the demographic variables was obtained using Tukey-Kramer’s adjustment for significance value.

Results and Discussion

Twelve of the 15 randomly selected schools in East Tennessee agreed to participate. Figure 1 displays the SMA classification (Metropolitan, Micropolitan, and

Other) for counties in East Tennessee, as well as, the locations of the participating schools. One school from each of the SMA classification areas chose not to participate for one or more of the following reasons: participation required both parental and student consent, administrators and/or teachers did not feel like time from the regular curriculum could be spared, or the school or school system did not allow data to be collected from students. The number of participating schools for each SMA was proportionally weighted to the population and included: 6 schools from the Metropolitan areas with two from each core city, 3 schools from the Micropolitan areas, and 3 from the Other area classification (Figure 1). A total of 232 7th grade students returned consent forms and completed the survey. The sample sizes for each school ranged from 8 to 38 students (Table 1). The SES level, as determined by the Department of Education free and reduced lunch program, for each school ranged from 25.3 to 99.3 percent, which is the percentage of students in that school that are economically disadvantaged (Table 1). Seven of the 12 participating schools in this survey had SES levels greater than the 50 % level that determines government funding for programs like free and reduced lunch.

In describing the demographic characteristics at the student level, most participants in this study were female (63.2 %) and Caucasian (74.5 %) (Table 2). Studies surveying food safety knowledge of college students have described similar populations with females comprising 62 to 65 % of respondents (Byrd-Bredbenner et al., 2007; Unklesbay et al., 1998). Some food safety surveys with adult consumers report the percentage of respondents who are female to be as high as 80 to 85 % (Roseman and Kurzynske, 2006; Li-Cohen and Bruhn, 2002; Meer and Misner, 2000). In many surveys,

both with college students and adults, Caucasians make up the majority (greater than 60 %) of respondents.

Food handling experience. The food handling experience of adolescents in this study and the mean knowledge and attitudes/behaviors scores and differences by response are described in Table 3. The majority (62.61 %) of adolescents report preparing both meals and snacks with a significantly higher proportion ($p=0.0016$) of females reporting meals and snacks as the primary types of food they prepare when compared to snacks only or no food preparation. The types of food prepared had an effect on the overall attitudes/behaviors scores with students who prepared both meals and snacks reporting significantly safer attitudes/behaviors than students who prepared no foods or snacks only; however, knowledge was not significantly different by types of food prepared. Most (40.87 %) prepare 0 to 5 meals or snacks in one week. There was no significant relationship between the total knowledge or attitudes/behaviors scores of the students or differences between genders for any response to the number of meals or snacks prepared. Students reported eating at a restaurant or fast food with their family 0 to 3 times a week, with no response difference between genders. Students who reported eating out with their family 0 to 3 or 4 to 10 times per week demonstrated significantly greater food safety knowledge than students who ate out more than 10 times a week, but attitudes/behaviors were not significantly different among levels of eating out.

In their study with 178 7th and 8th grade students, Haapala and Probart (2004) also found that the majority of students (52 %) prepare meals or snacks with females and males participating equally in food preparation. Byrd-Bredbenner et al. (2007) reported that 84 % of college students (mean age 19.9 ± 1.9) prepared at least one meal every

week. These results suggest that adolescents are beginning to prepare foods and while the frequency of food preparation will increase, even at the college level, food handling experience is limited among young consumers.

Knowledge measures. The adolescents in this study (n=231) demonstrated only a fair level of food safety knowledge, answering on average 48 % of the knowledge questions correctly. Richards et al. (2008) similarly found that 7th grade students (n =233) from 5 schools in Tennessee and North Carolina demonstrated only 51 % correct food safety knowledge, while Haapala and Probart (2004) found that 7th and 8th grade students (n = 178) had a slightly higher total with 72 % correct knowledge. It should be noted that the instrument in this study was a modified version of the survey used by Richards et al. (2008), thus knowledge differences with Haapala and Probart (2004) is likely due to differences in the instrument, not actual student knowledge.

The knowledge of adolescents in the current study on key food safety issues is described in Table 4. The adolescents demonstrated high levels (63–79 %) of knowledge in the importance and frequency of proper hygiene. The majority of participants (83 %) overestimated the temperatures needed to safely cook ground beef, but many (67 %) incorrectly chose color, over the use of a thermometer, as the best indicator of “doneness” of a hamburger. Awareness of cooling practices for leftover foods was high (88 %), but knowledge of proper meat defrosting methods was low with only 26 % correctly answering that thawing in the refrigerator is the safest method. The adolescents’ understanding of preventive cross-contamination practices, like separating foods and using different or clean utensils between foods, was fair with 57-62 % correctly

answering. Participants' knowledge of foodborne pathogens was low with 38 % not correctly recognizing *E. coli* O157:H7 as a pathogen that could cause foodborne illness.

Haapala and Probart (2004) reported similar results with adolescents demonstrating high levels of knowledge in proper hygiene (85 %) and cooling practices (89 %). However, their study reported that 63 % of adolescents correctly identified using a thermometer as the safest indicator of doneness of meat. This finding greatly differs from the current study which found that 67 % of adolescents identified color as the best indicator of doneness. The inconsistency in these findings may be due to the fact that question regarding safest method for determining meat doneness in the Haapala and Probart study was a true/false item, while the survey question in our study offered multiple choice answers.

Attitude/Behavior measures. Student perceptions of risk of foodborne illness were high, while self efficacy and personal responsibility towards food safety were fairly low (Table 5). Less than half of students felt they could affect their risk of foodborne illness by correctly handling foods, identifying higher risk foods, or recognizing common symptoms. Adolescents in the Haapala and Probart (2004) study also exhibited high perceptions toward the risk and severity of foodborne illness and low self efficacy. College students were found to have higher (82 %) self-efficacy scores (Byrd-Bredbenner et al., 2007). With adult consumers, Redmond and Griffith (2003) reported that while perceived threat or risk of foodborne illness was low, self efficacy was high with 66 % of consumers thinking they had full or nearly full control of their food safety and 84 % perceived their personal responsibility for food safety to be high. Overall, these results

suggest that a high level of confidence in ability to handle food safely increases with age and food handling experience.

Reported safe food handling behaviors by adolescents in this study were high for most behavior measures (Table 5); however, disconnects between knowledge and the reported behaviors in hygiene and temperature practices were observed. In this study, results showed that 63% knew the importance of hand-washing, but only 51% reported 'always' washing their hands before eating or preparing food; 79 % demonstrated knowledge of the importance of washing their hands after using the restroom, but only 59 % reported 'always' doing so; 50% reported 'always' following temperature directions, but 85% did not know how to determine if a hamburger was cooked properly, and 74% did not know how to safely thaw meat. These results support the findings of other research with adolescents (Haapala and Probart, 2004), college students (Byrd-Bredbenner et al., 2007; Garayoa et al., 2005), and even adults (Patil et al., 2005; Redmond and Griffith, 2003; Altekruise et al., 1996) where their reported behaviors exceeded their actual knowledge.

Knowledge and attitudes/behaviors by gender. Overall, no significant difference ($p=0.0805$) was found between genders in total food safety knowledge, with mean scores ranging from 38 to 42 % correct (Table 7). However, responses to some knowledge questions were significantly different by gender (Table 6). Only the questions regarding hygiene were highly significant ($p=0.0006$) with 55 % of females and only 23 % of males responding correctly. There was a significant difference ($p=0.0133$) between genders in overall scores for attitudes/behaviors towards food safety (Table 7). Significant differences in responses to questions relating to self efficacy and proper hygiene between

genders was observed (Table 6). Again, the difference between genders was highly significant for hygiene practices with females reporting higher frequency of washing hands after using the restroom (41 %) and using hand sanitizer (35 %) as compared to male reported behaviors, 18 and 14 %, respectively.

Many studies of college students and adults have reported that females demonstrate higher food safety knowledge and reported behaviors than males (Byrd-Bredbenner et al., 2007; Patil et al., 2005; Redmond and Griffith, 2003; Altekruise et al. 1996). However, Haapala and Probart (2004) also found, as in the current study, no overall significance difference of food safety knowledge between genders in adolescents. Their study suggested that with increasing age, females tend to get more practice in food handling and therefore score higher than males in studies of adults. Others have also suggested that food safety knowledge may increase with age and experience (Patil et al., 2005; Li-Cohen and Bruhn, 2002; Altekruise et al. 1996; Tauxe et al., 1987). The findings that reported attitudes and behaviors differ between genders in the current study may be explained by the higher proportion of females preparing both meals and snacks, and thus receiving more experience in handling a variety of foods. However, the frequency of food preparation or handling experience for adolescents in this study was low with no difference between genders. The overall lack of experience with food safety issues among adolescents may explain the lack of difference between genders in food safety knowledge.

Association with demographic variables. The socioeconomic status variable was found to be confounded with other variables, and thus was not included in the model.

Geographic area (i.e. location of residence) was not significant ($p > 0.05$) in determining

food safety knowledge or attitude/behavior of adolescents (Table 7). The association between geographic location of residence and food safety knowledge and behaviors has received little attention in research. Patil et al. (2005) found that use of preventive cross-contamination practices was poorest in the rural mountain area (Patil et al., 2005). Other studies report that consumers from urban areas tend to have lower food safety knowledge scores than those from rural areas (Shiferaw et al. 2000; Albrecht, 1995). The results from the current study suggest that any association between geographic location of residence and food safety knowledge or behaviors are yet to be established in adolescents in this study.

Significant differences were found with race for both knowledge ($p=0.0002$) and attitudes/behaviors ($p=0.0033$) (Table 6). Differences of least squares means were highly significant for both knowledge ($p=0.0021$) and attitudes/behaviors ($p=0.0189$) between Asian/Pacific and Caucasian students, with Caucasian students scoring higher (Table 8). There was also a significant difference between the knowledge scores of Caucasian and Native American students ($p=0.0363$), again with Caucasian students scoring higher. No significant differences were found between other ethnic groups.

Few studies with adolescents or college students have investigated and reported the relationship of race on food safety knowledge or attitudes and behaviors. Meer and Misner (2000) found that Caucasian adults scored significantly higher ($p<0.001$) in food safety knowledge than Hispanics, but no significant differences were found among other ethnic groups. Likewise, a FoodNet survey from 1996 to 1997 of 7,493 consumers found that Hispanics were more likely to engage in fewer safe food handling behaviors, such as washing hands and cutting boards after handling raw meat, than other ethnic groups

(Shiferaw et al. 2000). However, Patil et al. (2005) found that the difference in good hygiene between Caucasians and Hispanics was not significant, but that African Americans and Asian reported significantly higher use of good hygiene than Caucasians or Hispanics. The results from the current study indicated that Caucasian students score significantly higher in food safety knowledge measures and report safer behaviors than Asian/Pacific students. However, it should be noted that the Asian/Pacific student population was very small (less than 10 students) and 2 students of this ethnicity were removed from the sample as outliers since their questions were not completed. It is possible that a significant language barrier existed for some Asian/Pacific students, thus skewing results. However, the finding from this study that Caucasian students score higher in food safety knowledge and report safer attitudes and behaviors supports the findings of several studies with adults (Patil et al., 2005; Meer and Misner, 2000; Shiferaw et al. 2000).

Significance

While there have been many studies on the topics of food safety knowledge, attitudes, and behaviors, very few have focused on adolescents. This study aids in constructing a baseline of food safety knowledge, attitudes, and behaviors for various demographic groups that is vital for determining the specific educational strategies that will motivate adolescents to practice safer food handling. Overall, the adolescents in this study have less than optimal levels of food safety knowledge and safe food handling behaviors. Students' reported behaviors often exceeded their valid knowledge, especially relating to personal hygiene and cooking practices. Many studies have reported that knowledge may not definitively determine behaviors, so emphasis must be placed on not

only increasing knowledge, but encouraging and empowering adolescents to change their behaviors. Engaging students in age specific and hands-on activities that have real-world applications of food safety in the school setting will reinforce the importance of these concepts in students' daily lives.

The findings of this study support the need for food safety education efforts geared toward adolescents with focal points in hand-washing and use of proper cooking temperatures, as well as differences in behavior within gender and some ethnic groups. The results in this study suggest that some differences in knowledge and behaviors between demographic groups are less pronounced in adolescents than those found in similar studies with adults. With limited food handling experience and weaker relationships with demographic factors, dissemination of knowledge and development of safe behaviors through adolescent education may prove successful in improving consumer food safety. The information from this study will allow researchers and educators to more effectively develop and implement food safety education materials for this age group, as well as target specific populations in need of educational interventions.

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Chapter Two Tables

Table 1. Demographic characteristics of participating schools in East Tennessee

School	District ¹	Geographic area ²	SES level ³	Sample size ⁴
1	Bradley	Metro- Chattanooga	39.3	32
2	Polk	Metro- Chattanooga	66.0	14
3	Washington	Metro- Tri-Cities	57.0	38
4	Carter	Metro- Tri-Cities	57.6	10
5	Lenoir City	Metro- Knoxville	63.3	10
6	Knox	Metro- Knoxville	25.3	36
7	Newport	Micropolitan	41.1	13
8	Greene	Micropolitan	43.8	11
9	Cocke	Micropolitan	99.3	26
10	Scott	Other	97.8	8
11	Morgan	Other	48.6	20
12	Monroe	Other	69.8	16

¹District is designated by the Tennessee Department of Education

²Geographic area is based on U.S. Census Bureau Standard Metropolitan Areas classification

³SES (socioeconomic status) level represents the percentage of students in that school that are economically disadvantaged (i.e. eligible for the free and reduced lunch program)

⁴Sample size refers to the number of students in that school that participated in the food safety survey and submitted consent forms

Table 2. Demographic characteristics of participating 7th graders in East Tennessee

Characteristic	# Students (%)
Gender (n = 231)	
Female	146 (63.2)
Male	78 (33.8)
Race (n = 228)	
African American	15 (6.6)
Asian/Pacific	6 (2.6)
Caucasian	170 (74.5)
Hispanic	15 (6.6)
Native American	23 (10.1)
Geographic area ¹ (n = 232)	
Metropolitan	138 (59.5)
Micropolitan	49 (21.1)
Other	45 (19.4)

¹Geographic area is based on U.S. Census Bureau Standard Metropolitan Areas classification

Table 3. Food handling experience of participating East Tennessee 7th graders

Food Handling Experience	Total number (%)	Female number (%)	Male number (%)	Mean scores and differences ¹ among experience responses	
				Total Knowledge ² estimate \pm SE	Total Attitudes/Behaviors ² estimate \pm SE
Types of food prepared ³ (n = 230)					
Prepare no foods	30 (13.04)	14 (6.09)	16 (6.96)	42.1 \pm 3.0 ^A	59.6 \pm 2.4 ^B
Snacks only	54 (23.48)	27 (11.74)	27 (11.74)	50.0 \pm 2.3 ^A	69.0 \pm 1.9 ^B
Meals and snacks *	144 (62.61)	105 (45.65)	39 (16.96)	49.9 \pm 1.6 ^A	73.4 \pm 1.4 ^A
No answer	2 (0.87)	1 (0.44)	1 (0.44)	38.0 \pm 3.8 ^A	60.9 \pm 6.0 ^{AB}
Number of meals or snacks prepared ⁴ (n = 230)					
0 to 5	94 (40.87)	59 (25.65)	36 (15.65)	48.4 \pm 1.8 ^A	69.2 \pm 1.4 ^A
6 to 10*	83 (36.09)	56 (24.35)	27 (11.74)	49.0 \pm 4.1 ^A	72.3 \pm 1.5 ^A
More than 10	50 (21.74)	32 (13.91)	18 (7.83)	50.8 \pm 3.2 ^A	70.6 \pm 6.5 ^A
No answer	3 (1.30)	1 (0.44)	2 (0.87)	25.6 \pm 7.8 ^B	57.7 \pm 2.0 ^A
Frequency of eating out ⁵ (n= 230)					
More than 10 times	10 (4.35)	5 (2.17)	5 (2.17)	33.8 \pm 5.1 ^B	61.8 \pm 4.2 ^{AB}
4 to 10	65 (28.26)	43 (18.70)	22 (9.57)	48.2 \pm 2.1 ^A	70.2 \pm 1.6 ^A
0 to 3	150 (65.24)	97 (42.17)	53 (23.04)	50.6 \pm 1.5 ^A	71.8 \pm 1.1 ^A
No answer	5 (2.17)	2 (0.87)	3 (1.30)	35.2 \pm 5.8 ^{AB}	56.9 \pm 4.8 ^B

¹ Mean separation based on Tukey-Kramer ($p < 0.05$) adjustment method. Means within responses to food handling experience questions followed by the same letter are not significantly different

² Knowledge and Attitudes/Behaviors scores normalized to 100, with possible range of scores 0 to 100.

³ Significant difference between female and male response ($p = 0.0016$)

* Large deviation and cell chi-square values indicate specific response differs by gender

⁴ Number of meals or snacks prepared by the student in one week ($p = 0.6130$)

⁵ Frequency the student and their family eats out (i.e. at a restaurant or fast food) in one week ($p = 0.6058$)

Table 4. East Tennessee adolescents' knowledge of select food safety issues

Food safety issue	Level ¹ of knowledge demonstrated
Hygiene/hand-washing	63 % knew washing hands was important to prevent illness 79 % indicated hand should be washed after using the bathroom, before handling food, and more frequently when someone is sick
Adequate cooking	67 % thought color was the best indicator of doneness of a hamburger, while only 15 % knew a food thermometer should be used 83 % chose 180°F or above as safe temperatures for ground beef cooking
Cooling practices	88 % answered that leftover foods should be refrigerated within 2 hours 39 % considered defrosting frozen meat on the kitchen counter to be safe; only 26 % correctly chose thawing in the refrigerator as the safest method
Preventive cross-contamination practices	62 % knew that using the same knife to cut raw chicken and vegetables was an example of cross-contamination 57 % recognized that raw meat, poultry, and seafood should be kept separate from other foods to prevent cross contamination
Knowledge of foodborne illness and pathogens	83 % thought that food could make them sick if not handled properly 38 % did not recognize <i>E. coli</i> O157:H7 as a pathogen

¹ Level refers to percent of students (n = 231 students) reporting the specified answer

Table 5. East Tennessee adolescents' reported behaviors and attitudes towards food safety risk, self efficacy, and personal responsibility

Food safety issue	Level ¹ of attitude or behavior expressed
Perception of risk of foodborne illness	<p>63 % believed that almost all foodborne illnesses are preventable</p> <p>71 % perceived foodborne illness to be serious enough to require medical attention</p> <p>83 % thought bacteria in food could cause illness if the food is not handled correctly</p>
Self efficacy towards foodborne illness	<p>32 % felt they could 'always' correctly handle food to prevent illness</p> <p>14 % believed they could 'always' identify foods with higher risks for foodborne illness</p> <p>36 % expected they could 'always'(12 %) or 'sometimes'(24 %) recognize common symptoms of foodborne illness</p>
Personal responsibility towards food safety	<p>35% anticipated being able to 'always' properly handle foods to prepare a safe meal for their family</p> <p>48 % reported that when they see adults handling food improperly, they 'always'(18 %) or 'sometimes'(30 %) point out their mistakes</p>
Reported food safety behaviors	<p>77 % report 'always'(50 %) or 'sometimes'(27 %) carefully following time and temperature directions when preparing food</p> <p>80 % report 'always'(51 %) or 'sometimes'(29 %) washing hands before preparing or eating food</p> <p>59 % report 'always' washing hands after using the restroom</p> <p>66 % report 'always'(12 %) or 'sometimes'(24 %) using hand sanitizer to clean their hands</p>

¹ Level refers to percent of students (n = 231) reporting the specified answer

Table 6. Significant differences¹ in East Tennessee adolescent knowledge and attitudes/behaviors of food safety by gender

Food safety issue	% Answering knowledge question correctly or responding to attitudes/behavior statements 'always' or 'sometimes'		
	Female	Male	P – value
<u>Knowledge</u>			
Q. When should hands be washed? A. after using the bathroom, before handling food, and more frequently when someone is sick	55.41	23.81	0.0006
Q. What is the safest way to defrost meat? A. in the refrigerator	14.29	12.55	0.0446
Q. A pathogen is: A. a bacterium that can make you sick	42.42	18.18	0.0247
Q. It is okay to eat pizza that has been sitting out on the counter all night A. False	51.08	23.81	0.0274
Q. Bacteria cannot grow in food stored in the refrigerator A. False	50.65	22.51	0.0086
<u>Attitudes/Behaviors</u>			
Q. I feel that I know how to correctly handle my food so that I do not become sick A. Sometimes	35.93	13.42	0.0397
Q. I could properly handle food to prepare a safe meal for my family A. Always	26.84	9.09	0.0417
Q. I use hand sanitizer to clean my hands A. Sometimes	34.63	13.85	0.0276
Q. I wash my hands after each time I used the restroom A. Always	41.13	18.18	0.0288

¹Significant differences (p< 0.05) obtained from the exact test in contingency table analysis. (n=231)

Table 7. Least squares estimates and mean separation¹ of knowledge and attitudes/behaviors of adolescents by gender, race, and geographic area

Effect	Knowledge ² estimate ± SE	Attitudes/Behaviors ² estimate ± SE
Gender³		
Female	42.0 ± 2.1 ^A	66.2 ± 18.7 ^A
Male	38.4 ± 2.2 ^A	63.3 ± 1.8 ^B
Race⁴		
African American	43.2 ± 3.8 ^{AB}	63.8 ± 3.1 ^{AB}
Asian/Pacific	26.8 ± 6.0 ^B	54.5 ± 5.1 ^A
Caucasian	49.5 ± 1.3 ^A	70.2 ± 1.1 ^B
Hispanic	41.5 ± 4.1 ^{AB}	67.9 ± 3.2 ^{AB}
Native American	40.0 ± 3.2 ^B	65.1 ± 2.4 ^{AB}
Geographic area⁵		
Metropolitan	43.3 ± 1.9 ^A	68.4 ± 1.6 ^A
Micropolitan	36.6 ± 2.7 ^A	62.4 ± 2.3 ^A
Other	40.7 ± 2.8 ^A	62.3 ± 2.2 ^A

¹ Mean separation based on Tukey-Kramer (p<0.05) adjustment method. Means within gender, race, or geographic area followed by the same letter are not significantly different

² Knowledge and Attitudes/Behaviors scores normalized to 100, with possible range of scores 0 to 100. SE = standard error. (n=231)

³ Gender fixed effect test: knowledge p = 0.0805; attitudes/behaviors p = 0.0133

⁴ Race fixed effect test: knowledge p = 0.0002; attitudes/behaviors p = 0.0033

⁵ Geographic area fixed effect test: knowledge p = 0.866; attitudes/behaviors p = 0.0280

Table 8. Differences of least squares means within geographic area, gender, or race

Obs	Effects	Effect differences	Adjusted P value ¹	
			Knowledge	Attitudes/Behaviors
1	Area	Metro – Micro	0.0765	0.0683
2	Area	Metro – Other	0.5862	0.0532
3	Area	Micro – Other	0.4486	0.9998
4	Gender	Female – Male	0.0805	0.0133
5	Race	African American – Asian/Pacific	0.1477	0.5192
6	Race	African American – Caucasian	0.5283	0.2754
7	Race	African American – Hispanic	0.9982	0.8878
8	Race	African American – Native American	0.9678	0.9973
9	Race	Asian/Pacific – Caucasian	0.0021	0.0189
10	Race	Asian/Pacific – Hispanic	0.2369	0.1599
11	Race	Asian/Pacific – Native American	0.2734	0.2916
12	Race	Caucasian – Hispanic	0.3214	0.9496
13	Race	Caucasian – Native American	0.0363	0.205
14	Race	Hispanic – Native American	0.9982	0.9512

¹Tukey-Kramer's adjusted p-value: significance at $p < 0.05$ (n=231)

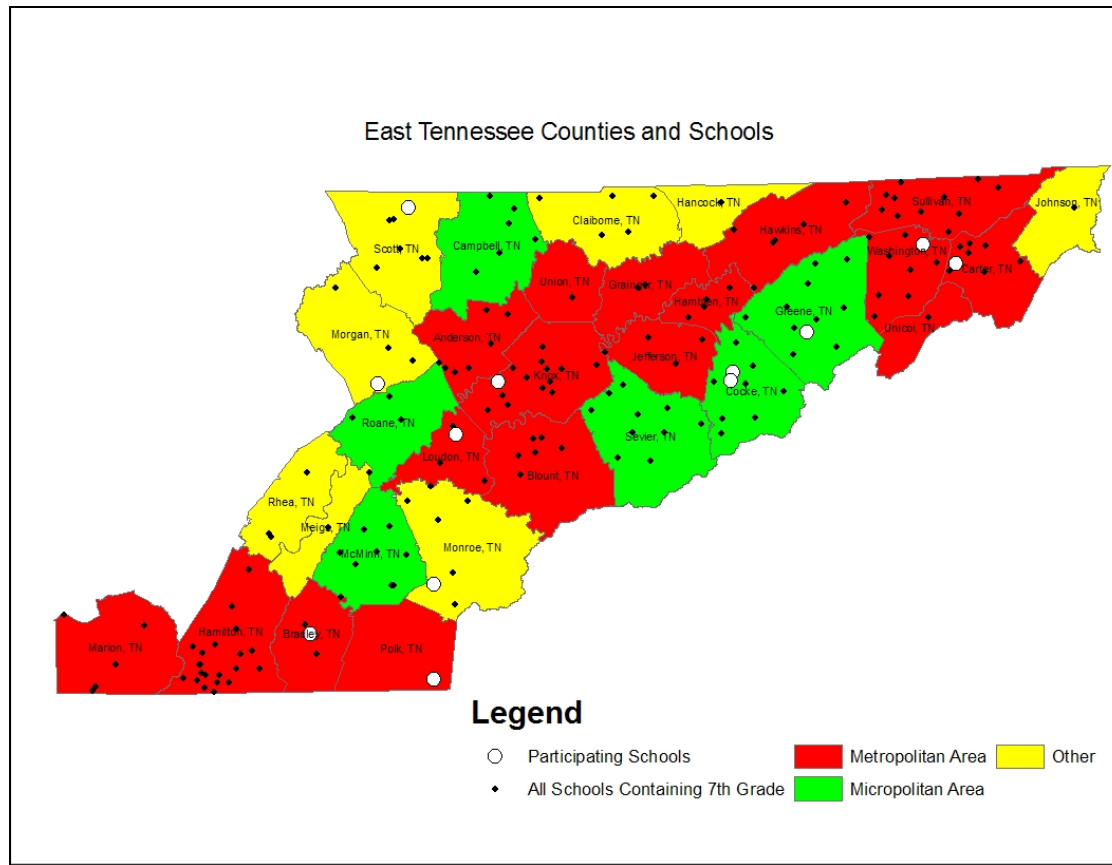


Figure 1. Map of East Tennessee SMA and participating schools

**Chapter Three: Comparison of Adolescent Baseline Food
Safety Knowledge, Attitudes, and Behaviors from Two Studies**

Abstract

Educational research suggests that middle school is an ideal time to teach food safety since adolescents are in the process of setting life-long behaviors and are, therefore, more likely to synthesize new food safety knowledge into positive behaviors. Describing the baseline of food safety knowledge, attitudes, and behaviors for adolescents is vital for determining the specific educational strategies that will motivate them to practice safer food handling.

The objective of this investigation was to compare the data resulting from two studies which measured food safety knowledge, attitudes, and behaviors of 7th grade students in an attempt to better define the baseline knowledge of adolescents in East Tennessee (TN). Both studies used modified forms of the same survey. Independent sample t-tests and chi-square analysis were applied to describe and determine significant differences in food safety knowledge or attitudes/behaviors between the study populations.

No significant differences ($p < 0.05$) were found between study populations in food safety knowledge or attitudes/behaviors, thus supporting the findings of each study that their samples were representative of the larger 7th grade population. The results of this comparison suggest that the food safety curriculum targeted to adolescents and implemented within core discipline classrooms of Study 1 would likely be effective at raising student knowledge and improving students' food handling behaviors across the entire population of 7th grade students in East TN.

Introduction

Despite a consensus in the public health community that learning safe food-handling habits at an early age benefits health in the short and long term, many adolescents (5th – 8th grade) have not received adequate education on the topic of food safety (USDA, 1998). Some researchers contend that with the increase of pathogenic microbes (Byrd-Bredbenner et al, 2007) and the changes in eating habits of Americans, today's youth are more at risk of experiencing a foodborne illness than previous generations (Coulston, 1999; ADA, 1997). It has been suggested that adolescents have had limited opportunities to learn about safe food handling for at least two reasons: changes in the education system have resulted in the reduction or elimination of courses and curricula in family and consumer sciences where food safety was once taught (USDA, 1998; Beard, 1991); and increasing numbers of working mothers and growing reliance on convenience, take out, and restaurant foods have decreased opportunities for adolescents to learn safe food handling through observation (USDA, 1998; Kastner, 1995). Researchers suggest that the most effective food safety education is tailored toward changing those behaviors which are most likely to result in foodborne illnesses: cook, clean, chill, and separate (Medeiros et al., 2001). The success of these interventions depends upon alignment of educational programs with specific needs of the targeted demographic groups in order to motivate them to practice safer food handling.

Food safety education resources for kindergarten through 12th grade students are available through a wide variety of sources. A well known example of such a resource is the Fight BAC!TM campaign launched by the partnership for Food Safety Education to teach consumers about safe food handling by focusing on four messages of clean,

separate, cook, and chill (USDA, 1997). However, this resource and others have not been widely used in school classrooms. Richards et al. (2008) suggest that a likely reason is that many teachers are unaware of the resources and uncertain of how to incorporate them into their current curricula that is already strained by the state curriculum standards and accountability testing. Also, they propose that teachers are unlikely to teach materials with which they have little background knowledge or interest, especially when little attention is paid to educating the teacher who will implement those materials (Richards et al., 2008). Richards et al. (2008) found that designing an educational intervention that correlated food safety concepts to state-tested curriculum standards and included an intensive two day training session for teachers was an effective means of successfully integrating food safety materials into core discipline classrooms.

Educational research suggests that middle school is an ideal time to teach food safety since adolescents are in the process of setting life-long behaviors and are, therefore, more likely to synthesize new food safety knowledge in a way that will lead to the development of life-long behaviors (Richards et al., 2008; USDA, 1998). Haapala and Probart (2004) also agree that there is a need for food safety education among adolescents and that the school setting would be an effective place to reach young consumers. Their study with 178 middle school students found that this age group had only a fair level of food safety knowledge regarding the food safety education focal points (cook, clean, chill, and separate) with 72 % answering correctly. Likewise, Richards et al. (2008) reported that in their study of 233 7th grade students, 51 % demonstrated correct food safety knowledge. They also found disconnects between knowledge and behavior with 73 % of students reporting desirable food safety attitudes and behaviors (Richards et al.,

2008). Haapala and Probart (2004) revealed the same disconnect. Their study also highlighted the finding that no significant difference in food safety knowledge or behavior was indicated between genders, where as, similar studies with adults overwhelmingly report that females score higher than males (Haapala and Probart, 2004). The study also suggested that the lack of gender difference may be consistent with the finding that boys and girls participated equally in meal and snack preparation at home (Haapala and Probart, 2004). These results, along with government initiatives, support the need for further study of food safety knowledge, attitudes, and behaviors among adolescents to improve consumer education efforts and, ultimately, have positive impacts on changing consumer food safety behaviors.

The objective of this investigation was to statistically compare the baseline food safety knowledge, attitudes, and behaviors of 7th grade students between two studies to better define the baseline of food safety knowledge and attitudes/behaviors for adolescents in East TN.

Materials and Methods

Context of Study 1: “Food Safety in the Classroom” (Richards et al., 2008). The data from Study 1 was collected as part of a larger study funded by the USDA’s National Integrated Food Safety Initiative (NIFSI). *Food Safety in the Classroom* evaluated the effectiveness of an integrated food safety curriculum written for seventh grade students in Tennessee. The interdisciplinary curriculum was correlated directly to state content standards for middle school students and includes highly effective instructional strategies that teach food safety concepts through all core subject classes (science, math, social studies, and language arts).

Questionnaire development. The study instrument, administered as a 64 item survey encompassing both food safety and state curriculum standards content, consisted of 40 multiple-choice items to measure knowledge and 15 true/false and 9 Likert-scale (A- Never, D-Always) questions that assessed attitudes and behavior. The instrument was field tested by a group of similar seventh grade students at a non-pilot test school for internal reliability and validity ($\alpha=0.868$) prior to its use (See Appendix 2 for a copy of the assessment for Study 1). This instrument was administered pre, post, and 6 weeks following the implementation of the curriculum.

Context of Study 2: East Tennessee Adolescents (Pedigo et al, 2008). The data for Study 2 were collected during a research project funded by the University of Tennessee's Center of Excellence for Food Safety. The objective of the research was to characterize the food safety knowledge, attitudes, and behaviors of adolescents in East TN to determine the relationships with demographic variables and establish the need for food safety education interventions. Participants in the study were 7th grade students from 12 East TN schools (n=232) chosen through a proportionally weighted, stratified random sample. This statistically rigorous approach for selecting participants attempted to represent and generalize results for the entire 7th grade population in East TN (24701 students). The instrument was administered only once in this study.

Assessment Instrument. The survey for Study 2 was a modified version of the Study 1 instrument. This adapted survey consisted of 20 multiple-choice knowledge questions, 11 true/false and 9 Likert-scale (A- Never, D-Always) questions that assessed attitudes and behavior for food safety content only. A 5 item demographic survey assessing gender,

race, and food handling experience was administered concurrently (See Appendix 1 for a copy of the assessment for Study 2).

Data Analyses. The pretest scores from Study 1 were obtained and sorted to include only the questions that were included in the modified assessment administered in Study 2 (i.e. all questions dealing with state content standards were removed). Individual student assessment scores were considered outliers and removed from the data set under the following conditions: (1) the entire assessment was not finished, or (2) student responses were “offline” on the scantron sheet giving too few or too many answers on the answer form.

Item analyses by question were completed for both surveys to describe the participants’ responses and compare the baseline knowledge and attitudes/behaviors for common food safety measures of the surveys. Data were aggregated in Microsoft Excel by totaling the knowledge questions to obtain the mean knowledge scores, while attitude/behavior mean scores were determined by adding the true/false and Likert scale questions together. In Study 1, the Likert scale included the responses: never, rarely, sometimes, and usually. The Study 2 Likert scale responses were: never, rarely, sometimes, and always. To account for the difference in scale, a new response (‘most of the time’) was created to include responses sometimes, usually, and always. Total knowledge and attitudes/behavior scores were normalized to 100 with a possible range of scores of 0 to 100.

All statistical analyses were completed using SAS (version 9.1, Cary, NC). An independent samples test (t-test) was used to compare overall means for knowledge and attitudes/behaviors between the populations of the study 1 and Study 2. Chi-square

analysis with Fisher's exact test was applied to determine significant differences in food safety knowledge or attitudes/behaviors between the study populations.

Results and Discussion

Knowledge measures. No significant difference in overall knowledge was found between study populations (Table 9). However, significant differences among responses to specific knowledge questions were observed (Table 10). The adolescents of Study 2 generally outperformed the students of the Study 1 in questions relating to bacteria and foodborne pathogens. It should be noted that the Study 2 assessment was administered late in the school year (April-May) when, according to the Tennessee state curriculum standards for seventh grade, students would have already studied plant and animal cells structure and function. The test sites for Study 1 administered the assessment earlier in the school year (October-November) when students may not have studied cells. It is possible that the additional knowledge of cell structure and function, though not specific to bacteria, may have impacted the knowledge base of Study 2 because students might have transferred knowledge to make more educated guesses, thus possibly accounting for the differences observed between the two studies. It is also worth noting that several major foodborne illness outbreaks, including the Peter Pan peanut butter *Salmonella* outbreak, occurred in the time between Study 1 and Study 2 that received national media attention and may have affected the level of awareness of food safety for the students in Study 2.

Attitude/Behavior measures. The overall mean food safety attitudes and behavior scores for studies 1 and 2 were not significantly different (Table 9). However, significant

differences in responses to specific attitude questions (Table 10) and in reported behaviors (Table 11) were observed.

Three questions assessing attitudes towards food safety were significantly different between the studies (Table 10). Interestingly, the differences were observed only in questions relating to the perception of risk or severity of foodborne illness. Students from Study 2 perceived risks of foodborne illness to be less severe, with 61 % (compare to 39 % in Study 1) answering that most people do not go to the doctor when they get food poisoning. Students in Study 2 also felt they were less at risk, with only 46 % (compared to 54 % in Study 1) believing there are bacteria in food that could make them sick. A potential source of bias in this comparison may be that teachers participating in Study 1 received professional development training with food safety materials prior to pre-testing their students and therefore, in preparing students for the assessment and subsequent educational intervention, may have inadvertently shared more of their own food safety beliefs and perceptions with their students.

Significant differences in responses to questions assessing food handling and hygiene behaviors were also found between students of the two studies (Table 11). In the two questions relating to safe food handling, a higher percentage of students in Study 1 responded that they perform these behaviors ‘most of the time’ in comparison to Study 2 students. There is likely a significant source of bias in these cases, since the response ‘most of the time’ was generated a priori to account for scale differences between the studies. Behavior questions relating to hygiene were also found to be significantly different, with more students from Study 2 responding that they ‘never’ perform these behaviors than students in Study 1. Again, this finding may be biased by the fact that

students in Study 1 were preparing to participate in a large scale research project that included the presence of university researchers as opposed to the one time assessment with no investigator present for Study 2.

Significance

The findings of both Study 1 and Study 2 suggest that there is a significant lack of food safety knowledge among adolescent students in Tennessee. These studies also report low levels of safe food handling behaviors among students. Since the baseline level of knowledge and attitudes/behaviors of the adolescents in both studies were statistically similar, and given that both used statistically rigorous methods of research, the data suggests that these baselines are representative of the general adolescent population in East TN.

With limited ability to learn and observe food safety at home, adolescents should receive food safety education at school to become safe adult consumers. Study 2 found that some differences in knowledge and behaviors between demographic groups are less pronounced in adolescents than those found in similar studies with adults. These results suggest that with limited food handling experience and fewer relationships with demographic factors, dissemination of knowledge and development of safe behaviors through adolescent education may prove successful in improving overall consumer food safety. Study 1 found that an educational intervention model that included professional development training for teachers and a food safety curriculum targeted to adolescents and implemented within the school curricula was highly effective at raising student knowledge (21% gain) and improving students' food handling behaviors (8.47% gain)

(Richards et al., 2008). These results of the current study suggest that similar results could be expected across the entire population of 7th grade students in East TN.

The information from these studies will allow researchers and educators to more effectively develop and adapt food safety education materials for this age group, as well as target educational interventions in a meaningful way to school curricula. The successful education of adolescents in food safety knowledge, attitudes, and subsequent safe behaviors will hopefully produce safer consumers and reduce overall the threat of foodborne illness.

List of References

List of References

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Chapter Three Tables

Table 9. Descriptive statistics and independent samples test of Study 1 and Study 2 adolescents' food safety knowledge and attitudes/behaviors

	Study ¹	n	Mean ²	Std. Deviation	Std. Error Mean	t	df	P-value
%Knowledge	1	246	48.76	14.95	.95	0.31	476	0.76
	2	232	48.31	16.16	1.06			
%Attitudes & Behaviors	1	246	77.69	13.24	.84	1.72	476	0.09
	2	232	75.35	16.33	1.07			

¹Study 1 refers to the population of students from the Richards et al. (2008) study (*Food Safety in the Classroom*), while Study 2 comprises a representative population of 7th graders in East Tennessee from Pedigo et al. (2008).

² Knowledge and Attitudes/Behaviors scores normalized to 100, with possible range of scores 0 to 100 %.

Table 10. Significant differences¹ in adolescent food safety knowledge and attitudes between study populations

Food safety issue	% of students answering question correctly		
	*Study 1	Study 2	P – value
<u>Knowledge</u>			
Q. Which is not true of bacteria? A. All bacteria can make you sick.	46.78	53.22	0.0110
Q. When bacteria grow they: A. Grow in number not in size.	46.59	53.51	0.0060
Q. How do bacteria get the nutrients they need to survive? A. All the above: make their own energy, scavenge nutrients from environment, and attach to other living things	54.77	45.23	0.0395
Q. A pathogen is: A. a bacterium that can make you sick	44.22	55.78	0.00097
Q. What is the safest way to defrost meat? A. in the refrigerator	58.67	41.33	0.0383
<u>Attitudes²</u>			
Q. Most people go to the doctor when they get food poisoning. A. False	39.00	61.00	0.0067
Q. There are bacteria in my food that can make me sick if my food is not handled correctly. A. True	53.66	46.34	0.0095
Q. All bacteria can make me sick. A. False	47.68	52.32	0.0190

¹ Significant differences (p< 0.05) obtained from Fisher’s exact test in contingency table analysis

*Study 1 refers to the population of students from the Richards et al. (2008) study (*Food Safety in the Classroom*), while Study 2 comprises a representative population of 7th graders in East Tennessee from Pedigo et al. (2008).

² Questions measuring attitudes where true or false

Table 11. Significant differences¹ in adolescent food safety attitudes and behaviors between study populations

Food safety issue	% responding to attitudes/behavior statements			
	Response ²	Study 1	Study 2	P – value
Q. I feel that I know how to correctly handle my food so that I do not become sick.	Never	2.44	7.33	0.0158
	Rarely	9.35	11.64	
	Most of the time*	86.99	81.03	
Q. When preparing food, I carefully follow temperature and time directions on food labels.	Never	3.66	11.26	0.0012
	Rarely	7.32	10.99	
	Most of the time*	87.80	78.35	
Q. I wash my hands before preparing or eating food.	Never*	3.25	8.62	0.0014
	Rarely	6.91	9.05	
	Most of the time	86.59	82.33	
Q. I use hand sanitizer to clean my hands.	Never*	4.57	12.50	0.0017
	Rarely	24.39	19.83	
	Most of the time	69.51	67.24	
Q. I wash my hands after each time I used the restroom.	Never*	1.63	8.19	0.0002
	Rarely	5.69	6.03	
	Most of the time	89.84	85.78	

¹ Significant differences (p< 0.05) obtained from Fisher’s exact test in contingency table analysis

² The response ‘most of the time’ includes the responses ‘sometimes’ (both studies), ‘usually’ (Richards et al. 2008), and ‘always’ (Pedigo et al. 2008), which were combined to account for differences in scales between the studies under comparison

*Indicates large deviations (cell chi-square values) were associated with that response, which would suggest that the significant difference between the populations is occurring at that response level

Appendix

Appendix 1. Assessment for study of adolescents in East TN

Directions: Read each of the following statements or questions below and choose the BEST answer from the given. Fill in the matching bubble on your answer sheet.

- 1) Which of the following is NOT true about bacteria?
 - a) They are microscopic.
 - b) They are made up of one cell.
 - c) They can be found on most surfaces.
 - d) All bacteria make you sick.

- 2) When bacteria grow they:
 - a) Grow in size from an infant to adult.
 - b) Grow in number, not in size.
 - c) Require more and more food to grow larger.
 - d) Eventually get too big and die.

- 3) How do bacteria get the nutrients they need to survive?
 - a) Some make their own energy from the sun.
 - b) Some scavenge from the environment around them.
 - c) Some attach to other living things.
 - d) All of these are true.

- 4) A pathogen is:
 - a) A bacterium that helps in digestion.
 - b) A bacterium used to make pepperoni.
 - c) A bacterium that can make you sick.
 - d) A bacterium used to make medicines.

- 5) All of the following are pathogens EXCEPT:
 - a) *Salmonella*
 - b) *Lactobacillus*
 - c) *E. coli* O157:H7
 - d) *Listeria*

- 6) Which of the following is NOT made using helpful bacteria?
 - a) Pickles
 - b) Eggs
 - c) Pepperoni
 - d) Sauerkraut

- 7) The MOST IMPORTANT thing you can do to keep from getting sick from a pathogen is to:
 - a) Refrigerate leftovers.
 - b) Wash your hands.
 - c) Frequently wipe kitchen surfaces.
 - d) Use a hand sanitizer.

- 8) Which is the BEST example of cross-contamination?
 - a) Not reheating food properly.
 - b) Leaving food out at room temperature for too long.
 - c) Using the same knife to cut raw chicken and vegetables.
 - d) None of the above.

- 9) Leftover foods should be refrigerated within:
 - a) 30 minutes
 - b) 1 hours
 - c) 2 hours
 - d) 3 hours

- 10) Bacteria grow most rapidly in temperatures of:
- a) At zero degrees
 - b) Below 40 degrees
 - c) Above 140 degrees
 - d) Between 40-140 degrees
- 11) The safest way to tell if a hamburger is cooked to the proper temperature is to:
- a) Use a food thermometer.
 - b) Check to see if the inside is still pink.
 - c) Burn the outside of the burger.
 - d) None of the above.
- 12) Which of the following is a possible outcome of not handling food properly?
- a) Getting sick and requiring medical attention.
 - b) Not getting sick at all.
 - c) Getting sick for a few days and then feeling better .
 - d) All of these are possible outcomes.
- 13) It is okay to eat raw cookie dough:
- a) Anytime. Raw eggs won't hurt you.
 - b) Only if the cookie dough is store bought.
 - c) Only if it is homemade dough.
 - d) Never. Raw eggs in the dough put you at risk for Salmonellosis.
- 14) The safest way to defrost frozen meat is to:
- a) Set it out on the counter.
 - b) Place it in the refrigerator.
 - c) Cook it while it is frozen.
 - d) None of the above.
- 15) To make sure that your ground beef is safe to eat it should be cooked to in an internal temperature of
- a) 160 F
 - b) 180 F
 - c) 200 F
 - d) 212 F
- 16) A foodborne illness is
- a) Any illness humans get from food.
 - b) An illness you are born with.
 - c) Only preventable with a vaccine.
 - d) Cannot be passed from one person to another.
- 17) Which of the following can cause a foodborne illness?
- a) Bacteria
 - b) Viruses
 - c) Parasites
 - d) All of the above
- 18) Which of the following is NOT a common symptom of foodborne illnesses?
- a) Chest pains
 - b) Diarrhea

- c) Vomiting
 19) You should wash your hands
 a) After using the bathroom.
 c) More frequently when someone around you is sick.
- d) Headache
 b) Before handling food.
 d) All of these are true.
- 20) Which of the following does NOT need to be done in order to avoid foodborne illnesses?
 a) Make sure that all food is thoroughly cooked.
 c) Refrigerate all leftovers immediately.
- b) Throw away all leftovers.
 d) All of these are true.

For the following statements:		TRUE	FALSE
	Fill in Bubble "A" if the statement is TRUE.		
	Fill in Bubble "B" if the statement is FALSE.		
21	It is possible to wash my hands thoroughly using only water.	A	B
22	When preparing food, it is okay to use the same surfaces (cutting board, counter top) and utensils for meats and vegetables.	A	B
23	It is okay to eat pizza that has been sitting out on the counter all night as long as I warm it up first.	A	B
24	Most people go to the doctor when they get food poisoning.	A	B
25	More people are hospitalized each year with food poisoning than with the flu.	A	B
26	Almost all food-poisonings are preventable.	A	B
27	If I clean a surface with soap and water, it will kill all the bacteria.	A	B
28	Bacteria cannot grow in food stored in a refrigerator.	A	B
29	There may be bacteria in my food that can make me sick if my food is not handled correctly.	A	B
30	All bacteria can make me sick.	A	B
31	To prevent cross contamination, it is important to keep raw meat, poultry, and seafood away from other foods in the grocery cart and refrigerator.	A	B

For the following statements, <u>fill in the bubble</u> of the choice that applies most often.		Never	Rarely	Sometimes	Always
	A - The statement is <i>never</i> true. B - The statement is <i>rarely</i> true. C - The statement is <i>sometimes</i> true. D - The statement is <i>always</i> true.				
32	I feel that I know how to correctly handle my food so that I do not become sick.	A	B	C	D
33	When preparing food, I carefully follow temperature and time directions on the food packaging labels.	A	B	C	D
34	If necessary, I could properly handle a variety of meats and vegetables to prepare a safe meal for my family.	A	B	C	D
35	I wash my hands before preparing or eating food.	A	B	C	D
36	When I see an adult handling food improperly, I point out her or his mistakes.	A	B	C	D
37	I can identify foods that have a higher risk of making me sick.	A	B	C	D
38	I use hand sanitizer to clean my hands	A	B	C	D
39	I wash my hands after each time I use the restroom.	A	B	C	D
40	I can recognize the most common symptoms of food poisoning.	A	B	C	D
Questions 41-45 are on the next page.					

41) What is your gender?

a) Female

b) Male

42) What is your race?

a) African American

b) Asian/Pacific

c) Caucasian

d) Hispanic

e) Native American

43) What types of food do you prepare?

a) I don't prepare any type of food

b) Snacks only

c) Snacks and meals

44) How many meals or snacks do you prepare in a week?

a) 0 to 5

b) 6 to 10

c) More than 10 meals or snacks

45) How many times does your family eat at a restaurant or fast food during a week?

a) More than 10 times
c) 0 to 3

b) 4 to 10

Thank you for participating in this Survey!

Appendix 2: Food Safety in the Classroom assessment (Richards et al., 2008)

Directions: Read each of the following statements or questions below and choose the **BEST** answer from the choices given. Use a #2 pencil to completely fill in the bubble of your answer choice (do not use hash marks, check marks, or X's). Be sure to erase completely if you are trying to change an answer.

Science

- 1) Which of the following is NOT true about bacteria?
 - They are microscopic.
 - They are made up of only one cell.
 - They can be found on most surfaces.
 - All bacteria can make you sick.

- 2) Which of the following is NOT one of the three basic shapes of bacteria?
 - Circular
 - Bacilli
 - Spiral
 - Cocci

- 3) When bacteria grow they:
 - Grow in size from an infant to an adult.
 - Grow in number, not in size.
 - Eventually get too big and die.
 - Require more and more food to grow larger.

- 4) How do bacteria get the nutrients they need to survive?
 - Some make their own energy from sunlight.
 - Some scavenge their nutrients from the environment around them.
 - Some attach to other living things.
 - All of these are true.

- 5) A pathogen is:
 - A bacterium that helps in digestion.
 - A bacterium used to make pepperoni.
 - A bacterium that can make you sick.
 - A bacterium used to make medicines.

- 6) An example of indirect contact is:
 - Touching the desk and then touching your eyes, mouth, or nose.
 - Getting a kiss on the cheek from Aunt Mildred.
 - Shaking hands with a friend.
 - Hugging your parents.

- 7) Which of the following is NOT a food made using helpful bacteria?
 - Pickles
 - Eggs
 - Pepperoni
 - Sauerkraut

- 8) All of the following are pathogens EXCEPT:
 - Salmonella
 - Lactobacillus
 - E. coli
 - Listeria

- 9) The best way to avoid getting sick from a pathogen is to:
 - Rinse your hands in cold water for 5 seconds.
 - Wash your hands in warm water with soap for 20 seconds.
 - Avoid touching any surface.
 - Wipe your hands on a dish towel.

- 10) Bacterial cells are different from animal cells in that bacteria cells:
 - Contain DNA.
 - Have a cell wall.
 - Do not have a nucleus.
 - Contain cytoplasm.

Language Arts

- 11) Which of the following is considered a bacterial "hot zone" in your house?
- Kitchen
 - Living Room
 - Bedroom
 - Closets
- 12) The MOST IMPORTANT thing you can do to keep from getting sick from bacteria is to:
- Refrigerate leftovers.
 - Wash your hands.
 - Frequently wipe kitchen surfaces.
 - Use a hand sanitizer.
- 13) Which is the BEST example of cross-contamination?
- Using the same knife to cut raw chicken and vegetables.
 - Leaving food sitting at room temperature for too long.
 - Not reheating food properly.
 - None of the above.
- 14) Leftover foods should be refrigerated within:
- 30 minutes
 - 1 hour
 - 2 hours
 - 3 hours
- 15) Bacteria grow most rapidly at temperatures of:
- At zero degrees.
 - Below 40 degrees.
 - Above 140 degrees.
 - Between 40-140.
- 16) The safest way to tell if a hamburger is cooked to the proper temperature is to:
- Use a food thermometer.
 - Check the inside to see if it is still pink.
 - Burn the outside of the burger.
 - None of the above.
- 17) The purpose of a press release is to:
- Track outbreaks of foodborne illnesses.
 - Share information or news with the media.
 - Determine the cause of a foodborne illness.
 - Sell products or services.
- 18) Which of the following is NOT part of a press release?
- Title page.
 - Contact information.
 - Headline.
 - Dateline.
- 19) When writing a press release you should:
- Tell the audience that the information is intended for them and why they should read it.
 - Start with a brief description of the news, and then explain who announced it, and not the other way around.
 - Avoid excessive use of adjectives and fancy language.
 - All of these are true.
- 20) Which of the following is a possible outcome of NOT handling food properly?
- Getting sick and requiring medical attention.
 - Getting sick for a few days and then feeling better.
 - Not getting sick at all.
 - All of these are possible outcomes.

Math

21) It is okay to eat raw cookie dough:

- anytime. The raw eggs will not hurt you.
- only if the cookie dough is store bought.
- only if the cookie dough is homemade.
- never. Raw cookie dough puts you at risk for salmonellosis.

22) The safest way to defrost frozen meat is to:

- set it out on the counter.
- place it in the refrigerator.
- cook it while it is frozen.
- None of the above.

23) To make sure that your hamburger is safe to eat it should be cooked to an internal temperature of:

- 160 F.
- 180 F.
- 200 F.
- 212 F.

24) A data set with data points of (1, 2, 3, 4, & 5) would have a mean of:

- 2.5
- 3.0
- 3.5
- 5

25) A data set with the data points of (16, 17, 22, 22, 25, & 30) would have a mode of:

- 6
- 14.0
- 22
- 26.4

26) A data set with data points of (6, 7, 7, 10, & 16) would have a range of:

- 5
- 7.0
- 9.2
- 10

27) A data set with data points of (2, 4, 6, 8, & 10) would have a median of:

- 5
- 5.6
- 6
- 8

28) Jimmy is exactly 5 feet tall. His height at 4x and 10x would be:

- 5 ft and 10 ft
- 9 ft and 15 ft
- 20 ft and 50 ft
- 20 ft and 40 ft.

29) If a bacterium's generation time was 10 minutes and you started with one bacterium, how many bacteria would there be after one hour?

- 1
- 6.0
- 32
- 64

30) The difference between a sample and a population is:

- a sample is selected from a population.
- a population is selected from a sample.
- a sample refers to people and a population refers to objects.
- There is no difference between a population and a sample.

Social Studies

- 31) A foodborne illness is
- any illness that humans get from food.
 - an illness you are born with.
 - only preventable with a vaccine.
 - cannot be passed from one person to another.
- 32) Which of the following can cause a foodborne illness?
- Bacteria
 - Viruses
 - Parasites
 - All of these can cause a foodborne illness.
- 33) Which of the following is NOT a common symptom of foodborne illnesses?
- Chest pains
 - Diarrhea
 - Vomiting
 - Headache
- 34) You should wash your hands
- after using the bathroom.
 - before handling food.
 - more frequently when someone around you is sick.
 - All of these are true.
- 35) Most foodborne outbreaks are caused by:
- not keeping food hot or cold enough.
 - poor personal hygiene (not washing your hands).
 - cross-contaminating raw and cooked foods.
 - None of the above.
- 36) The bacteria with an onset time of 30 minutes to 8 hours is :
- Salmonella*
 - Staphylococcus aureus*
 - E. coli* O157:H7
 - Listeria*
- 37) The life expectancy rate in a county is:
- the number of people expected to die each year.
 - the average number of years a person in that county can expect to live.
 - the quality of life a person in that county can expect.
 - none of the above.
- 38) A country's percentage of arable land tells us:
- the percentage of land in that country that cannot be used to grow crops.
 - the percentage of land in that county that is suitable for growing crops.
 - the types of crops grown in that county.
 - None of the above.
- 39) Which of the following does NOT need to be done in order to avoid foodborne illnesses?
- Make sure that all food is thoroughly cooked.
 - Throw away leftovers.
 - Refrigerate all leftovers immediately.
 - Separate meat and veggies when preparing foods.
- 40) When researching outbreaks of foodborne illnesses it is important to know:
- the location of the outbreak.
 - the number of reported cases of illness.
 - the likely cause of the outbreak.
 - All of these are true.

For the following statements:		TRUE	FALSE
	Fill in the appropriate Bubble completely if the statement is TRUE or FALSE . Be sure to completely erase if you are changing your answer.		
41	It is possible to wash my hands thoroughly using only water.	<input type="radio"/>	<input type="radio"/>
42	When preparing food, it is okay to use the same surfaces (cutting board, counter top) and utensils for meats and vegetables.	<input type="radio"/>	<input type="radio"/>
43	It is okay to eat pizza that has been sitting out on the counter all night as long as I warm it up first.	<input type="radio"/>	<input type="radio"/>
44	Most people go to the doctor when they get food poisoning.	<input type="radio"/>	<input type="radio"/>
45	More people are hospitalized each year with food poisoning than with the flu.	<input type="radio"/>	<input type="radio"/>
46	Almost all food-poisonings are preventable.	<input type="radio"/>	<input type="radio"/>
47	Food-poisonings only occur in under developed countries.	<input type="radio"/>	<input type="radio"/>
48	If I clean a surface with soap and water, it will kill all the bacteria.	<input type="radio"/>	<input type="radio"/>
49	Water can make me sick.	<input type="radio"/>	<input type="radio"/>
50	Bacteria cannot grow in foods stored in the refrigerator.	<input type="radio"/>	<input type="radio"/>
51	There are bacteria in my food that can make me sick if my food is not handled correctly.	<input type="radio"/>	<input type="radio"/>
52	All bacteria can make me sick.	<input type="radio"/>	<input type="radio"/>
53	A bacteria cell is different from an animal cell because the bacteria cell does not have a nucleus.	<input type="radio"/>	<input type="radio"/>
54	Bacterial growth means an orderly increase in the number of bacteria.	<input type="radio"/>	<input type="radio"/>
55	To prevent cross contamination, it is important to keep raw meat, poultry, and seafood away from other foods in the grocery cart and refrigerator.	<input type="radio"/>	<input type="radio"/>

For the following statements, fill in the bubble of the choice that applies most often.		Never	Rarely	Sometimes	Usually
	The statement is <i>never</i> true. The statement is <i>rarely</i> true. The statement is <i>sometimes</i> true. The statement is <i>usually</i> true.				
56	I feel that I know how to correctly handle my food so that I do not become sick.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
57	When preparing food, I carefully follow temperature and time directions on the food packaging labels.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
58	If necessary, I could properly handle a variety of meats and vegetables to prepare a safe meal for my family.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
59	I wash my hands before preparing or eating food.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
60	When I see an adult handling food improperly, I point out her or his mistakes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
61	I can identify foods that have a higher risk of making me sick.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
62	I use hand sanitizer to clean my hands	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
63	I wash my hands after each time I use the restroom.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
64	I can recognize the most common symptoms of food poisoning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Thank you for participating in this survey.

Table 12. East Tennessee adolescent data summary

School	Students	Avg K ¹	Avg A/B ²	SMA ³	SES ⁴	%Female	%Black	%Asia/ Pacific	%White	%Hispanic	%Native American	%Meals &snacks ⁵	%Prepare ⁶ >10	% Eat out ⁷ >6
Washington	39	49.5	71.3	Metro	57.0	60.5	0.0	5.3	81.6	7.9	7.9	43.6	7.7	43.6
Polk	13	53.6	74.3	Metro	66.0	61.5	7.7	0.0	38.5	0.0	53.8	69.2	23.1	30.8
Carter	10	56.0	72.3	Metro	57.6	80.0	0.0	0.0	90.0	0.0	10.0	60.0	40.0	40.0
Knox	35	49.6	73.6	Metro	25.3	47.2	12.0	0.0	71.4	8.6	14.3	62.9	22.9	25.7
Lenoir City	8	38.8	60.6	Metro	63.3	37.5	0.0	16.7	50.0	16.7	16.7	25.0	0.0	12.5
Greene	11	55.0	72.3	Micro	43.8	81.8	0.0	0.0	72.7	0.0	18.2	72.7	36.4	54.5
Newport	13	41.9	65.6	Micro	41.1	84.6	0.0	0.0	92.3	7.7	0.0	53.8	7.7	38.5
Cocke	25	41.2	67.5	Micro	99.3	60.0	24.0	0.0	60.0	8.0	8.0	72.0	28.0	20.0
Bradley	32	50.5	71.8	Metro	39.3	69.7	6.3	3.1	81.3	6.3	3.1	71.9	21.9	31.3
Morgan	19	47.1	68.0	Other	48.6	84.2	10.5	0.0	78.9	5.3	5.3	78.9	26.3	26.3
Monroe	16	53.1	64.4	Other	69.8	56.3	6.3	25.0	68.8	0.0	0.0	68.8	25.0	31.3
Scott	8	46.9	73.1	Other	97.8	37.5	12.5	0.0	75.0	12.5	0.0	50.0	37.5	37.5

¹The average food safety knowledge score for the school

²The average food safety attitudes/behavior score for the school

³U.S. Census Bureau Standard Metropolitan Area classification for the county in which the school is located

⁴SES (socioeconomic status) level represents the percentage of students in that school that are economically disadvantaged (i.e. eligible for the free and reduced lunch program)

⁵The percent of students who prepare both meals and snacks during a week

⁶The percent of students who prepare greater than 10 meals or snacks in one week

⁷The percent of students who eat out (i.e. at a restaurant or fast food) with their family more than 6 times in one week

Vita

Ashley Shanay Pedigo was born June 10, 1985 and raised in Westmoreland, TN. All throughout her early education, she loved going to school, learning and reading new information, and participating in sports and leadership activities. She graduated from high school as Valedictorian and the State President of the Future Business Leaders of America. From the University of Tennessee, she graduated summa cum laude with honors and received a Bachelors degree in Food Science and Technology. Ashley has presented research at four international conferences and co-presented seven professional development workshops. She received a Master of Science degree with a major in Food Science and Technology and a minor in Statistics on May 8, 2008.

Ashley aspires to integrate food microbiological laboratory research, epidemiology, and public health education as it applies to food safety. She will continue the pursuit of her aspirations in the doctorate program in Comparative and Experimental Medicine with a concentration in epidemiology at the University of Tennessee. Overall, she would like to cultivate her knowledge and experience in either a government environment, such as the CDC or state health department, or academic environment as a university faculty member.