Creation and Evaluation of a Food Safety Educational Curriculum

for High School Students

BY

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THESIS

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AJB
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Study Hypotheses and Specific Aims</td>
<td>2</td>
</tr>
<tr>
<td>2. REVIEW OF LITERATURE</td>
<td>4</td>
</tr>
<tr>
<td>2.1 Foodborne Disease in the United States</td>
<td>4</td>
</tr>
<tr>
<td>2.2 Food Safety in the Home</td>
<td>6</td>
</tr>
<tr>
<td>2.3 Foodborne Disease Risk Factors</td>
<td>14</td>
</tr>
<tr>
<td>2.3.1 Consumption of Foods and Food Handling Practices</td>
<td>14</td>
</tr>
<tr>
<td>2.3.2 Race and Ethnicity</td>
<td>15</td>
</tr>
<tr>
<td>2.3.3 Age</td>
<td>17</td>
</tr>
<tr>
<td>2.3.3.1 Adolescent Food Handling in the Home</td>
<td>18</td>
</tr>
<tr>
<td>2.3.3.2 Adolescent Food Handling in the Food Service Industry</td>
<td>20</td>
</tr>
<tr>
<td>2.4 Review of Food Safety Interventions</td>
<td>21</td>
</tr>
<tr>
<td>2.4.1 Home Economics</td>
<td>21</td>
</tr>
<tr>
<td>2.4.2 Food Safety Interventions for Adolescents and Minorities</td>
<td>23</td>
</tr>
<tr>
<td>2.5 Comic Book Interventions</td>
<td>27</td>
</tr>
<tr>
<td>2.6 The Principles of Effective Prevention Programs Model</td>
<td>28</td>
</tr>
<tr>
<td>3. MATERIALS AND METHODS</td>
<td>29</td>
</tr>
<tr>
<td>3.1 Study Population</td>
<td>29</td>
</tr>
<tr>
<td>3.2 Intervention Design</td>
<td>29</td>
</tr>
<tr>
<td>3.3 Educational Comic Book</td>
<td>30</td>
</tr>
<tr>
<td>3.3.1 Inside Front Cover</td>
<td>31</td>
</tr>
<tr>
<td>3.3.2 Story 1: “At the Local Restaurant”</td>
<td>31</td>
</tr>
<tr>
<td>3.3.3 Story 2: “Germ Takedown”</td>
<td>32</td>
</tr>
<tr>
<td>3.3.4 Story 3: “True Stories from the Kitchen: The Tale of the Terrible Turkeys”</td>
<td>32</td>
</tr>
<tr>
<td>3.3.5 Story 4: “True Stories from the Kitchen: The Tale of the Killer Hamburgers”</td>
<td>32</td>
</tr>
<tr>
<td>3.3.6 Story 5: “A Funny Thing Happened on the Way to the Fork”</td>
<td>33</td>
</tr>
<tr>
<td>3.3.7 Epidemiology Work Pages</td>
<td>33</td>
</tr>
<tr>
<td>3.3.8 Outbreak Investigation Curriculum Definitions</td>
<td>34</td>
</tr>
<tr>
<td>3.3.9 Inside Back Cover: “National Outbreak Reporting System Form”</td>
<td>34</td>
</tr>
<tr>
<td>3.3.10 Back Cover: “Meat Must be Cooked to the Correct Temperature on a Meat Thermometer to Ensure Safety and Quality”</td>
<td>35</td>
</tr>
<tr>
<td>3.4 Educational Curriculum</td>
<td>35</td>
</tr>
<tr>
<td>3.4.1 Curriculum Materials</td>
<td>36</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS (continued)

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4.2</td>
<td>Curriculum Overview ................................................. 37</td>
</tr>
<tr>
<td>3.4.2.1</td>
<td>Epidemiology Work Pages, NORS form, and Discussion ............. 37</td>
</tr>
<tr>
<td>3.4.2.2</td>
<td>NORS Form Outbreak Analysis ........................................ 37</td>
</tr>
<tr>
<td>3.4.2.3</td>
<td><em>MMWR</em> Activity Part 1 ............................................... 38</td>
</tr>
<tr>
<td>3.4.2.4</td>
<td><em>MMWR</em> Activity Part 2 ............................................... 38</td>
</tr>
<tr>
<td>3.5</td>
<td>Baseline Data Procedures ........................................... 38</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Survey Development ................................................... 38</td>
</tr>
<tr>
<td>3.5.2</td>
<td>Data Collection ...................................................... 39</td>
</tr>
<tr>
<td>3.6</td>
<td>Intervention ......................................................... 39</td>
</tr>
<tr>
<td>3.7</td>
<td>Follow-up Data Procedures ........................................... 40</td>
</tr>
<tr>
<td>3.7.1</td>
<td>Survey Development ................................................... 40</td>
</tr>
<tr>
<td>3.7.2</td>
<td>Data Collection ...................................................... 40</td>
</tr>
<tr>
<td>3.8</td>
<td>Statistical Analysis .................................................. 41</td>
</tr>
<tr>
<td>4.</td>
<td>RESULTS ................................................................. 43</td>
</tr>
<tr>
<td>4.1</td>
<td>Baseline Sample and Participants ................................... 43</td>
</tr>
<tr>
<td>4.2</td>
<td>Baseline Knowledge Gaps ............................................. 46</td>
</tr>
<tr>
<td>4.3</td>
<td>Factors Associated with the Baseline Knowledge Score ........... 55</td>
</tr>
<tr>
<td>4.4</td>
<td>Linear Regression Model Predicting Baseline Score ............... 58</td>
</tr>
<tr>
<td>4.5</td>
<td>Follow-up Sample and Participants ................................ 60</td>
</tr>
<tr>
<td>4.6</td>
<td>Increase in Follow-up Knowledge Score ............................ 64</td>
</tr>
<tr>
<td>4.7</td>
<td>Factors Associated with Increase in Knowledge Score ............ 74</td>
</tr>
<tr>
<td>4.7.1</td>
<td>Demographic Characteristics ......................................... 74</td>
</tr>
<tr>
<td>4.7.2</td>
<td>Comic Book Exposure .................................................. 74</td>
</tr>
<tr>
<td>4.8</td>
<td>Behavioral Change ..................................................... 75</td>
</tr>
<tr>
<td>4.9</td>
<td>Community Interaction ............................................... 82</td>
</tr>
<tr>
<td>4.10</td>
<td>Student Evaluation of Curriculum .................................. 83</td>
</tr>
<tr>
<td>4.11</td>
<td>Linear Regression Model Predicting Increase in Score .......... 84</td>
</tr>
<tr>
<td>5.</td>
<td>DISCUSSION ............................................................ 86</td>
</tr>
<tr>
<td>5.1</td>
<td>Baseline Knowledge Score ........................................... 86</td>
</tr>
<tr>
<td>5.1.1</td>
<td>Race/Ethnicity ......................................................... 87</td>
</tr>
<tr>
<td>5.1.2</td>
<td>Socioeconomic Status and Seafood Cooking Experience .......... 87</td>
</tr>
<tr>
<td>5.1.3</td>
<td>Cooking Experience ................................................... 88</td>
</tr>
<tr>
<td>5.1.4</td>
<td>Gender ................................................................. 90</td>
</tr>
<tr>
<td>5.2</td>
<td>Gaps in Food Safety Knowledge ..................................... 91</td>
</tr>
<tr>
<td>5.3</td>
<td>Evaluation of Intervention According to the Principles of Effective Prevention Programs Model .................. 92</td>
</tr>
<tr>
<td>5.4</td>
<td>Follow-up Knowledge Score and Associated Variables .......... 93</td>
</tr>
<tr>
<td>5.4.1</td>
<td>Grade ................................................................. 94</td>
</tr>
<tr>
<td>5.4.2</td>
<td>Exposure to the Comic Book ....................................... 94</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS (continued)

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4.3 Associated Variables and the Principles of Effective Prevention</td>
<td>95</td>
</tr>
<tr>
<td>Programs: Cultural Relevance and Community Interaction</td>
<td></td>
</tr>
<tr>
<td>5.5 Increases in Food Safety Knowledge, Behavioral Changes, and</td>
<td>96</td>
</tr>
<tr>
<td>Student Evaluation of the Curriculum</td>
<td></td>
</tr>
<tr>
<td>5.6 Strengths of Study</td>
<td>99</td>
</tr>
<tr>
<td>5.7 Limitations and Future Research</td>
<td>99</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>101</td>
</tr>
<tr>
<td>Appendix A</td>
<td>102</td>
</tr>
<tr>
<td>Appendix B</td>
<td>107</td>
</tr>
<tr>
<td>Appendix C</td>
<td>112</td>
</tr>
<tr>
<td>Appendix D</td>
<td>117</td>
</tr>
<tr>
<td>Appendix E</td>
<td>171</td>
</tr>
<tr>
<td>Appendix F</td>
<td>175</td>
</tr>
<tr>
<td>Appendix G</td>
<td>194</td>
</tr>
<tr>
<td>Appendix H</td>
<td>199</td>
</tr>
<tr>
<td>Appendix I</td>
<td>205</td>
</tr>
<tr>
<td>Appendix J</td>
<td>208</td>
</tr>
<tr>
<td>Appendix K</td>
<td>210</td>
</tr>
<tr>
<td>CITED LITERATURE</td>
<td>216</td>
</tr>
<tr>
<td>VITA</td>
<td>226</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. REVIEW OF KNOWLEDGE GAPS AND FOOD HANDLING BEHAVIORS THAT CONTRIBUTE TO THE TRANSMISSION OF FOODBORNE DISEASE IN THE HOME, CHICAGO, ILLINOIS, 2012</td>
<td>9</td>
</tr>
<tr>
<td>II. BASELINE CHARACTERISTICS OF HIGH SCHOOL STUDENTS PARTICIPATING IN A KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=195) AND SCORE OUT OF 29 KNOWLEDGE QUESTIONS</td>
<td>44</td>
</tr>
<tr>
<td>III. FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENT PARTICIPATING IN A BASELINE KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=195)</td>
<td>48</td>
</tr>
<tr>
<td>IV. TOP TEN QUESTIONS MOST FREQUENTLY ANSWERED INCORRECTLY BY HIGH SCHOOL STUDENTS PARTICIPATING IN A KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS WHO REPORTED COOKING ON THEIR OWN OFTEN OR ALWAYS, 2012 (N=65)</td>
<td>54</td>
</tr>
<tr>
<td>V. STUDENT CHARACTERISTICS ASSOCIATED WITH BASELINE KNOWLEDGE SCORE, LINEAR REGRESSION ANALYSIS (N=175), 2012</td>
<td>59</td>
</tr>
<tr>
<td>VI. CHARACTERISTICS OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=175) AND SCORE OUT OF 29 KNOWLEDGE QUESTIONS</td>
<td>61</td>
</tr>
<tr>
<td>VII. FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=171)</td>
<td>68</td>
</tr>
<tr>
<td>VIII. RELATIVE FREQUENCIES OF RESPONSES TO BEHAVIORAL CHANGE AND BELIEF QUESTIONS BY HIGH SCHOOL STUDENTS WITHOUT MISSING INFORMATION ON A KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS 2012 (N≤155)</td>
<td>78</td>
</tr>
</tbody>
</table>
LIST OF TABLES (continued)

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IX. STUDENT CHARACTERISTICS ASSOCIATED WITH FOLLOW-UP KNOWLEDGE SCORE INCREASE, LINEAR REGRESSION ANALYSIS (N=134), 2012</td>
<td>85</td>
</tr>
<tr>
<td>X. EPIDEMIOLOGY WORK PAGE TABLE</td>
<td>130</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Frequency distribution of knowledge score out of 29 knowledge questions of high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=195)</td>
<td>47</td>
</tr>
<tr>
<td>2. Relative frequency of correct answers to meat handling questions (N=11 questions) by meat handling frequency of high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=195)</td>
<td>56</td>
</tr>
<tr>
<td>3. Relative frequency of correct answers to questions by ethnicity and seafood cooking frequency of high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=195)</td>
<td>57</td>
</tr>
<tr>
<td>4. Frequency distribution of change in knowledge score out of 29 knowledge questions of high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=171)</td>
<td>66</td>
</tr>
<tr>
<td>5A–C. Proportionate analysis of change in knowledge score by strata for high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=171)</td>
<td>67</td>
</tr>
</tbody>
</table>
LIST OF ABBREVIATIONS

CDC        Centers for Disease Control and Prevention
CHEF       Chicago Educational Food Handler
DALY       Disability-adjusted life year
FDA        Food and Drug Administration
HUS        Hemolytic uremic syndrome
MMWR       Morbidity and Mortality Weekly Report
NORS       National Outbreak Reporting Systems
spp.       Species
SSRFHS     Smart Suburban Restaurant Food Handler Study
WHO        World Health Organization
UIC        University of Illinois at Chicago
USDA       United States Department of Agriculture
SUMMARY

Inadequate knowledge and unsafe food handling behaviors are a major contributory factor to the transmission of foodborne disease. Certain populations, such as young adults and ethnic minorities, may be especially at risk for infection with foodborne disease due to knowledge gaps and an increased likelihood of engaging in risky eating behaviors and food handling practices. To determine the efficacy of a foodborne disease intervention at amending knowledge gaps in these populations, an integrated curriculum and educational comic book were developed for students in a predominantly minority high school. Frequencies of correct answers to each knowledge question were examined to determine the food safety knowledge gaps. Bivariate and regression analyses were performed to identify student variables associated with the knowledge score and increase in knowledge score. The majority of participating students (n=195) were Hispanic, female, and in the 11th grade. Students completed a baseline survey to determine knowledge gaps prior to the educational intervention. Hispanic ethnicity, more experience cooking meat, less experience cooking seafood, and more experience cooking alone were significantly and independently associated with increased baseline knowledge score. A follow-up survey was completed after exposure to the intervention to determine changes in food safety knowledge, self-reported behaviors, and personal hygiene of the students. Food safety knowledge scores increased from 37% to 60% on the follow-up survey. Among the more substantial increases in knowledge, several related to the proper mechanisms for storing, thawing, and checking the temperature of food; cross contamination; and the vulnerable populations for foodborne disease. Hispanic origin, being in the 11th grade, reading all of the educational comic book, and talking to friends or family about what they learned in the curriculum were significantly and independently associated with a greater increase in knowledge.
score. Overall, students enjoyed the curriculum and believed that it had contributed to their knowledge about food safety and foodborne disease epidemiology. The educational intervention appeared effective at improving food safety knowledge and behaviors in a high school student population.
1. INTRODUCTION

1.1 Introduction

Foodborne diseases result in a substantial burden in the United States: it is estimated that to cause 325,000 people are hospitalized and 5,000 deaths annually (Mead et al. 1999). While many cases of foodborne disease are attributable to factors outside of the home, inadequate knowledge and unsafe food handling behaviors contributors to transmission. In fact, it has been suggested that if all home food preparers practiced safe food handling techniques 100% of the time the incidence of illness could be reduce by half (Medeiros et al. 2001). Studies have found that young adults are significantly more likely to engage in risky eating behaviors that may put them and others at risk for foodborne disease (Abbot et al. 2009; Altekruse et al. 1999). This is of particular consequence because teenagers make up a substantial portion of the food service workforce. The Bureau of Labor Statistics has estimated that 21% of all food and beverage service workers are aged 16–19 years old (U.S. Department of Labor, Occupational Outlook Handbook, 2010–11 Edition, Food and Beverage Serving and Related Workers 2011). In addition, 40.8% of employment for teenage workers is in the food service industry (Hirshman and Voloshin 2007). When improper food safety is utilized in these circumstances, young people are not only putting themselves at risk for illness but also may be putting family members or restaurant patrons with increased susceptibility to foodborne diseases at a greater risk. Thus, high school students represent an important population in which to intervene to increase food safety knowledge because they are at an age in which they will soon be responsible for increased amounts of food preparation for themselves and others.

This study determined food safety knowledge gaps among students in a predominantly minority Chicago high school. Baseline and follow-up cross-sectional surveys were conducted in
March 2012 with 195 and 171 students, respectively. The 34-question survey instrument was self-administered to obtain information about the knowledge, behaviors, and personal hygiene of the students. Students and teachers evaluated the curriculum to determine its efficacy to teach food safety and epidemiological concepts in an educational and interactive manner and gauge the extent of behavioral change in students and their families and friends.

1.2 **Study Hypotheses and Specific Aims**

The goals and hypotheses of this project are:

**Specific Aim 1:** To determine baseline knowledge scores and gaps in food safety knowledge in high school students.

We hypothesized that the average score on pre-intervention surveys will be 60%, and that the following characteristics would be associated with increased knowledge scores: gender (female>male), year in school (seniors>juniors), having had cooking experience either on one's own or with parental supervision, and having worked or working in the food service industry. This project will demonstrate in what knowledge areas high school students need greater education.

**Specific Aim 2:** To create a low-cost feasible reproducible food safety and hand hygiene curriculum and comic book that is based on input from teachers and students.

The curriculum was suitable for high school students and required no substantial increase in school resources. It was designed to be easily adopted by teachers as their own curriculum and complementary to other core curriculum such as reading, math, oral communication, and
science. This curriculum was based on elements of published food safety and hygiene interventions, including the modification of an existing educational comic book for food handlers to make it appropriate for high school students. The comic book and curriculum was created with input from teachers and timed to be incorporated as a tool to teach food safety, hand hygiene, and basic foodborne disease outbreak investigation in a preexisting environmental health unit.

**Specific Aim 3:** To perform and assess a food safety and hand hygiene educational intervention for high school students in order to demonstrate its potential to increase knowledge.

We performed a food safety and hand hygiene intervention in a high school. Food safety knowledge scores from before and after the intervention were compared to quantify the impact of the intervention. We hypothesized that the educational intervention will result in a 20% increase in knowledge score.
2. REVIEW OF LITERATURE

2.1 Foodborne Disease in the United States

Foodborne diseases result in a substantial burden in the United States: it is estimated that each year 325,000 people are hospitalized and 5,000 deaths occur with hospitalization rates ranging from 0.6% to 29% and case-fatality rates up to 2.5% (Mead et al. 1999; Rocourt et al. 2003). Cases of foodborne disease represent a large range of severity from mild cases of diarrheal disease to cases requiring hospitalization and resulting in long-term sequelae. Although the mildest cases may represent only a minor inconvenience, chronic sequelae occur as a result of as many as 2%–3% of cases of foodborne disease; potential sequelae include hemolytic uremic syndrome (HUS) as a result of *Escherichia coli* O157:H7 infection, Guillain-Barré syndrome associated with *Campylobacter jejuni* infection, chronic toxoplasmonic encephalitis, and reactive arthritis and Reiter’s syndrome following salmonellosis or shigellosis (Rocourt et al. 2003; Griffin et al. 1988; Poropatich et al. 2010; Finch et al. 1986; Dworkin et al. 2001, Lindsay 1997). The prevalence of these sequelae are impacted by several factors, including changing population dynamics and growing rates of antimicrobial resistance among organisms causing foodborne disease.

The severity of the morbidity associated with a case of foodborne disease is greatly impacted by both the immune status of the individual affected and the resistance status of the organism. Some groups are particularly likely to have a greater degree of severity and lethality associated with disease transmission; these include the very young, the elderly, pregnant women, and the immunocompromised (Rocourt et al. 2003; Gerba et al. 1996). The potential impact of disease on these groups is further exacerbated by changes in population dynamics. With improvements in medical technologies, groups such as the elderly and immunocompromised are
able to live longer despite decreased immune system functionality. It is thus estimated that approximately 20% of the population is at an increased risk for foodborne disease due to immunosuppression (Rocourt et al. 2003; Gerba et al. 1996). When vulnerable populations are concentrated within a single location, the possibility of transmission can be particularly high. Settings such as nursing homes, hospitals, and daycare centers may present a particularly large risk for transmission (Jones 2010; Ethelberg et al. 2006; Weber and Rutala 2001).

Further impacting the morbidity and mortality is the increasing prevalence of antimicrobial resistance. Studies have found increased rates of antimicrobial resistance in non-typhi Salmonella serotypes, Campylobacter species, and Escherichia coli O157:H7 (Mølbak 2005; Kaesbohrer et al. 2012). An increasing prevalence of antimicrobial resistance in these pathogens has had a serious human health impact, including a reduced efficacy of and choice in treatment and increased transmission and virulence (Mølbak 2005). The combination of increased numbers of susceptible populations with antibiotic resistance organisms has led to the emergence of foodborne disease as a serious public health concern.

The burden of foodborne disease represents more than just the immediate costs associated with morbidity and mortality. One public health indicator of the impact of disease is the DALY, or “disability adjusted life year,” that serves as a measure of years lost of “healthy” life (Metrics: Disability-Adjusted Life Year (DALY) 2012). Several studies have examined the DALY’s that are lost due to foodborne disease. For example, two studies of Dutch populations have estimated that the mean burdens associated with campylobacteriosis and E. coli O157:H7 are 1,400 DALY per year and 116 DALY per year, respectively (Havelaar et al. 2000; Havelaar et al. 2004). Another manner in which to quantify the impact of foodborne disease is through its economic burden. A recent study by Scharff (2010) estimated that foodborne illness in the United States...
alone costs approximately $152 billion in healthcare costs, loss of productivity, and other economic losses (Havelaar et al. 2004). This study also estimated that in Illinois alone there is a total cost of $6,487,000,000 in medical costs, quality of life losses, and lost life expectancy annually due to the burden of foodborne disease (Scharff 2010). Clearly, foodborne disease has an important public health impact that necessitates the assurance of food safety in the entire spectrum of food preparation from farm to fork.

2.2. **Food Safety in the Home**

Although much attention has been given to restaurants as a setting for foodborne disease outbreaks, improper food handling in the home still creates a substantial risk for the transmission of foodborne disease. Recent estimates suggest that 52% of outbreaks occurred in restaurant settings and 15% occurred in the home (Gould et al. 2011). While the Centers for Disease Control and Prevention estimated that during the 1990s 80% of foodborne disease outbreaks originated outside of the home, this is likely a result of under-reporting and predominantly representative of foodborne disease cases with the greatest degree of severity (Bean et al. 1988–1991). In fact, the World Health Organization (WHO) approximated that only 10% of foodborne disease incidents are reported and a study of infectious intestinal disease in England estimated that for each case of disease reported to authorities, 136 cases occurred that were not reported (“FAO/WHO Collaborating Centre for Research and Training in Food Hygiene and Zoonoses” 1992; Jeremy 1999). The reporting of foodborne disease may be particularly unlikely for cases that occur in the home. While active surveillance for cases of foodborne disease with mild or nonexistent symptoms occurs in the case of restaurant outbreaks, foodborne disease cases occurring in the home are likely to only be reported when they are particularly severe. The WHO
suggested that this may occur “because most people regard diarrhoea as a transient inconvenience rather than a symptom of disease, the vast majority of diarrhoeal episodes do not result in a visit to a physician, even though the person may be incapacitated for several days” (Rocourt et al. 2003, page 3). Thus, the reported cases of foodborne disease in the home are largely reflective of only those with great severity, including those that require hospitalization or that occur in groups that are particularly vulnerable to foodborne disease such as the elderly, immunocompromised, and very young (Scott 1996). The combination of these factors likely results in an underrepresentation of the home as a setting for foodborne disease transmission.

Furthermore, even when the initial transmission of foodborne disease occurs outside of the home, there is an increased risk for secondary transmission to family members. In a summary of foodborne disease outbreaks occurring in England and Wales, it was estimated that of 4,115 bacterial foodborne disease outbreaks occurring between 1989 and 1991, 89% were classified as family outbreaks as opposed to outbreaks affecting members of single households (Sockett et al. 1993). A study by the French Communicable Diseases Network also found a high incidence of linked cases of foodborne disease among families (Guiguet et al. 1992). The prevalence of secondary transmission within the home may obscure the attribution of food as the primary mechanism for the transmission of diarrheal disease (Mead et al. 1999). Thus, when improper food preparation techniques and hand hygiene are utilized within the home it creates an additional risk for the transmission of foodborne disease, regardless of whether the primary transmission of disease occurred in the home or not.

There are a variety of knowledge gaps and resulting food handling behaviors that contribute to the transmission of foodborne disease in the home (Table I). In a review of foodborne disease and other hygiene issues within the home, there were serious gaps in
consumer food safety knowledge regarding time and temperature abuse, cross-contamination, and potential sources of bacterial contamination (Scott 1996; Ministry of Agriculture, Fisheries and Food 1988; Scott 1992). The CDC cited a number of improper food safety practices that may lead to foodborne disease transmission in the home, including “the pooling of eggs, holding of hazardous foods at temperatures that permit amplification of low-dose pathogens, incomplete cooking of foods such as hamburgers, and cross-contamination of cooked foods” (Altekruse et al. 1997). When food safety knowledge gaps are combined with their resulting improper food handling behaviors, an increased probability of foodborne disease transmission occurs. In fact, it has been suggested that if all home food preparers practiced safe food handling techniques 100% of the time the incidence of foodborne illness could be reduced by half (Medeiros et al. 2001).
## TABLE I
**REVIEW OF KNOWLEDGE GAPS AND FOOD HANDLING BEHAVIORS THAT CONTRIBUTE TO THE TRANSMISSION OF FOODBORNE DISEASE IN THE HOME**

<table>
<thead>
<tr>
<th>Food Safety Concept</th>
<th>Reference</th>
<th>Country</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-contamination</td>
<td>25</td>
<td>USA</td>
<td>Only 43% of undergraduate students in this study could identify the correct way to prevent cross-contamination following handling raw meat on a cross-sectional survey of food safety knowledge. Only 67% of students kept dirty dishes separated from clean and washed the cutting board between preparing raw chicken and raw vegetables when observed.</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>England and Wales</td>
<td>In a review of foodborne infection and intoxication between 1970 and 1979, 14% of 396 salmonellosis outbreaks were attributed to cross-contamination.</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>Wales</td>
<td>In an observational study, 60% of consumers used the same cutting board for cutting both raw and ready-to-eat items without washing in between.</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>USA</td>
<td>In a report of an outbreak, cases of <em>Listeria</em> food poisoning were attributed to cross-contamination of environmental surfaces by <em>Listeria</em>-contaminated hogs head cheese. Fourteen cases were identified, eight of which met the case definition. Seven patients were hospitalized and two died.</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>USA</td>
<td>In a report of an outbreak, cases of campylobacteriosis were most likely caused by the consumption of lettuce cross-contaminated with raw chicken juice. This emphasizes the need to keep certain foods and cooking utensils separate during food handling. Fourteen individuals met the case definition with no hospitalizations and no fatalities.</td>
</tr>
</tbody>
</table>
TABLE I (continued)

REVIEW OF KNOWLEDGE GAPS AND FOOD HANDLING BEHAVIORS THAT CONTRIBUTE TO THE TRANSMISSION OF FOODBORNE DISEASE IN THE HOME

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<tr>
<th>Food Safety Concept</th>
<th>Reference Number</th>
<th>Country</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thawing frozen meat</td>
<td>26</td>
<td>England and Wales</td>
<td>In a review of foodborne infection and intoxication between 1970 and 1979, 6.1% of 1,000 outbreaks were attributed to not adequately thawing meat prior to being the cooking process.</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>USA</td>
<td>In a report of an outbreak, cases of salmonellosis were attributed to cooking frozen turkeys without thawing or defrosting. In this outbreak, 27 cases occurred with no hospitalizations or deaths</td>
</tr>
<tr>
<td>Preparing food while ill</td>
<td>26</td>
<td>England and Wales</td>
<td>In a review of foodborne infection and intoxication between 1970 and 1979, 5.2% of outbreaks were attributed to food preparation by infected food handlers.</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>USA</td>
<td>In a report of an outbreak, cases of Norovirus food poisoning were attributed to food handlers working while ill. Several food-service workers worked while ill during the period between January and February of 2006. A line cook vomited in the restaurant on January 28th, possibly leading to increased environmental contamination and transmission of the virus. In this outbreak, 364 cases occurred with no hospitalizations or deaths.</td>
</tr>
</tbody>
</table>
TABLE I (continued)

REVIEW OF KNOWLEDGE GAPS AND FOOD HANDLING BEHAVIORS THAT CONTRIBUTE TO THE TRANSMISSION OF FOODBORNE DISEASE IN THE HOME

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<th>Food Safety Concept</th>
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<th>Country</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handwashing (continued)</td>
<td>27</td>
<td>Wales</td>
<td>In an observational study, 66% of the study population of consumers did not wash their hands prior to beginning food preparation.</td>
</tr>
<tr>
<td>Food storage and time and temperature abuse</td>
<td>25, 26</td>
<td>USA, England and Wales</td>
<td>Only 34% of these college students could identify the correct place to store raw meat in the refrigerator on a cross-sectional food safety knowledge survey. In practice, 40% of students stored meat in the correct location. In a study of 1,000 outbreaks, 39.6% were attributed to storage at ambient temperatures, 31.9% were attributed to inadequate cooling, and 5.7% were due to improper warm holding.</td>
</tr>
<tr>
<td>Properly cooking ground beef</td>
<td>32, 33, 34</td>
<td>USA, USA, USA</td>
<td>Approximately 80% of hamburgers consumed by ill persons were prepared at home. In a report of an outbreak, cases of E. coli food poisoning were attributed to the consumption of undercooked hamburgers from a fast food chain. 45 cases of hemolytic uremic syndrome and 3 deaths were reported. In a cross-sectional survey of food safety knowledge and behaviors in pregnant or lactating women participating in the Women, Infants, and Children (WIC) program, 77% of participants used meat or meat juice color to determine the doneness of ground beef.</td>
</tr>
<tr>
<td>Food Safety Concept</td>
<td>Reference Number</td>
<td>Country</td>
<td>Explanation</td>
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</tr>
<tr>
<td>Checking the internal temperature of meats</td>
<td>25</td>
<td>USA</td>
<td>Only 41% of college students knew that a metal stem thermometer must be used to check the temperature of meat to ensure doneness. In practice, only 28% of students used a thermometer to check doneness.</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>USA</td>
<td>In a report of an outbreak, cases of <em>Salmonella</em> serotype <em>enteritidis</em> (SE) infection were associated with eating improperly prepared turkey and stuffing containing eggs. A meat thermometer was not used to check the internal temperature of the meat or the stuffing prior to serving. As a result of this outbreak, seven cases were identified with two hospitalizations and one death.</td>
</tr>
<tr>
<td>Avoiding risky eating behavior</td>
<td>25</td>
<td>USA</td>
<td>Twenty percent of college students reported consuming risky food items such as raw oysters, clams, or mussels; rare hamburger; raw homemade cookie dough or cake batter; or sushi.</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>USA</td>
<td>This cross-sectional survey of unsafe food consumption practices reported a higher prevalence of consuming undercooked or raw eggs in households with children aged 13–17.</td>
</tr>
</tbody>
</table>
TABLE I (continued)

REVIEW OF KNOWLEDGE GAPS AND FOOD HANDLING BEHAVIORS THAT CONTRIBUTE TO THE TRANSMISSION OF FOODBORNE DISEASE IN THE HOME

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</tr>
</thead>
<tbody>
<tr>
<td>Avoiding risky eating behavior, continued</td>
<td>37</td>
<td>USA</td>
<td>In a report of an outbreak, ill individuals consumed raw ground beef contaminated with <em>Salmonella typhimurium</em>. Cases reported eating ground beef that was either plain or seasoned with onions and an herb mix and that the consumption of raw beef during the holidays was a practice brought from Europe by their ancestors. Investigators identified 107 confirmed and 51 probable cases. Seventeen patients were hospitalized and no deaths were reported.</td>
</tr>
<tr>
<td>Immuno-compromised individuals and foodborne disease</td>
<td>25</td>
<td>USA</td>
<td>In a cross-sectional survey, only 68% of undergraduate college students could identify the risk groups for foodborne disease. Roma tomatoes contaminated with fecal material were the most likely cause of the outbreak. Particular care should have been taken to avoid contamination given the immunocompromised condition of those participating in the games. A total of 141 cases occurred among those attending the transplant games, no hospitalizations or deaths were reported.</td>
</tr>
<tr>
<td>Cleaning versus sanitizing</td>
<td>34</td>
<td>USA</td>
<td>In a study of WIC participants, 44% of pregnant or lactating women could not correctly define sanitizing. In a report of an outbreak, cases of illness were most likely caused by cleaning, but not sanitizing, the meat slicer used to slice the pre-cooked ham. Eighteen individuals met the case definition of staphylococcal food poisoning and two hospitalizations were reported.</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>USA</td>
<td></td>
</tr>
</tbody>
</table>
2.3 **Foodborne Disease Risk Factors**

There are a number of factors that increase the risk of foodborne disease transmission. Studies have found that the consumption of specific foods and prevalence of specific food handling practices, age, and race/ethnicity are all associated with an increased risk of contracting foodborne disease. This is particularly true because of the association between some risky food handling behaviors and both age and race/ethnicity.

2.3.1 **Consumption of Foods and Food Handling Practices**

There are a number of specific foods that increase the risk of acquiring a foodborne disease. Research has found that the foods most frequently associated with foodborne disease outbreaks include meat and meat products, poultry, eggs and egg products, fish/shellfish, and “miscellaneous foods” (buffet foods, sandwiches, or other foods comprised of multiple ingredients (Rocourt et al. 2003; Michino and Otsuki 2000; Gormley et al. 2011; Stafford et al. 2008; Hennessy et al. 2004). The consumption of farm animal products specifically creates an increased risk for *Salmonella*, *Campylobacter*, and Shiga toxin-producing *E. coli* 0157 infection (Stafford et al. 2008; Hennessy et al. 2004; Gillespie et al. 2005). In addition, the consumption of raw or undercooked seafood products has been shown to represent a substantial risk for infection with foodborne disease. A study of foodborne disease outbreaks between 1983 and 1992 found that fish was the third most reported vehicle of transmission (Lipp and Rose 1997). Potential contaminants of seafood include *Vibrio* species (spp.), *Salmonella* spp., *Clostridium* spp., *Campylobacter* spp., *Shigella* spp., *Listeria monocytogenes*, *Yersinia enterocolitica* and several human foodborne viruses; in addition, improper handling of seafood can lead to the development
of a number of toxins leading to scromboid poisoning, ciguatera poisoning, and paralytic shellfish poisoning (Lipp and Rose 1997; Feldhusen 2000).

While the consumption of these foods has been associated with an increased risk for disease, specific food handling behaviors also play a role (Table I). The WHO stated that there are three main factors that can contribute to outbreaks; these include factors relating to contamination, factors relating to the survival of microorganisms, and factors related to microbial growth (Rocourt et al. 2003). Relating to all of these factors, it appears that time and temperature abuse and inappropriate storage may play a predisposing role in many foodborne disease outbreaks, particularly within a residential setting (Rocourt et al. 2003; Gillespie et al. 2011). There are several food handling practices that have been found to be associated with foodborne disease outbreaks from specific organisms. A review of foodborne disease outbreaks in England and Wales suggested that cross-contamination, inadequate heat treatment, inappropriate storage, and infected food handlers were significantly associated with outbreaks of *E. coli* O157, *Campylobacter*, and *Salmonella*; outbreaks of *Clostridium perfringens* and *Salmonella*; outbreaks of scrombotoxin and *Clostridium perfringens*; and outbreaks of viral pathogens, respectively (Gormley et al. 2011). If inadequate knowledge results in the utilization of any of the previously mentioned contributory factors, the risk of foodborne disease is increased.

2.3.2 **Race and Ethnicity**

Research has found that individuals of some races and ethnicities are at increased risk for several foodborne diseases. Specifically, data suggests that individuals of African American or Hispanic ancestry are at a particularly increased risk. Analyses of cases of salmonellosis and
shigellosis collected from FoodNet sites in the United States suggest that age-adjusted rates may be higher among Black individuals than among Whites (Shiferaw et al. 2004; Chang et al. 2009). In addition, studies of data collected by the Notifiable Diseases Surveillance System in United States counties have found that the prevalence of cases of listeriosis, salmonellosis, shigellosis, and *E. coli* O157:H7 infections are greater for Hispanics than non-Hispanics (Chang et al. 2009; Pouillot et al. 2012; Arshad et al. 2007). Differences in socioeconomic status and food preferences may play a role in the differing rates of foodborne disease by race/ethnicity.

The combination of food insecurity and differing food preferences may play a role in the disparity in rates of foodborne illness by race and ethnicity. One example of this is a difference in the rates of consumption of fish and shellfish. Some racial or ethnic groups may be more likely to consume seafood. One study found that non-White individuals and those with a larger household size are more likely to consume seafood at home (Wan and Hu 2012). Due to factors such as religious affiliation and ethnic food preferences such as ceviche, many Hispanic individuals frequently consume seafood. One study found that 97% of responding Hispanics in New York City identified themselves as seafood eaters; within this population, increasing household size was also associated with an increased frequency of seafood consumption (Weinstein and Bisogni 1999). An additional contributing factor to the increased consumption of fish by non-White individuals may be that fisherman are able to inexpensively cook and prepare fish that they have caught themselves. A study of Indiana fishermen found that non-White anglers were significantly more likely to consume greater than the recommended safe amount of fish (Sheaffer and O’Leary 2005). Another study of anglers in the Calumet Region determined that while 57% of White individuals had consumed fish that they had caught, the prevalence of this behavior was 78% and 93% for Black and Hispanic individuals, respectively (Fisher et al.
Further supporting the conclusion that subsistence fishing is more common among non-White individuals, a study of anglers on the Savannah River found that black fisherman both ate larger portions of fish and ate fish more often than White fisherman; the frequency of noncommercial fish consumption in this study was also correlated with both lower education and socioeconomic status (Burger and Stephens 1999).

2.3.3 **Age**

Evidence suggests that adolescents, as opposed to younger children, may share many of the same risks for foodborne infection as do older adults, there may be an additional risk associated with decreased age and experience (Sockett and Rodgers 2001). This is true because adolescents may be of increased likelihood to utilize both improper food handling techniques and risky eating behaviors (Altekruse et al. 1999; Haapala and Probart 2004; Morrone and Rathbun 2003; Byrd-Bredbenner et al. 2007). For example, in a randomized telephone survey of eight states, decreased age was associated with not routinely washing hands with soap after handling raw meat, not routinely sanitizing a cutting surface after contact with raw meat, eating raw hamburger and raw oysters, and drinking raw milk (Altekruse et al. 1999). Additionally, studies of both middle school and undergraduate college students illustrate improper food safety behavior. In a study of middle school students in Pennsylvania, participants frequently reported seldom washing their hands before eating at the cafeteria or a restaurant (Haapala and Probart 2004). There were also substantial unsafe food behaviors in undergraduate college populations. One survey of food safety behavior in Ohio University students showed high rates of the consumption of undercooked hamburger (Morrone and Rathbun 2003). This study also found that the placing of food safety labels on raw meat and poultry has not been sufficient to
ameliorate risky eating behaviors in this population (Morrone and Rathbun 2003). In addition, in a national study of undergraduate students in the United States there was a low reported utilization of proper food handling behaviors in the areas of thermometer use and food storage (Abbot et al. 2009; Byrd-Bredbenner et al. 2007). It may be possible that the previously described reported behavior underestimates the actual prevalence of these behaviors. In a study of Rutgers University students there were substantial differences in the frequency of reported food safety behaviors and the completion of these behaviors in practice; specifically, there was a significant discrepancy in the reported and observed behaviors in the areas of hand washing and thermometer use (Abbot et al. 2009).

Although food safety knowledge in high school students has not been reported in the literature, there have been studies of knowledge in middle school and undergraduate college students. Middle school students in Pennsylvania were found to have substantial knowledge gaps in several areas, including proper internal temperatures to cook meat and appropriate sanitation techniques (Haapala and Probart 2004). Knowledge gaps were also apparent in studies of undergraduate college students. In a national survey, undergraduate college students had low food safety knowledge regarding the common food sources of foodborne disease (Abbot et al. 2009; Byrd-Bredbenner et al. 2007). Additionally, several studies found that college students had low knowledge of the minimal internal temperature to cook raw meat (Byrd-Bredbenner et al. 2007; Stein et al. 2010; Yarrow et al. 2009). A lack of awareness of the dangers of cooking meat while ill was also found among students at Kansas State University (Yarrow et al. 2009). For adolescents, an inadequate knowledge of food safety and resulting improper food handling skills create a health risk both in the home and in a restaurant food handling environment.
2.3.3.1 Adolescent Food Handling in the Home

The current economic climate combined with increased numbers of women seeking careers outside of home has led to dual-employment and single parent households becoming more common, if not the norm. According to the Employment Policy Foundation’s Center for Work and Family Balance, households containing single-earner married couples have decreased from 66% of households in 1940 to 25% of households in 2000; it is estimated that if current trends continue, this proportion will decrease to only 17% in 2030 (Clay 2005). Children from dual-employment and single parent households are less likely to engage in family meals (Bauer et al. 2012). Thus, increasing rates of maternal employment outside the household have led to both increased fast food consumption and increased rates of adolescent food preparation; while previously a mother may have been responsible for teaching her children how to cook food safely, adolescents are now often left with the task of preparing foods for themselves and their families with little to no food safety knowledge (Anderson 1998). In fact, in a study of Pennsylvania middle school students, 92% reported preparing meals or snacks at home (Haapala and Probart 2004). While the frequency of preparing meals or snacks at home is high, research suggests that the frequency of preparing food with parental assistance is lower; in fact, a study of Minnesota public schools students found that approximately 69% of adolescent reported helping prepare dinner (Larson et al. 2006). Among these students, female students and those of lower socioeconomic status were of increased likelihood to have reported helping prepare a meal. While food preparation with parental assistance may provide some additional access to food safety knowledge, this may be dampened by what has been deemed an overall “deskilling” within the kitchen that is not limited to only the younger demographic (Kornelson 2009; Lyon et
Thus, even if students have experience preparing food with parental assistance, the parents themselves may not have adequate food safety knowledge to pass on to their adolescent children.

2.3.3.2 Adolescent Food Handling in the Food Service Industry

The potential impact of poor food safety knowledge in adolescents is further exacerbated by the large numbers of adolescents employed in the food service industry. The Bureau of Labor Statistics has estimated that 21% of all food and beverage service workers are aged 16–19 years old (U.S. Department of Labor, Occupational Outlook Handbook, 2010–11 Edition, Food and Beverage Serving and Related Workers 2011). In addition, 40.8% of employment for teenage workers is in the food service industry (Hirshman and Voloshin 2007). The food service industry is often the gateway into the workforce for teenagers. The American Restaurant Association estimates that not only have 50% of Americans worked in a restaurant at some point in their career, but also that one in four got their first job in the food service industry (National Restaurant Association 2012). Of even greater concern is the possibility of adolescent employment in industries in that they would be directly serving populations that are particularly vulnerable to foodborne disease. An additional 2% and 9% of workers aged 16–19 are employed in healthcare support occupations and personal services occupations, respectively (Hirshman and Voloshin 2007). Because these occupations involve work with the elderly and childcare services in addition to often requiring food preparation, they present a particular risk for the transmission of foodborne disease.

The large prevalence of adolescents in the food service industry becomes particularly relevant to the prevention of the transmission of foodborne disease when decreased age is
associated with a lack of knowledge. A recent analysis of food handlers in suburban Chicago found that age was significantly associated with food safety knowledge, with food handlers aged 18–29 years of age having significantly lower mean food safety knowledge when compared to food handlers aged 40 years of age or older (Manes et al. 2012). Within restaurants, commonly reported causes of foodborne disease outbreaks include poor hand hygiene, improper temperatures for cooking and holding food, and cross-contamination (U.S. Food And Drug Administration 2004). When a lack of knowledge results in improper food safety in these circumstances, young people are not only putting themselves at risk for illness but also may be putting family members or restaurant patrons with increased susceptibility to foodborne diseases at a greater risk. Due to an increased rate of food consumption outside of the home, even just one unknowledgeable food worker can lead to an outbreak of foodborne illness. Data suggest that an increase in dual-employment households has also led to decreased time for cooking at home and an increase in food expenditure for eating out (Manchester and Clauson 1996). Because people eat out more frequently, there is an increased risk for the transmission of foodborne disease when food handlers lack food safety knowledge.

2.4 **Review of Food Safety Interventions**

2.4.1 **Home Economics**

In the current economic and employment climate, much of the responsibility for teaching safe food handling skills is placed on home economics, or family and consumer sciences instructors. However, this is inadequate for several reasons. There has been a reduction of food safety knowledge exposure at school; most states do not require family and consumer science (home economics) education, and some schools have removed it entirely (Byrd-Bredbenner et al.
Even when a home economics course is offered, students who choose this course option must become acquainted with a variety of areas of study, including personal, family, and child development; nutrition, foods, and hospitality; fashion and textiles; housing and interior design; and consumer education (California Commission on Teacher Credentialing 2005). The requirement that students must “demonstrate knowledge of the principles of food safety and sanitation, including foodborne illnesses, their causes, and prevention” makes up one of 70 content area standards that students are expected to master upon completion of their home economics course (California Commission on Teacher Credentialing 2005). Even when schools offer home economics coursework, they are often hard-pressed to find qualified instructors (US Department of Education Office of Post-secondary Education 2008). Although renewed recognition of the importance of home economics has led for a call for its return, there are several areas that challenge the practical application of this ideal (Beard 1991). With pressure to meet the requirements of the No Child Left Behind Act of 2001, increased focus has been placed on the classroom to cover materials that will be tested on state assessments (Abrams 2004; Perreault 2000). While there may be a place for food safety education within health education classes, such learning opportunities are often displaced by those that are determined to have greater priority such as teen pregnancy and obesity prevention (Altekruse et al. 1997; Collins et al. 1995).

Despite these challenges, it is thought that “probably the most effective means of promoting food hygiene is via hygiene education programmes in schools” (Scott 1996, page 8). In fact, even with decreases in the teaching of home economics, food safety is not without its place in schools today. A United States Department of Agriculture/Food and Drug Administration (USDA/FDA) Education Initiative determined food safety can be effectively
taught in science courses in order to reinforce scientific concepts and provide them with a practical application (Koepl and Robey 1998). The USDA/FDA Education Initiative also determined that the most effective food safety interventions are easily integrated into existing course material, hands-on, and “fun” (Koepl and Robey 1998). Although more research on the high school food safety education interventions is needed, integrated approaches have previously been utilized in the middle school and collegiate settings with success.

2.4.2 **Food Safety Interventions for Adolescents and Minorities**

Currently, there have been few food safety interventions that have specifically addressed knowledge gaps in young adults and even fewer that have specifically addressed minorities. In a review of literature, two food safety interventions were found that addressed middle school students, two that addressed undergraduate college students, and one that addressed minorities. There were no food safety interventions that specifically addressed high school students in the preexisting literature.

One intervention for middle school students was conducted by researchers at the University of Tennessee in the fall semesters of the 2006 and 2007 school year (Richards et al. 2008). This pilot study consisted of 233 middle school students from two suburban schools, two rural schools, and one urban school. Prior to implementation of the intervention, students were tested to determine their baseline food safety knowledge and self-reported food safety behaviors and attitudes. The curriculum was developed by food safety and microbiology experts and designed to meet state content standards of and be integrated into science, math, social studies, and language arts classes. Specific elements of the curriculum included culturing petri dishes and analyzing bacterial growth data and researching foodborne disease outbreaks and then writing
press releases to relay the information they had learned to their peers. Teaching training and on-site instructional support was also provided. Students who participated in the intervention demonstrated significant gains in knowledge and self-reported behaviors and attitudes on follow-up assessments directly following curriculum implementation. Specific subject areas of knowledge increases were not noted in the literature. The results of this study suggest than an interdisciplinary food safety curriculum may be effective at increasing knowledge scores in an adolescent population.

Another food hygiene intervention for middle school students was conducted in South Korea in 2010 (Kim et al. 2012). This intervention, conducted with 400 middle school students from Seoul and Gyeonggi-do, focused on hand hygiene and utilized the stages of change model. Prior to implementation of the intervention, students participated in a survey that measured their hand washing behaviors, stages of change regarding hand hygiene, self-efficacy, positive and negative beliefs, and food safety knowledge. The intervention was conducted by high school mentors and comprised of three lessons followed by discussions and quizzes and one lab experiment. The lessons focused on hand hygiene, food poisoning, and general food safety. Following the intervention, students had significant gains in hand washing self-efficacy, progress towards the action state of change, proper hand washing behavior, and food safety knowledge. Specifically, knowledge about Norovirus and health, key times to wash hands, hand washing techniques, and the meaning of hazard analysis and critical control points (HACCP) were significantly increased. These results suggest that a curriculum including discussion and involving leadership from older students may be effective at increasing food safety knowledge.

For undergraduate college students, two examples of food safety interventions were found in the literature. The first utilized a web-based intervention to increase food safety
knowledge and improve food safety attitudes, beliefs, and behaviors (Yarrow et al. 2009). Fifty-nine health and non-health majors completed all elements of this study and all participating students were predominantly responsible for their own food preparation. Students completed a questionnaire that assessed their food safety attitudes, beliefs, knowledge, and self-reported practices. After completing the questionnaire, students participated in a web-based intervention that included three educational modules requiring 30–60 minutes each. Components of the modules included “food safety instruction with clip art, animated graphics, flash card activities, quizzes, word seek activities, crossword puzzles, drag-n-drop activities, audio clips, and links to the World Wide Web” (Yarrow et al. 2009). Both health and non-health majors had significant improvements in knowledge, attitude, beliefs, and self-reported practices, however, these increases were significantly greater for health majors. Following the intervention, students were significantly more concerned about eating undercooked eggs, alfalfa sprouts, and uncooked hotdogs; drinking unpasteurized apple juice; proper thawing mechanisms; and time and temperature abuse. Student knowledge about cooking food while ill, the correct temperature to cook ground beef, and how to determine doneness of eggs and ground beef all significantly improved; accordingly, self-reported practices associated with this knowledge also improved significantly. The results of this study suggest that while food safety interventions can be effective for all students, they may be particularly successful with students who already have a health sciences background.

The second intervention utilized a social marketing campaign to educate undergraduate college students about food safety (Stein et al. 2010). This study consisted of 1,122 college students at Rutgers University. Prior to implementation of the campaign, students were surveyed to assess their baseline food safety knowledge. Substantial knowledge gaps were found in the
areas of proper temperatures for cooking, reheating, and refrigerating foods. After completing this survey, researchers began a four-week social marketing campaign that consisted of posters, tabletops, flyers, mass emails, and campus newspaper announcements. Specific food safety knowledge areas that were targeted with these educational materials included proper hand washing techniques, cooking to meat to proper internal temperatures, proper temperatures for refrigeration, and proper handling of leftovers. Post-intervention, there were significant gains in all areas except proper hand washing techniques. Students stated that emails and posters were particularly effective at increasing their food safety knowledge. The results of this study suggest that food safety interventions using a visual teaching method, such as a poster, may be effective at increasing food safety knowledge.

One of the most well-known food safety interventions is the Partnership for Food Safety Education’s Fight BAC! campaign. One study, conducted by researchers at the University of Connecticut in 2000, examined this campaign’s effectiveness in an urban Latino population (Dharod et al. 2004). Prior to exposure to the campaign, 500 Latino consumers completed a survey consisting of 30 food safety questions. After completion of the survey, participants were provided with “a shopping bag displaying the Fight BAC! logo and containing sanitation supplies, a meat thermometer, and food safety education materials” (Branscum and Sharma 2009). Food safety educational materials focused on four central messages: clean, separate, cook, and chill. Individuals exposed to the campaign had significantly greater knowledge scores than those who were not. These results suggest that a culturally appropriate food safety intervention can be effective at increasing food safety knowledge in urban Latino populations.
2.5 **Comic Book Interventions**

Although some previous food safety interventions have been successful in young adult populations, comic books present a novel mechanism for relaying food safety knowledge to high school students. Data suggest comic books are becoming more widely used, both as a teaching tool in high schools and as a mechanism for health intervention (Branscum and Sharma 2009; Viadero 2009). In fact, in 2004 Maryland state educators launched a statewide initiative to encourage the use of comic books in schools (Viadero 2009). Also effective in increasing overall literacy was the Comic Book Project; this project, launched in 2001, served to provide disadvantaged students with the opportunities to create their own comic books (Viadero 2009).

Overall, it has been suggested that students who read comic books read more in general; this was seen to be particularly true for children from low and middle income households (Branscum and Sharma 2009; Ujiie and Krashen 1996). Within the health arena, comic books have previously been successfully utilized in interventions on nutrition, schistosomiasis, lymphatic filariasis, tobacco use, and pesticide exposure (Trent and Kinlaw 1979; Yuan et al. 2000; El Setouhy and Rio 2003; Bush et al. 2005; Leibman et al. 2007). In addition, comic books have been successfully utilized to increase food handler knowledge in a restaurant setting in Chicago-proper and suburban Chicago (Dworkin et al. 2012; Manes et al. 2012).

Although comic book interventions have been used with success, they have not gone without criticism. For one, it appears that as the comic book, or graphic novel, demographic has shifted to a more adult audience fewer children are reading comic books. One study found that the proportion of students reporting comics was 25% of boys and 1% of girls and 19% of boys and 5% of girls for middle and lower income schools, respectively (Ujiie and Krashen 1996). The rates of reading comic books in this study were also much higher among male students than
female students. Contradictorily, comic books may be regarded as “immature” by older high school students. One high school librarian quoted a student as saying comic books were for adults "who still live in their parents' basement and eat Hot Pockets" (Viadero 2009). Despite these factors, results of previous interventions suggest that a scientifically oriented educational comic book and accompanying curriculum may be effective at increasing food safety knowledge in a high school student population.

2.6 **The Principles of Effective Prevention Programs Model**

According to the Principles of Effective Prevention Programs model, there are nine principles that are considered attributes of an effective prevention program (Nation at al. 2003). These principles, derived from examples of effective prevention programs in the literature, include that a program should be comprehensive, have varied teaching methods, have sufficient dosage, be theory driven, promote positive relationships, be appropriately timed and socioculturally relevant, include an outcome evaluation, and have well-trained staff. A utilization of these factors, in conjunction with a review of previous food safety interventions, suggests that the prepared intervention may be successful at increasing food safety knowledge in a high school student population.
3. MATERIALS AND METHODS

3.1 Study Population

This research was developed in collaboration with the Noble Street Charter School of Chicago, Illinois. The Noble Street Charter School was selected due to its preexisting relationship with the University of Illinois at Chicago (UIC) of Chicago, Illinois and health science focus. The school also represented an opportunity to provide a food safety intervention to a largely minority population. The school agreed to participate in the research and approved the curriculum after UIC Institutional Review Board and Chicago Public Schools Research Review Board approval. A convenience sample of 231 students enrolled in health science classes in the 11th and 12th grades at Noble Street Charter School and their instructors were invited to participate and provided with consent and parental permission forms (Appendices A-C). Students were asked to read and sign the consent form and have their parents read and sign the parental permission form and return both to the classroom instructor. Confidentiality for each student was assured. Eligible participants were defined as students with signed parental permission and student consent forms.

3.2 Intervention Design

Between July 2011 and February 2012, an engaging comic book and curriculum were created with the objective of increasing food safety knowledge in high school students. The curriculum was designed to be: (1) suitable for high school students and require no substantial increase in school resources; (2) easily adopted by teachers as their own curriculum; (3) complementary to other core curriculum such as reading, math, oral communication, and science and informed by local, state, and national learning standards; (4) based on elements of published
food safety and hygiene interventions, including the modification of existing educational comic books designed for restaurant food handlers (“A knowledge assessment and intervention to reduce food poisoning risk factors related to restaurant food handlers,” USDA 2008-35201; “Creation and evaluation of language-appropriate evidence-based educational materials for food safety training of restaurant food handlers,” USDA 2008-01691). The comic book and curriculum were drafted with assistance from an artist, shared with two school science faculty members for feedback input, and piloted with two 12th grade students. A curriculum guide was created for the instructors (Appendix D). Instructors reviewed the curriculum and asked any questions. The comic book and curriculum were modified based on this input from teachers and students. Specific local, state, and national learning objectes were selected to be met with this curriculum (Appendix E).

3.3 **Educational Comic Book**

The comic book consisted of five short stories depicting real and fictitious foodborne disease outbreaks (Appendix F). The stories from the preexisting educational comic book were targeted to remedy knowledge gaps in restaurant food handlers. The school comic book was modified to remove information that would be relevant to food handlers but not consumers and to add an additional story and corresponding work pages that students would use to solve a fictional foodborne outbreak investigation. Each story was designed to address specific food safety knowledge gaps. The artist, David Castelleno, created the illustrations and inserted or replaced the text as needed or directed by the primary investigators. The comic book consisted of the following components:
3.3.1 **Inside Front Cover**

The inside front cover consisted of a panel from the comic book for the CHEF study (“Creation and evaluation of language-appropriate evidence-based educational materials for food safety training of restaurant food handlers,” USDA 2008-01691) that illustrated groups particularly at risk for foodborne illness. Illustrations of food handlers who appeared in the SSRFHS study comic (“A knowledge assessment and intervention to reduce food poisoning risk factors related to restaurant food handlers,” USDA 2008-35201) described these risk groups. A diagram from the USDA was included to describe the four ways to protect consumers from foodborne disease (“Be Food Safe” 2011). This page also included the sources of data for the comic book and credits for those involved in its creation.

3.3.2 **Story 1: “At the Local Restaurant”**

The first story was created as a modification of a comic book from the SSRFHS study Components that applied to food handlers only, such as dangers associated with temperature control of fish and histamine development and the economic impact on a restaurant of not ensuring food safety, were omitted. This story illustrated the comic’s hero, Tiny Chef, helping restaurant food handlers correct food safety errors in a kitchen that is preparing dinner for the president. This comic book addressed cross-contamination, proper storage of potentially contaminated items and ready-to-eat food, cooling foods, how a person can ensure food is safely cooked, how to thaw frozen meat, proper storage of cooked rice, the human impact of foodborne disease, and the danger zone for pathogen growth (Table 1).
3.3.3 **Story 2: “Germ Takedown”**

The second story was taken from the SSRFHS study comic book. This story described how The Sanitizer, a restaurant food handler, engaged a germ dressed to resemble a *luchador* (Mexican wrestler) in a battle with proper handwashing and avoidance of the danger zone for pathogen growth. The steps involved in handwashing and the difference between cleaning and sanitizing were illustrated (Table 1).

3.3.4 **Story 3: “True Stories from the Kitchen: The Tale of the Terrible Turkeys”**

The third story was taken from the SSRFHS study comic book. A real foodborne disease outbreak in which a restaurant that did not adequately thaw Thanksgiving turkeys that resulted in many people becoming sick was described. Specific food handling concepts, including the correct way to thaw frozen meat, avoidance of storage at temperatures in the danger zone for pathogen growth, and the correct way to cool large containers of hot food were addressed (Table 1).

3.3.5 **Story 4: “True Stories from the Kitchen: The Tale of the Killer Hamburgers”**

The fourth story was taken from the SSRFHS comic book. A real foodborne disease outbreak was described in which a fast food chain did not completely cook their hamburgers, resulting in the death of three children. The transmission of *E. coli*, hemolytic uremic syndrome, and the proper procedure to follow after handling ground meat for handwashing, storage, and cooking were addressed by this story (Table 1).
3.3.6 **Story 5: “A Funny Thing Happened on the Way to the Fork”**

Created for this study and using a “from farm to fork” approach, the story described a fictional foodborne disease outbreak in which students are required to determine the most likely origin. At the farm, the role of animal crowding in vertical and horizontal transmission of foodborne disease pathogens was addressed. Images of two common foodborne bacteria (*Campylobacter* and *Salmonella*) were provided by the Institute of Food Research ("Salmonella" 2011; “Campylobacter” 2011). At the restaurant, improper thawing of meat, cross-contamination of ready-to-eat food, and failure to check the temperature of the chicken, were portrayed as potential mechanisms by which the outbreak could occur (Table 1). A menu for a catered event was provided for students’ use in analyzing the outbreak. The symptoms of foodborne disease and bacterial reproduction within the human body were also addressed and the steps of a foodborne disease outbreak were presented.

3.3.7 **Epidemiology Work Pages**

The first of the epidemiology work pages described the purpose of, formula for, and interpretation of food-specific attack rates. A table with the frequencies of the consumption of specific food items and disease status (e.g., those who consumed chicken and did get sick versus those who consumed chicken and did not get sick) was included. Space was provided for students to complete the calculations. Questions were included for students to think critically about and interpret the calculated food-specific attack rates and decide: (1) which food item was most responsible for the outbreak, (2) why they chose that food, and (3) if there were any other suspect food items with elevated attack rates.
The second epidemiology work page provided instruction on the purpose for, calculation of, and interpretation of relative risk, epidemiologic cohorts, and two-by-two tables, and provided these tables for the two food items with elevated attack rates. Questions were included for students to think critically about and interpret the calculated relative risks and (1) decide which food item is most likely responsible for the outbreak based on the relative risk and (2) interpret why some persons who consumed the contaminated food did not become sick and some persons who did not consume the contaminated food did become sick.

3.3.8 **Outbreak Investigation Curriculum Definitions**

Definitions of terms included in the comic book that may not be familiar to high school students and pronunciations of the pathogen names were included on these pages. Definitions were derived from authoritative sources (The American Heritage Dictionary of the English Language 2000; Centers for Disease Control 2011; Stedman's Medical Dictionary 2000; Minnesota Department of Agriculture, Diary and Food Inspection Division 1998; Oxford Dictionary of English 2003; Food and Agriculture Association of United Nations 2011; Dorland’s Medical Dictionary for Health Consumers 2007; Random House Webster’s Unabridged Dictionary 2001; Gordis 2009; Arrow Specific 2011; King Country Health Department 2011; Mosby’s Medical Dictionary 2005).

3.3.9 **Inside Back Cover: “National Outbreak Reporting System Form”**

One page reprinted a portion of the CDC’s National Outbreak Reporting System (NORS) form (National Outbreak Reporting System Form 2008). This was the page that collected the primary mode of transmission, incubation period, duration of illness, signs or symptoms,
secondary cases, traceback, and recall. The purpose of this form as a tool in outbreak investigations was described in local, state, and national health departments.

3.3.10 **Back Cover: “Meat Must be Cooked to the Correct Temperature on a Meat Thermometer to Ensure Safety and Quality”**

The page consisted of an image describing the importance of a meat thermometer relative to relying on color to ensure safety and quality in meat. This image was obtained with permission from the brochure title “Now You’re Cooking… Using a Food Thermometer” that was created by the Washington State University Extension (Takeuchi 2006). Also included on this page is a series of questions for the students to complete to test their understanding of the material. All of the answers can be found in either the education comic book or on the NORS form.

3.4 **Educational Curriculum**

A 120- to 150-minute curriculum based on the comic book was created to accompany the comic book. The curriculum consisted of reviewing and discussing the comic book, analyzing a NORS report form of a fictitious Norovirus outbreak at their high school, and presenting the results their analysis of a *Morbidity and Mortality Weekly Report (MMWR)* of a foodborne disease outbreak. Each report was selected to demonstrate an important food safety concept, such as cross-contamination (Table 1). The curriculum consisted of two sessions, each lasting approximately 60 to 75 minutes. A curriculum guide was created to help instructors facilitate the curriculum.
There were some substantial differences in the manner in which the curriculum was implemented in different classrooms. For example, the 11th grade classes took the pre-intervention survey as homework due to classroom time constraints per the instructors’ preference. In addition, while observing in the 12th grade classroom part of a class was removed during the curriculum implementation due to inappropriate apparel. This resulted in those students missing a portion of the curricular instruction.

By the end of the curriculum, students were expected to be able to generate hypotheses based on the presentation of a foodborne disease outbreak and to become familiar with determinants of foodborne disease; define and interpret terms related to food safety, hand hygiene, outbreak investigation, and epidemiology; calculate food specific attack rates and relative risks; become familiar with the NORS form, and demonstrate an understanding of how food safety and hand hygiene can be applied in the kitchen to prevent the transmission of foodborne disease.

3.4.1 **Curriculum Materials**

Included in the curriculum manual was a description of the materials that would be required for both teachers and students:

Per student:

- One copy of educational comic book
- One copy of the School Outbreak NORS form
- Calculator
- One *MMWR* article
- One copy of the *MMWR* Investigation Worksheet
• One copy of the Student Evaluation form
• One copy of the Post-Intervention survey

Per teacher:
• One copy of the Teacher Evaluation form

3.4.2 **Curriculum Overview**

3.4.2.1 **Epidemiology Work Pages, NORS Form, and Discussion**

Students were instructed to analyze data from a fictional foodborne disease outbreak provided in the educational comic book (Story 5) and calculate food-specific attack rates and the relative risk of becoming ill after exposure to a contaminated food item. Based on this information, students were asked to interpret these analysis results. Students then discussed and critically analyzed their results, the content of the educational comic book, and a NORS form created for a fictitious outbreak at their school.

3.4.2.2 **NORS Form Outbreak Analysis**

At the instructors’ request, a form describing a fictitious outbreak of Norovirus among students at the Noble Street Charter School was created (Appendix K). The values for incubation period, duration of illness, and signs and symptoms were determined based on the mean values in a review of Norovirus outbreaks (Atmar and Estes 2006; Siebenga et al. 2010). Students were instructed to analyze the results provided on the form and predict which pathogen was most likely responsible for the outbreak by researching the signs and symptoms of illness.
3.4.2.3 **MMWR Activity Part 1**

Students were divided into groups, provided with one of the *MMWR* reports, and asked to critically analyze their provided foodborne disease outbreak. The *MMWR* reports were distributed to student groups as per the instructor’s preference. Students were instructed to use the information gathered from the *MMWR* article to identify any unsafe food handling that may have led to the outbreak and create a testable hypothesis that could be used in an outbreak investigation. Each *MMWR* article was selected to exemplify certain food safety concepts addressed in the educational comic book. The *MMWR* articles were included in the Instructor Guidelines for Teaching (Appendix E).

3.4.2.4 **MMWR Activity Part 2**

Students were instructed to continue to develop their presentations for the first 15 minutes of class time. Each group then was instructed to give an eight-minute presentation followed by two minutes of questioning.

3.5 **Baseline Data Procedures**

The following procedures were utilized to collect data on student’s baseline food safety and epidemiology knowledge.

3.5.1 **Survey Development**

A 34-question survey instrument was developed to obtain baseline information about the knowledge, behaviors, and personal hygiene of the students (Appendix G). The 29 food safety knowledge questions included true-false, multiple-choice, fill-in-the-blank, and short answer
format and tested knowledge of the optimal temperatures for bacterial growth, proper mechanisms for storing and thawing foods, cross-contamination, and foodborne disease epidemiology. Participants were also asked about their hand-washing behaviors. Food handler demographic information was collected and included grade in school, gender, cooking experience, history of restaurant employment, and frequency of specific food handling tasks (including handling and cooking raw meat/poultry, seafood, eggs, and vegetables/fruits).

3.5.2 **Data Collection**

Surveys were self-administered by these students during class time (12th grade students) or as homework (11th grade students). Students in the 11th grade completed the baseline survey as homework due to classroom time constraints and as per the instructor’s preference. Students were instructed to complete the surveys without any assistance. Students who did not provide consent or whose parents did not provide permission still participated in the curriculum, but did not take the survey. Students that did not have consent and permission were instructed to complete homework during the survey administration.

3.6 **Intervention**

In March 2012, a curriculum was implemented during the classes’ environmental health and digestive systems units during two class sessions. All 11th and 12th grade students enrolled in a health science class were provided with the educational comic book to read as homework prior to beginning the classroom instruction. Student participation was voluntary in the sense that students had the opportunity to consent to participate in the assessment of the curriculum. The curriculum itself was not voluntary because it consisted of basic public health information within
the mission of the school to teach its students and this instruction is replacing other instruction that would have occurred during that school time.

3.7 Follow-up Data Procedures

The following procedures were utilized to collect data on student’s food safety and epidemiology knowledge after exposure to the educational curriculum.

3.7.1 Survey Development

The follow-up survey consisted of the same 29 knowledge questions on the baseline survey, with the addition of a question regarding the danger zone for pathogen growth to assess the students’ exposure to the comic book (Appendix H). Ten questions designed to evaluate the student’s exposure to the curriculum and the degree of post-intervention behavioral change were added to this survey. Students were also asked about whether or not they shared information that they had learned from the curriculum with family and/or friends and if they believed that these individuals had learned new information and changed their food handling behaviors. Students were encouraged to provide further elaboration on these answers through comments.

3.7.2 Data Collection

In the class period after the two class sessions, consented 11th and 12th grade students completed a post-intervention survey. Students without parental permission or consent completed homework during survey administration. Following the survey, students and instructors were asked to provide feedback about the comic book and curriculum student and teacher evaluation forms (Appendices I and J).
3.8 **Statistical Analysis**

Statistical analysis was performed using SAS 9.2 for Windows (SAS, Chicago, Illinois.). An overall knowledge score was determined by the number of correctly answered knowledge questions of the 29 from the survey. Increase in knowledge score was determined by the number of correctly answered questions on the baseline survey subtracted from the number of correctly answered questions of the 29 from the follow-up survey. A knowledge strata variable was created by grouping scores into four categories. Categories were comprised of very low (≤25%), low (26%–50%), moderate (51%–75%), and high (≥76%). Frequencies of correct answers to each knowledge question were examined to determine the food safety knowledge gaps. Bivariate analyses were performed to identify student variables associated with the knowledge score and increase in knowledge score. Analysis of Variance models were employed to compare the mean knowledge scores and mean knowledge increase for variables with more than two categories and T-tests were performed to compare the mean knowledge scores and mean knowledge increase between two category variables. Regression models were used to examine the associations between eligible factors such as grade level, gender, cooking experience, and food service employment, and the outcomes of pre-intervention knowledge score and post-intervention knowledge increase. Variables that had a statistically significant association (\(p<0.1\)) with the knowledge score and knowledge increase from bivariate analyses were included in the multivariate analysis. The initial regression model included all significant student characteristics to predict the knowledge score and knowledge increase. Model selection was completed using stepwise selection with backward elimination to produce a more parsimonious set of eligible predictors. A probability of Type I Error of \(\alpha=0.10\) was used to determine the significant student characteristics to remain in the regression model. A subset analysis of only students reporting
meat handling experience was completed to determine the frequency of correct responses to meat handling questions and subset analysis of only students reporting cooking often or always on their own was completed to determine frequently missed questions.
4. RESULTS

4.1 Baseline Sample and Participants

In March 2012, all 231 11th and 12th grade students enrolled in health science classes at the Noble Street Charter School were invited to participate in the survey and provided with parental permission and student consent forms. Of these, 195 (84%) completed the required forms and participated in the survey. Reasons for nonparticipation by 36 students included parental refusal (2; 1%), student refusal (1; 0.4%), and absence on the day of the survey (33, 14%).

Of the 195 students, 61% were female and 71% and 29% were in the 11th grade and 12th grade, respectively (Table II). Seventy percent (136) described themselves as Hispanic/Latino, 15% (30) as Non-Hispanic Black, 4% (8) as Non-Hispanic White, 2% (3) as Asian/Pacific Islander, and 9% (18) as Multi-racial or Other race/ethnicity. Twelve percent (24) of the students had prior restaurant employment experience, including 10 students who worked at a fast food restaurant. Female students more frequently reported cooking on their own often or always than did male students (27% and 19%, respectively; \(p<0.05\)). Students reported handling and cooking seafood infrequently, with 61% of students reporting never handling raw seafood and 64% of students reporting never cooking seafood. Students who reported cooking seafood also reported cooking on their own significantly more frequently than did students who did not report cooking seafood (\(p<0.05\)). The frequency of cooking with parental assistance was low among both groups and did not differ significantly by seafood cooking experience (\(p=0.60\)). Hispanic ethnicity was common among the 42 students who reported often or always handling or cooking seafood (100% and 73%, respectively).
<table>
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<th>Frequencies</th>
<th>Bivariate Analysis</th>
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</tr>
<tr>
<td>Grade</td>
<td></td>
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<tr>
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<tr>
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<td>54 (28): 12.0 (41)</td>
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<tr>
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<tr>
<td>Males</td>
<td>75 (39): 10.2 (35)</td>
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<tr>
<td>Females</td>
<td>118 (61): 11.1 (38)</td>
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<td>136 (70): 10.1 (35)</td>
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<td>3 (2): 9.7 (33)</td>
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<tr>
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<td>18 (9): 12.2 (42)</td>
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<tr>
<td>Yes</td>
<td>10 (5): 10.7 (37)</td>
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</tr>
<tr>
<td>No</td>
<td>185 (95): 10.7 (37)</td>
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<td></td>
</tr>
<tr>
<td>Frequency of Cooking with Parents</td>
<td></td>
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</tr>
<tr>
<td>Never</td>
<td>26 (13): 9.3 (32)</td>
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<td></td>
</tr>
<tr>
<td>Rarely</td>
<td>57 (30): 11.4 (39)</td>
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</tr>
<tr>
<td>Sometimes</td>
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<td>32 (17): 11.0 (38)</td>
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<tr>
<td>Always</td>
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<tr>
<td>Rarely</td>
<td>37 (19): 10.6 (37)</td>
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<tr>
<td>Sometimes</td>
<td>73 (38): 10.3 (36)</td>
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### TABLE II (continued)

**BASELINE CHARACTERISTICS OF HIGH SCHOOL STUDENTS PARTICIPATING IN A KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=195) AND SCORE OUT OF 29 KNOWLEDGE QUESTIONS**

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<th>Frequencies</th>
<th>Bivariate Analysis</th>
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<tr>
<td></td>
<td>N (%)</td>
<td>Score (%)</td>
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<td><strong>Experience Handling Raw Meat or Poultry</strong></td>
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<td></td>
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</tr>
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<td>Not at all</td>
<td>63 (36)</td>
<td>10.1 (35)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>90 (51)</td>
<td>11.0 (38)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>23 (13)</td>
<td>13.0 (45)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Handling Raw Seafood</strong></td>
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<td></td>
<td>0.5849</td>
</tr>
<tr>
<td>Not at all</td>
<td>119 (68)</td>
<td>11.0 (38)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>49 (28)</td>
<td>11.0 (38)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>8 (4)</td>
<td>9.8 (34)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Handling Raw Eggs</strong></td>
<td></td>
<td></td>
<td>0.2533</td>
</tr>
<tr>
<td>Not at all</td>
<td>44 (25)</td>
<td>10.7 (37)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>71 (40)</td>
<td>10.6 (37)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>61 (35)</td>
<td>11.5 (40)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Handling Raw Vegetables or Fruit</strong></td>
<td></td>
<td></td>
<td>0.0347</td>
</tr>
<tr>
<td>Not at all</td>
<td>30 (17)</td>
<td>10.0 (35)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>68 (39)</td>
<td>10.6 (37)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>77 (44)</td>
<td>11.7 (40)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Cooking Meat or Poultry</strong></td>
<td></td>
<td></td>
<td>0.0551</td>
</tr>
<tr>
<td>Not at all</td>
<td>71 (40)</td>
<td>10.2 (35)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>78 (44)</td>
<td>11.3 (39)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>27 (16)</td>
<td>11.8 (41)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Cooking Seafood</strong></td>
<td></td>
<td></td>
<td>0.4756</td>
</tr>
<tr>
<td>Not at all</td>
<td>125 (71)</td>
<td>11.2 (39)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>36 (20)</td>
<td>10.5 (36)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>15 (9)</td>
<td>10.4 (36)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Cooking Raw Eggs</strong></td>
<td></td>
<td></td>
<td>0.2242</td>
</tr>
<tr>
<td>Not at all</td>
<td>59 (29)</td>
<td>10.4 (36)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>66 (38)</td>
<td>11.0 (38)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>51 (33)</td>
<td>11.5 (40)</td>
<td></td>
</tr>
</tbody>
</table>
4.2 **Baseline Knowledge Gaps**

The overall student mean knowledge score was 37% (11/29 questions) (Figure 1). Among the more substantial knowledge gaps identified, several related to optimal temperatures for cooking, proper mechanisms for thawing food, cross-contamination, and the vulnerable populations for foodborne disease (Table III). No students could identify the danger zone for pathogen growth. Only 1 (0.5%) student identified the proper temperature to cook hamburger. Twelve percent of students accurately identified that the only way to be certain that a frozen chicken breast is safe to eat is by checking its internal temperature with a metal stem thermometer. Only 9% of the students knew that cooked rice can have germs that can make people sick. Among the food thawing questions, 89% of students did not correctly identify the refrigerator and the microwave (if it will be used immediately) as a safe place to thaw meat. Overall, only 5% of students could define cross-contamination. For questions regarding vulnerable populations, more than 75% of students did not know that persons with HIV/AIDS, pregnant women, and the elderly are at greater risk for foodborne disease. For hand-hygiene questions, 33% of the students incorrectly identified as true that it is acceptable to turn off the water with your bare hands or clothes when hand-washing has been completed. Eighty-eight percent (161) of students reported always washing their hands after using the toilet. Students who reported cooking often or always had substantial knowledge gaps in the areas of time and temperature for cooking, cross-contamination, food items that present a risk for foodborne disease, vulnerable populations for foodborne disease, and the proper mechanisms for thawing frozen meat (Table IV).
Figure 1. Frequency distribution of knowledge score out of 29 knowledge questions of high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=195).
TABLE III
FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A BASELINE KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=195)

<table>
<thead>
<tr>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>Overall n=195</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time and Temperature</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamburger and other ground beef mixtures, such as meatloaf, should be cooked to at least what temperature on a meat thermometer? (160°F)</td>
<td>Fill-in-the-blank</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Germs that make people sick grow well between which temperatures? (40°F or 41°F to 135°F or 140°F) (^a)</td>
<td>Fill-in-the-blank</td>
<td>0</td>
</tr>
<tr>
<td>You can be certain that a frozen chicken breast is safe to eat if… (It reaches a high enough temperature as measured on a metal stem thermometer)</td>
<td>Multiple-choice</td>
<td>24 (12.3)</td>
</tr>
<tr>
<td>Cold food must be kept between 50°F and 60°F. (False)</td>
<td>True/False</td>
<td>52 (26.7)</td>
</tr>
<tr>
<td><strong>Food Storage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw meat can be stored anywhere in a refrigerator as long as it is wrapped in plastic. (False)</td>
<td>True/False</td>
<td>58 (29.7)</td>
</tr>
<tr>
<td>It is NOT a safe food practice to transfer a large pot of hot soup into several smaller containers and then place all of those smaller containers in the refrigerator to cool. (False)</td>
<td>True/False</td>
<td>80 (41.0)</td>
</tr>
</tbody>
</table>
TABLE III (continued)

FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A BASELINE KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=195)

<table>
<thead>
<tr>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>Overall n=195</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thawing Food</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Putting a frozen chicken breast on the counter at room temperature is a safe way</td>
<td>True/False</td>
<td>62 (31.8)</td>
</tr>
<tr>
<td>to get it to thaw (defrost). ( \textit{False} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Which of the following are acceptable methods to thaw (defrost) beef?</td>
<td>Multiple-choice</td>
<td></td>
</tr>
<tr>
<td>Beef may be placed in cold water to defrost. ( \textit{True, cold running water} )</td>
<td></td>
<td>58 (29.8)</td>
</tr>
<tr>
<td>Beef may be placed in the microwave to defrost if it will be cooked right away.</td>
<td></td>
<td>22 (11.3)</td>
</tr>
<tr>
<td>( \textit{True} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef may be placed in the refrigerator to defrost. ( \textit{True} )</td>
<td></td>
<td>30 (15.4)</td>
</tr>
<tr>
<td><strong>Germs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You can be sure food is safe to eat when it smells and tastes normal. ( \textit{False} )</td>
<td>True/False</td>
<td>128 (65.6)</td>
</tr>
<tr>
<td>Uncooked meat (such as beef or chicken) is potentially contaminated with germs that</td>
<td>True/False</td>
<td>184 (94.4)</td>
</tr>
<tr>
<td>can cause people to be hospitalized. ( \textit{True} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE III (continued)

FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A BASELINE KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=195)

<table>
<thead>
<tr>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>Overall n=195</th>
</tr>
</thead>
<tbody>
<tr>
<td>You can be sure frozen chicken breast is safe to eat because the freezing process</td>
<td>True/False</td>
<td>105 (53.9)</td>
</tr>
<tr>
<td>kills any germs potentially contaminating the meat. <em>(False)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw eggs can have germs that can make people sick. <em>(True)</em></td>
<td>True/False</td>
<td>137 (75.3)</td>
</tr>
<tr>
<td>If vegetables for a salad were splashed with a few drops of raw chicken juice,</td>
<td>True/False</td>
<td>86 (44.1)</td>
</tr>
<tr>
<td>they will be made safe to eat by rinsing with water. <em>(False)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eating ground meat that is not completely cooked can cause <strong>bloody</strong> diarrhea.</td>
<td>True/False</td>
<td>92 (47.2)</td>
</tr>
<tr>
<td><em>(True)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully cooked rice can have germs that can make people sick. <em>(True)</em></td>
<td>True/False</td>
<td>17 (8.8)</td>
</tr>
<tr>
<td><em>Salmonella</em> can infect a chicken by contact from one chicken to another. <em>(True)</em></td>
<td>True/False</td>
<td>22 (11.3)</td>
</tr>
<tr>
<td><em>Salmonella</em> can infect a chicken from an infected mother hen to her unhatched</td>
<td>True/False</td>
<td>12 (6.2)</td>
</tr>
<tr>
<td>chick. <em>(True)</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE III (continued)

**FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A BASELINE KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=195)**

<table>
<thead>
<tr>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>Overall n=195</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning and Sanitizing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The difference between cleaning and sanitizing is… (<em>Cleaning is to remove food or other types of soil from a surface but sanitizing is to reduce the number of germs on a clean surface to safe levels.</em>)</td>
<td>Multiple-choice</td>
<td>141 (72.3)</td>
</tr>
<tr>
<td>Hand Washing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the temperature of the water important when washing your hands? (<em>Yes, and it should be warm</em>)</td>
<td>Multiple-choice</td>
<td>116 (59.5)</td>
</tr>
<tr>
<td>For how many seconds should you lather your hands with soap? (<em>20 seconds is enough</em>)</td>
<td>Multiple-choice</td>
<td>105 (53.9)</td>
</tr>
<tr>
<td>How should you turn off the water? (<em>Using the paper towel</em>)</td>
<td>Multiple-choice</td>
<td>131 (67.2)</td>
</tr>
<tr>
<td>Restaurant food handlers do not need to wash their hands after using the bathroom if they only urinated (and did not have a bowel movement). (<em>False</em>)</td>
<td>True/False</td>
<td>187 (95.9)</td>
</tr>
<tr>
<td>Cross-contamination</td>
<td>Short answer (2 points)</td>
<td>9 (4.6)</td>
</tr>
<tr>
<td>In one or two sentences, explain cross-contamination in the kitchen. (<em>2 points, one for germ transfer, one for mechanism within the kitchen</em>)</td>
<td>Short answer (2 points)</td>
<td>9 (4.6)</td>
</tr>
</tbody>
</table>
### Foodborne Disease Epidemiology

Which of the following four terms represent the four major ways to prevent the transmission of foodborne disease? (*Clean, separate, cook, chill*)

- *Multiple-choice* 35 (18.0)

*Salmonella* causes an estimated 1.4 to 3 million cases and more than 500 deaths in the United States annually. (*True*)

- *True/False* 49 (25.1)

During an outbreak of illness at a restaurant, health department investigators interview individuals who have eaten at the restaurant in order to… (*Compare what was eaten by sick individuals to what was eaten by individuals who did not become sick*)

- *Multiple-choice* 112 (57.4)

### Vulnerable Populations for Foodborne Disease

Meat or poultry that is not cooked well enough is of relatively high risk to cause disease in which of the following groups?

- *Multiple-answer* 18 (9.2)

Meat or poultry that is not well done is of relatively high risk to cause disease in those infected with HIV/AIDS. (*True*)

- *Multiple-choice* 39 (20.0)
Vulnerable Populations for Foodborne Disease (continued)

Meat and poultry that is not cooked well enough is of relatively high risk to cause disease in which of the following groups?  

<table>
<thead>
<tr>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>Overall n=195</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat or poultry that is not cooked well enough is of relatively high risk to cause disease in which of the following groups?</td>
<td>Multiple-answer</td>
<td>Multiple-choice</td>
</tr>
<tr>
<td>Meat or poultry that is not well done is of relatively high risk to cause disease in the elderly. (True)</td>
<td></td>
<td>42 (21.5)</td>
</tr>
<tr>
<td>Meat or poultry that is not well done is of relatively high risk to cause disease in young children. (True)</td>
<td></td>
<td>87 (44.6)</td>
</tr>
</tbody>
</table>
## TABLE IV

TOP TEN QUESTIONS MOST FREQUENTLY ANSWERED INCORRECTLY BY HIGH SCHOOL STUDENTS PARTICIPATING IN A KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS WHO REPORTED COOKING ON THEIR OWN OFTEN OR ALWAYS, 2012 (N=65)

<table>
<thead>
<tr>
<th>Category</th>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time and Temperature</strong></td>
<td>Germs that make people sick grow well between which temperatures? (40°F or 41°F to 135°F or 140°F)³</td>
<td>Fill-in-the-blank</td>
<td>65 (100)</td>
</tr>
<tr>
<td><strong>Time and Temperature</strong></td>
<td>Hamburger and other ground beef mixtures, such as meatloaf, should be cooked to at least what temperature on a meat thermometer? (160°F)</td>
<td>Fill-in-the-blank</td>
<td>64 (98.5)</td>
</tr>
<tr>
<td><strong>Cross-contamination</strong></td>
<td>In one or two sentences, explain cross-contamination in the kitchen. (2 points, one for germ transfer, one for mechanism within the kitchen)</td>
<td>Short answer (2 points)</td>
<td>63 (96.9)</td>
</tr>
<tr>
<td><strong>Germs</strong></td>
<td>Fully cooked rice can have germs that can make people sick. (True)</td>
<td>True/False</td>
<td>59 (90.8)</td>
</tr>
<tr>
<td><strong>Time and Temperature</strong></td>
<td>You can be certain that a frozen chicken breast is safe to eat if… (It reaches a high enough temperature as measured on a metal stem thermometer)</td>
<td>Multiple-choice</td>
<td>59 (90.8)</td>
</tr>
<tr>
<td><strong>Vulnerable Populations</strong></td>
<td>Meat or poultry that is not well done is of relatively high risk to cause disease in those infected with HIV/AIDS. (True)</td>
<td>True/False</td>
<td>56 (86.2)</td>
</tr>
<tr>
<td><strong>Thawing Food</strong></td>
<td>Beef may be placed in the microwave to defrost if it will be cooked right away. (True)</td>
<td>True/False</td>
<td>55 (84.6)</td>
</tr>
<tr>
<td><strong>Thawing Food</strong></td>
<td>Beef may be placed in the refrigerator to defrost. (True)</td>
<td>True/False</td>
<td>52 (80.0)</td>
</tr>
<tr>
<td><strong>Foodborne Disease</strong></td>
<td>Which of the following four terms represent the four major ways to prevent the transmission of foodborne disease? (Clean, separate, cook, chill)</td>
<td>Multiple-choice</td>
<td>50 (76.9)</td>
</tr>
<tr>
<td><strong>Vulnerable Populations</strong></td>
<td>Meat or poultry that is not well done is of relatively high risk to cause disease in the elderly. (True)</td>
<td>True/False</td>
<td>47 (72.3)</td>
</tr>
</tbody>
</table>
4.3 **Factors Associated with the Baseline Knowledge Score**

Bivariate analysis indicated student characteristics significantly associated with the baseline knowledge score (Table II). Students in the 12th grade scored significantly, but not substantially higher than students in the 11th grade (41% and 36%, respectively; \( p<0.05 \)). Although non-Hispanic White students scored higher than other races/ethnicities, the magnitude was small and all scored within the range of 33%–43%. The score did not differ significantly by gender. Students who reported often handling raw meat or poultry had a greater mean knowledge score compared to those who reported this food handling task sometimes or not at all (45%, 38%, and 35%, respectively, \( p<0.05 \)). In addition, students who reported often handling raw fruit or vegetables had a greater mean knowledge score compared to those who reported this food handling task sometimes or not at all (40%, 37%, and 35%, respectively, \( p<0.05 \)). The score did not differ significantly by restaurant employment, fast food employment, or cooking experience alone or with parental assistance.

In a subset analysis of meat handling questions, students who reported often handling meat were significantly more likely to correctly identify the refrigerator and cold running water as safe places to thaw frozen meat than were students who reported handling meat sometimes or not at all (Figure 2). Hispanic students that often cooked seafood had lower knowledge. In a comparison of knowledge gaps by ethnicity and seafood cooking frequency, Hispanic students who reported cooking seafood sometimes or often were significantly more likely to incorrectly identify as true that cold food must be kept between 50°F and 60°F and that the temperature of the water is not important when washing one’s hands compared to students of other ethnicities and Hispanic students who reported never cooking seafood (Figure 3).
Figure 2. Relative frequency of correct answers to meat handling questions (N=11 questions) by meat handling frequency of high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=195).

<table>
<thead>
<tr>
<th>Statement</th>
<th>Frequency</th>
<th>Handling All the Time (N=23)</th>
<th>Not Handling All the Time (N=172)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncooked meat may be contaminated with germs that can cause people to become hospitalized.</td>
<td>95.7</td>
<td>94.2</td>
<td>60.9</td>
</tr>
<tr>
<td>You can be sure a frozen chicken breast is safe to eat because freezing kills all germs.</td>
<td>52.9</td>
<td>52.9</td>
<td>56.5</td>
</tr>
<tr>
<td>Cold water is an acceptable place to thaw beef.*</td>
<td>56.5</td>
<td>52.9</td>
<td>30.4</td>
</tr>
<tr>
<td>Eating ground meat not completely cooked can cause bloody diarrhea.</td>
<td>52.2</td>
<td>52.2</td>
<td>30.4</td>
</tr>
<tr>
<td>Raw meat can be stored anywhere in refrigerator wrapped in plastic.</td>
<td>52.2</td>
<td>43</td>
<td>43.5</td>
</tr>
<tr>
<td>Vegetable splashed with raw chicken juice must be thrown away.</td>
<td>43.5</td>
<td>27.9</td>
<td>32</td>
</tr>
<tr>
<td>Putting a frozen chicken breast on the counter is a safe way to thaw it.</td>
<td>32</td>
<td>30.4</td>
<td>27.9</td>
</tr>
<tr>
<td>The refrigerator is an acceptable place to thaw beef.*</td>
<td>30.4</td>
<td>13.4</td>
<td>21.7</td>
</tr>
<tr>
<td>The microwave is an acceptable place to thaw beef if it will be cooked right away.</td>
<td>21.7</td>
<td>9.9</td>
<td>13.4</td>
</tr>
<tr>
<td>You can be certain frozen chicken breast is safe if...</td>
<td>12.2</td>
<td>4.35</td>
<td>9.9</td>
</tr>
<tr>
<td>Hamburger should be cooked to what temp on meat thermometer?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significantly different with α=0.05
Figure 3. Relative frequency of correct answers to questions by ethnicity and seafood cooking frequency of high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=195).
4.4 Linear Regression Model Predicting Baseline Score

A linear regression was completed with the 175 of 195 (90%) students with no missing information to examine factors independently associated with food safety knowledge. In the final linear regression model predicting knowledge, Hispanic ethnicity, experience cooking meat, experience cooking seafood, and experience cooking alone were significantly associated with knowledge score (Table V). When controlling for these factors, Hispanic students scored 2.28 points lower in a scale of 0 to 29 than other races/ethnicities ($p<0.05$). Students who reported cooking meat more frequently had higher knowledge scores (about 1.53 points, $p<0.05$). However, students who reported cooking seafood more frequently had lower knowledge scores (about 1.74 points, $p<0.05$). A greater frequency of experience cooking on one’s own was associated with higher knowledge scores.
TABLE V

STUDENT CHARACTERISTICS ASSOCIATED WITH BASELINE KNOWLEDGE SCORE,
LINEAR REGRESSION ANALYSIS (N=175), 2012

<table>
<thead>
<tr>
<th>Student Characteristics</th>
<th>Multivariate Analysis</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate (Standard Error)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>13.51 (0.96)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic or Latino Origin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Ref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>-2.28 (0.53)</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Frequency of Cooking Meat or Poultry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes or Often</td>
<td>Ref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>-1.53 (0.57)</td>
<td>0.0076</td>
<td></td>
</tr>
<tr>
<td>Frequency of Cooking Seafood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes or Often</td>
<td>Ref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>1.74 (0.58)</td>
<td>0.0031</td>
<td></td>
</tr>
<tr>
<td>Experience Cooking on Own</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>Ref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>-1.48 (0.98)</td>
<td>0.1348</td>
<td></td>
</tr>
<tr>
<td>Sometimes, Rarely, or Never</td>
<td>-1.78 (0.93)</td>
<td>0.0575</td>
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</tr>
</tbody>
</table>
4.5 **Follow-up Sample and Participants**

Among the 195 students who participated in the baseline knowledge survey, 171 (88%) participated in the educational intervention and were in attendance for the follow-up knowledge survey. One hundred forty-three (84%) of the 171 students and two (100%) of the instructors completed an evaluation of the curriculum. Of the 143 students who completed a student evaluation, 73 (51%) reported reading part of the comic book, 70 (49%) reported reading all of the comic book, and 82 (57%) reported re-reading part or all of the comic book.

Of the 171 students surveyed, 62% were female, 75% were in the 11th grade, and 25% were in the 12th grade (Table VI). Seventy-one percent (121) described themselves as Hispanic/Latino, 15% (26) as Non-Hispanic Black, 4% (6) as Non-Hispanic White, 2% (3) as Asian/Pacific Islander, and 9% (15) as Multi-racial or Other race/ethnicity. For the most part, there was not a significant difference in the frequency of cooking experience or restaurant employment between the baseline and follow-up participants. One exception was that compared to the baseline characteristics there was a significant increase in those who reported sometimes handling raw eggs (50% versus 39%, p=0.05).
TABLE VI
CHARACTERISTICS OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=175) AND SCORE OUT OF 29 KNOWLEDGE QUESTIONS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N (%)</th>
<th>Baseline Score (%)</th>
<th>Follow-up Score (%)</th>
<th>Increase in Score (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grade</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>11th</td>
<td>126 (75)</td>
<td>10.3 (36)</td>
<td>17.9 (62)</td>
<td>7.6 (26)</td>
<td></td>
</tr>
<tr>
<td>12th</td>
<td>43 (25)</td>
<td>12.0 (41)</td>
<td>15.1 (52)</td>
<td>3.1 (11)</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.6974</td>
</tr>
<tr>
<td>Males</td>
<td>65 (38)</td>
<td>10.2 (35)</td>
<td>16.8 (58)</td>
<td>6.6 (23)</td>
<td>74</td>
</tr>
<tr>
<td>Females</td>
<td>104 (62)</td>
<td>11.1 (38)</td>
<td>17.4 (60)</td>
<td>6.3 (22)</td>
<td></td>
</tr>
<tr>
<td><strong>Race/Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0072</td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>6 (4)</td>
<td>12.4 (43)</td>
<td>17.4 (60)</td>
<td>5.0 (17)</td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>121 (71)</td>
<td>10.1 (35)</td>
<td>17.5 (60)</td>
<td>7.4 (26)</td>
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</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>26 (15)</td>
<td>12.2 (42)</td>
<td>15.9 (55)</td>
<td>3.7 (13)</td>
<td></td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>3 (2)</td>
<td>9.7 (33)</td>
<td>16.3 (56)</td>
<td>6.6 (23)</td>
<td></td>
</tr>
<tr>
<td>Other/Multiracial</td>
<td>15 (9)</td>
<td>12.2 (42)</td>
<td>16.5 (57)</td>
<td>4.3 (15)</td>
<td></td>
</tr>
<tr>
<td><strong>Restaurant Employment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>171</td>
</tr>
<tr>
<td>Currently Employed</td>
<td>7 (4)</td>
<td>12.1 (42)</td>
<td>19.1 (66)</td>
<td>7.0 (24)</td>
<td></td>
</tr>
<tr>
<td>Formerly Employed</td>
<td>14 (8)</td>
<td>11.3 (39)</td>
<td>18.1 (62)</td>
<td>6.8 (23)</td>
<td></td>
</tr>
<tr>
<td>Never Employed</td>
<td>146 (88)</td>
<td>10.7 (37)</td>
<td>17.0 (59)</td>
<td>6.3 (22)</td>
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</tr>
<tr>
<td><strong>Fast-Food Employment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>98</td>
</tr>
<tr>
<td>(Former or Current)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>10 (6)</td>
<td>10.7 (37)</td>
<td>17.7 (61)</td>
<td>7.0 (24)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>161 (94)</td>
<td>10.7 (37)</td>
<td>17.2 (59)</td>
<td>6.5 (22)</td>
<td></td>
</tr>
<tr>
<td><strong>Frequency of Cooking with Parents</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>Never</td>
<td>25 (14)</td>
<td>9.3 (32)</td>
<td>16.2 (56)</td>
<td>6.9 (24)</td>
<td></td>
</tr>
<tr>
<td>Rarely</td>
<td>46 (31)</td>
<td>11.4 (39)</td>
<td>18.4 (63)</td>
<td>7.0 (24)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>51 (30)</td>
<td>10.7 (37)</td>
<td>17.9 (62)</td>
<td>7.2 (25)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>29 (17)</td>
<td>11.0 (38)</td>
<td>18.1 (62)</td>
<td>7.1 (24)</td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>13 (8)</td>
<td>10.6 (37)</td>
<td>15.4 (53)</td>
<td>4.8 (17)</td>
<td></td>
</tr>
</tbody>
</table>
TABLE VI (continued)

CHARACTERISTICS OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=175) AND SCORE OUT OF 29 KNOWLEDGE QUESTIONS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N (%)</th>
<th>Baseline Score (%)</th>
<th>Follow-up Score (%)</th>
<th>Increase in Score (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency of Cooking on Own</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>Never</td>
<td>13 (8)</td>
<td>9.8 (34)</td>
<td>16.3 (56)</td>
<td>6.5 (22)</td>
<td></td>
</tr>
<tr>
<td>Rarely</td>
<td>32 (19)</td>
<td>10.6 (37)</td>
<td>16.6 (57)</td>
<td>6.0 (21)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>68 (41)</td>
<td>10.3 (36)</td>
<td>17.6 (61)</td>
<td>7.3 (25)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>41 (25)</td>
<td>11.3 (39)</td>
<td>19.0 (66)</td>
<td>7.7 (27)</td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>12 (7)</td>
<td>12.6 (43)</td>
<td>18.2 (63)</td>
<td>5.6 (19)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Handling Raw Meat or Poultry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>Not at all</td>
<td>60 (39)</td>
<td>10.1 (35)</td>
<td>16.6 (57)</td>
<td>6.5 (22)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>73 (47)</td>
<td>11.0 (38)</td>
<td>18.2 (63)</td>
<td>7.2 (25)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>22 (14)</td>
<td>13.0 (45)</td>
<td>19.8 (68)</td>
<td>6.8 (23)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Handling Raw Seafood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>78</td>
</tr>
<tr>
<td>Not at all</td>
<td>104 (68)</td>
<td>11.0 (38)</td>
<td>17.9 (62)</td>
<td>6.9 (24)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>39 (26)</td>
<td>11.0 (38)</td>
<td>19.0 (66)</td>
<td>8.0 (28)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>9 (6)</td>
<td>9.8 (34)</td>
<td>12.4 (43)</td>
<td>2.6 (9)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Handling Raw Eggs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>38</td>
</tr>
<tr>
<td>Not at all</td>
<td>34 (22)</td>
<td>10.7 (37)</td>
<td>16.0 (55)</td>
<td>5.3 (18)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>77 (50)</td>
<td>10.6 (37)</td>
<td>18.3 (63)</td>
<td>7.7 (27)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>44 (28)</td>
<td>11.5 (40)</td>
<td>18.2 (63)</td>
<td>6.7 (23)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Handling Raw Vegetables or Fruit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>Not at all</td>
<td>29 (19)</td>
<td>10.0 (35)</td>
<td>15.3 (53)</td>
<td>5.3 (18)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>72 (46)</td>
<td>10.6 (37)</td>
<td>17.5 (60)</td>
<td>6.9 (24)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>54 (35)</td>
<td>11.7 (40)</td>
<td>19.3 (67)</td>
<td>7.6 (26)</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE VI (continued)

CHARACTERISTICS OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=175) AND SCORE OUT OF 29 KNOWLEDGE QUESTIONS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N (%)</th>
<th>Baseline Score (%)</th>
<th>Follow-up Score (%)</th>
<th>Increase in Score (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experience Cooking Meat or Poultry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>68 (45)</td>
<td>10.2 (35)</td>
<td>17.1 (59)</td>
<td>6.9 (24)</td>
<td>0.9768</td>
</tr>
<tr>
<td>Sometimes</td>
<td>58 (28)</td>
<td>11.3 (39)</td>
<td>18.1 (62)</td>
<td>6.8 (23)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>26 (17)</td>
<td>11.8 (41)</td>
<td>18.7 (64)</td>
<td>6.9 (24)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Cooking Seafood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.1416</td>
</tr>
<tr>
<td>Not at all</td>
<td>120 (77)</td>
<td>11.2 (39)</td>
<td>18.2 (63)</td>
<td>7.0 (24)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>29 (19)</td>
<td>10.5 (36)</td>
<td>17.5 (60)</td>
<td>7.0 (24)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>6 (4)</td>
<td>10.4 (36)</td>
<td>13.5 (47)</td>
<td>3.1 (11)</td>
<td></td>
</tr>
<tr>
<td><strong>Experience Cooking Raw Eggs</strong></td>
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<td></td>
<td></td>
<td></td>
<td>0.1285</td>
</tr>
<tr>
<td>Not at all</td>
<td>46 (30)</td>
<td>10.4 (36)</td>
<td>16.2 (56)</td>
<td>5.8 (20)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>70 (45)</td>
<td>11.0 (38)</td>
<td>18.7 (64)</td>
<td>7.7 (27)</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>38 (25)</td>
<td>11.5 (40)</td>
<td>18.4 (63)</td>
<td>6.9 (24)</td>
<td></td>
</tr>
<tr>
<td><strong>Exposure to the Educational Comic Book</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0027</td>
</tr>
<tr>
<td>Read some or all of the comic book</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some</td>
<td>16.0 (55)</td>
<td>5.1 (18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>18.4 (63)</td>
<td>7.8 (27)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.6 **Increase in Follow-up Knowledge Score**

Overall, student knowledge score increased 6.5 questions (23 percentage points rise from 37% to 60%) compared to the baseline score (p<0.05) (Figure 4). Seventy-five percent of students increased by at least one strata (Figure 5B). Among the 171 students completing the follow-up survey, 5 (3%) had a score that decreased by greater than six points (21% decrease) or one or more strata (Figure 5B and 5C). Four of these students had missing answers on most or all of the questions and one student only responded with the first possible answer choice. All of these students were in the 12th grade.

Overall, there were only four questions for which students did not exhibit a significant increase in knowledge. With the exception of a question regarding the epidemiology of *Salmonella*, these questions reflected areas in which students already had relatively high levels of baseline knowledge including the necessity of a food handler washing their hands after using the bathroom, whether the water should be cool or warm while washing one’s hands, and the potential for uncooked meat to be contaminated with germs that could cause a person to become hospitalized (Table VII). Among the more substantial increases in knowledge, several were related to the proper mechanisms for storing, thawing, and checking the temperature of food; cross-contamination; and the vulnerable populations for foodborne disease. Students were significantly more likely to identify that reaching a high enough temperature as measured on a metal stem thermometer is the only way to determine that a frozen chicken breast is safe to eat (increase from 12% to 55%; p<0.05). Knowledge about bloody diarrhea being a potential manifestation of eating undercooked ground meat increased from 47% to 83% (p<0.05). After exposure to the curriculum, students were significantly more likely to identify as false that raw meat can be stored anywhere in a refrigerator as long as it is wrapped in plastic (increase from
30% to 63%; \( p < 0.05 \). With regards to proper mechanisms for thawing meat, students were significantly more likely to identify as false that putting a frozen chicken breast on the counter at room temperature is a safe way to get it to thaw (increase from 32% to 70%, \( p < 0.05 \)) as well as to identify as true that the microwave is a safe place to thaw frozen beef as long as it will be used right away (increase in score from 11% to 41%, \( p < 0.05 \)). Knowledge that vegetables for a salad splashed with a few drops of raw chicken juice will not be made safe by rinsing with water increased from 44% to 77% \( (p < 0.05) \). Knowledge that fully cooked rice and raw eggs can have germs that can make people sick increased by 9% to 40% and 75% to 90%, respectively \( (p < 0.05) \). The percentage of students who were able to both correctly define cross-contamination and give an example of a potential mechanism within a kitchen increased from 4% to 33% \( (p < 0.05) \). Knowledge that you cannot be sure food is safe to eat when it smells and tastes normal increased from 66% to 87% \( (p < 0.05) \). The percentage of students who identified 20 seconds as the length of time to wash their hands increased from 54% to 72% \( (p < 0.05) \). Significantly more students were able to identify the vulnerable populations for foodborne disease; the percentages of students who were able to identify those with HIV/AIDS, pregnant women, and the elderly as a vulnerable populations increased from 9% to 39%, 20% to 49%, and 22% to 51%, respectively \( (p < 0.05) \). Of the three epidemiology questions consisting of Salmonella epidemiology, outbreak investigation, and disease prevention, two had a significant increase, with the percentage of students able to identify that the four major ways to prevent the transmission of foodborne disease are to clean, separate, cook, chill increasing from 18% to 28% \( (p < 0.05) \) and the percentage of students able to identify the purpose of foodborne disease outbreak investigation increasing significantly from 58% to 70% \( (p < 0.05) \).
Figure 4. Frequency distribution of change in knowledge score out of 29 knowledge questions of high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=171).
Figure 5A–C. Proportionate analysis of change in knowledge score by strata for high school students participating in a knowledge survey in Chicago, Illinois, 2012 (N=171).
### Time and Temperature

<table>
<thead>
<tr>
<th>Questions</th>
<th>Question Type</th>
<th>Pre-intervention number correct (n=195)</th>
<th>Post-intervention number correct (n=171)</th>
<th>Knowledge Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamburger and other ground beef mixtures, such as meatloaf, should be cooked to at least what temperature on a meat thermometer? (160°F)</td>
<td>Fill-in-the-blank</td>
<td>1 (0.5)</td>
<td>24 (14.0)</td>
<td>+13.5%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Germs that make people sick grow well between which temperatures? (40°F or 41°F to 135°F or 140°F)</td>
<td>Fill-in-the-blank</td>
<td>0</td>
<td>14 (8.2)</td>
<td>+8.2%</td>
<td>n/a</td>
</tr>
<tr>
<td>You can be certain that a frozen chicken breast is safe to eat if… (It reaches a high enough temperature as measured on a metal stem thermometer)</td>
<td>Multiple-choice</td>
<td>24 (12.3)</td>
<td>94 (55.0)</td>
<td>+42.7%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Cold food must be kept between 50°F and 60°F. (False)</td>
<td>True/False</td>
<td>52 (26.7)</td>
<td>89 (52.1)</td>
<td>+25.4%</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

### Food Storage

<table>
<thead>
<tr>
<th>Questions</th>
<th>Question Type</th>
<th>Pre-intervention number correct (n=195)</th>
<th>Post-intervention number correct (n=171)</th>
<th>Knowledge Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw meat can be stored anywhere in a refrigerator as long as it is wrapped in plastic. (False)</td>
<td>True/False</td>
<td>58 (29.7)</td>
<td>107 (62.6)</td>
<td>+32.9%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>It is NOT a safe food practice to transfer a large pot of hot soup into several smaller containers and then place all of those smaller containers in the refrigerator to cool. (False)</td>
<td>True/False</td>
<td>80 (41.0)</td>
<td>102 (59.7)</td>
<td>+18.7%</td>
<td>0.0008</td>
</tr>
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</table>
### TABLE VII (continued)

FREQUENCY OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=171)

<table>
<thead>
<tr>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>Pre-intervention number correct n=195</th>
<th>Post-intervention number correct n=171</th>
<th>Knowledge Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thawing Food</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Putting a frozen chicken breast on the counter at room temperature is a safe way to get it to thaw (defrost). <em>(False)</em></td>
<td>True/False</td>
<td>62 (31.8)</td>
<td>120 (70.2)</td>
<td>+38.4%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Which of the following are acceptable methods to thaw (defrost) beef?</td>
<td>Multiple-choice</td>
<td>58 (29.8)</td>
<td>81 (47.4)</td>
<td>+17.6%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Beef may be placed in cold water to defrost. <em>(True, cold running water)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef may be placed in the microwave to defrost if it will be cooked right away. <em>(True)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef may be placed in the refrigerator to defrost. <em>(True)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Germs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You can be sure food is safe to eat when it smells and tastes normal. <em>(False)</em></td>
<td>True/False</td>
<td>128 (65.6)</td>
<td>149 (87.1)</td>
<td>+21.5%</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>
### TABLE VII (continued)

FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=171)

<table>
<thead>
<tr>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>Pre-intervention number correct n=195</th>
<th>Post-intervention number correct n=171</th>
<th>Knowledge Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Germs (continued)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncooked meat (such as beef or chicken) is potentially contaminated with germs that can cause people to be hospitalized. (<em>True</em>)</td>
<td>True/False</td>
<td>184 (94.4)</td>
<td>166 (97.1)</td>
<td>+2.7%</td>
<td>0.2850</td>
</tr>
<tr>
<td>You can be sure frozen chicken breast is safe to eat because the freezing process kills any germs potentially contaminating the meat. (<em>False</em>)</td>
<td>True/False</td>
<td>105 (53.9)</td>
<td>118 (69.0)</td>
<td>+15.1%</td>
<td>0.0023</td>
</tr>
<tr>
<td>Raw eggs can have germs that can make people sick. (<em>True</em>)</td>
<td>True/False</td>
<td>137 (75.3)</td>
<td>154 (90.1)</td>
<td>+14.8%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>If vegetables for a salad were splashed with a few drops of raw chicken juice, they will be made safe to eat by rinsing with water. (<em>False</em>)</td>
<td>True/False</td>
<td>86 (44.1)</td>
<td>132 (77.2)</td>
<td>+33.1%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Eating ground meat that is not completely cooked can cause bloody diarrhea. (<em>True</em>)</td>
<td>True/False</td>
<td>92 (47.2)</td>
<td>142 (83.0)</td>
<td>+35.8%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Fully cooked rice can have germs that can make people sick? (<em>True</em>)</td>
<td>True/False</td>
<td>17 (8.8)</td>
<td>69 (40.4)</td>
<td>+31.6%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td><em>Salmonella</em> can infect a chicken by contact from one chicken to another. (<em>True</em>)</td>
<td>True/False</td>
<td>22 (11.3)</td>
<td>21 (12.3)</td>
<td>+1.0%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td><em>Salmonella</em> can infect a chicken from an infected mother hen to her unhatched chick. (<em>True</em>)</td>
<td>True/False</td>
<td>12 (6.2)</td>
<td>17 (9.9)</td>
<td>+3.7%</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>
TABLE VII (continued)

FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=171)

<table>
<thead>
<tr>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>Pre-intervention number correct n=195</th>
<th>Post-intervention number correct n=171</th>
<th>Knowledge Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cleaning and Sanitizing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The difference between cleaning and sanitizing is… (Cleaning is to remove food or other types of soil from a surface but sanitizing is to reduce the number of germs on a clean surface to safe levels.)</td>
<td>Multiple-choice</td>
<td>141 (72.3)</td>
<td>140 (81.9)</td>
<td>+9.6%</td>
<td>0.0026</td>
</tr>
<tr>
<td><strong>Hand Washing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the temperature of the water important when washing your hands? (Yes, and it should be warm)</td>
<td>Multiple-choice</td>
<td>116 (59.5)</td>
<td>111 (64.9)</td>
<td>+5.4%</td>
<td>0.1161</td>
</tr>
<tr>
<td>For how many seconds should you lather your hands with soap? (20 seconds is enough)</td>
<td>Multiple-choice</td>
<td>105 (53.9)</td>
<td>123 (71.9)</td>
<td>+18.0%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>How should you turn off the water? (Using the paper towel)</td>
<td>Multiple-choice</td>
<td>131 (67.2)</td>
<td>152 (88.9)</td>
<td>+21.7%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Restaurant food handlers do not need to wash their hands after using the bathroom if they only urinated (and did not have a bowel movement). (False)</td>
<td>True/False</td>
<td>187 (95.9)</td>
<td>160 (93.6)</td>
<td>-2.3%</td>
<td>0.4669</td>
</tr>
</tbody>
</table>
### TABLE VII (continued)

**FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=171)**

<table>
<thead>
<tr>
<th>Questions (Answers)</th>
<th>Question Type</th>
<th>Pre-intervention number correct n=195</th>
<th>Post-intervention number correct n=171</th>
<th>Knowledge Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cross-contamination</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In one or two sentences, explain cross-contamination in the kitchen. (2 points, one for germ transfer, one for mechanism within the kitchen)</td>
<td>Short answer (2 points)</td>
<td>9 (4.6)</td>
<td>56 (32.6)</td>
<td>+28.0%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td><strong>Foodborne Disease Epidemiology</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Which of the following four terms represent the four major ways to prevent the transmission of foodborne disease? (Clean, separate, cook, chill)</td>
<td>Multiple-choice</td>
<td>35 (18.0)</td>
<td>48 (28.1)</td>
<td>+10.1%</td>
<td>0.0026</td>
</tr>
<tr>
<td>Salmonella causes an estimated 1.4 to 3 million cases and more than 500 deaths in the United States annually. (True)</td>
<td>True/False</td>
<td>49 (25.1)</td>
<td>41 (24.0)</td>
<td>-1.1%</td>
<td>0.2850</td>
</tr>
<tr>
<td>During an outbreak of illness at a restaurant, health department investigators interview individuals who have eaten at the restaurant in order to… (Compare what was eaten by sick individuals to what was eaten by individuals who did not become sick)</td>
<td>Multiple-choice</td>
<td>112 (57.4)</td>
<td>119 (69.6)</td>
<td>+12.2%</td>
<td>0.0111</td>
</tr>
</tbody>
</table>
### Vulnerable Populations for Foodborne Disease

Meat or poultry that is not cooked well enough is of relatively high risk to cause disease in which of the following groups?

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre-intervention number correct n=195</th>
<th>Post-intervention number correct n=171</th>
<th>Knowledge Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat or poultry that is not well done is of relatively high risk to cause disease in those infected with HIV/AIDS. <em>(True)</em></td>
<td>18 (9.2)</td>
<td>66 (38.6)</td>
<td>+29.4%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Meat or poultry that is not well done is of relatively high risk to cause disease in pregnant women. <em>(True)</em></td>
<td>39 (20.0)</td>
<td>84 (49.1)</td>
<td>+29.1%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Meat or poultry that is not well done is of relatively high risk to cause disease in the elderly. <em>(True)</em></td>
<td>42 (21.5)</td>
<td>87 (50.9)</td>
<td>+29.4%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Meat or poultry that is not well done is of relatively high risk to cause disease in young children. <em>(True)</em></td>
<td>87 (44.6)</td>
<td>114 (66.7)</td>
<td>+22.1%</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

TABLE VII (continued)

FREQUENCIES OF CORRECT RESPONSES TO KNOWLEDGE QUESTIONS ASKED OF HIGH SCHOOL STUDENTS PARTICIPATING IN A FOLLOW-UP KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N=171)
4.7 **Factors Associated with Increase in Knowledge Score**

Bivariate analysis demonstrated student characteristics significantly associated with the increase in knowledge score (Table VI).

4.7.1 **Demographic Characteristics**

Students in the 11th grade had an increase in score that was twice as great as students in the 12th grade (increase from 36% to 62% and 41% to 52%, respectively; $p<0.05$). Hispanic students had a significantly greater increase in score than did students of other races or ethnicities (increase from 35% to 60% and 42% to 55%, respectively; $p=0.05$). Students who reported often handling seafood had a significantly lower increase in score than did those who reported sometimes or not at all handling seafood (34% to 43% increase, 38% to 66% increase, and 38% to 62% increase respectively; $p<0.05$). There was not a significant difference in score increase by gender, ever having restaurant employment, or frequency of cooking on one’s own or with parental assistance and only a modest borderline increase for those who reported never handling raw eggs (37% to 55% increase in score) versus those who reported sometimes handling raw eggs (37% to 63% increase in score) ($p=0.05$).

4.7.2 **Comic Book Exposure**

Among students who reported reading all of the comic book (n=70), knowledge score increased by 7.8 points (27 percentage-point rise from to 36% to 63%). For comparison, the knowledge score of students who reported reading only part of the comic book increased by 5.1 points (18 percentage-point rise from 38% to 55%). While both groups had significantly increased knowledge scores when compared to baseline, the increase in knowledge score was
significantly greater for students who reported reading all of the educational comic book \( (p<0.05) \). The baseline knowledge score did not differ for these two groups \( (p=0.50) \). Seventy students \( (49\%) \) reported re-reading part of the comic book, 12 \( (8\%) \) reported re-reading all of the comic book, and 61 \( (43\%) \) did not report re-reading the comic book at all. The difference in knowledge score was from 10.3 to 16.4 points \( (35\% \text{ to } 57\% \text{ knowledge score}) \) for those who did not re-read the comic book, 11.1 to 17.6 points \( (38\% \text{ to } 61\% \text{ knowledge score}) \) for those who re-read only part of the comic book, and 10.8 to 18.8 points \( (37\% \text{ to } 65\% \text{ knowledge score}) \) for those who re-read all of the comic book. The change in knowledge score did not differ significantly by re-reading the comic book \( (p=0.60) \).

Students in the 11th grade were significantly more likely to read all of the comic book than were students in the 12th grade \( (54\% \text{ and } 33\% \text{ of students, respectively; } p<0.05) \). Male students were more likely to read all of the comic book than female students \( (58\% \text{ and } 43\%, \text{ respectively}) \), however this difference was not significant \( (p=0.10) \). In a subset of only 11th grade students, male students were significantly more likely to read all of the comic book than were female students \( (76\% \text{ and } 44\% \text{ of students, respectively; } p<0.05) \). Compliance with reading the entire comic book as assigned did not differ significantly by race, experience cooking with parental assistance, or experience cooking on one’s own.

4.8 **Behavioral Change**

Among the 140 students with information, 51\% \( (71 \text{ students}) \) reported that they changed food safety behaviors after reading the comic book, 15\% \( (21 \text{ students}) \) reported that they had not changed any behaviors, and 34\% \( (48 \text{ students}) \) reported that they were unsure \( (\text{Table VIII}) \). Comments were available for 94\% \( (67 \text{ students}) \) of the 71 students who responded that they had
changed their food safety behaviors. Commonly reported areas of behavioral change included washing hands for a longer period of time, sanitizing surfaces after contact with potentially contaminated food, making sure to cook meat to the correct temperatures and thawing meat appropriately, avoiding cross-contamination, being more careful about food eaten outside of the home, and being more cautious in general. Twenty-one percent of comments related to washing hands for a full twenty seconds and 10% of comments related to sanitizing surfaces between preparing raw and ready-to-eat foods. One student reported that, “I noticed how I clean my hands for a longer period of time and sanitize to make sure my food is ok to eat.” Another student stated that, “I am going to make sure I wash my hands more thoroughly when I am about to cook for others and myself.” Thirty percent of comments related to making sure to cook meat to the proper temperature and ensuring this temperature was correct by checking the internal temperature of meat with a metal stem thermometer. One student stated that, “I will use a thermometer in the meat to see if everyone can eat it.” Sixteen percent of comments regarding behavioral change related to thawing or defrosting meat in the proper location and 19% of comments related to avoiding cross-contamination, including ensuring the separation of raw and ready-to-eat foods. One student reported that, “I will make sure my foods do not touch and won’t leave food to thaw on the countertop.” Another student responded that, “I am more aware of where I put items in the refrigerator.” Sixteen percent of students stated that they would be more careful about ensuring food safety in general. Importantly, one of these students was employed as a food handler, stating, “I will make sure that the food I am eating is safe to the fullest. Also, at work I will make sure that all of the food I cook is prepared correctly.” The risk perception associated with foodborne illness also increased, with one student promising that they will “be more aware about what can get you sick and know what to do and what not to do.” Six percent of
comments expressed that their food safety awareness would extend outside of the home, with one student stating that, “I will look twice at my food whenever I go out somewhere because now I am more aware of what can/can’t get me sick.”

Quantitatively, 61% (101) of 166 students who answered that they had undergone behavioral change reported that they washed their hands for a longer period of time after completing the curriculum. The majority (53%) of students who answered that they did wash their hands for a longer period of time responded that they washed their hands for 20 seconds; with 13% (19 students) responding that they washed their hands until they saw bubbles, 9% (13 students) responding that they washed their hands for 10 seconds, and 3% (5 students) responding that they washed their hands for 5 seconds. Among the students who responded that they washed their hands for a longer period of time, 42% (57 students) responded that they exhibited this behavioral change all of the time and 39% (54 students) responded that they exhibited this behavioral change most of the time.

Seventy-eight percent of students (99 students) responded that it was true that they were more careful to prevent raw meat from contaminating other foods. Thirty-five percent of students (46 students) responded that they were more careful to prevent cross-contamination all of the time and 40% responded that they were more careful to prevent cross-contamination most of the time. Seventy-four percent of students (86) responded that it was true that after the curriculum they were more careful to cook meat to the proper temperatures. Regarding their frequency of exhibiting this behavior, 36% (41) responded that they were more careful to cook meat to the proper temperature all of the time and 36% (41) responded that they exhibited this behavior most of the time.
### TABLE VIII

**RELATIVE FREQUENCIES OF RESPONSES TO BEHAVIORAL CHANGE AND BELIEF QUESTIONS BY HIGH SCHOOL STUDENTS WITHOUT MISSING INFORMATION ON A KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS 2012 (N≤155)**

<table>
<thead>
<tr>
<th>Reported Behavior or Belief</th>
<th>Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Washing hands for a longer period of time</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>101 (69)</td>
</tr>
<tr>
<td>No</td>
<td>46 (31)</td>
</tr>
<tr>
<td><strong>Amount of time now spent washing hands</strong></td>
<td></td>
</tr>
<tr>
<td>5 seconds</td>
<td>5 (4)</td>
</tr>
<tr>
<td>10 seconds</td>
<td>13 (11)</td>
</tr>
<tr>
<td>20 seconds</td>
<td>80 (68)</td>
</tr>
<tr>
<td>Until student sees bubbles</td>
<td>19 (17)</td>
</tr>
<tr>
<td><strong>Frequency of washing hands for a longer period of time</strong></td>
<td></td>
</tr>
<tr>
<td>All of the time since completing the unit</td>
<td>57 (42)</td>
</tr>
<tr>
<td>Most of the time since completing the unit</td>
<td>54 (39)</td>
</tr>
<tr>
<td>Sometimes since completing the unit</td>
<td>20 (15)</td>
</tr>
<tr>
<td>Rarely since completing the unit</td>
<td>6 (4)</td>
</tr>
<tr>
<td><strong>Being more careful to prevent raw meat from contaminating other foods</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>99 (78)</td>
</tr>
<tr>
<td>No</td>
<td>28 (22)</td>
</tr>
<tr>
<td><strong>Frequency of being more careful to prevent raw meat from contaminating other foods</strong></td>
<td></td>
</tr>
<tr>
<td>All of the time since completing the unit</td>
<td>36 (35)</td>
</tr>
<tr>
<td>Most of the time since completing the unit</td>
<td>52 (40)</td>
</tr>
<tr>
<td>Sometimes since completing the unit</td>
<td>18 (14)</td>
</tr>
<tr>
<td>Rarely since completing the unit</td>
<td>15 (11)</td>
</tr>
<tr>
<td>Reported Behavior or Belief</td>
<td>Frequencies</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td></td>
<td>N (%)</td>
</tr>
<tr>
<td><strong>Being more careful to cook meat to the proper internal temperature</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>86 (74)</td>
</tr>
<tr>
<td>No</td>
<td>30 (26)</td>
</tr>
<tr>
<td><strong>Frequency of being more careful to cook meat to the proper temperature</strong></td>
<td></td>
</tr>
<tr>
<td>All of the time since completing the unit</td>
<td>41 (36)</td>
</tr>
<tr>
<td>Most of the time since completing the unit</td>
<td>41 (36)</td>
</tr>
<tr>
<td>Sometimes since completing the unit</td>
<td>13 (11)</td>
</tr>
<tr>
<td>Rarely since completing the unit</td>
<td>19 (17)</td>
</tr>
<tr>
<td><strong>Changed behaviors related to food as a result of being taught this curriculum</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>71 (51)</td>
</tr>
<tr>
<td>No</td>
<td>21 (15)</td>
</tr>
<tr>
<td>Unsure</td>
<td>48 (34)</td>
</tr>
<tr>
<td><strong>Spoke with friends or family about curriculum</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>45 (28)</td>
</tr>
<tr>
<td>No</td>
<td>118 (72)</td>
</tr>
<tr>
<td><strong>Friends or family learned new information about food safety</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>30 (33)</td>
</tr>
<tr>
<td>No</td>
<td>33 (36)</td>
</tr>
<tr>
<td>Don’t know</td>
<td>28 (31)</td>
</tr>
<tr>
<td><strong>Friends or family engaging in new food safety behaviors</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>19 (23)</td>
</tr>
<tr>
<td>No</td>
<td>30 (36)</td>
</tr>
<tr>
<td>Don’t know</td>
<td>34 (41)</td>
</tr>
<tr>
<td>Reported Behavior or Belief</td>
<td>Frequencies N (%)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Enjoyed reading the comic book</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>128 (91)</td>
</tr>
<tr>
<td>No</td>
<td>13 (9)</td>
</tr>
<tr>
<td>Believes high schools should provide students with the comic book and curriculum</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>129 (93)</td>
</tr>
<tr>
<td>No</td>
<td>10 (7)</td>
</tr>
<tr>
<td>The information in the curriculum was taught in a manner that the student could understand</td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>71 (51)</td>
</tr>
<tr>
<td>Somewhat agree</td>
<td>58 (42)</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>7 (5)</td>
</tr>
<tr>
<td>Somewhat disagree</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>2 (1)</td>
</tr>
<tr>
<td>The classroom activities helped the student to better understand the concepts taught in the curriculum</td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>62 (45)</td>
</tr>
<tr>
<td>Somewhat agree</td>
<td>56 (41)</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>15 (11)</td>
</tr>
<tr>
<td>Somewhat disagree</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>5 (4)</td>
</tr>
<tr>
<td>The comic book and curriculum taught me new information about food safety that the student did not know before</td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>91 (66)</td>
</tr>
<tr>
<td>Somewhat agree</td>
<td>38 (28)</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>6 (4)</td>
</tr>
<tr>
<td>Somewhat disagree</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>3 (2)</td>
</tr>
</tbody>
</table>
### TABLE VIII (continued)

RELATIVE FREQUENCIES OF RESPONSES TO BEHAVIORAL CHANGE AND BELIEF QUESTIONS BY HIGH SCHOOL STUDENTS WITHOUT MISSING INFORMATION ON A KNOWLEDGE SURVEY IN CHICAGO, ILLINOIS, 2012 (N≤155)

<table>
<thead>
<tr>
<th>Reported Behavior or Belief</th>
<th>Frequencies N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The comic book and curriculum taught me new information about epidemiology that the student did not know before</td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>49 (36)</td>
</tr>
<tr>
<td>Somewhat agree</td>
<td>56 (41)</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>24 (17)</td>
</tr>
<tr>
<td>Somewhat disagree</td>
<td>5 (4)</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>4 (3)</td>
</tr>
</tbody>
</table>
4.9 **Community Interaction**

Thirty-eight students (38% of those responding) stated that it was true that they had spoken with friends or family about the curriculum (Table VIII). Thirty-three students further elaborated on this response. Commonly reported topics that students spoke about with their family or friends included proper mechanisms for thawing (15% of comments), ensuring meat is cooked to the correct temperature and the use of a metal stem thermometer (24% of comments), and cross-contamination (18% of comments). Four students stated that they had advised their parents to purchase a metal stem thermometer. Regarding both cross-contamination and the importance of cooking meat properly, one student reported, “I told my mom how cooked food might still have a chance of being contaminated if things aren’t done properly.”

In addition, 26% of students reporting that they had spoken with their friends and family about food safety believed that these individuals had learned new information from their discussion. Twenty-three students further elaborated on this question with comments. For students providing additional comments, commonly occurring responses included that friends/family had learned new information regarding cross-contamination (43% of comments), proper mechanisms for thawing meat (30% of comments), and cooking meat to the proper temperature as read on a metal stem thermometer (26% of comments). One student commented that their friends and/or family had, “learned that unsafe behavior in the kitchen can make you sick.” Another expressed that they knew their family had learned new information “because some family members were shocked by what I told them.” There was also evidence that the food safety knowledge associated with this curriculum disseminated even further than just the student’s friends and family, as one student reported that their mother had relayed the
information and the comic book to her cooking class and two additional students stated that they had spoken about the curriculum with their parents who were employed as chefs.

Of students reporting talking with their friends and family about the information learned as a result of this curriculum, 50% (19) believed that their friends or family had changed their food safety behaviors as a result of these conversations. Fifteen students further elaborated on this response with comments. Commonly reported behavioral changes included being more careful to cook to the proper temperature (53% of comments), being more careful in the kitchen in general, and being more careful to thaw meat properly (each 20% of comments). Specifically, one student reported witnessing their family members use safer food behaviors and stated that, “I saw my sister defrost meat properly and saw my dad not handle raw shrimp with the rest of our dinner.”

4.10 **Student Evaluation of Curriculum**

Overall, 91% of students (128 students) reported that they enjoyed reading the comic book (Table VIII). Ninety-three percent of students (129 students) believed that schools should provide students with the comic book and curriculum. The majority of students reported that the curriculum was taught in an understandable manner; the proportion of students either strongly or somewhat agreeing that the curriculum had been taught in a manner they could understand and that the classroom activities helped the student to better understand the concepts taught in the curriculum were 93% (129 students) and 86% (118 students), respectively. In addition, the proportion of students reporting that they strongly or somewhat agreed that the curriculum had taught them new information about food safety and epidemiology that they had not learned before were 94% (129 students) and 77% (105 students), respectively.
4.11 **Linear Regression Model Predicting Increase in Score**

A linear regression was completed with the 134 of 171 (78%) students with no missing information. In the final model predicting a post-intervention increase in knowledge, Hispanic origin, grade in school, degree of exposure to the educational comic book, and reporting talking to friends or family about what they learned in the curriculum were significantly associated with increase in knowledge score (Table IX). When controlling for these factors, Hispanic students had a significantly greater increase in knowledge score compared to students of other race/ethnicities (Hispanic students score improved by 1.81 more points on a scale of 0 to 29; \( p<0.05 \)). Students in the 12th grade had a significantly lower increase in score than did students in the 11th grade (about 3.11 points lower increase in score, \( p<0.05 \)). In addition, students who reported only reading some of the comic book had a marginally significantly lower increase in score than did students who reported reading all of the educational comic book (about 1.40 points lower increase in score, \( p=0.07 \)). Community interaction was significantly associated with increase in knowledge score, with those students who did not report speaking to their friends or family having a significantly lower increase in knowledge score than did students who reported speaking with friends or family about what they learned in the curriculum (\( p<0.05 \)).
<table>
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<th>$p$ value</th>
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<tr>
<td>Intercept</td>
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<td></td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
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<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.81 (0.87)</td>
<td>0.0391</td>
</tr>
<tr>
<td>Grade in School</td>
<td></td>
<td></td>
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<tr>
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</tr>
<tr>
<td>12th Grade</td>
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<tr>
<td>Comic Book Exposure</td>
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<tr>
<td>Read Some of the Comic Book</td>
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<td>Talked to Family or Friends about Curriculum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.81 (0.87)</td>
<td>0.0393</td>
</tr>
</tbody>
</table>
5. DISCUSSION

5.1 **Baseline Knowledge Score**

Inadequate knowledge and unsafe food handling behaviors are a major contributory factor to the transmission of foodborne disease; in fact, if all home food preparers practiced safe food handling techniques 100% of the time the incidence of foodborne illness could be reduced by half (Medeiros et al. 2001). Knowledge levels may be particularly low in demographic segments with decreased experience in the kitchen, such as high school students (Abbot et al. 2009; Sockett and Rodgers 2001; Altekruse et al. 1999; Haapala and Probart 2004; Morrone and Rathbun 2003; Byrd-Bredbenner et al. 2007; Stein et al. 2010; Yarrow et al. 2009). The high school students in this study had a mean knowledge score of only 37% and this is especially important because they are at an age at which they are or will soon be responsible for increased food preparation for themselves and others. Although there were methodological differences, this baseline knowledge score was lower than knowledge scores found in previous studies of middle school and undergraduate college students and particularly low considering that previous studies had found that students in health-based areas of study have greater food safety knowledge (Yarrow et al. 2009). For example, three studies of middle school students found mean food safety knowledge scores of 72%, 51%, and 65% (Haapala and Probart 2004; Richards et al. 2008; Kim et al. 2012). For undergraduate college students, mean knowledge scores of 60% and 80% were reported (Byrd-Bredbenner et al. 2007; Yarrow et al. 2009).
5.1.1 **Race/Ethnicity**

The difference in mean knowledge scores between this study and those conducted previously may be attributable to demographic differences in the study populations. While this study was conducted in an urban school district with a study population that was 70% Hispanic and 15% non-Hispanic Black, most previous food safety studies of adolescents were conducted in rural or suburban locations and/or with predominantly non-Hispanic White students (Haapala and Probart 2004; Byrd-Bredbenner et al. 2007; Yarrow et al. 2009). This is significant because there has been a demonstrated disparity in the rates of some foodborne diseases in Hispanic and non-Hispanic black populations (Shiferaw et al. 2004; Change et al. 2009; Pouillot et al. 2012; Arshad et al. 2007). Evidence from this study, as well as others, suggest that some of this disparity may be due to lower levels of food safety knowledge in these populations. In this study, Hispanic students scored significantly lower on the knowledge survey than did students of other races/ethnicities when controlling for other factors. Studies of food handlers in urban and suburban Chicago also support the presence of decreased baseline levels of food safety knowledge in Hispanic individuals (Manes et al. 2012; Panchal et al. 2012).

5.1.2 **Socioeconomic Status and Seafood Cooking Experience**

An additional reason for the lower baseline knowledge score in this study may be due to socioeconomic differences between the population and those previously examined. Although it was deemed to be inappropriate to ask about parental income levels in this high school population, there is some evidence that suggests that experience handling seafood may serve as a proxy for socioeconomic status. While rates of seafood consumption are higher in some races/ethnicities, this study found an association between sometimes or often cooking seafood
and decreased knowledge score when controlling for other factors including Hispanic ethnicity (Wan and Hu 2012; Weinstein and Bisogni 1999). Further supporting this conclusion is that some studies suggest that food insecurity may be associated with greater levels of seafood consumption (Sheaffer and O’Leary 2005; Fisher et al. 2010; Burger and Stephens 1999). In addition, in this study students who reported cooking seafood with greater frequency were more likely to report cooking food without parental assistance. A study of adolescents participating in Project EAT (Eating Among Teens) survey suggested that families with lower levels of income may rely more on the adolescents to prepare food (Larson et al. 2006). Thus, although it may seem counterintuitive that increased experience is associated with lower knowledge scores, this association may be a reflection of the association between food safety knowledge and socioeconomic status. Although both were independently associated, the combination of both increased seafood cooking frequency and Hispanic ethnicity was associated with substantial knowledge gaps in several areas, including hand washing and time and temperature abuse (Figure 3).

5.1.3 **Cooking Experience**

More intuitively, this study found a significant and independent association between both increased frequency of cooking raw meat and increased frequency of cooking on one’s own and increased knowledge score. Students who reported often cooking meat were significantly more likely to be able to identify proper mechanisms for thawing meat than were students who reported cooking meat less frequently ($p=0.05$). That being said, students who reported often or always cooking on their own still had some substantial knowledge gaps regarding the correct
minimum internal temperatures to cook meat, the definition of cross-contamination, food items that make people sick, and the vulnerable populations for foodborne disease.

It was unexpected that there was not a significant association with knowledge score and either experience cooking with parental assistance or restaurant employment in this study. However, both were associated with a higher knowledge score. Analyses of parental employment and domestic kitchen dynamics suggest that it may be possible that the insignificant association between cooking with parental assistance and knowledge score may be due to an increased reliance on convenience food, increased parental employment outside of the home, and the associated overall “deskilling” of populations in modern society in general (Clay 2005; Bauer et al. 2013; Anderson 1988; Larson et al. 2006; Kornelson 2009; Lyon et al. 2003). Unlike previous analyses of adolescent employment structure and studies of food safety knowledge in college students, students in this study reported a relatively low rate of restaurant employment experience (Byrd-Bredbenner 2007; Bureau of Labor Statistics 2011; Hirshman and Voloshin 2007). Unlike previous studies, this study took place at a charter school with a public health focused curriculum. Because the school places a large priority in ensuring college acceptance for its students, it is likely that attention was more focused on school work than extra-curricular employment. Previously, a randomized telephone survey of college students found that 40% had restaurant experience (Byrd-Bredbenner et al. 2007). The relatively low sample size (only 12%) of students reporting restaurant employment and youth of students in this study is likely responsible for the positive, but not significant, association between restaurant employment experience and food safety knowledge score. In addition, even the students who reported restaurant food handling experience are likely to have low food safety knowledge; a study of
restaurant food handlers in suburban Chicago found that even within restaurant food handlers, decreased age is associated with lower knowledge scores (Manes et al. 2012).

5.1.4 **Gender**

Unlike most previous literature, this study did not find a significant association between gender and food safety knowledge. Studies of both middle school and undergraduate college students have found that female students have significantly and substantially greater food safety knowledge than do male students (Haapala and Probart 2004; Byrd-Bredbenner et al. 2007; Stein et al. 2010; Kim et al. 2012). While this study did find that knowledge scores were higher in female students, the lack of association in this study was likely due to a lack of gendered cooking experience in this population both at home and in school. Food safety knowledge was associated with experience cooking on one’s own, and not experience cooking with parental assistance. An increased rate of maternal employment may contribute to this difference. The Intergenerational Panel Study of Parents and Children (IPSPC), a study of women and their children in the Detroit metropolitan area suggested that mothers who “devote a relatively large proportion of their time to paid employment may contribute to the erosion of gender-stereotypical housework behaviors in their children”; within the IPSPC study, maternal employment was significantly associated with lower levels of “gendered” housework among daughters (Cunningham 2001). In addition, the Noble Street Charter School does not offer a home economics curriculum. A study of home economics enrollment in Georgia suggested that participants are predominantly female (82% of 1,024 students surveyed) (Rutter et al. 2005). It is likely that both of these factors played a role in the lack of association between gender and knowledge score in this study.
5.2 **Gaps in Food Safety Knowledge**

The students participating in this study had substantial knowledge gaps in several areas, including the optimal temperatures for cooking, proper mechanisms for thawing food, cross-contamination, and the vulnerable populations for foodborne disease (Table III). In this study, no students could identify the danger zone for pathogen growth, only 1 (0.5%) student identified the proper temperature to cook hamburger, and only 12% of students accurately identified that the only way to be certain that a frozen chicken breast is safe to eat is by checking its internal temperature with a metal stem thermometer. These are largely reflective of knowledge gaps and unsafe food handling behaviors previously found in studies of middle school and undergraduate college students. For example, middle school and undergraduate college students have previously demonstrated a lack of knowledge in the areas of thermometer use, food storage, hand hygiene, and appropriate sanitation techniques to prevent cross-contamination (Abbot et al. 2009; Haapala and Probart 2004; Byrd-Bredbenner et al. 2007; Stein et al. 2010; Yarrow et al. 2009; Kim et al. 2012). Furthermore, knowledge gaps in these areas may lead to unsafe food handling behaviors that have been associated with the occurrence of foodborne disease outbreaks. Previously, cross-contamination, inadequate heat treatment, inappropriate storage, and food preparation by infected food handlers were significantly associated with outbreaks (Rocourt et al. 2003; Gormley et al. 2011; Gillespie et al. 2011). These factors suggest that these knowledge gaps may be important to remedy in order to prevent the transmission of foodborne disease in the high school student population.
5.3 **Evaluation of Intervention According to the Principles of Effective Prevention Programs Model**

According to the Principles of Effective Prevention Programs model, there are nine principles that are considered attributes of effective prevention programs including: being comprehensive, having varied teaching methods and sufficient dosage, being theory driven, promoting positive relationships, being appropriately timed and socioculturally relevant, including an outcome evaluation, and having well-trained staff (Nation et al. 2003). The educational intervention described above abided by this model in several ways. The comic book and curriculum aimed to be comprehensive by including both theoretical food safety information and its application in real-life situations by describing outbreak investigation. The curriculum and comic book included a variety of teaching methods by requiring students to utilize reading, mathematics, science, and oral communication. The dosage of the curriculum could have been greater, as it was only taught in a two-day curriculum. However, with current constraints on the time available to teach material outside of that covered on assessments, the dosage of the curriculum was as large as it could be and sufficient to increase knowledge substantially in the high school student population. The theories behind the Principles of Effective Prevention Programs were utilized, as were components of food safety curricula that had previously been found to be effective. Although the intervention did not directly promote positive relationships with family and the community, many students reported sharing what they had learned from the curriculum with their friends and family. The curriculum was appropriately timed to fit in with a preexisting digestive systems unit and target students at a time when they are likely to begin to be responsible for increased food preparation for themselves and others. Several elements, including the use of colorful illustrations and the *luchador* comic, were included to make the
curriculum socioculturally relevant to Hispanic students (Elder et al. 2009). A guide for teaching was provided to help instructors teach this curriculum and instructors were also already well-versed in the teaching of the health sciences. Finally, an extensive analysis was conducted to determine the efficacy of the curriculum within this population. This served as the outcome evaluation for this this study.

5.4 **Follow-up Knowledge Score and Associated Variables**

Post-intervention, students demonstrated a significant increase in knowledge score. Overall, student knowledge score increased 6.5 questions (22 percentage-point rise from 37% to 60%) compared to the baseline score and 75% of students had a knowledge score increase of at least one strata (Figure 4, Figure 5B). The majority of students began with a low level of knowledge (knowledge score of 26%–50%) on the baseline assessment and increased to a moderate level of knowledge (51%–75% knowledge score) on the follow-up assessment. This is similar to results found from previous interventions of middle school and undergraduate college students (Stein et al. 2010; Richards et al. 2008; Kim et al. 2012) and twice as great as that found in one previous intervention for undergraduate college students (Yarrow et al. 2009).

There were several factors that were significantly and independently associated with increase in knowledge score. These factors included grade, race/ethnicity, degree of exposure to the comic book, and having spoken with friends or family about what they learned in the curriculum.
5.4.1 Grade

Regarding grade, in this study, students in the 12th grade improved by approximately 3 point less in knowledge score than did students in the 11th grade. There are several factors that might be associated with this decrease. Some 12th grade students demonstrated a lack of compliance with the educational curriculum suggesting that they may not have taken it as seriously. For example, five students demonstrated a loss of at least one knowledge strata on the follow-up survey (Figure 5B). Students who demonstrated a substantially lower knowledge score either had missing information for most or all of the questions or only chose the first possible answer. All of these students were in the 12th grade. In addition, students in the 12th grade were significantly less likely to report reading all of the comic book. This likely played a role in the difference in knowledge increase for 11th and 12th grade students, and future analyses should consider removing at least the 12th grade students who did not comply with the follow-up survey in order to get a more accurate analysis of the factors associated with increase in knowledge score.

5.4.2 Exposure to the Comic Book

The degree of exposure to the comic book was significantly associated with increased knowledge score. Those students who reported reading all of the comic book had an approximately one point greater increase in score than did those who reported reading only part of the comic book (Table VIII). The two groups did not score significantly differently on the baseline survey, suggesting that the difference in knowledge increase was attributable to exposure to the comic book and not characteristics that might predispose one group to read the comic book while another does not. Male students were more likely to read all of the comic
book. This difference likely reflects gendered differences tendency to read of comic books noted in a study of comic book reading, reading enjoyment, and pleasure reading among middle class and Chapter 1 middle school students in Los Angeles (Ujiie and Krashen 1996).

5.4.3 **Associated Variables and the Principles of Effective Prevention Programs: Cultural Relevance and Community Interaction**

Two variables that were significantly and independently associated with knowledge score have a direct connection to the Principles of Effective Prevention Programs. These variables include sociocultural relevance and promoting positive relationships (Nation at al. 2003). The intervention was found to be particularly effective at increasing food safety knowledge in Hispanic students. Hispanic students had an average increase of almost two points greater on the follow-up survey than did students of other races/ethnicities. An analysis of efficacious interventions in Hispanic populations suggested that interventions containing colorful illustrations and personalized information may be particularly effective (Elder et al. 2009). This intervention included a colorful comic book with a *luchador* (Mexican wrestler) comic that increased the personalization. These components may have contributed to the effectiveness of this intervention in Hispanic populations and suggest that the intervention may be socioculturally appropriate for Hispanic high school students. However, Hispanic students also scored significantly lower at baseline, and therefore had the potential for a larger increase in score. Future research should determine what elements can make food safety interventions in particular efficacious in this population.

Another factor that was significantly associated with increase in knowledge score was having communicated with family and friends about the curriculum. Students who reported
speaking with family and friends had an average score increase of almost two points higher on the follow-up survey. The Principles of Effective Prevention Programs model suggests that promoting positive interaction with family and community may lead to a more effective intervention (Nation et al. 2003). There are two possible reasons why this difference occurred, and they may have been mutually reinforcing. It is possible that students who communicated with their family and friends regarding the curriculum may have already learned the information to a greater extent or had more enthusiasm about the topic, thereby allowing for this communication. Another possibility is that the process of sharing information with family and friends provided students with an opportunity to discuss these concepts and reinforced the information allowing them to achieve greater increases in knowledge. Either way, by promoting positive interaction with family and friends the curriculum served as a more effective intervention.

5.5 **Increases in Food Safety Knowledge, Behavioral Changes, and Student Evaluation of the Curriculum**

The knowledge gain resulting from this intervention successfully met that which was proposed in our hypotheses (>20% increase in score). There were only a few questions for which students did not have a significant knowledge increase. These areas by and large reflected topics that had been covered previously by the school’s preexisting public health curriculum. Students had previously had some exposure to epidemiological concepts. This extent of this exposure was greater among students in the 12th grade. For example, these students already had some introduction to the application of relative risk. There was one epidemiology question on which students did have a significant knowledge increase. Students were more likely to correctly
identify the purpose of foodborne disease outbreak investigation and therefore did gain some public health knowledge. There were also several specific important areas in which food safety knowledge gains occurred.

Among the more substantial increases in knowledge, several related to the proper mechanisms for storing, thawing, and checking the temperature of food; cross-contamination; and the vulnerable populations for foodborne disease. After exposure to the curriculum, students were significantly more likely to identify as false that raw meat can be stored anywhere in a refrigerator as long as it is wrapped in plastic (increase from 30% to 63%; \( p < 0.05 \)), significantly more likely to identify as false that putting a frozen chicken breast on the counter at room temperature is a safe way to get it to thaw (increase from 32% to 70%, \( p < 0.05 \)), and significantly more likely to identify as true that vegetables for a salad splashed with a few drops of raw chicken juice will not be made safe by rinsing with water (increase from 44% to 77%; \( p < 0.05 \)). The percentage of students who identified 20 seconds as the length of time to wash their hands increased from 54% to 72% (\( p < 0.05 \)). Each of these questions represents an area in which students increased from low to moderate levels of knowledge. These areas are important because they represent both knowledge gaps from found in previous of studies of adolescent food safety knowledge and practices that would put an individual at risk for infection with or transmission of foodborne disease as previously discussed.

Fifty-one percent of the students in this study also expressed belief that they would change their food safety behaviors in several areas, including washing hands for a longer period of time, sanitizing surfaces after contact with potentially contaminated food, making sure to cook meat to the correct temperatures and thaw meat appropriately, avoiding cross-contamination, and being more careful about food eaten outside of the home. Because knowledge is not always
associated with behavioral change, it is significant that the students also had currently or planned to in the future enact changes in behavior. Because of the possibility for students to impact food safety in the restaurant industry, it is particularly important that one of the students intended to utilize safer food behaviors both at home and at their food handling job. The impact of the curriculum reached beyond just the exposed students. Forty-five students (28% of those responding) stated that they had spoken with friends or family about the curriculum. From these discussions, commonly reported knowledge increases and intended changes in behavior included cross-contamination, proper mechanisms for thawing meat, and cooking meat to the proper temperature as read on a metal stem thermometer. This suggests that the curriculum has the potential to impact consumer food safety in the community as well as among the students at the participating school.

The students’ evaluation of the curriculum was largely positive. Overall, 91% of students (128 students) reported that they enjoyed reading the comic book and 93% of students (129 students) believed that schools should provide students with the comic book and curriculum. Furthermore, most students believed that the curriculum was taught in a way that they could understand (93% of students). While the majority of students believed that they had learned new information about food safety (94% of students), the proportion of students reporting that they had learned new information about epidemiology was lower (77% of students). This is likely because of the preexisting public health focus of the school and is reflected in the lower increase in score for epidemiology questions relative to questions pertaining to food safety.
5.6  **Strengths of Study**

The strengths of this study include that it was the first to access baseline knowledge levels and the effectiveness of an educational intervention in a high school setting, and specifically a setting including urban, predominantly minority students. The results of this intervention suggest that students demonstrated significant and substantial knowledge gains and behavioral changes in many areas, including those that could put them at risk for the transmission of foodborne disease. Furthermore, this intervention suggests that the dissemination of food safety knowledge in a population of high school students may lead to knowledge gains and behavioral changes in the students’ friends and families as well. This intervention also demonstrated the effectiveness of a novel educational tool, a comic book, at increasing food safety knowledge in this population.

5.5  **Limitations and Future Research**

This study also had several limitations. Although the intervention was effective in this population, the utilization of only one school limits the generalization of these results to other high school populations with differing demographics. For example, although there were not significant knowledge gains in epidemiology in this population, a school without a preexisting public health and health sciences program would likely have greater improvements. Two areas included in the Principles of Effective Prevention Programs model could have been better addressed by this intervention. If possible, an increased “dosage,” or amount of time available in the classroom may have increased the effectiveness of this intervention. It would have been beneficial as well to have had more control of compliance and implementation in classrooms to further control the dosage of the curriculum. Secondly, the results suggest that because increase
in knowledge score was associated with interacting with family and friends about the curriculum, a greater amount of community interaction built into the curriculum may also increase effectiveness. One proposed element of the study that was eliminated due to time constraints was to include a survey for family and friends that students would administer as a part of the curriculum. This survey would include questions for students to quiz their friends or family about their food handling practices. By including this survey, it would encourage students to discuss elements of the curriculum with their family and friends as well as provide the opportunity for these individuals to identify risky food handling practices within the home. This would likely increase the students’ follow-up knowledge gain as well as the potential overall impact of the curriculum in the community overall. We were also not able to establish the reason for the racial and ethnic difference in food safety knowledge. Future research should determine what factors contribute to racial differences in food safety knowledge and if this curriculum is effective at increasing food safety knowledge in other high school student populations as well.
APPENDIX A

University of Illinois at Chicago
Consent for Participation in Research
“An educational research project on food poisoning for high school students.”

**Why am I being asked?**

The University of Illinois at Chicago School of Public Health is evaluating a curriculum for high school students about food safety to prevent food poisoning. Your school has been selected because of its health science curriculum. A total of 360 11th and 12th grade high school students are being asked to volunteer to participate in this study. If you choose to participate, you will be asked to complete a survey that asks questions about food safety in order to determine your current knowledge. You may be asked to complete a follow-up survey after being taught a food safety and hand hygiene curriculum. We ask that you read this form and ask any questions you may have before agreeing to participate in this research.

Participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University or with your school. If you choose to participate, you will be to withdraw at any time without affecting these relationships.

Dr. Mark Dworkin is leading this project and he is volunteering his time.

**Why is this research being done?**

High school students represent an important population in which to intervene to increase food safety knowledge because they are at an age in which they will soon be responsible for increased amounts of food preparation for themselves and others. This research is being done to determine if high school student food safety knowledge can be improved by a curriculum because improved food safety knowledge may reduce the risk for food poisoning.
What is the purpose of this research?

The purpose of this research is to determine if a new curriculum for teaching high school students can successfully improve their knowledge of food safety and hand hygiene.

What are the procedures involved?

You will be asked to do the following things:

A survey will be performed where you will be asked questions about your knowledge about food handling, hand hygiene, and germs. This survey will be performed in English and may take approximately 20 minutes. Surveys will be conducted as a group during class time. Data from these surveys will be analyzed by UIC project staff. Approximately 360 students will be asked to participate.

A curriculum developed by the UIC School of Public Health has been created and will be taught to all 11th and 12th grade students. This curriculum includes information about food safety and the investigation of foodborne disease. The curriculum will take several hours of class time and may be conducted during more than one class period as per the teacher’s preference. After implementation of the curriculum, you will receive a follow-up survey to determine how well the curriculum improves food safety knowledge lasting approximately 20 minutes. You will also be asked to provide feedback about the curriculum.

What are the potential risks and discomforts?

There is no substantial risk to you for participating in this research; however, there is the risk that a breach of privacy (others will know you are participating in research) and confidentiality (accidental disclosure of identifiable data) may occur. Names are only collected for internal record keeping and they will be destroyed. No student’s name will be disclosed in reports by UIC research staff.

Are there benefits to taking part in the research?

You may improve your knowledge of food safety and hand hygiene. There is no direct benefit to you for participating in this research. However, because of your participation in this research, educational materials that target what high school students need to know will be created that could help them be safer food handlers in the future.
What other options are there?

The only other option is not to participate in this survey. However, the curriculum will be taught to all 11th and 12th grade students.

What about privacy and confidentiality?

Names are only collected for internal record keeping. No student’s name will be disclosed in reports by UIC research staff. Study information that identifies you and this consent form signed by you may be looked at and/or copied for examining the research by the UIC Office for the Protection of Research Subjects and State of Illinois Auditors.

If the results of the research are published or discussed in conference, no information will be included that would reveal your identity. If any information were obtained in connection with this study that could identify you, then it would remain confidential and would only be disclosed with your permission or as required by the law.

What are the costs for participating in this research?

There are no costs for participating in this research.

Will there be reimbursement for any expenses or payment for participation in this research?

There is no payment for participation in this research.

Can I withdraw or be removed from the study?

You may choose whether or not to participate in this research and you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don’t want to answer and still remain in the study.
Who should I contact if I have questions?

The researchers conducting this study are Dr. Mark Dworkin and his research staff. Anne Burke is serving as the primary investigator on this study. The research being conducted has been developed for her master’s thesis. You may ask any questions you have now, or later by contacting Dr. Mark Dworkin at (312) 413-0348 or emailing mdworkin@uic.edu or Anne Burke at (316)304-5909 or emailing aburke8@uic.edu.

What are my rights as a research subject?

If you feel that you have not been treated according to the descriptions in this form, or you have any questions about your rights as a research subject, you may call the Office for the Protection of Research Subjects (OPRS) at (312) 996-1711 (local) or 1-866-789-6215 (toll-free) or email OPRS at uicirb@uic.edu.

Remember: Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the university or with your school. If you decide to participate, you will be free to withdraw at any time without affecting these relationships.

You may make a copy of this form for your information and to keep for your records.
Signature of Subject

I have read (or someone has read to me) the above information. I have been given the opportunity to ask questions and my questions have been answered to my satisfaction.

I am providing consent to participate in this study, including completing a survey that asks questions about food safety in order to determine my current knowledge, completing a follow-up survey after participating in a food safety and hand hygiene curriculum, and providing an evaluation of this curriculum. I agree to participate in this research. I have been given a copy of this form.

If you agree to participate, please check and sign below.

☐ Yes, I agree to participate.

☐ No, I do not agree to participate.

________________________________________  ______________________________
Signature                                      Date

________________________________________
Printed Name
APPENDIX B

University of Illinois at Chicago
Permission for Participation in Research
“An educational research project on food poisoning for high school students.”

**Why am I being asked?**

The University of Illinois at Chicago School of Public Health is evaluating a curriculum for high school students about food safety to prevent food poisoning. Your child’s school has been selected because of its health science curriculum. A total of 360 high school students are being asked to volunteer to complete a survey that asks questions about food safety in order to determine their current knowledge. Your child may be asked to complete a follow-up survey after being taught a food safety and hand hygiene curriculum. We ask that you read this form and ask any questions you may have before agreeing for your child to participate in this research.

Participation in this research is voluntary. Your decision whether or not your child will participate will not affect your current or future relations with the university or with your child’s school. If you to allow your child to participate, he or she is free to withdraw at any time without affecting that relationship.

Dr. Mark Dworkin is leading this project and he is volunteering his time.

**Why is this research being done?**

High school students represent an important population in which to intervene to increase food safety knowledge because they are at an age in which they will soon be responsible for increased amounts of food preparation for themselves and others. This research is being done to determine if high school student food safety knowledge can be improved by a curriculum because improved food safety knowledge may reduce the risk for food poisoning.
What is the purpose of this research?

The purpose of this research is to determine if a new curriculum for teaching high school students can successfully improve their knowledge of food safety and hand hygiene.

What are the procedures involved?

Students will be asked to do the following things:

A survey will be performed where each student is asked questions about his or her knowledge about food handling, hand hygiene, and germs. This survey will be performed in English and may take approximately 20 minutes. Surveys will be conducted as a group during class time. Data from these surveys will be analyzed by UIC project staff. Approximately 360 students will be asked to participate.

A curriculum developed by the UIC School of Public Health has been created and will be taught to 11th and 12th grade students. This curriculum includes information about food safety and the investigation of foodborne disease. The curriculum will take several hours of class time and may be conducted during more than one class period as per the teacher’s preference. After implementation of the curriculum, 11th and 12th grade students will receive a follow-up survey lasting approximately 20 minutes to determine how well the curriculum improves food safety knowledge. The 11th and 12th grade students will also be asked to provide feedback about the curriculum.

What are the potential risks and discomforts?

There is no substantial risk to the students for participating in this research; however, there is the risk that a breach of privacy (others will know the subject is participating in research) and confidentiality (accidental disclosure of identifiable data) may occur. Names are only collected for internal record keeping and they will be destroyed. No student’s name will be disclosed in reports by UIC research staff.

Are there benefits to taking part in the research?

Students in the 11th and 12th grade may improve their knowledge of food safety and hand hygiene. There is no direct benefit to students for participating in this research. However, because of their participation in this research, educational materials that target what high school students need to know will be created that could help them be a safer food handler in the future.
What other options are there?

The only other option is not to participate in this survey. However, the curriculum will be taught to all 11th and 12th grade students.

What about privacy and confidentiality?

Names are only collected for internal record keeping. No student’s name will be disclosed in reports by UIC research staff. Study information which identifies you and this consent form signed by you may be looked at and/or copied for examining the research by the UIC Office for the Protection of Research Subjects and State of Illinois Auditors.

If the results of the research are published or discussed in conference, no information will be included that would reveal the student’s identity. If any information were obtained in connection with this study and that could identify the student, then it would remain confidential and would only be disclosed with your permission or as required by the law.

What are the costs for participating in this research?

There are no costs for participating in this research.

Will there be reimbursement for any expenses or payment for participation in this research?

There is no payment for participation in this research.

Can my child withdraw or be removed from the study?

You may choose whether or not to allow your child to participate in this research and your child may withdraw at any time without consequences of any kind. Your child may also refuse to answer any questions he or she doesn’t want to answer and still remain in the study.
Who should I contact if I have questions?

The researchers conducting this study are Dr. Mark Dworkin and his research staff. Anne Burke is serving as the primary investigator on this study. The research being conducted has been developed for her master’s thesis. You may ask any questions you have now, or later by contacting Dr. Mark Dworkin at (312) 413-0348 or emailing mdworkin@uic.edu or Anne Burke at (316) 304-5909 or emailing aburke8@uic.edu.

Parents please be aware that under the Protection of Pupil Rights Act. 20 U.S.C. Section 1232©(1)(A), you have the right to review a copy of the questions asked of or materials that will be used with your students. If you would like to do so, you should contact Dr. Mark Dworkin at (312) 413-0348 or emailing mdworkin@uic.edu or Anne Burke at (316) 304-5909 or emailing aburke8@uic.edu to obtain a copy of the questions or materials.

What are my child’s rights as a research subject?

If you feel that your child has not been treated according to the descriptions in this form, or you have any questions about your child’s rights as a research subject, you may call the Office for the Protection of Research Subjects (OPRS) at (312) 996-1711 (local) or 1-866-789-6215 (toll-free) or email OPRS at uicirb@uic.edu.

Remember: Your child’s participation in this research is voluntary. Your decision whether or not to allow him or her to participate will not affect your current or future relations with the university. If you decide to allow participation, your child will be free to withdraw at any time without affecting that relationship.

You may make a copy of this form for your information and to keep for your records.
**Signature of Subject**

I have read (or someone has read to me) the above information. I have been given the opportunity to ask questions and my questions have been answered to my satisfaction. I am providing permission for my child to participate in this study, including completing a survey that asks questions about food safety in order to determine their current knowledge, completing a follow-up survey after participating in a food safety and hand hygiene curriculum, and providing an evaluation of this curriculum. I agree to have my child participate in this research. I have been given a copy of this form.

Please indicate whether you agree to have your child participate in this study by checking one of the boxes below.

- [ ] Yes, I agree to have my child participate.
- [ ] No, I do not agree to have my child participate.

_________________________________________  ___________________________
Signature  Date

_________________________________________
Printed Name

Name(s) and grade(s) of your child or children in grades 11–12 who will be participating in this study

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APPENDIX C

University of Illinois at Chicago
Consent for Participation in Research
“An educational research project on food poisoning for high school students.”

Why am I being asked?

The University of Illinois at Chicago School of Public Health is evaluating a curriculum for high school students about food safety to prevent food poisoning. Your school has been selected because of its health science curriculum and two instructors are being asked to volunteer to participate in this study. If you choose to participate, you will be asked to teach and evaluate a food safety curriculum. We ask that you read this form and ask any questions you may have before agreeing to participate in this research.

Participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the university or with your school. If you choose to participate, you will be free to withdraw at any time without affecting these relationships.

Dr. Mark Dworkin is leading this project and he is volunteering his time.

Why is this research being done?

High school students represent an important population in which to intervene to increase food safety knowledge because they are at an age in which they will soon be responsible for increased amounts of food preparation for themselves and others. This research is being done to determine if high school student food safety knowledge can be improved by a curriculum because improved food safety knowledge may reduce the risk for food poisoning.
What is the purpose of this research?

The purpose of this research is to determine if a new curriculum for teaching high school students can successfully improve their knowledge of food safety and hand hygiene.

What are the procedures involved?

You will be asked to do the following things:

A curriculum developed by the UIC School of Public Health has been created and you will be asked to teach this curriculum to your students. This curriculum includes information about food safety and the investigation of foodborne disease. The curriculum will take several hours of class time and may be conducted during more than one class period as per your preference. After implementation of the curriculum, you will receive an evaluation to determine your opinion of the effectiveness and feasibility of the curriculum.

What are the potential risks and discomforts?

There is not a substantial risk to you for participating in this research; however, there is the risk that a breach of privacy (others will know the subject is participating in research) and confidentiality (accidental disclosure of identifiable data) may occur. Names are only collected for internal record keeping and they will be destroyed. No instructor’s name will be disclosed in reports by UIC research staff.

Are there benefits to taking part in the research?

There is no direct benefit to you for participating in this research. However, because of your participation in this research, educational materials that target what high school students need to know and are effective in the classroom will be created that could help them be a safer food handler in the future.

What other options are there?

The only other option is not to participate in this evaluation.
What about privacy and confidentiality?

Names are only collected for internal record keeping. No instructor’s name will be disclosed in reports by UIC research staff. Study information that identifies you and this consent form signed by you may be looked at and/or copied for examining the research by the UIC Office for the Protection of Research Subjects and State of Illinois Auditors.

If the results of the research are published or discussed in conference, no information will be included that would reveal your identity. If any information were obtained in connection with this study that could identify you, then it would remain confidential and would only be disclosed with your permission or as required by the law.

What are the costs for participating in this research?

There are no costs for participating in this research.

Will there be reimbursement for any expenses or payment for participation in this research?

There is no payment for participation in this research.

Can I withdraw or be removed from the study?

You may choose whether or not to participate in this research and you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don’t want to answer and still remain in the study.

Who should I contact if I have questions?

The researchers conducting this study are Dr. Mark Dworkin and his research staff. Anne Burke is serving as the primary investigator on this study. The research being conducted has been developed for her master’s thesis. You may ask any questions you have now, or later by contacting Dr. Mark Dworkin at (312) 413-0348 or emailing mdworkin@uic.edu or Anne Burke at (316) 304-5909 or emailing aburke8@uic.edu.
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If you feel that you have not been treated according to the descriptions in this form, or you have any questions about your rights as a research subject, you may call the Office for the Protection of Research Subjects (OPRS) at (312) 996-1711 (local) or 1-866-789-6215 (toll-free) or email OPRS at uicirb@uic.edu.

**Remember:** Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the university or with your school. If you decide to participate, you will be free to withdraw at any time without affecting these relationships.

You may make a copy of this form for your information and to keep for your records.
**Signature of Subject**

I have read (or someone has read to me) the above information. I have been given the opportunity to ask questions and my questions have been answered to my satisfaction. I am consenting to participate in this research, including teaching and evaluating the provided curriculum. I agree to participate in this research. I have been given a copy of this form.

If you agree to participate, please check and sign below.

- [ ] **Yes**, I agree to participate.
- [ ] **No**, I do not agree to participate.

_________________________________________  ______________________________
Signature                                      Date

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<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum Guide</td>
</tr>
<tr>
<td>Answers to comic book questions</td>
</tr>
<tr>
<td>Answers to Epidemiology Work Pages</td>
</tr>
<tr>
<td>MMWR Investigation Worksheet</td>
</tr>
<tr>
<td>MMWR Instructor Summaries</td>
</tr>
<tr>
<td>National Outbreak Reporting System form</td>
</tr>
<tr>
<td>Morbidity and Mortality Weekly (MMWR) articles</td>
</tr>
<tr>
<td><em>Listeria</em>: Hog head cheese</td>
</tr>
<tr>
<td><em>Campylobacter</em>: Cross-contamination</td>
</tr>
<tr>
<td>Norovirus: Ill food workers</td>
</tr>
<tr>
<td><em>Salmonella typhimurium</em>: Raw ground beef</td>
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<tr>
<td><em>Salmonella javiana</em>: U.S. Transplant Games</td>
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CURRICULUM GUIDE

OVERVIEW

Grade: 11

Subjects addressed: Biology, Environmental Sciences, General Science, Health

Session 1 Class Time: 60–75 minutes

Session 2 Class Time: 60–75 minutes

Total Class Time: 2–2.5 hours

OBJECTIVE

By the end of the curriculum, students should be able to generate hypotheses based on the presentation of a foodborne disease outbreak and become familiar with determinants of foodborne disease; define and interpret terms related to food safety, hand hygiene, outbreak investigation, and epidemiology; calculate food specific attack rates and relative risks; become familiar with the National Outbreak Reporting System form, and demonstrate an understanding of how food safety and hand hygiene can be applied in the kitchen to prevent the transmission of foodborne disease.

MATERIALS

Per student:

- One copy of educational comic book
- One copy of the National Outbreak Reporting System form
- Calculator
- One Morbidity and Mortality Weekly Report (MMWR) article
- One copy of the MMWR Investigation Worksheet
- One copy of the Student Evaluation form
- One copy of the Post-Intervention survey

Per teacher:

- One copy of the Teacher Evaluation form
APPENDIX D (continued)

VOCABULARY WORDS (For definitions, see educational comic book dictionary on pages 15–16 of the educational comic book)

Animal husbandry, Campylobacter, case-control study, Clostridium, cohort, colonize, control measures, cross-contamination, Escherichia coli (E. coli), enteric, environmental contamination, exposure, feces, food poisoning, food processing, food-specific attack rate, foodborne disease outbreak, generate hypothesis, germ, internal temperature, Listeria, metal stem thermometer, Norovirus, outbreak, outcome, pandemic, pathogenic, pulse-field gel electrophoresis, relative risk, Salmonella, stature, temperature abuse, unwittingly, wreak havoc

NATIONAL SCIENCE EDUCATION STANDARDS

Specific Content Standards

Unifying Concepts and Processes Standard

• Systems, order, and organization
• Evidence, models, and explanation
• Change, constancy, and measurement
• Form and function

Science As Inquiry Standard

• Abilities necessary to do scientific inquiry
• Understanding about scientific inquiry

Life Science Standard

• The cell
• Interdependence of organisms
• Behavior of organisms

Science in Personal and Social Perspectives Standard

• Personal and community health
• Environmental quality
• Natural and human-induced hazards
• Science and technology in local, national, and global challenges

History and Nature of Science Standard

• Science as a human endeavor
• Nature of scientific knowledge
• Historical perspectives
APPENDIX D (continued)

ENGLISH LANGUAGE ARTS STANDARD: LITERACY IN SCIENCE AND TECHNICAL SUBJECTS

Key Ideas and Details

- RST.11–12.1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

- RST.11–12.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Craft and Structure

- RST.11–12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

Integration of Knowledge and Ideas

- RST.11–12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

HIGH SCHOOL MATH STANDARDS

Statistics and Probability

S-ID Summarize, represent, and interpret data on two categorical and quantitative variables

S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

S-MD.7 Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

ILLINOIS STATE BOARD OF EDUCATION LEARNING STANDARDS FOR PHYSICAL DEVELOPMENT AND HEALTH: LATE HIGH SCHOOL

22.A.5a: Explain strategies for managing contagious, chronic, and degenerative disease.

22.A.5b: Evaluate the effectiveness of health promotion and illness prevention methods using data from actual work stations.

22.C.5: Compare and contrast how individuals, communities, and states prevent and correct health-threatening environmental problems (e.g., recycling, banning leaf burning, restaurant inspections, OSHA standards in the work place).
PREPPING THE LESSON


2. Make enough copies of the *MMWR* articles so that each student will have one copy. Students will be divided in 5 groups with each group reviewing one *MMWR* article. Make one copy of the *MMWR* Investigation Worksheet per student.

3. Assign students to read the educational comic book and review the National Outbreak Reporting System form as homework in the class prior to utilizing this curriculum. Instruct students to read the comic book stories and do the outbreak investigation worksheet to the best of their abilities. Students may work together on this worksheet. Students should also be instructed to complete the five questions on the back of the comic book. These questions will be reviewed at the beginning of the first day of instruction.

4. Assign student groups for the *MMWR* activity. Students should be divided in 5 groups of 3–6 persons and work as groups to develop a brief presentation based on the guidance provided.

IMPLEMENTING THE LESSON

SESSION ONE

INTRODUCTORY DISCUSSION (Conduct the day after assigning the comic book as homework)

**INTRODUCTION (Read to students):** Our local governments like the City of Chicago or the nearby counties have a health department. One of their functions is to keep an eye out for outbreaks of disease (this is called *surveillance*), investigate those outbreaks, and stop them from spreading to more people. One of the tools health departments use to gather information is the field of *epidemiology*. For example, the National Outbreak Reporting System form is used to gather information following an outbreak. We will now go over the answers to the questions on the back of the educational comic book.

1. Review the answers to the questions on the page of the comic book with students (found on pg. 11 of the Instructor Guidelines for Teaching).

2. Ask discussion questions to determine understanding from the comic book:

   - What does the word “foodborne” mean?
     - The word “foodborne” generally refers to disease and means carried or contracted by eating food.
• What causes foodborne disease?
  o Answers will vary and may include bacteria, bacterial toxins, parasites, viruses, mycotoxins, metal contamination as well as causes related to human behavior—such as improper food handling, not washing your hands, not cooking things to the correct temperature, and cross-contamination.

• Why is this an important issue?
  o Answers will vary, and may cover the personal and economic costs of foodborne disease.
  o Inform students that 5,000 people die and 325,000 people are hospitalized in the United States each year from foodborne disease.

ACTIVITY ONE: COMPLETING THE EPIDEMIOLOGY WORK PAGES

BACKGROUND: Outbreak investigation is an important tool that can be used to identify the source of a foodborne disease outbreak. One method used to suggest what may have caused the outbreak is calculating the food-specific attack rate.

OBJECTIVE: Students will be able to analyze data from a fictional foodborne disease outbreak and calculate food-specific attack rates and the relative risk of becoming ill with foodborne disease after being exposed to a contaminated food item. Students will learn how to interpret these analysis results.

DISCUSS:
• What is epidemiology?
  o Prompt students: Epidemiology is defined as the study of the distribution and determinants of disease within a given population. Can anyone explain this definition?
  ▪ Distribution—Epidemiology studies how disease is spread throughout a population. Are there particular risk groups? Certain areas where disease is more concentrated than others?
  ▪ Determinants—Epidemiology investigates risk factors that may lead an individual to have a greater likelihood of contracting or developing disease.

• How can epidemiology help in the understanding of a foodborne disease outbreak?
  o Epidemiology can help inform the determinants (what pathogen and food caused the disease) and distribution (who became sick) of foodborne disease. This information is important to an outbreak investigation in which who became sick is compared with what individuals ate to attempt to identify what was responsible for the outbreak and thereby control it. Epidemiology also enables
investigators to calculate the food-specific attack rate and relative risk. In the study of foodborne disease epidemiology, scientists track diseases in both human and animal populations.

1. Instruct students to turn to pg. 13 of the educational comic book. Ask for any questions regarding the outbreak investigation story.

2. **DISCUSS:**
   - What is a food-specific attack rate?
     - The food-specific attack rate is a tool used by epidemiologists to predict which food item was most likely responsible for the foodborne disease outbreak. The food-specific attack rate is the ratio of who ate a certain food item and became sick to all of those who ate that food item.

   - How is it calculated?
     \[
     \text{Food-specific Attack Rate} = \frac{\text{Number of persons who ate a specific food and became ill}}{\text{Total number of persons who ate a specific food}} \times 100
     \]

   - Why can’t you be certain that the food with the highest food-specific attack rate is the cause of the outbreak?
     - To be absolutely certain, you’d like to find a germ in a specimen (such as feces) from a person who got sick and find the identical kind of germ in a suspect food.
     - A high food-specific attack rate can occur for a food that many sick people did not eat. For example, if there are 100 cases of disease and only 10 restaurant patrons consumed mushrooms but 9 of those 10 persons are cases, you get an attack rate of 90% for mushrooms but it does not explain the other 91 cases of disease so it is not clearly the cause of the outbreak.
     - A food that really is the cause might have germs that are not distributed throughout all of a food item. This could lead to a food-specific attack rate that is not high even though the food is to blame.

3. Go through calculation questions on the epidemiology work pages (pg. 13 of the educational comic book). The answers are provided in the Instructor Guidelines for Teaching. Ask students for their answer and how they calculated it for one or two examples, then go through answers to the questions.

4. Go through the through the Thought Questions on pg. 13, ask students why they provided the answers they did with discussion.
5. **DISCUSS:**
   - What is the relative risk?
     - The ratio of the probability of an event (developing a disease) occurring in exposed people compared to the probability of the event in non-exposed people. For example, in a foodborne disease outbreak the relative risk would be the probability of becoming sick with foodborne illness for those who ate contaminated food compared to the probability of becoming sick in those that did not eat that food. If RR=1 there is no effect, RR>1 suggests greater risk in exposed individuals, RR<1 suggests less risk in exposed individuals, indicating a protective effect.

   - How is it calculated?
     
     \[ RR = \frac{a/(a+b)}{c/(c+d)} \]

6. Go through calculation questions on the epidemiology work pages (pg. 14 of the educational comic book). Ask students for their answer and how they calculated it for one or two examples, then go through answers to the questions (found on pg. 13–14 of the Instructor Guidelines for Teaching).

7. Go through the Thought Questions on pg. 14, ask students why they provided the answers they did with discussion.

**ACTIVITY TWO (PART 1): RESEARCHING A REAL FOODBORNE DISEASE OUTBREAK**

**BACKGROUND (Read to students):** Foodborne diseases have recently been an important topic in the news. Recent outbreaks from *Salmonella* and antibiotic-resistant *E. coli* have led to hospitalizations and in some cases even death.

**OBJECTIVE:** Students will research a foodborne disease outbreak and use the information gathered from the news story to identify any unsafe food handling that may have led to the outbreak and create a testable hypothesis which could be used in an outbreak investigation.

**DISCUSS:** Pages 7–9 show two real-life examples of other foodborne disease outbreaks.

1. What are some important questions to ask when attempting to deduce what caused a foodborne disease outbreak?
   - The first step in a foodborne disease investigation is to identify cases (individuals who have become infected with foodborne illness). Investigators then interview these individuals in order to identify the who, what, when, where, why, and how of the outbreak.
APPENDIX D (continued)

2. What do you think is meant by identifying the “Who” in the outbreak? The “What”? The “When”? The “Where”? The “Why”? The “How”? Ask the class to brainstorm answers
   - Answers may vary, outbreak investigators determine the characteristics of who is infected, by what pathogen/agent and with what symptoms, when and where the outbreak took place, how the disease was transmitted, and why it occurred as well as any food handling errors that may have contributed.

3. In the case of “The Tale of the Terrible Turkeys” and “The Tale of the Killer Hamburgers” what are the answers to these questions?
   - The Tale of the Terrible Turkeys
     i. Who: 50 restaurant patrons
     ii. What: A germ called Clostridium, resulting in diarrhea, stomach cramps, nausea, chills, fever, and an achy feeling.
     iii. When: Thanksgiving Day
     iv. Where: An Oregon restaurant
     v. How: Restaurant patrons consumed either turkey that had not been thawed correctly or gravy or stuffing that had not been properly cooled, allowing germs to grow.
     vi. Why: The turkeys were all defrosted at one time so they did not all cook completely, they were then held at a temperature that was too warm. Drippings from the turkey were used to make gravy, and both this gravy and the stuffing were cooled in containers that were too large. The containers did not cool evenly, allowing germs to grow.
   - The Tale of the Killer Hamburgers
     i. Who: 500 people became sick, 3 children died.
     ii. What: The outbreak was caused by E. coli, symptoms included bloody diarrhea and hemolytic uremic syndrome.
     iii. When: Unknown
     iv. Where: At a fast-food chain
     v. How: People of all ages ate hamburgers from a fast-food restaurant that had not been cooked to well-done.
     vi. Why: Hamburgers were not cooked well-done. E. coli occasionally contaminates meat during slaughter and the hamburgers were not cooked well enough to kill all of the E. coli bacteria.

INTRODUCTION (Read to students): The results of foodborne disease outbreak are often reported so that others can learn from the investigation. One source that publishes these outbreaks is the Morbidity and Mortality Weekly Report (MMWR) from the Centers for Disease Control and Prevention (CDC). Reports such as these help to inform others about factors that are important in the prevention of foodborne disease transmission.
APPENDIX D (continued)

1. Divide students into 5 groups of 3–6 persons. Each group will be assigned one of the following *MMWR* articles.


2. Distribute copies of the selected report to each group (1 copy of the report per student) and the one copy of the *MMWR* Investigation Worksheet per student. Use the following instructions for the students:

   **ASSIGNMENT INSTRUCTIONS FOR STUDENTS:**

   For this activity, you will be analyzing the results of a real-life foodborne outbreak investigation. Each outbreak has been selected as an example of the result of foodborne errors, so pay attention to any use of vocabulary terms from the Curriculum Dictionary or food safety concepts in the Outbreak Investigation Reports. Please answer the questions on the *MMWR* Investigation Worksheet as a group. Your first resource for the answers to the questions is the Outbreak Investigation Report, but in the case that answers cannot be found from this resource the internet may also be used. Each group will analyze one outbreak and give an 8 minute presentation of the results of their analysis at the beginning of the next class period with 2 minutes following for questions.
3. Students will spend the remainder of the class working on the MMWR Investigation Worksheets. The instructor should be available to assist the students and answer any questions. If computer and internet access is available then students may research any questions that they cannot answer using the internet.
   - Suggested websites:  http://www.cdc.gov
     http://www.fsis.usda.gov

SESSION TWO

Note: This session should occur after at least two days after Session 1 to allow time for the groups to prepare their presentations.

ACTIVITY TWO (PART 2)

1. Allow students 10 minutes to finish preparing their presentations.

INSTRUCT: Today, students will report on the MMWR articles. Each report should last 8 minutes and 2 minutes of questioning will follow. Does anyone have any questions before beginning presentations?

2. Each group should present their results for 8 minutes.
3. At the conclusion of 8 minutes, each group will answer questions from the instructor and their classmates for up to 2 minutes.

ACTIVITY THREE: EVALUATIONS

1. Distribute the Student Evaluation to students.
2. Read students the following instructions:

INSTRUCT: This is an evaluation of the curriculum that will take about 10 minutes to complete. Your feedback will provide valuable information about the curriculum. Please complete the Student Evaluation and turn it in when you are finished.

COMPLETING THE CURRICULUM

1. After the curriculum has been completed, fill out the Teacher Evaluation form.
ANSWERS TO QUESTIONS ON THE BACK OF THE EDUCATIONAL COMIC BOOK

1. Name three food safety errors that were completed by the chef in the Outbreak Investigation story in the educational comic book and describe how they may have contributed to the restaurant foodborne disease outbreak.

The chef did not properly thaw the chicken so part of it remained frozen and it was not able to cook evenly; cross-contaminated the lettuce with raw chicken juice, which may have allowed the germs to spread from the chicken to the salad; and did not check the temperature of the chicken breast with a metal stem thermometer, which would have ensured the center of the chicken had been cooked enough to kill the germs. (Found on pg. 11 of the educational comic book)

2. List, in order, the steps involved in good hand washing.

The steps involved in good hand washing are to turn on warm water and wet your hands, use liquid soap and water to lather hands for 20 seconds, rinse with the water, dry hands with a clean paper towel, and turn off the water with a paper towel without touching the faucet handle or knob with bare hands. (Found on pg. 5–6 of the educational comic book)

3. What is hemolytic uremic syndrome (HUS) and what germ is it associated with?

Hemolytic uremic syndrome is a syndrome in which blood cells break apart resulting in the kidneys becoming clogged and stopping working. Persons with hemolytic uremic syndrome sometimes require dialysis. Hemolytic uremic syndrome sometimes occurs as a result of E. coli food poisoning. (Found on pg. 7 of the educational comic book)

4. In addition to diarrhea, what are the other signs or symptoms that are collected on the National Outbreak Reporting System form?

Other signs and symptoms include vomiting, bloody stools, fever, abdominal cramps, HUS, and being asymptomatic. (Found on pg. 2 of the National Outbreak Reporting System form, for definition of HUS please see previous question)

5. When an outbreak investigation occurs in a school, what are the school characteristics that are collected on the National Reporting System form?

School characteristics collected on the National Reporting System form include the total approximate enrollment, grade levels, and primary funding of involved schools. (Found on pg. 5 of the National Outbreak Reporting System form).
When conducting a foodborne disease outbreak investigation, one way in which to analyze the data is to calculate food-specific attack rates. Information considered by investigators can include the various food sources, what food was prepared, cases of ill versus well people, and who ate what, when did they eat, and how much did they eat.

Food-specific attack rates are calculated using the following formula:

\[
\text{Food-specific Attack Rate} = \frac{\text{Number of persons who ate a specific food and became ill}}{\text{Total number of persons who ate a specific food}} \times 100
\]

**Example:** At a fast food restaurant, of the 100 people who ate a hamburger, 45 became ill.

\[
\frac{45}{100} \times 100 = 0.45(100) = 45\% \text{ attack rate for the hamburger} = \text{The food specific attack rate for the hamburger.}
\]

What does this food-specific attack rate tell you?

If hamburger is the cause of the outbreak, then it made 45% of the hamburger eaters become ill. But the attack rate is not proof that a specific food is the cause. It just helps you decide if you think a specific food is probably the cause.

Public health officials surveyed those who had attended the event. They received the following results:

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Baked Chicken</th>
<th>Beef Sirloin</th>
<th>Eggplant Parmesan</th>
<th>Salad</th>
<th>Mashed Potatoes</th>
<th>Garlic Bread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of persons exposed to food item who became ill</td>
<td>33</td>
<td>4</td>
<td>2</td>
<td>30</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>Number of persons exposed to food item who did not become ill</td>
<td>5</td>
<td>41</td>
<td>8</td>
<td>20</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>Number of persons not exposed to food item who became ill</td>
<td>7</td>
<td>36</td>
<td>38</td>
<td>18</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Number of persons not exposed to food item who did not become ill</td>
<td>55</td>
<td>19</td>
<td>52</td>
<td>32</td>
<td>17</td>
<td>10</td>
</tr>
</tbody>
</table>

Calculate the food-specific attack rates for each food item:

**Baked Chicken:** \[\frac{33}{(33+5)} \times 100 = 86.8\%\]

**Salad:** \[\frac{30}{(30+20)} \times 100 = 60.0\%\]
Beef Sirloin: \[ \frac{4}{(41+4)} \times 100 = 8.9\% \]

Mashed Potatoes: \[ \frac{36}{(36+33)} \times 100 = 47.8\% \]

Eggplant Parmesan: \[ \frac{2}{(2+8)} \times 100 = 20.0\% \]

Garlic Bread: \[ \frac{30}{(30+40)} = 42.9\% \]

Thought Questions:

1. Which food item was most likely responsible for the outbreak? Why do you think this is the case?
   The chicken appears to be most likely to be responsible. The chicken has the highest attack rate (86.8%).

2. Is there another food item that also has a high attack rate? How might you explain this?
   The salad also has a high attack rate (60%). There could have been cross-contamination from the chicken. Also, chicken eaters might have also eaten a salad. So chicken may be the cause but since chicken eaters ate salad often, salad may falsely look suspicious.

Calculating the relative risk can help to inform the conclusion of what most likely caused a foodborne disease outbreak. Epidemiologists call the subjects of this type of study a “cohort.”

For example, if a GROUP of people attend a wedding reception and become sick, the epidemiologist calls this group a “cohort.”

Epidemiologists use the relative risk to determine if a certain factor (such as consuming a food) increases the probability of an event occurring (such as developing a disease). In this example, the act of consuming a certain food would be known as the ‘exposure’ and becoming ill would be the “outcome.”

The relative risk (RR) can be interpreted as a multiplicative increase or decrease in risk associated with an exposure (If RR=3 this means that those with the exposure are 3 times more likely to be diseased than those not exposed, if RR=1/3 this means that those with the exposure are 1/3 as likely to be diseased). Since 1/3 is less than 1, this means that the exposure is actually protective instead of making it more likely that people get sick.

One tool epidemiologists use to determine relative risk is called a 2x2 Table. This is because there are two boxes horizontally and two boxes vertically.

<table>
<thead>
<tr>
<th>Consumed food</th>
<th>Diseased</th>
<th>Non-diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Number of diseased persons exposed to food item</td>
<td>b. Number of non-diseased persons exposed to food item</td>
<td></td>
</tr>
<tr>
<td>c. Number of diseased persons not exposed to food item</td>
<td>d. Number of non-diseased persons not exposed to food item</td>
<td></td>
</tr>
</tbody>
</table>

Relative Risk Formula: \[ RR = \frac{a/(a+b)}{c/(c+d)} \]
Use the information on the previous page to calculate the relative risks associated with eating baked chicken and salad. One of the boxes has already been filled out for you.

**Chicken:** \[
\frac{33}{(33+5)} = \frac{33}{38} = 0.8684 \approx 7.69
\]

**Salad:** \[
\frac{30}{(30+20)} = \frac{30}{50} = 0.6
\]

**Table: Chicken and Salad Consumption**

<table>
<thead>
<tr>
<th></th>
<th>Diseased</th>
<th>Non-diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumed</td>
<td>33</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Diseased</th>
<th>Non-diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumed</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

**Thought Questions:**

3. How does this impact which food item you think is most likely to have caused the outbreak?

The relative risk of contracting foodborne disease is 7.69 times higher for those who ate the chicken relative to those who did not eat the chicken. This is much higher than the relative risk associated with having eaten the salad (1.67 times greater risk for those who consumed the salad relative to those who did not. This further suggests that the chicken may have been responsible. It does not rule out that the salad may have also played some role in the outbreak.

4. Why didn’t everyone who consumed the contaminated food become sick? Why did some who did not consume the contaminated food become sick?

Some people may have had factors such as stronger immune systems that stopped the germ from causing disease. Also, some chickens may have had more germs on them. Some who did not consume the food may have become sick because they may not recall eating a food such as if they only tasted from someone else’s plate. So when asked, “Did you eat chicken?” they might say no but, really, they had eaten a bite of chicken.
**APPENDIX D (continued)**

**MMWR INVESTIGATION WORKSHEET**

**Instructions:** In groups of 3 to 6 persons, complete the following questions about your assigned *Morbidity and Mortality Weekly Report (MMWR)* article. As a group, develop an 8-minute presentation of the results of your analysis of the foodborne disease outbreak from your article. The presentation should address each of the questions listed below. Time outside of class may be required to complete this activity. Each group will present their results during the assigned class period. The presentation of your results will be followed by up to 2 minutes of questioning from your teacher and classmates.

1. **What is the germ or agent responsible for this outbreak of foodborne disease?**

2. **How can human beings become exposed to this germ/agent?**

3. **What are the initial symptoms of this foodborne disease? What are the later symptoms of this foodborne disease if it is not treated?**

4. **What is the morbidity (cases, hospitalizations) and mortality (deaths) that resulted from this outbreak?**

5. **Are there any risk groups particularly affected by this disease?**

6. **Describe the outbreak:**
   a. **How many people were involved?**
APPENDIX D (continued)

b. Where did it occur?

c. When did it occur?

d. Why did it occur? Were there any food safety errors that caused this outbreak to occur?

7. What were the main findings of the outbreak investigation?

8. What were the control measures implemented to prevent further spread of disease?

9. What food safety concepts or vocabulary terms were important to this foodborne disease outbreak?

10. (Answer only for the group with the listeriosis outbreak) Is head cheese sold in your city? If so, who consumes it?
**Listeria: Hog Head Cheese**

Outbreak of invasive listeriosis associated with the consumption of hog head cheese. (2011, April 8)  
[http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6013a2.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6013a2.htm).

11. What is the germ or agent responsible for this outbreak of foodborne disease?

*Listeria monocytogenes* was responsible for this foodborne disease outbreak.

12. How can human beings become exposed to this germ/agent?

*Listeria monocytogenes* is found in soil, water, and silage (feed prepared by storing and fermenting green forage plants in a silo). Deli meats are a recognized vehicle for infection.

13. What are the initial symptoms of this foodborne disease? What are the later symptoms of this foodborne disease if it is not treated?

Symptoms range from mild in some cases to severe disease in animals and people. Some people get no symptoms (asymptomatic). Initial symptoms include fever, muscle aches, and gastrointestinal symptoms such as nausea or diarrhea. Later symptoms of invasive listeriosis include sepsis (blood infection) and encephalitis (brain infection). In pregnant women, the fetus can become infected leading to spontaneous abortion, stillbirths, or sepsis in infancy.

14. What is the morbidity (cases, hospitalizations) and mortality (deaths) that resulted from this outbreak?

Fourteen cases were identified, eight of which met the case definition. Seven patients were hospitalized and two died.

15. Are there any risk groups particularly affected by this disease?

Pregnant women, their unborn children, older adults, and immunocompromised individuals (individuals with decreased effectiveness of their immune system, such as those with HIV/AIDS). Pregnant women are particularly at risk.

16. Describe the outbreak:

a. How many people were involved?

Fourteen cases of listeriosis occurred in the cluster. Eight patients had cases which met the case definition.

b. Where did it occur?

Louisiana

c. When did it occur?

Between January and June of 2010.
d. Why did it occur? Were there any food safety errors that caused this outbreak to occur?

It is possible that environmental contamination occurred in the factory.

17. What were the main findings of the outbreak investigation?

Interviewed cases reported symptoms including fever, altered mental status, diarrhea, vomiting, and weakness. Three of the patients reported eating hog head cheese (a meat jelly made from swine heads and feet). The product was bought from two grocery stores and traced back to a single brand of hog head cheese. *Listeria monocytogenes* was cultured from three product samples and two environmental samples from the processing establishment.

18. What were the control measures implemented to prevent further spread of disease?

500,000 pounds of hog head cheese and sausage was recalled because of possible contamination.

19. What food safety concepts or vocabulary terms were important to this foodborne disease outbreak?

*Environmental contamination*: *Listeria monocytogenes* was cultured from the refrigeration unit and door threshold.

*Sanitization*: Properly sanitizing the refrigerator unit could have prevented environmental contamination.

20. Is head cheese sold in your city? If so, who consumes it?

Yes, some ethnic groups are more likely to eat it. Certain European, Chinese, Korean, and Vietnamese cultures consume head cheese.

*Campylobacter*: Cross-contamination


1. What is the germ or agent responsible for this outbreak of foodborne disease?

*Campylobacter jejuni* was responsible for this foodborne disease outbreak.

2. How can human beings become exposed to this germ/agent?

Common sources of outbreaks include unpasteurized milk and contaminated drinking water. Less frequent cases are associated with improper handling and preparing of poultry.

3. What are the initial symptoms of this foodborne disease? What are the later symptoms of this foodborne disease if it is not treated?

Initial symptoms include diarrhea, vomiting, nausea, and abdominal cramping. Untreated infection by *Campylobacter jejuni* may result in Guillain-Barré syndrome, a demyelinating disorder resulting in paralysis.

4. What is the morbidity (cases, hospitalizations) and mortality (deaths) that resulted from this outbreak?

Fourteen individuals met the case definition with no hospitalizations and no fatalities.
APPENDIX D (continued)

5. **Are there any risk groups particularly affected by this disease?**
   *(Students may have trouble finding this answer)* Immunocompromised individuals are susceptible, and young adults are an important risk group due to lack of food handling knowledge (contaminating themselves from raw meat).

6. **Describe the outbreak:**
   a. **How many people were involved?**
      Fourteen individuals met the case definition.
   b. **Where did it occur?**
      Southwestern Oklahoma
   c. **When did it occur?**
      August 1996
   d. **Why did it occur? Were there any food safety errors that caused this outbreak to occur?**
      Cross-contamination of lettuce with raw chicken juice. The countertop surface was too small to separate raw poultry from ready-to-eat foods. It was not certain whether or not the cook properly sanitized the surface after cutting up the chicken. The cook used a kitchen towel to dry her hands.

7. **What were the main findings of the outbreak investigation?**
   All cases interviewed reported diarrhea, 93% reported fever, 93% reported abdominal cramps, 79% reported nausea, 36% reported vomiting, and 21% reported visible blood in their stools. Lettuce consumption was associated with all cases and only four controls (OR=48.3). Lasagna consumption also occurred significantly more in cases than in controls (OR=6.7). Inspection suggested that the countertop was too small to properly separate raw meat from ready-to-eat products and that the chef had been drying her hands on a kitchen towel instead of a disposable paper towel.

8. **What were the control measures implemented to prevent further spread of disease?**
   It was recommended that the restaurant enlarge its food-preparation table, install a disposable hand towel dispenser, and have food handlers wash their hands and cooking utensils between use while preparing different foods.

9. **What food safety concepts or vocabulary terms were important to this foodborne disease outbreak?**
   *Cross-contamination:* Consuming lettuce cross-contaminated with raw chicken juice was most likely the cause of the outbreak. This emphasizes the need to keep certain foods and cooking utensils separate during food handling.
   *Sanitize:* The cook probably did not properly sanitize the cooking surface between cutting up the raw chicken and the lettuce.
   *Separate:* The restaurant did not have sufficient separation between areas where raw poultry and ready-to-eat foods were handled.
   *Hand hygiene:* Hands may not have been properly washed. Also, it is important to dry hands on a clean paper towel instead of a dirty towel.
Norovirus: Ill food workers


1. What is the germ or agent responsible for this outbreak of foodborne disease?
   Norovirus was responsible for this foodborne disease outbreak.

2. How can human beings become exposed to this germ/agent?
   Norovirus can be transmitted person to person (via the fecal-oral route) and spread through contaminated airborne droplets, food, water, and environmental surfaces.

3. What are the initial symptoms of this foodborne disease? What are the later symptoms of this foodborne disease if it is not treated?
   The predominant symptom is vomiting, but other symptoms include watery diarrhea, stomach pain, headaches, muscle aches, and possibly fever. Symptoms subside in 1–3 days without treatment.

4. What is the morbidity (cases, hospitalizations) and mortality (deaths) that resulted from this outbreak?
   Out of 364 cases, there were no hospitalizations or deaths.

5. Are there any risk groups particularly affected by this disease?
   The elderly, those with underlying conditions such as cardiovascular disease and immunosuppressive therapy.

6. Describe the outbreak:
   a. How many people were involved?
      At least 364 restaurant patrons became ill.
   b. Where did it occur?
      Eaton County, Michigan
   c. When did it occur?
      January 2006
   d. Why did it occur? Were there any food safety errors that caused this outbreak to occur?
      Several food-service workers were ill during the period between January and February of 2006. A line cook vomited in the restaurant on January 28th, possibly leading to increased environmental contamination and transmission of the virus.

7. What were the main findings of the outbreak investigation?
   One employee became ill on January 19th, but did not work while ill. A sibling of this employee became ill and continued working. A line cook worked while ill and vomited at the restaurant. Next, investigators interviewed patrons of the restaurant; 364 of the 584 patrons met the case definition for having had Norovirus infection. Of those infected, 88.2% reported diarrhea with
APPENDIX D (continued)

71.7% reporting vomiting. The attack rate was highest for those who had dined on January 28th (attack rate=33.7%). An analysis of what food items were consumed with illness suggested that those consuming the antipasti platter (OR=2.96) and garlic mashed potatoes (OR=4.05) were associated with illness. The sanitizer used by the restaurant was ineffective against Norovirus.

8. **What were the control measures implemented to prevent further spread of disease?**
   All food prepared between January 27–30 was discarded, all ill employees were excluded from working for at least 72 hours or until symptoms had subsided, and the facility was cleaned extensively.

9. **What food safety concepts or vocabulary terms were important to this foodborne disease outbreak?**
   Food should not be prepared for others while an individual is sick.

   - *Environmental contamination*: Environmental contamination due to vomiting may have led to increased transmission to employees and patrons.
   - *Sanitation*: If the sanitizer used in the restaurant was effective against Norovirus then the environmental contamination may not have been as severe.

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*Salmonella typhimurium*: Raw ground beef


1. **What is the germ or agent responsible for this outbreak of foodborne disease?**
   *Salmonella typhimurium* was responsible for this foodborne disease outbreak.

2. **How can human beings become exposed to this germ/agent?**
   *Salmonella* lives in the intestinal tract of humans and other animals, including birds. *Salmonella* is usually transmitted to humans by eating foods contaminated with animal feces. *Salmonella* present on raw meat and poultry could survive if the product is not cooked to a safe minimum internal temperature, as measured with a food thermometer.

3. **What are the initial symptoms of this foodborne disease?**
   What are the later symptoms of this foodborne disease if it is not treated?

4. The initial symptoms are diarrhea, fever, and abdominal cramps. Bloody diarrhea may also occur. *Salmonella* usually resolves completely, but a small number of persons develop a syndrome, resulting in joint pain, irritation of the eyes, and painful urination. Person’s with impaired immune systems are at increased risk for developing meningitis, urinary tract infections, abscesses (an accumulation of pus) of soft tissues, osteomyelitis (bone infections), and vascular infections.

5. **What is the morbidity (cases, hospitalizations) and mortality (deaths) that resulted from this outbreak?**
APPENDIX D (continued)

One hundred seven cases were confirmed and 51 probable cases were identified. Seventeen patients were hospitalized and no deaths were reported.

6. Are there any risk groups particularly affected by this disease?
Those who are immunocompromised, such as transplant recipients, are particularly at risk as are young children, the elderly, and those who take stomach antacids.

7. Describe the outbreak:
   a. How many people were involved?
      107 confirmed and 51 probable cases were identified.
   b. Where did it occur?
      Wisconsin
   c. When did it occur?
      1994 winter holiday season
   d. Why did it occur? Were there any food safety errors that caused this outbreak to occur?
      Individuals consumed raw ground beef contaminated with *Salmonella typhimurium*.
      Cases reported eating ground beef that was either plain or seasoned with onions and an herb mix and that the consumption of raw beef during the holidays was a practice brought from Europe by their ancestors.

8. What were the main findings of the outbreak investigation?
Of the cases, symptoms included diarrhea (98%), abdominal cramps (88%), chills (77%), body aches (71%), fever (65%), nausea (60%), and bloody stools (43%). Raw beef was reported as being consumed by significantly more sick individuals (88%) than well individuals (20%) (OR=28). Sick individuals were significantly more likely to have purchased beef from one butcher shop (OR=56) and significantly more likely to eat raw ground beef even with knowledge of the risks (OR=18.1). Samples of raw ground beef from the butcher shop grew *Salmonella typhimurium*.
The grinder used on the ground beef had not been properly cleaned, this could have allowed for environmental contamination of meat products.

9. What were the control measures implemented to prevent further spread of disease?
The butcher was informed of the contamination of the raw ground beef sold at his butcher shop. Publicity about the outbreak may have prevented customers from consuming ground beef from this butcher shop. The grinder was cleaned more thoroughly to eliminate possible environmental contamination. The meat had been discarded at the end of each day.

10. What food safety concepts or vocabulary terms were important to this foodborne disease outbreak?
*Environmental contamination*: The meat grinder was not cleaned thoroughly enough. This may have allowed further contamination of meat products, leading to the a longer outbreak.
*Sanitation*: Proper sanitization of the meat grinder would have eliminated the possibility for further environmental contamination.
*Meat temperatures*: Ground beef should be heated to 155°F before it is consumed. Consuming raw meat puts an individual at increased risk for infection with foodborne disease.
Salmonella javiana: Transplant Games


1. **What is the germ or agent responsible for this outbreak of foodborne disease?**

   *Salmonella javiana* was responsible for this foodborne disease outbreak. This is the fifth most common serotype of *Salmonella* in the United States and was responsible for 2.4% of isolates reported to the CDC in 2001. (There are more than 2,000 serotypes of *Salmonella*.)

2. **How can human beings become exposed to this germ/agent?**

   *Salmonella* lives in the intestinal tract of humans and other animals, including birds. *Salmonella* is usually transmitted to humans by eating foods contaminated with animal feces. *Salmonella* present on raw meat and poultry could survive if the product is not cooked to a safe minimum internal temperature, as measured with a food thermometer.

3. **What are the initial symptoms of this foodborne disease? What are the later symptoms of this foodborne disease if it is not treated?**

   The initial symptoms are diarrhea, fever, and abdominal cramps. Bloody diarrhea may also occur. *Salmonella* usually resolves completely, but a small number of persons develop a syndrome, resulting in joint pain, irritation of the eyes, and painful urination. Person’s with impaired immune systems are at increased risk for developing meningitis, urinary tract infections, abscesses (an accumulation of pus) of soft tissues, osteomyelitis (bone infections), and vascular infections.

4. **What is the morbidity (cases, hospitalizations) and mortality (deaths) that resulted from this outbreak?**

   141 cases occurred among those attending the transplant games, no hospitalizations or deaths were reported.

5. **Are there any risk groups particularly affected by this disease?**

   Those who are immunocompromised, such as transplant recipients, are particularly at risk as are young children, the elderly, and those who take stomach antacids. Antirejection therapy (medication that keeps the body from rejecting the transplanted organ) puts immunocompromised individuals at increased risk.

6. **Describe the outbreak:**

   a. **How many people were involved?**

      141 cases were identified.

   b. **Where did it occur?**

      At the Transplant Games at a theme park in Orlando, Florida
c. When did it occur?
June 2002

d. Why did it occur? Were there any food safety errors that caused this outbreak to occur?
Roma tomatoes contaminated with fecal material were the most likely cause of the outbreak. Particular care should have been taken to avoid contamination given the immunocompromised condition of those participating in the games.

7. What were the main findings of the outbreak investigation?
Finding from interviews performed after the games revealed that 82 (22%) of the 369 transplant attendee households reported illness with predominant symptoms including diarrhea (93%), abdominal pain (79%), and fever (51%). The majority (91%) of persons interviewed reported eating at the theme park. Analysis determined that diced Roma tomatoes were consumed significantly more often by sick individuals than by well individuals (OR=4.3). Microbiological evidence suggested that the Roma tomatoes were contaminated with feces.

8. What were the control measures implemented to prevent further spread of disease?
Physicians were advised to be aware of possible exposure to *Salmonella javiana* in recipients of solid organ and bone marrow transplants. Empiric therapy (treatment of suspected cases before lab tests confirm the illness) may be advised in this circumstance. Because produce is a source of Salmonella infections in the United States, consumers should be advised to wash tomatoes and produce items thoroughly before eating.

9. What food safety concepts or vocabulary terms were important to this foodborne disease outbreak?
*Risk groups:* Those who are immunocompromised (such as receiving an organ transplant or having HIV/AIDS), elderly, pregnant, or young children are particularly at risk for foodborne disease.
Outbreak of Invasive Listeriosis Associated with the Consumption of Hog Head Cheese—Louisiana, 2010

During January–June 2010, a total of 14 cases of laboratory-confirmed invasive listeriosis were reported to the Louisiana Office of Public Health (OPH). Isolates of *Listeria monocytogenes* from the blood samples of eight patients were identified as serotype 1/2a and had pulsed-field gel electrophoresis (PFGE) pattern combinations that were indistinguishable from one another. The detection of this cluster prompted an investigation in coordination with CDC, the Louisiana Department of Agriculture and Forestry (LDAF), and the U.S. Department of Agriculture’s Food Safety and Inspection Service (USDA-FSIS). In-depth epidemiologic and environmental investigations of the cluster were initiated on July 26, including food history interviews of four patients. Three patients reported eating hog head cheese (a meat jelly made from swine heads and feet); the product was purchased at two grocery stores in Louisiana. A traceback investigation determined that a single brand of hog head cheese was common between the two grocery stores. *L. monocytogenes* serotype 1/2a was cultured from one of three product samples and from two of 16 environmental samples collected by LDAF at the processing establishment; the product and one of the two environmental samples yielded isolates with PFGE pattern combinations that were indistinguishable from the patient isolates. On August 14, LDAF coordinated a voluntary recall of approximately 500,000 pounds of hog head cheese and sausage because of possible contamination with *L. monocytogenes*. This is the first published report of an invasive listeriosis outbreak associated with hog head cheese, which is a ready-to-eat (RTE) meat. USDA-FSIS has a "zero tolerance" policy for *L. monocytogenes* contamination of RTE food products (1), requesting recall of such products at any detectable level of *L. monocytogenes* contamination. LDAF imposes and enforces equivalent requirements in state-inspected establishments.

Invasive listeriosis has been nationally notifiable since 1999. In 2003, the Council of State and Territorial Epidemiologists recommended prompt, routine interviews of all patients using a standardized questionnaire and forwarding all *L. monocytogenes*
isolates from clinical laboratories for PFGE subtyping at public health laboratories (2). Accordingly, the Louisiana OPH collects demographic and clinical information for all reported cases of invasive listeriosis. Patients are interviewed immediately for food histories using CDC’s Listeria Initiative questionnaire.* Patient isolates are sent to the Public Health Central Laboratory at OPH for confirmation and PFGE characterization.

Louisiana OPH epidemiologists noted that 14 cases of invasive listeriosis had been reported during January–June 2010, which exceeded the state's average of five cases reported during each January–June period during the previous 3 years. For this investigation, a cluster-associated case was defined as isolation of *L. monocytogenes* serotype 1/2a from a normally sterile site (e.g., blood or cerebrospinal fluid) or from placental or fetal tissue (in the setting of miscarriage or stillbirth) since January 1, 2010, and PFGE pattern combination GX6A16.0001 and GX6A12.0001.

Eight patients had illnesses that met the case definition. Their median age was 64 years (range: 38–93 years). Six patients were men; no patients were pregnant. Six patients had one or more underlying medical conditions (i.e., human immunodeficiency virus [HIV] infection, alcohol abuse, cancer, and diabetes mellitus). Illness onsets occurred from February 18 to June 16 (Figure). Signs and symptoms included fever (n = 6 patients), altered mental status (n = 3), diarrhea (n = 3), vomiting (n = 3), and weakness (n = 2). Seven patients were hospitalized; two patients died.

OPH epidemiologists obtained food histories from four patients; the remaining patients could not be reached for interview because of their illness or death. Two patients initially reported eating hog head cheese purchased from the same grocery store. Upon re-interview, a third patient also reported eating hog head cheese purchased from a grocery store in another city. A fourth patient could not be reached for re-interview but had initially reported eating "other deli meats," a category that would include hog head cheese. The traceback investigation determined that only one brand of hog head cheese was sold at both stores, suggesting that this brand was the outbreak source.

OPH sanitarians conducted an environmental investigation at both grocery stores to gather additional information on the suspect product. The sanitarians determined that hog head cheese offered for sale arrived in small, 0.7 pound blocks that were individually vacuum-sealed at the processing establishment. Each store weighed and priced the product and sold it in the refrigerated meat section. The sanitarians collected one unopened package of mild hog head cheese from the first store and two unopened packages of hog head cheese, one mild and one spicy, from the second store. At CDC's Enteric Diseases Laboratory Branch, *L. monocytogenes* serotype 1/2a with the outbreak PFGE pattern combination was isolated from the package of spicy hog head cheese.

This finding triggered a voluntary recall of approximately 500,000 pounds of hog head cheese and sausage that was processed on the same equipment. LDAF also collected 16 environmental samples from the processing establishment. Cultures of samples from a refrigeration unit and a door threshold yielded *L. monocytogenes*. An isolate from the refrigeration unit exhibited the outbreak PFGE pattern combination, and an isolate from the door threshold exhibited a pattern combination that was new to the PulseNet
database (GX6A16.1362 and GX6A12.1939). CDC and the USDA Agricultural Research Service further characterized the patient, product, and environmental isolates using multiple-locus variable-number tandem repeat analysis and multilocus genotyping (3). All isolates, with the exception of the isolate from the door threshold, displayed indistinguishable multiple-locus variable-number tandem repeat analysis patterns and identical multilocus genotyping haplotypes (2.12_1/2a), further strengthening the association between the outbreak-associated cases and the hog head cheese producer.

Reported by

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Editorial Note

_L. monocytogenes_ can be found in soil, water, and silage, and causes a spectrum of illness ranging from asymptomatic infection to severe disease in both animals and humans. Invasive listeriosis, including sepsis and meningoencephalitis, occurs predominantly in older adults, persons with impaired immune systems, fetuses, and neonates. Based on its ubiquitous nature and the ability of the bacterium to establish itself in food processing environments, _L. monocytogenes_ presents unique challenges for the food industry and regulatory agencies in their efforts to prevent the contamination of RTE foods. In addition, unlike most foodborne pathogens, _L. monocytogenes_ can multiply at refrigerator temperatures.

Most cases of invasive listeriosis in the United States are sporadic (4). However, the advent of PulseNet for molecular subtyping of foodborne bacterial pathogens has revolutionized the ability of public health and regulatory officials to detect clusters and outbreaks and trace them to their sources (5). PulseNet is a network of laboratories in local, state, and federal health and regulatory agencies that use standard protocols, equipment, and nomenclature to upload PFGE patterns into a central database for comparison with one another. For _L. monocytogenes_, this usually consists of two patterns per isolate (i.e., images resulting from the use of two restriction enzymes, Ascl and Apal). In Louisiana, when OPH epidemiologists noted an unusually high listeriosis case count in 2010, PulseNet showed through molecular subtyping that eight cases were related, prompting the investigation.
Epidemiologic investigations of listeriosis clusters are challenging because case counts often are relatively small, some patients might not be available for interview, and others frequently report consumption of common food items that are higher-risk foods for *L. monocytogenes* contamination (6). In addition, the lengthy and variable incubation period of listeriosis (3–70 days) can result in recall bias and difficulty establishing an appropriate exposure period for food histories (7). Finally, immunocompromised persons who would be suitable controls for matched case-control studies often are difficult to identify. To address these challenges, CDC established the Listeria Initiative in 2004 to aid investigations of listeriosis clusters by using a standardized, extended case-form questionnaire to obtain timely food exposure histories from all persons with listeriosis reported in the United States (2). Patients are interviewed once illness is confirmed (rather than waiting for cluster detection). Using the Listeria Initiative questionnaire and associated database, hog head cheese was recognized as an uncommon food item that was common among the patients.

The implicated brand of hog head cheese originated from a small, state-inspected processing establishment in Louisiana, which produces approximately 600 pounds of hog head cheese per week. This establishment was under federal inspection until January 2007. Routine FSIS microbiologic testing of products at the establishment detected *L. monocytogenes* contamination in October and December 2006; the company voluntarily recalled 290 pounds of hog head cheese in January 2007. Four *L. monocytogenes* isolates from USDA-FSIS samples collected in 2006 did not match the 2010 outbreak-related PFGE pattern combination. In addition, *Listeria* contamination was not detected in any of the 12 product samples collected by LDAF since 2007; analysis of routine environmental samples collected by the management of the processing establishment during January–July 2010 also did not detect *Listeria*. However, the outbreak strain was identified in environmental samples collected during the investigation, which was several weeks after the manufacture of the outbreak-associated products (Figure), suggesting that persistent environmental contamination in the processing establishment was responsible for product contamination and resulting illnesses.

USDA-FSIS and state-inspected, meat-producing and poultry-producing establishments are required to develop a hazards analysis critical control points (HACCP) plan to prevent or eliminate reasonable hazards (including *L. monocytogenes* contamination of RTE products) using effective interventions. An FSIS risk assessment (8) determined that using combinations of interventions (e.g., testing and sanitation of food contact surfaces, prepackaging and postpackaging interventions, and the use of growth inhibitors) was more effective than any single intervention. The Listeria Rule† encourages establishments producing RTE products subject to postlethality contamination (e.g., contamination after cooking) to introduce combinations of interventions to eliminate and prevent the growth of *L. monocytogenes* in their products. Establishments choosing not to introduce such interventions or to only introduce growth inhibitors are required to test food contact surfaces for *Listeria* and are subject to more frequent product and surface sampling by the regulatory agency.
Although this is the first report of a listeriosis outbreak associated with the consumption of hog head cheese, RTE deli meats are a recognized vehicle for *Listeria* infection and have been associated with several past outbreaks in the United States (9). Persons at risk for listeriosis, including older adults, pregnant women, and persons with immunocompromising conditions or therapies, should take additional precautions to lower their risk for infection. § CDC, USDA-FSIS, and FDA have developed food safety education guidance for persons at risk for listeriosis and those who prepare meals for at-risk persons (Box).

**Acknowledgments**

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* Available at http://www.cdc.gov/nationalsurveillance/listeria_surveillance.html.


**What is already known on this topic?**

Multistate outbreaks of listeriosis led to U.S. regulatory policy changes and industry controls of *Listeria monocytogenes* contamination in ready-to-eat (RTE) meat and poultry products.

**What is added by this report?**

This is the first report of an association between an outbreak of invasive listeriosis and hog head cheese, indicating continuing challenges for RTE meat processors to prevent *L. monocytogenes* contamination, and the vulnerability of at-risk populations to invasive infections through consumption of contaminated RTE meat.

**What are the implications for public health practice?**

The combined application of PulseNet, a molecular subtyping network, and the Listeria Initiative, an enhanced surveillance program, was indispensible for the outbreak investigation and subsequent identification and recall of potentially contaminated product.
FIGURE. Number of invasive listeriosis cases, by month of patient specimen collection, and investigation timeline after an outbreak associated with consumption of hog head cheese—Louisiana, 2010

Abbreviations: OPH = Louisiana Office of Public Health; LDAF = Louisiana Department of Agriculture and Forestry; PFGE = pulsed-field gel electrophoresis; USDA-FSIS = U.S. Department of Agriculture Food Safety and Inspection Service.

Alternate Text: The figure above shows the number of invasive listeriosis cases, by month of patient specimen collection, and investigation timeline, after an outbreak associated with consumption of hog head cheese in Louisiana in 2010. Illness onsets occurred from February 18 to June 16.

BOX. Guidance for listeriosis prevention among persons at risk

Eating food contaminated with the bacterium *Listeria monocytogenes* can cause a potentially life-threatening, invasive disease called listeriosis. Pregnant women, older adults, and persons with weakened immune systems caused by medical conditions or treatment are at higher risk for listeriosis. Symptoms include fever, headache, stiff neck, confusion, loss of balance, and convulsions. Pregnant women might experience only mild illness; however, listeriosis during pregnancy can lead to miscarriage or stillbirth, premature delivery, or life-threatening infection of the newborn.

CDC, the U.S. Department of Agriculture (USDA) Food Safety and Inspection Service, and Food and Drug Administration recommend that at-risk persons and those who prepare meals for at-risk persons adhere to the following guidance.

Pay attention to the following foods and advice:

- Do not eat hot dogs, lunch meats, cold cuts, other deli meats (e.g., bologna), or fermented or dry sausage, unless they are reheated to 165°F (74°C) or until steaming hot just before serving.

- Do not eat refrigerated pâté or meat spreads from a deli or meat counter or from a refrigerated section of the store. Foods that do not need refrigeration, such as canned or shelf-stable pâté and meat spreads, are safe to eat. Refrigerate after opening.

- Do not eat refrigerated smoked seafood, unless it is contained in a cooked dish, such as a casserole, or unless it is a canned or shelf stable product. Refrigerated smoked seafood, such as salmon, trout, whitefish, cod, tuna, or mackerel, is most
often labeled as “nova-style,” “lox,” “kippered,” “smoked,” or “jerky.” The fish is found in the refrigerator section or sold at seafood and deli counters of grocery stores and delicatessens. Canned and shelf stable tuna, salmon, and other fish products are safe to eat.

- Do not drink raw (unpasteurized) milk, and do not eat foods that have unpasteurized milk in them.
- Do not eat soft cheese such as feta, queso blanco, queso fresco, brie, Camembert, as well as blue-veined cheeses, and panela cheese (queso panela) unless it is labeled as made with pasteurized milk. Make sure the label says, “Made with pasteurized milk.”

**To keep food safe:**

- Use a refrigerator thermometer to check the refrigerator's inside temperature. The refrigerator should be 40°F (4°C) or lower, and the freezer should be 0°F (-18°C) or lower.
- *Listeria monocytogenes* can grow in the refrigerator. Use a refrigerator thermometer to check the refrigerator’s inside temperature. The refrigerator should be 40°F (4°C) or lower, and the freezer should be 0°F (-18°C) or lower.
- Clean up all spills in the refrigerator right away, especially juices from hot dog and lunch meat packages, raw meat, and raw poultry.
- Clean the inside walls and shelves of the refrigerator with hot water and liquid soap, then rinse.
- Divide leftovers into shallow containers to promote rapid, even cooling. Cover with airtight lids or enclose in plastic wraps or aluminum foil. Use leftovers within 3 to 4 days.
- Use precooked or ready-to-eat food as soon as possible. Do not store the product in the refrigerator beyond the use-by date; follow USDA refrigerator storage time guidelines:
  - Hot dogs: store opened package no longer than 1 week and unopened package no longer than 2 weeks.
  - Lunch and deli meat: store factory-sealed, unopened package no longer than 2 weeks. Store opened packages and meat sliced at a local deli no longer than 3 to 5 days.

**Follow these four simple steps:**

*Clean:* Wash hands and surfaces often. Wash hands often with soap and warm water, especially after touching hot dogs, raw meat, chicken, turkey, seafood, or their
juices. Use clean dishes, spoons, knives, and forks. Wash countertops with hot soapy water and clean up spills right away. To keep cutting boards clean, wash them with hot, soapy water after each use. If sanitizing a cutting board, use a solution of 1 tablespoon of unscented, liquid chlorine bleach per gallon of water to flood the surface of the cutting board; allow it to stand for several minutes. Rinse with clear water and air or pat dry with clean paper towels.

Separate: Do not cross-contaminate. Keep raw meat, fish, and poultry away from other food that will not be cooked. Use one cutting board for fresh produce and bread and a separate one for raw meat, poultry, and seafood. Never place cooked food on a plate that previously held raw meat, poultry, seafood, or eggs without first washing the plate with hot soapy water. Do not reuse marinades used on raw foods unless they are brought to a boil first.

Cook: Cook to proper temperatures. Use a food thermometer to ensure that food is cooked to a safe minimum internal temperature. Cook ground beef or pork to 160°F (71°C), poultry to 165°F (74°C), and seafood to 145°F (63°C). Cook shrimp, lobster, and crab until they turn red and the flesh is pearly opaque. Cook clams, mussels, and oysters until the shells open. Cook eggs until the yolks and whites are firm. Use only recipes in which the eggs are cooked or heated to 160°F (71°C).

Chill: Refrigerate promptly. Refrigerate or freeze within 2 hours; refrigerate or freeze within 1 hour in hot weather (≥90°F [≥32°C]). Do not leave meat, fish, poultry, or cooked food sitting out. Purchase perishable foods last, and go directly home from the grocery store. In hot weather, take a cooler with ice or another cold source to transport foods safely.


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Outbreak of Campylobacter Enteritis Associated with Cross-Contamination of Food—Oklahoma, 1996

On August 29, 1996, the Jackson County Health Department (JCHD) in southwestern Oklahoma notified the Oklahoma State Department of Health (OSDH) of a cluster of Campylobacter jejuni infections that occurred during August 16-20 among persons who had eaten lunch at a local restaurant on August 15. This report summarizes the investigation of these cases and indicates that C. jejuni infection was most likely acquired from eating lettuce cross-contaminated with raw chicken. This report also emphasizes the need to keep certain foods and cooking utensils separate during food handling.

A case was defined as illness in a person who had eaten lunch at the restaurant on August
APPENDIX D (continued)

15, 1996, and had onset of diarrhea (i.e., three or more loose stools during a 24-hour period) or vomiting during August 16–20. Of 25 persons available for interview who had eaten lunch at the restaurant on August 15, a total of 14 (56%) had had an illness that met the case definition. The median age of patients was 33 years (range: 5–52 years); 10 (71%) were female. All patients reported diarrhea; 13 (93%), fever; 13 (93%), abdominal cramps; 11 (79%), nausea; five (36%), vomiting; and three (21%), visible blood in their stools. The median incubation period was 3 days (range: 1–5 days). Two (14%) patients were hospitalized. Stool specimens were collected from 10 patients; all yielded *C. jejuni*. No food items were available for testing.

To identify risk factors for illness, OSDH, in collaboration with JCHD, conducted a case-control study of 14 patients and 11 controls (i.e., persons who had eaten lunch with patients at the implicated restaurant on August 15 but did not become ill). Health department staff visited the restaurant to obtain information about menu items, to observe food preparation, and to inspect the kitchen.

All 14 patients and four (36%) controls reported eating lettuce (odds ratio {OR}=48.3; 95% confidence interval {CI}=2.3–infinity; p less than 0.01). Eleven (79%) patients and three (27%) controls had eaten lasagna (OR=6.7; 95% CI=1.1–42.7; p less than 0.05). Both lettuce and lasagna were statistically associated with illness. Lettuce consumption accounted for all cases, and lasagna consumption accounted for 79% of cases.

Inspection of the restaurant indicated that the countertop surface area was too small to separate raw poultry and other foods adequately during preparation. The cook reported cutting up raw chicken for the dinner meals before preparing salads, lasagna, and sandwiches as luncheon menu items. Lettuce for salads was shredded with a knife, and the cook wore a towel around her waist that she frequently used to dry her hands. Bleach solution at the appropriate temperature (greater than 75 F {greater than 24 C}) and concentration (greater than 50 ppm) was present to sanitize tables surfaces, but it was uncertain whether the cook had cleaned the countertop after cutting up the chicken. The lettuce or lasagna was probably contaminated with *C. jejuni* from raw chicken through unwashed or inadequately washed hands, cooking utensils, or the countertop.

JCHD recommended that the restaurant enlarge its food-preparation table and install a disposable hand towel dispenser and that food handlers wash hands and cooking utensils between use while preparing different foods.

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**Editorial Note**

Editorial Note: *Campylobacter* is one of the most common causes of foodborne disease in
the United States, causing approximately 2 million cases of gastroenteritis each year (1). Illness associated with *Campylobacter* infection is usually mild, but can be severe and even fatal. Although it did not occur in this outbreak, Guillain-Barré syndrome (GBS), a demyelinating disorder resulting in acute neuromuscular paralysis, is a serious sequela of *Campylobacter* infection (2). Up to 40% of patients with GBS have evidence of *Campylobacter* infection before onset of symptoms (2).

Most illnesses associated with *Campylobacter* infection are sporadic. Common source outbreaks occur, and most have been traced to unpasteurized milk and contaminated drinking water (1). In comparison, most sporadic cases, and those in this outbreak, are associated with improper handling and preparing of poultry (1). *Campylobacter* has been found in up to 88% of broiler chicken carcasses in the United States (1,3). The infectious dose of *Campylobacter* is low; ingestion of only 500 organisms, easily present in one drop of raw chicken juice, can result in human illness (1). Therefore, contamination of foods by raw chicken is an efficient mechanism for transmission of this organism.

Restaurants provide opportunities for outbreaks of foodborne disease because large quantities of different foods are handled in the same kitchen. Failure to wash hands, utensils, or countertops can lead to contamination of foods that will not be cooked. The food handler involved in this outbreak had not received training in food safety. The Food and Drug Administration has developed guidelines for food handlers to prevent cross-contamination of foods; however, states are not required to adopt these guidelines (4).

Laws mandating certification of food-service employees differ by state. Twelve states have requirements for certification of food-service managers in all jurisdictions, 21 states have requirements in some jurisdictions, and 17 states have no requirements (5). Of 33 states for which information is available, only two have statewide requirements for training of food handlers (5).

States can reduce the risk for foodborne illness in restaurants by ensuring that restaurant employees receive training in food safety. For example, food handlers should be aware that pathogens can be present on raw poultry and meat and that foodborne disease can be prevented by adhering to the following measures: 1) raw poultry and meat should be prepared on a separate countertop or cutting board from other food items; 2) all utensils, cutting boards, and countertops should be cleaned with hot water and soap after preparing raw poultry or meat and before preparing other foods; 3) hands should be washed thoroughly with soap and running water after handling raw poultry or meat; and 4) poultry should be cooked thoroughly to an internal temperature of 180 F (82 C) or until the meat is no longer pink and juices run clear.

References

APPENDIX D (continued)


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Norovirus Outbreak Associated with Ill Food-Service Workers—Michigan, January–February 2006

On January 30, 2006, the Barry-Eaton District Health Department (BEDHD) in Michigan was notified of gastrointestinal illness in several members of two dining parties after a meal at an Eaton County restaurant on January 28. An investigation was initiated by BEDHD to identify the source and agent of infection and to determine the scope of illness among patrons and employees of this national chain restaurant. Norovirus genogroup I (GI) was detected in stool specimens submitted by multiple patrons and employees. The investigation revealed that several food-service workers had been ill during January 19–February 3, 2006, and that a line cook had vomited in the restaurant on January 28, possibly increasing environmental contamination and
transmission of virus. This report summarizes the findings of the outbreak investigation, which determined that at least 364 restaurant patrons had become ill. The findings underscore the need for 1) ongoing education of food-service workers regarding prevention of norovirus contamination and transmission; 2) enforcement of policies regarding ill and recently ill food-service workers; and 3) environmental decontamination with effective disinfectants to eliminate the presence of norovirus.

After learning of the outbreak on January 30, BEDHD launched an epidemiologic and environmental assessment. The restaurant was open for dinner on weekdays and lunch and dinner on weekends and served up to 800 persons daily with a staff of 32–50 employees. Initial investigation indicated that the index case was in an employee who worked as a server at the restaurant and became ill with symptoms of vomiting on or around January 19. Work records indicated that this employee did not work while ill. A second employee (a sibling to the server) became ill with abdominal cramps, diarrhea, and vomiting on January 21 and worked on the first and second days of illness; this person's duties included bartending and administrative work. Seven patrons reported that they had eaten at the restaurant during January 21–27. On January 28, a line cook (line cook A) vomited at home (at approximately 6:00 a.m.) before reporting to work at 11:00 a.m., then vomited again into a waste bin beside the frontline workstation at approximately 2:00 p.m. while preparing antipasti platters, pizzas, and salads. After vomiting, line cook A remained on site (but off the cooking line) and left work at 4:15 p.m. This person also reported to work on January 29 from 11:00 a.m. to 4:30 p.m. while still experiencing loose stools.

BEDHD began case finding by obtaining names of patrons from credit card receipts, records of delivery and catering events, and records of dinner reservations; information on patrons without reservations or those who paid with cash was not available. Using Internet-based telephone directories, BEDHD contacted patrons who dined at or consumed food prepared by the restaurant during January 19–February 3. Many patrons contacted BEDHD as a result of the extensive media coverage. BEDHD staff members administered patron interviews by telephone; the interviews included questions about basic demographics, date and time of the restaurant meal, food history, and illness history. Restaurant employees were interviewed in person or by telephone and additionally asked about their work schedules for this period.

BEDHD conducted two studies: 1) a descriptive study to characterize ill persons and 2) an analytic study to determine whether certain foods were associated with illness. Because only a portion of restaurant patrons could be identified or contacted, a case-control methodology was used for the analytic study.

For the descriptive study, a case in a patron was defined as illness in a patron who had eaten food prepared at the restaurant during January 19–February 3 and who had become ill with vomiting or diarrhea within 10–50 hours (I) after eating the food. A case in an employee was defined as illness in an employee who was ill with vomiting or diarrhea during January 19–February 3, regardless of the incubation period. To determine whether any changes occurred in rates of illness among patrons based on the time the meal was eaten, attack rates were calculated in 3-hour intervals for January 28 and 29, by dividing the number of cases in patrons who dined
during each time interval by the number of meals served for those periods.

For the analytic study, a case-patron was defined as a patron who had eaten food prepared at the restaurant during January 28–29 (the 2 days line cook A worked while symptomatic) and subsequently became ill with vomiting or diarrhea 10–50 hours after eating; a control was a patron who had the same exposure but no gastrointestinal illness. Statistical software was used to perform the analysis. Chi-square and Fisher's exact tests were used in the case-control analysis.

Stool specimens, obtained from patrons and employees, were tested for norovirus RNA by reverse transcriptase-polymerase chain reaction (RT-PCR) and for bacterial pathogens at the Michigan Department of Community Health (MDCH). All positive RT-PCR specimens were genotyped by sequence analysis.

**Descriptive Study**

A total of 625 persons were interviewed by BEDHD: 584 patrons (113 were well), 32 employees, and nine additional persons who became ill after contact with a patron or employee in whom a case was identified. A total of 364 patrons of the 584 interviewed met the descriptive study case definition; the median age was 40 years (range: 1–92 years), 58.5% were female, 88.2% reported diarrhea, 71.7% reported vomiting, and the median duration of illness was 42 hours (range: 2–172 hours) (Table). Patron onset of illness peaked during 12:00 a.m.–3:59 a.m. on January 30 (Figure 1). The median time from a meal at the restaurant until onset of symptoms was 32 hours. The number of cases was already decreasing on January 30, when BEDHD was notified and interventions were implemented.

A total of 281 patrons in whom cases were identified had dined on January 28, resulting in an attack rate of 33.7%; on January 29, the attack rate was 13.5% (64 cases divided by 475 meals). Analysis of patron illness based on date and time that the meal was eaten demonstrated that norovirus transmission was occurring in the restaurant before the vomiting incident on January 28 (Figure 2). The attack rate was highest for patrons who ate during 5:00 p.m.–7:59 p.m. on January 28. Transmission continued through the next day.

Of the 32 employees interviewed, cases were identified in 17 (53.1%). Seven (41.2%) of these 17 employees had worked while ill during January 21–30. Twelve employees (other than line cook A) worked on January 28 and subsequently became ill. Five (62.5%) of the eight line cooks who worked on January 28 became ill on or after January 28, compared with six (28.6%) of 21 servers.

**Analytic Study**

In the case-control study of patrons from the period January 28–29, a total of 45 were classified as case-patrons, and 91 were classified as controls. Two foods were found to have a statistically significant association with illness: the antipasti platter (odds ratio [OR] = 2.96; 95% confidence interval [CI] = 1.08–8.14) and garlic mashed potatoes (OR = 4.05; CI = 1.37–11.99). Eighteen patrons (10 who were ill and eight who were well) reported eating the antipasti platter. Sixteen
patrons (10 ill and six well) reported eating the garlic mashed potatoes.

Nine persons who had not eaten or worked at the restaurant became ill after contact with either a case-patron or case-employee (i.e., household or work contacts). Eight of these nine persons had symptoms of vomiting or diarrhea with illness onset during January 30–February 7.

All 14 stool specimens tested by RT-PCR were positive for norovirus GI. The companion bacterial samples tested negative. Results from the sequence analysis, using the degenerative primer set to produce a 213-bp amplicon of region B of the norovirus genome, demonstrated 100% sequence homology with the genotype GI/4 Chiba.

Environmental Assessment

The BEDHD environmental assessment of the restaurant identified deficiencies with employee hand-washing practices, cleaning and sanitizing of food and nonfood contact surfaces, temperature monitoring and maintenance of potentially hazardous food, and maintenance of hand-sink stations for easy accessibility and proper use. Three interventions were undertaken by the restaurant beginning January 30: 1) all food prepared during January 27–30 was discarded; 2) all ill employees were excluded from working for at least 72 hours after their symptoms had subsided; and 3) the facility was cleaned extensively. On February 3, BEDHD received reports of illness in three patrons who had dined at the restaurant on February 1, raising concern that residual contamination remained. Also on February 3, while reviewing the restaurant's clean-up procedures after the vomiting incident, BEDHD sanitarians discovered the restaurant had used a quaternary ammonium-based sanitizer that was ineffective against norovirus. BEDHD instructed the restaurant to disinfect according to MDCH and Michigan Department of Agriculture guidelines for environmental cleaning and disinfection of norovirus (2). The restaurant completed the disinfection with bleach solution before opening at 4:00 p.m. on February 3.

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Editorial Note:

Norovirus can be transmitted person to person (via the fecal-oral route) and spread through contaminated airborne droplets, food, water, environmental surfaces, and fomites (3). In the outbreak described in this report, at least 364 restaurant patrons became ill with gastroenteritis after dining at a restaurant where employees had reported to work while ill. In a norovirus outbreak, a vomiting incident is a major risk factor for norovirus illness and can double the attack rate (4). In this outbreak, vomiting by a line cook at the work station might have contributed to transmission. Because of the open physical layout of the restaurant, no barrier impeded airborne spread of the virus from the kitchen to the main dining area. Attack rates increased after this incident, and among employees who worked on January 28, a higher percentage of line cooks became ill compared with servers. In addition, other environmental contamination probably contributed to transmission. Low-level transmission was occurring in the week before January 28; seven patrons who dined at the restaurant during January 21–27 met the case definition. During January 21–February 3, exposure to virus likely occurred by
contact with contaminated surfaces and objects.

Foodborne transmission also might have contributed to the outbreak. The antipasti platter (a combination of calamari, bruschetta, and mozzarella cheese sticks with marinara sauce) was one of many dishes that line cook A prepared but the only item among those line cook A prepared that had a statistically significant association with illness. The other food that was linked with illness was the garlic mashed potatoes. However, only a small proportion of patrons ate either of these items.

Feline calicivirus, a proxy virus used for norovirus research, can persist in the environment for 21–28 days and is resistant to inactivation by certain cleaning agents (e.g., quaternary ammonium-based sanitizers) (5). In this outbreak, the restaurant's use of cleaning cloths soaked with a quaternary ammonium-based cleaning product likely was ineffective in disinfecting the restaurant (6).*

In 2006, MDCH received 144 reports of suspected or confirmed norovirus outbreaks throughout Michigan, compared with 34 in 2005 (MDCH, unpublished data, 2007). Norovirus genogroup II (GII) was identified in 97% of the 89 confirmed outbreaks in the state during 2006; GI was identified in the remaining 3% of the outbreaks. During 2000–2004, the predominant genogroup in calicivirus outbreaks in the United States was GII (79%), followed by GI (19%) and sapovirus (2%) (7). No other GI/4 outbreaks were detected in Michigan in 2006. In this outbreak, the detection of one norovirus genogroup (GI/4) in all stool specimens, including that of line cook A, suggests a single source of infection.

Approximately 50% of all norovirus outbreaks are linked to ill food-service workers (8). The Michigan Food Law of 2000,† which regulates Michigan food establishments, requires that food-establishment operators notify regulators when employees have infections with *Salmonella*, *Shigella*, *Escherichia coli* O157:H7 or hepatitis A. Food-service employees in Michigan also are obliged under the food law to inform their supervisors when they have symptoms of illness, such as diarrhea and vomiting. In October 2007, Michigan adopted several amendments to the Michigan Food Law of 2000, including the 2005 Food and Drug Administration Food Code.§ The 2005 Food Code includes norovirus as one of several highly pathogenic organisms that can be easily spread by ill food handlers and provides disease-specific conditions for work exclusion, restriction, and reinstatement.

After the outbreak described in this report, BEDHD issued four recommendations (based on previously published guidelines [9]) for infection control and environmental decontamination after any vomiting incident in a food-service establishment. First, any exposed food or single-service articles (e.g., drinking straws, takeout containers, and paper napkins) should be discarded, and all surface areas within at least a 25-foot radius of the vomiting site should be disinfected with a bleach solution (2). Second, ill employees should be excluded from work for at least 72 hours after symptoms subside, and employees returning after a gastrointestinal illness should be restricted from handling kitchenware or ready-to-eat food for an additional 72 hours. Third, because thorough disinfection might be necessary, partial or complete closure of the food establishment should be considered after a vomiting incident. Finally, restrooms used during or after a vomiting incident should be closed immediately until they are disinfected properly with
bleach solution.

Acknowledgments

This report is based, in part, on contributions by the Barry-Eaton District Health Dept; E Belk, P Clark, V Leykam, L Mosher, J Massey, S Bidol, J Collins, S Johnson, C Miller, MG Stobierski, M Wilkins, A Mattson, Michigan Dept of Community Health; and L Hainstock, Michigan Dept of Agriculture.

References


* The Environmental Protection Agency has approved the claims of effectiveness against norovirus of several antimicrobial disinfectants. Some of these products include quaternary ammonia-based disinfectants but are in combination with alcohols. These claims of effectiveness are based on in vitro studies that typically use a proxy virus (e.g., feline calicivirus); field effectiveness in the context of outbreaks has not been evaluated. A list of these products is available at http://www.epa.gov/oppad001/list_g_norovirus.pdf.

† Available at http://www.michigan.gov/mda/1,1607,7-125-1568_2387_2435---,00.html.

§ Available at http://www.cfsan.fda.gov/~dms/fc05-toc.html.

Figure 1
Outbreak of Salmonella Serotype Typhimurium Infection Associated with Eating Raw Ground Beef—Wisconsin, 1994

Despite previously publicized outbreaks of illness associated with and recommendations to
avoid eating undercooked meat, some persons continue to eat under-cooked or raw meat. This report summarizes the investigation of an outbreak of *Salmonella* serotype *typhimurium* gastrointestinal illness in Wisconsin associated with eating contaminated raw ground beef during the 1994 winter holiday season.

On December 29, 1994, physicians in a group medical practice in Dodge County (1994 estimated population: 79,360), Wisconsin, reported to the Public Health Unit of the Dodge County Human Services and Health Department (DCHSHD) that during December 27–29 they had treated 17 patients with acute gastrointestinal illness characterized by diarrhea and abdominal cramps. At least 14 patients reported having eaten raw ground beef that was either plain or seasoned with onions and an herb mix during the 72 hours before illness onset. Stool samples for culture were obtained from 11 patients; *Salmonella* serotype *typhimurium* that did not ferment tartrate was isolated from seven specimens. Based on these reports and findings, the DCHSHD issued a physician alert and press release that encouraged affected residents to report their illnesses and physicians to obtain stool cultures from case-patients. In addition, DCHSHD and the Bureau of Public Health, Wisconsin Division of Health (WDOH), initiated an investigation of this outbreak. A probable case of *Salmonella* infection was defined as diarrhea or abdominal cramps with onset during December 22, 1994–January 4, 1995, in a resident of or a visitor to Dodge County or any of the four contiguous counties. A confirmed case was defined as a stool culture positive for tartrate-negative *Salmonella typhimurium*.

DCHSHD and WDOH identified 107 confirmed and 51 probable case-patients (Figure 1); of these, 17 (16%) were hospitalized. Predominant manifestations of illness included diarrhea (98%), abdominal cramps (88%), chills (77%), body aches (71%), fever (65%), nausea (60%), and bloody stools (43%). The ages of ill persons ranged from 2 years to 90 years; 62% were male.

To assess potential risk factors for illness, DCHSHD and WDOH conducted a case-control study including 40 case-patients who were randomly selected from the persons with a stool specimen culture positive for tartrate-negative *Salmonella typhimurium* and 40 controls who were identified by random telephone digit dialing. The mean ages of cases and controls were similar (43 years for cases; 47 years for controls). Of 40 case-patients, 35 (88%) reported having eaten raw ground beef during December 22–January 4, compared with eight (20%) of 40 controls (odds ratio {OR}=28; 95% confidence interval {CI}=7-117). Among the 35 who ate raw ground beef, 34 (97%) had purchased the beef from one butcher shop, compared with three (37%) of the eight controls (OR=56; 95% CI=4-1881). Knowledge of previous reports of outbreaks related to eating raw or undercooked beef was less among ill persons than among controls (26 {65%} of 40 case-patients compared with 30 {75%} of 40 controls {OR=0.6; 95% CI=0.2-1.8}). However, 22 (85%) of the 26 case-patients who reported being aware of previous outbreaks associated with consumption of raw ground beef continued this behavior compared with seven (23%) of the 30 controls with knowledge of previous outbreaks (OR=18.1; 95% CI=4.0-92.0).

DCHSHD and WDOH obtained from case-patients six leftover samples of raw ground beef that had been purchased at the butcher shop on five dates during December 21–29 and
served in different homes. These samples were cultured for *Salmonella* sp.; all grew tartrate-negative *Salmonella typhimurium*. On December 30, 1994, staff of the Meat Safety and Inspection Bureau (MSIB), Wisconsin Department of Agriculture, Trade, and Consumer Protection (WDATCP), informed the proprietor of the butcher shop of a potential problem with consumption of raw ground beef from the shop and the need to properly label meat products. During the winter holiday season, the butcher shop sold both seasoned and unseasoned raw ground beef that had a warning label regarding safe handling of poultry. On January 2, 1995, inspectors from MSIB examined sanitary conditions in the butcher shop, obtained invoices indicating the origin and the quantity of the meat used to prepare the ground beef, and inspected the raw ground beef production method and selling practice in the butcher shop.

Meat from approximately 35 carcasses obtained from three different suppliers had been ground in the shop from December 21 through January 4. Leftover product was reported to have been discarded each day and not carried over for sale the next day. All parts of the meat grinder except for the auger housing were disassembled and individually cleaned and sanitized at the end of each day. This type of grinder allowed easy disassembly of the auger and other smaller parts; the auger housing was attached to the grinder with nuts and bolts and required a wrench for removal. However, the cleaning staff had not received instructions regarding removal of the auger housing and had cleaned only surfaces of the tunnel-like space for the auger with a brush.

Meat remnants were present in the auger housing when the grinder was disassembled. Twenty environmental swabs of the equipment and the areas related to the production of the ground beef were obtained for bacterial culture; all were negative for *Salmonella* sp. Stool specimens obtained from all five butchers at the shop were cultured; one was positive for tartrate-negative *Salmonella typhimurium*. Although this butcher denied illness, he had eaten raw ground beef at the shop during the outbreak interval.

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**Editorial Note**

Editorial Note: The investigation of this outbreak implicated consumption of contaminated raw ground beef as the source of *Salmonella* infection. Inadequate cleaning and sanitization of the meat grinder probably resulted in ongoing contamination of ground beef over many production days. The outbreak occurred during the winter holiday season, and some patients reported that consumption of raw ground beef during these holidays was a practice brought from Europe by their ancestors. The decline of cases after the holidays may have occurred because ground beef from the implicated butcher shop was no longer consumed raw or because the grinder was cleaned more thoroughly after WDATCP personnel spoke with the...
proprietor of the butcher shop on December 30. The five persons who became ill but did not report eating raw ground beef may not have remembered eating the raw ground beef, may have eaten undercooked ground beef or food that was contaminated from the raw ground beef, or may have become ill through person-to-person transmission.

Raw ground beef previously has been implicated as a vehicle for transmission of *Salmonella* (1,2), and undercooked ground beef is the most frequently recognized vehicle for *Escherichia coli* O157:H7 infection (3). The prevalence of *Salmonella* in beef ranges from 1% for raw beef carcasses (4) to 5%-7% for ground beef (U.S. Department of Agriculture, Food Safety and Inspection Service, unpublished data, 1994). Prevention measures include warning consumers of the health risks associated with eating raw ground beef and encouraging them to thoroughly cook ground beef and to adhere to safe food handling guidelines. Safe cooking and handling labels on raw or partially cooked meat and poultry are now required by the U.S. Department of Agriculture (USDA). However, the presence of safe food handling labels does not ensure adherence to safe practices. For example, an investigation of risk factors for sporadic *E. coli* O157:H7 infection indicated that of 43 food preparers who reported reading the safe food handling label on meat packages, 33 (77%) admitted to practices specifically discouraged on the label (5).

The investigation in Dodge County underscores that knowledge of health risks is not consistently associated with desirable changes in behavior. Despite public health warnings and publicity about related outbreaks, some consumers in Dodge County and elsewhere have continued to eat raw or undercooked foods of animal origin. For example, a telephone survey of a national sample of adults conducted by the Center for Food Safety and Applied Nutrition, Food and Drug Administration (FDA), during December 1992–February 1993 indicated that 53% consumed raw eggs; 23%, undercooked hamburgers; 17%, raw clams or oysters; 8%, raw sushi or ceviche; and 5%, steak tartare (raw hamburger meat) (6). Consumer advisories can be more effective if targeted to specific cultural or ethnic groups with such high-risk dietary practices, and WDATCP is planning two press releases this winter holiday period to warn consumers of the risks associated with eating raw ground beef.

In addition to consumer advisories, interventions to reduce the risks associated with the consumption of ground beef include the needs for 1) producers of ground beef to emphasize employee education and training on the recommended methods of cleaning and sanitizing meat-grinding equipment; 2) manufacturers to design meat-grinding equipment that is easily accessible for cleaning and sanitization; and 3) state regulatory and inspection authorities to adopt and enforce FDA's Food Code model requirements, which offer specific recommendations for handling, cooking, and storing raw meat; cleaning and sanitizing equipment and utensils; designing and constructing equipment; and advising consumers about the risks associated with consumption of raw or undercooked food of animal origin (7). The USDA's Food Safety and Inspection Service also has proposed changes in the meat and poultry inspection system to improve assessment and control of microbial pathogens in raw meat and poultry (8). Consumers can obtain more information on safe meat handling from the USDA’s Meat and Poultry Hotline (telephone {800} 535-4555).
APPENDIX D (continued)

References


Figure_1

Return to top.

Figure_1

Return to top.

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Outbreak of *Salmonella* Serotype *javiana* Infections—Orlando, Florida, June 2002

On July 16, 2002, the Minnesota Department of Health identified two cases of *Salmonella* serotype *javiana* infections among persons who had attended the 2002 U.S. Transplant Games held at theme park A in Orlando, Florida, during June 25–29. Isolates from both patients were indistinguishable by pulsed field gel electrophoresis (PFGE). The U.S. Transplant Games is a 4-day athletic competition among recipients of solid organ transplants (i.e., heart, liver, kidney, lung, and pancreas) and bone marrow transplants. Approximately 6,000 persons from the United States and five other countries, including 1,500 transplant-recipient athletes, participated in the games. This report summarizes the results of an ongoing epidemiologic and laboratory investigation that has identified 141 ill persons in 32 states who attended the games.

For case ascertainment and investigation purposes, a web-based survey was distributed electronically on July 20 to 1,100 attendees with known e-mail addresses, including athletes, donors, family members, and transplant professionals. Anonymous e-mail addresses for these persons were obtained from the organizers of the games. A case was defined as fever or diarrhea with onset during June 25–July 7 in a person who visited Orlando. A total of 369 (34%) persons responded by August 1; of these, 296 (80%) responded by July 22. Ninety-four (25%) persons reported that at least one household member had an illness that met the case definition, representing 141 ill persons.

For each of the 369 households, detailed information was collected for one person who was selected on the basis of birth date. Among these persons, 82 (22%) reported illness. The median age of ill respondents was 47 years (range: 4–71 years); 48 (59%) were transplant recipients, and 43 (52%) were receiving immunosuppressive therapy. Dates of illness onset ranged from June 26 to July 7. Predominant symptoms included diarrhea...
(93%), abdominal pain (79%), and fever (51%). Three (4%) respondents were hospitalized.

All survey respondents were asked about places they stayed, events they attended, and foods they ate while in Orlando. Fifty-one (66%) ill persons stayed at resorts located in theme park A during their time in Orlando, and 75 (91%) reported eating food items at establishments located in theme park A. On July 31, a second web-based survey containing questions about potentially suspect food items available in theme park A was distributed electronically to the 369 persons who responded to the first survey. Ill persons were asked about specific foods eaten during the 3 days before illness onset, and well persons were asked about the middle 3 days of the games (June 26–28). By August 2, a total of 222 (60%) persons had responded to the second survey; 41 had been ill. Univariate analysis demonstrated that ill persons were significantly more likely to report eating foods containing diced Roma tomatoes than were well persons (44% of ill versus 14% of well persons; adjusted odds ratio=4.3; 95% confidence interval=2.1–9.1). Preliminary microbiologic evaluation indicates fecal coliform contamination of the diced tomatoes.

To identify other potential cases of *S. Javiana*, the PFGE pattern for the outbreak strain was posted on PulseNet, the National Molecular Subtyping Network for Foodborne Disease Surveillance. A total of 18 additional infections caused by *S. javiana* with an indistinguishable PFGE pattern were identified in nine states (Illinois, Massachusetts, Michigan, Minnesota, New Hampshire, North Carolina, Pennsylvania, Tennessee, and Virginia). Of 16 patients who were interviewed, one was a games participant, and 12 others had visited theme park A during the last week of June but did not attend the games. Dates of illness onset ranged from June 24 to July 8. State and local health departments are investigating additional cases to establish epidemiologic links to the outbreak.

**Reported by:** B Toth, MPH, Orange County Health Dept, Orlando; D Bodager, MPA, RM Hammond, PhD, Florida Dept of Health. S Stenzel, JK Adams, Minnesota Dept of Health. T Kass-Hout, MD, RM Hoekstra, PhD, PS Mead, MD, Div of Bacterial and Mycotic Diseases, National Center for Infectious Diseases; P Srikantiah, MD, EIS Officer, CDC.

**Editorial Note:**

Salmonellosis causes an estimated 1.4 million illnesses each year in the United States (1). *S. javiana* is the fifth most common *Salmonella* serotype in the United States and accounted for 3.4% of *Salmonella* isolates reported to CDC during 2001 (CDC, unpublished data, 2002). The majority of persons infected with *Salmonella* have diarrhea, fever, and abdominal cramps 12–72 hours after exposure. The illness usually lasts 4–7 days, and the majority of persons recover without treatment.

Persons with impaired immune systems are at increased risk for having a more severe illness, atypical symptoms, and complications of infection. Among organ transplant
APPENDIX D (continued)

recipients, salmonellosis is associated strongly with antirejection therapy (2), and febrile illness with bacteremia is a more common presentation (3). Organ transplant patients are at increased risk for focal manifestations of illness including meningitis, urinary tract infections, abscesses of soft tissues, septic arthritis, osteomyelitis, and vascular infections, including infections of vascular grafts (4–6). Recurrence of nontyphoidal salmonellosis is common among this population and might occur in up to 35% of renal transplant recipients (2,3).

Physicians caring for recipients of solid organ and bone marrow transplants should be aware of possible exposure to S. javiana at the 2002 U.S. Transplant Games and should consider obtaining cultures (i.e., stool, blood, and urine) from ill patients with this exposure. The optimal therapy for Salmonella infection in transplant recipients is not known (4). However, because of the increased susceptibility to infection and the potential for complications, physicians might consider empiric antimicrobial therapy in transplant recipients with suspected salmonellosis from whom appropriate cultures have been obtained. The strain of S. javiana responsible for this outbreak is susceptible to several commonly used antimicrobials, including trimethoprim-sulfamethoxazole, ciprofloxacin, and ceftriaxone. Physicians should report culture-confirmed cases of salmonellosis to their local health department.

The use of a web-based survey in this investigation allowed a substantial number of persons who were dispersed geographically to be asked about potential exposures in a relatively short period of time. Twelve culture-confirmed cases of S. javiana among visitors to theme park A who did not attend the games were identified through PulseNet, indicating that the number of ill persons in this outbreak is probably much larger than what has been identified in the surveyed Transplant Games population. The combination of molecular subtyping, web-based technology, and routine public health surveillance facilitated the outbreak investigation.

The findings in this report are subject to at least two limitations. First, a web-based investigation limited responses to only those attendees with known e-mail addresses and Internet access. Second, although responses were received from both well and ill persons, households with ill persons might have been more likely to respond to a web-based survey. Therefore, it is difficult to calculate an accurate attack rate among attendees of the games.

Preliminary findings of the epidemiologic investigation have implicated fresh, pre-packaged diced Roma tomatoes supplied to theme park A as the probable vehicle for this outbreak. Efforts are under way to identify the source of these tomatoes and possible routes of contamination. Tomatoes are not a commonly recognized vehicle for Salmonella, and no evidence exists for widespread contamination of tomatoes available for purchase. However, tomatoes have been implicated in at least one previous outbreak of S. javiana infections (7), and cut surfaces of tomatoes and other fresh fruits and vegetables can support the growth of Salmonella and other enteric pathogens (8,9). Produce is recognized increasingly as a source of Salmonella infections in the United States, and consumers should wash tomatoes and other produce items thoroughly before
APPENDIX D (continued)


Acknowledgments


References


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APPENDIX E

National and State Educational Standards

Specific local, state, and national learning objectives were selected to be met with this curriculum:

National Science Education Standards


Specific Content Standards

**Unifying Concepts and Processes Standard**

- Systems, order, and organization
- Evidence, models, and explanation
- Change, constancy, and measurement
- Form and function

**Science As Inquiry Standard**

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

**Life Science Standard**

- The cell
- Interdependence of organisms
• Behavior of organisms

Science in Personal and Social Perspectives Standard
• Personal and community health
• Environmental quality
• Natural and human-induced hazards
• Science and technology in local, national, and global challenges

History and Nature of Science Standard
• Science as a human endeavor
• Nature of scientific knowledge
• Historical perspectives

Common Core State English Language Arts Standard: Literacy in Science and Technical Subjects

Authors: National Governors Association Center for Best Practices, Council of Chief State School Officers
Title: Common Core State Standards (insert specific content area if you are using only one)
Publisher: National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington D.C.
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Key Ideas and Details
• RST.11–12.1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
• RST.11–12.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
Craft and Structure

- RST.11–12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

Integration of Knowledge and Ideas

- RST.11–12.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Common Core State Math Standards

Authors: National Governors Association Center for Best Practices, Council of Chief State School Officers
Title: Common Core State Standards (insert specific content area if you are using only one)
Publisher: National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington D.C.
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Statistics and Probability

- S-ID Summarize, represent, and interpret data on two categorical and quantitative variables
- S-ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.
- S-MD.7 Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Illinois State Board Of Education Learning Standards for Physical Development and Health

Late High School

- 22.A.5b: Evaluate the effectiveness of health promotion and illness prevention methods using data from actual work stations.
- 22.C.5: Compare and contrast how individuals, communities, and states prevent and correct health-threatening environmental problems (e.g., recycling, banning leaf burning, restaurant inspections, OSHA standards in the work place).
WHO DO WE NEED TO PROTECT FROM FOODBORNE ILLNESS??

YOUNG CHILDREN HAVE DIED FROM ILLNESSES FROM FOOD, PREGNANT WOMEN, OLD PEOPLE, AND PERSONS WITH HIV/AIDS ARE ESPECIALLY AT RISK.

EVERYONE!! BUT THESE GROUPS ARE PARTICULARLY AT RISK.

THE USDA RECOMMENDS THE FOLLOWING FOUR WAYS TO PROTECT OURSELVES AND OTHERS AT HOME: CLEAN, SEPARATE, COOK, AND CHILL.

CLEAN: WASH HANDS AND SURFACES OFTEN.

SEPARATE: DON'T CROSS CONTAMINATE.

COOK: COOK TO PROPER TEMPERATURES.

CHILL: REFRIGERATE PROMPTLY.

THE USDA RECOMMENDS THAT CONSUMERS ARE AWARE OF THE FOUR MAJOR WAYS TO PROTECT THEMSELVES AND OTHERS FROM FOODBORNE DISEASE.

SOURCES OF DATA AND FACTS IN THIS BOOKLET: UNITED STATES DEPARTMENT OF AGRICULTURE, CENTERS FOR DISEASE CONTROL AND PREVENTION, MORTALITY AND MORTALITY WEEKLY REPORT, THE NATIONAL RESTAURANT ASSOCIATION, THE JOURNAL OF FOOD PROTECTION, CLINICAL INFECTIOUS DISEASES, FOOD AND DRUG ADMINISTRATION. PHOTOGRAPHS OF CAMPYLOBACTER AND SALMONELLA ARE COURTESY OF THE INSTITUTE OF FOOD RESEARCH.

THIS EDUCATIONAL COMIC BOOK WAS CREATED BY THE UNIVERSITY OF ILLINOIS SCHOOL OF PUBLIC HEALTH.

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CONTRIBUTOR: ANNE BURKE
APPENDIX F (continued)

AT THE LOCAL RESTAURANT

THE KITCHEN STAFF IS EXCITED BECAUSE THE PRESIDENT WILL BE EATING AT THEIR RESTAURANT DURING A BRIEF VISIT. ALTHOUGH THE STAFF WILL PREPARE A SPECIAL MEAL, THE EVIL KLASS STAFF AND HIS ASSISTANT SEA SERIOUS HAVE OTHER PLANS.

I HAVE CREATED UNSAFE FOOD CONDITIONS THROUGHOUT THE KITCHEN! WHEN THE PRESIDENT GETS FOOD POISONING, I WILL RULE THE WORLD.

I LOVE THE WORDS "FOOD POISONING". THEY SOUND SO DANGEROUS.

LOOK, FRIENDS, READY TO EAT FOOD LIKE THIS SALAD, WAS STORED BELOW EGGS AND MEAT. RAW EGGS AND MEAT MAY HAVE GERMS THAT CAN MAKE YOU SICK. THEY CAN'T BE STORED RIGHT ABOVE READY TO EAT FOODS.

BUT THE MEAT IS WRAPPED IN PLASTIC TIN! CHEF.

LOOK, TWO MISTAKES. THE TEMPERATURE IN THIS REFRIGERATOR IS NOT COLD ENOUGH. GERMS FROM FOOD THAT MAKE PEOPLE SICK GROW WELL BETWEEN 41°F AND 135°F.

AND THERE IS A LARGE CONTAINER OF WARM SOUP HERE.

41°F OR LOWER IS IMPORTANT.

THIS LARGE POT OF WARM SOUP WILL WARM THE REFRIGERATOR AND HELP GERMS TO GROW!

EVEN IF WRAPPED IN PLASTIC, ACCIDENTS HAPPEN AND THE JUICE COULD LEAK OUT. WE DON'T TAKE CHANCES WITH FOOD SAFETY. PEOPLE CAN GET VERY SICK AND EVEN DIE.

NO! HE'S CORRECTING MY ERRORS!

IN THE KITCHEN, GABRIELO MARTINEZ AND PEPPER GREEN ARE PREPARING THE FOOD. FOR LUCKY FOR THE KITCHEN STAFF, TINY CHEF IS HERE TO HELP.

I'LL GET SOME FOOD OUT OF THE REFRIGERATOR. WE NEED EGGS, MEAT, AND SALAD.
APPENDIX F (continued)

Before cooling food, you should divide large containers of warm food into smaller containers.

Shallow pans cool the food quicker.

For large food items like meat, you can cut it into smaller pieces.

The warm soup is removed from the refrigerator. Now the chefs are working on cooking chicken.

The chicken looks done. Out it comes!

This meat stea thermometer should show an internal temperature of at least 165°F for poultry, but it is only 135°F! I think this chicken was still frozen in the center when it was put in the oven!

I didn't defrost it on the counter, I know you should not defrost meat, poultry, or fish on the counter, because germs can grow.

Well, somebody did. Now the outside of the chicken looks done but the inside is not safely cooked. I guess we could smell it and taste it, if it seems ok, then we could serve it.

No, my friend! You cannot be sure food is safe from germs if it smells and tastes normal.

This tiny chef is a whiny chef!
APPENDIX F (continued)

To Defrost Meat or Poultry Safely...

- **FSW**: Safe if frozen solid.
- **Submerged Under Running Tap Water (If water is no warmer than 70°F)**:
  - **Oh Yeah! The water is perfectly below 70°F.**
  - **I'm still cold!**
- **In a Microwave if it will be cooked immediately afterward**:
  - **If you cook rice and leave it out at room temperature for many hours, it could make people sick. They can get vomiting or diarrhea. The germs that do this in rice can survive hot cooking temperatures. They only make trouble if you let the cooked rice sit out at room temperature for hours.**

Was this rice left out overnight or was it just cooked?

I cooked it last night, but it's safe to eat right? Because it was fully cooked.

Pepper is cooking meat.

- **The President loves hamburgers. These four look done.**
- **Yes, they are the right temperature, 160°F.**
- **That is different than cooking a chicken. I see that different foods have to be cooked to different temperatures to be safe. Ground beef is only 160°F but turkey or chicken is 165°F.**
- **I wish he would lose that metal stem thermometer! Metal stem, that's the one that is best for meat isn't it?**

In restaurants, ground beef may be cooked to 155°F if it is that warm for at least 15 seconds.
COOKING FOOD TO THE RIGHT TEMPERATURE IS A MATTER OF LIFE AND DEATH FOR SOME PEOPLE.

BEEF CAN HAVE GERMS THAT CAUSE BLOODY DIARRHEA. THESE GERMS CAN MAKE SOMEONE WHO EATS UNSAFE FOOD GET SEVERE STOMACH CRAMPS AND LATER THEIR DIARRHEA CAN LOOK LIKE PURE BLOOD! THEY CAN BE HOSPITALIZED AND EVEN DIE! ALL THIS BECAUSE THE MEAT WAS NOT COOKED TO A SAFE TEMPERATURE. WE CAN TOTALLY PREVENT THIS IN THE KITCHEN!

YOU ARE KILLING ME WITH THIS FOOD SAFETY INFORMATION!

NO MARY! PLEASE HELP ME.

IS EVERYTHING ALRIGHT IN THERE?

REMEMBER 41 AND 135? IF THAT BEEF WAS BETWEEN 41°F AND 135°F FOR MORE THAN 4 HOURS IT MUST BE THROWN AWAY. GERMS GROW WELL IN THAT TEMPERATURE RANGE, AND THESE GERMS CAN KILL.

41 AND 135? HE'S GOING TO THROW AWAY PERFECTLY DANGEROUS BEEF!

I GET CRAMPS JUST THINKING ABOUT IT.

THIS IS STRANGE. THERE ARE SO MANY FOOD SAFETY ERRORS IN THIS KITCHEN. IT CAN ONLY MEAN...

THIS IS NOT WHAT I MEANT BY GETTING ME A BRACELET.

MY PLANS WOULD HAVE WORKED IF IT WEREN'T FOR FOOD SAFETY.

HERE COMES THE PRESIDENT!

FOOD SAFETY HAS NEVER BEEN SO EXCITING!

WE NEED TO KEEP EVERYONE SAFE FROM FOOD POISONING.

THE END
First, the challenger washes his hands.

First you turn on warm water and wet your hands.

Then use liquid soap and water and get a good lather, lots of bubbles and rub the hands together. I like this to take a little time, like 20 seconds. If I'm in a hurry, I still take time to do this.

Rinse in the water, then dry your hands with a clean paper towel. Don't wipe your hands on your clothes or apron.

Turn off the water with a paper towel but don't touch the faucet handle or knob with your clean hands.

The sanitizer makes a surprise move. He turns down the temperature in the room.

Hey! It's only 40°F in here. That's no good for me! Turn up the heat!

Wanting to be helpful, the sanitizer responds to the devil germ's request for heat.

Oh, I'll turn up the heat alright. Germs don't grow well at temperatures above 115°F.

If I can't stand the heat, I'll have to get out of the kitchen.
THE DEVIL GERM IS NO MATCH FOR CLEVER FOOD SAFETY MOVES.

YUP, HE’S DONE!

OHH! HE’S TOAST!

THE CROWD GOES WILD!!!

AND THE WINNER IS, THE SANITIZER!

LONG LIVE THE SANITIZER!

TIME TO CLEAN UP THE MESS. FIRST, JOSE CLEANS THEN HE SANITIZES.

CLEANING IS REMOVING FOOD AND OTHER STUFF YOU CAN SEE FROM A COUNTER OR PLATE.

SANIZING IS GETTING RID OF GERMS SO THE SURFACE IS SAFE FOR FOOD TO TOUCH IT. YOU MIGHT USE A CHEMICAL OR A HOT WATER DISH WASHER.
APPENDIX F (continued)

IT'S THANKSGIVING DAY, BUT AFTER EATING AT AN OREGON RESTAURANT, NO ONE COULD BE THANKFUL AFTER THEIR HOLIDAY MEAL.

DIARRHEA, STOMACH CRAMPS AND NAUSEA STRUCK 50 PEOPLE WHO ATE AT THE RESTAURANT.

SOME PEOPLE THREW UP, FELT CHILLS, HAD A FEVER AND FELT ACHY.

WHAT WENT WRONG?

THE RESTAURANT HAD 30 FROZEN TURKEYS TO THAW IN TWO DAYS.

30 TURKEYS IN 48 HOURS? I DON'T THINK SO!

THE INITIAL DEFROST TOOK PLACE IN A WALK-IN REFRIGERATOR, BUT TIME WAS RUNNING OUT AND THE CUSTOMERS WOULD BE ARRIVING SOON.

SO, THE 30 TURKEYS WERE DEFROSTED IN ONLY 3 SINKS, WHICH MAKES RAINING COLD WATER OVER EACH TURKEY VERY DIFFICULT.

HUUH, CHECK OUT ALL THESE TURKEYS!

GOT ROOM FOR A COUPLE MORE?

IS THAT BLOOD IN MY DIARRHEA?

YOU SHOULD HAVE THOUGHT OF THAT WEEKS AGO!

NO PROBLEM, WE CAN HANDLE THAT! CHAING POULTRY IN THE FRIDGE IS A SAFE PRACTICE, BUT I CAN'T WAIT FORBIE!
THE TURKEYS WERE ROASTED, SLICED AND STORED IN THE DISPLAY REFRIGERATOR WHICH WAS KEPT AT 50°F.

ARE YOU SURE THAT'S COLD ENOUGH?

THE TEMPERATURE WAS NOT COLD ENOUGH. THAT MADE CONDITIONS GOOD FOR SERMS TO MAKE MORE SERMS.

OH MAN, THIS IS A GREAT PLACE TO START OUR FAMILY! THE FRIDGE IS OVER 40°F.

I ALWAYS WANTED A LARGE FAMILY!

THE GRIDDINGS FROM THE TURKEYS WERE USED TO MAKE THE GRAVY. THE GRAVY WAS COOKED IN 22-QUART CONTAINERS. THE STUFFING WAS COOKED THE SAME WAY.

I'M CONCERNED ABOUT THE SIZE OF THE CONTAINERS. YOU MIGHT NOT GET THE GRAVY IN THE CENTER OF EACH CONTAINER TO COOL. YOU SHOULD USE SMALLER CONTAINERS!

A SERM CALLED CLOSTRIDIUM GREW VERY SUCCESSFULLY UNDER THESE CONDITIONS.

I FINALLY HAVE THE BIG FAMILY I ALWAYS WANTED!

AND TO THINK THAT KIND RESTAURANT FOOD HANDLER MADE ALL THIS POSSIBLE!

I GUESS WE COULDN'T HANDLE THIS MUCH FOOD IN SO LITTLE TIME WITHOUT COMPROMISING FOOD SAFETY.

YOU COULD SAY THAT AGAIN!

YOU ARE CHARGED WITH TEMPERATURE ABUSE! THOSE TURKEYS SHOULD HAVE BEEN THAWED IN THE REFRIGERATOR SET AT 41°F OR LOWER OR COVERED WITH COLD RUNNING WATER.

WE COULDN'T HANDLE THIS MUCH FOOD IN SO LITTLE TIME WITHOUT COMPROMISING FOOD SAFETY. SIGH...

IT'S ENOUGH TO MAKE YOU SICK!

AND THE GRAVY SHOULD HAVE BEEN COOKED IN SMALLER CONTAINERS TO ALLOW THE FOOD TO COOL ALL THE WAY THROUGH.

AND IT DID!
APPENDIX F (continued)

TRUE STORIES FROM THE KITCHEN

THE TALE OF THE KILLER HAMBURGERS

IT ALL STARTED INNOCENTLY.
A FAST FOOD RESTAURANT CHAIN MADE
HAMBURGERS. PEOPLE OF ALL AGES ATE
THEM. BUT THE HAMBURGERS WERE NOT
COOKED WELL-DONE AND A GERMINAMED
E.COLI OCCASIONALLY CONTAMINATES
GROUND MEAT.

DURING A PERIOD OF THREE MONTHS,
MORE THAN 500 PEOPLE WERE SICKENED
WITH DIARRHEA. 1 OUT OF EVERY 10 SICK
PERSONS HAD BLOODY DIARRHEA. 45
PEOPLE BECAME EVEN MORE SICK WITH
HEMOLYTIC UREMIC SYNDROME!

HEMOLYTIC: BLOOD CELLS
UREMIC: BREAK APART.

THE KIDNEYS GET CLOSED
UP AND STOP WORKING, SO
THE PERSON MAY NEED
DIALYSIS.

3 CHILDREN DIED, INCLUDING
A 2 YEAR OLD BOY.

SOME FACTS ABOUT E.COLI

IN THIS OUTBREAK, THE E.COLI GERMS WERE IN FROZEN GROUND MEAT PATTIES THE RESTAURANT USED AND THEY WERE NOT COOKED LONG ENOUGH TO GET THE MEAT WELL DONE.
E.COLI OCCASIONALLY CONTAMINATES MEAT DURING THE SLAUGHTER PROCESSING OF CATTLE.
FOR EXAMPLE, THE ANIMAL'S INTESTINES CAN GET DAMAGED OR LEAK FECES AND THAT GETS MIXED IN WITH THE GROUND MEAT. THE U.S. CENTERS FOR DISEASE CONTROL AND PREVENTION ESTIMATES THAT EACH YEAR, MORE THAN 75 PERSONS DIE AND MORE THAN 2,700 PERSONS ARE HOSPITALIZED WITH THIS KIND OF E.COLI
DISEASE.

AFTER HANDLING GROUND MEAT:
WASH HANDS TO GET THE
GERMS OFF YOU BEFORE YOU
MIGHT TRANSFER THEM TO
ANOTHER FOOD OR SURFACE.
IMMEDIATELY
REFRIGERATE OR
FREEZE IT OR COOK IT.

THE FDA RECOMMENDS
YOU COOK HAMBURGERS
AND GROUND MEAT
MIXTURES LIKE MEATLOAF
TO AN INTERNAL
TEMPERATURE OF 160°F FOR
15 SECONDS. USE A MEAT
THERMOMETER.
APPENDIX F (continued)

A FUNNY THING HAPPENED ON THE WAY TO THE FORK

NOW HERE’S AN OUTBREAK FOR YOU TO SOLVE.

MY NAME IS BACTERIA, AND DON’T LET MY SMALL STATURE FOOL YOU AS YOU NEED A MICROSCOPE TO SEE ME. I’M SOMETIMES KNOWN AS A “BAD EGG” AND WOULD LOVE NOTHING MORE THAN TO WEAKEN YOU WITHIN YOUR INTESINES. JOIN ME TO LEARN HOW A GERMS MAKES THE JOURNEY FROM THE FARM TO YOUR FORK.

SO THERE I WAS, MINDING MY OWN BUSINESS IN THE CHICKEN COOP...

THAT’S ME DOWN HERE, REALLY SMALL.

WANTED
DEAD OR ALIVE

CAMYLOBACTER SALMONELLA
CRIME: CAUSING THOUSANDS OF PEOPLE TO BECOME ILL WITH FOODBORNE DISEASE EACH YEAR IN THE UNITED STATES

I QUICKLY MADE MY MOVE TO COLONIZE THE CHICKENS. SOME BIRDS WERE EASY, THEY HAD BEEN INFECTED AS EGGS AND WERE BORN CONTAINING CAMYLOBACTER IN THEIR MUSCLES. ENVIRONMENTAL CONTAMINATION WAS THE DOWNFALL OF THE REST.

INSIDE THE CHICKEN COOP

NOW, I’VE BEEN KNOWN TO FREQUENT SOME SHADY ESTABLISHMENTS, BUT THE COMBINATION OF POULTRY AND FECES MADE THIS JUST MY KIND OF PLACE.

HOW SUXE OF ME, I FORGOT TO INTRODUCE YOU TO MY PARTNERS IN CRIME, CAMYLOBACTER AND SALMONELLA.

BUT WHEN IT CAME TIME TO PROCESS THE CHICKENS SO THAT IT COULD BE USED AS FOOD, I KNEW THAT WAS MY OPPORTUNITY TO HITCH A RIDE TO A RESTAURANT.

AMAZINGLY, BEING LIKE ME, HE CAN SURVIVE FOR 16 WEEKS EVEN IN A REALY COLD FREEZER (~4°F).

AS THE CHICKENS WERE PROCESSED, THINGS CAN GET A BIT SPLASHY. IF YOU ARE SMART LIKE ME, YOU MAKE SURE TO GO ALONG WITH THE SPLASHES FOR A RIDE.

SALMONELLA CAN INFECT CHICKEN BY CONTACT FROM ONE INFECTION CHICKEN TO AN UNINFECTED CHICKEN. ALSO, FROM AN INFECTED MOTHER CHICKEN TO HER CHICK.

GOTcha!
APPENDIX F (continued)

A RESTAURANT UNINTENTIONALLY PURCHASED SALMONELLA-CONTAMINATED CHICKEN. I COULD TOUCH OUT THE REFRIGERATION, BUT ALL THE CHEF WOULD HAVE TO DO TO STOP ME FROM INFECTING HIS CUSTOMERS WAS USE PROPER FOOD HANDLING AND COOKING PRACTICES.


IF YOU WANT TO BE SURE THAT CHICKEN IS SAFE TO EAT FROM SEEING LIKE SALMONELLA, THEN YOU'RE NOT TO GET THE TEMPERATURE IN THE CHICKEN TO BE AT LEAST 165°F, THAT IS NOT THE TEMPERATURE OF THE OVEN WHICH IS TURNED ON MUCH HOTTER, BUT RATHER THE TEMPERATURE OF THE CENTER OF THE THICKEST PART OF THE MEAT. IF I SPEND AT LEAST 5 SECONDS AT 165°F THEN I CAN'T INFLICT ANYONE.

WHERE DID I PUT THAT METAL STEAM THERMOMETER?

MUHAHAHAHAHA!

THE CHEF SHOULD HAVE USED A METAL STEAM THERMOMETER TO CHECK THE INTERNAL TEMPERATURE OF THE CHICKEN. BUT HE DIDN'T, BRINGING ME CLOSER TO INFECTING HUMANS. REMEMBER THAT FROZEN CENTER! IT NEVER HEAT UP ALL THE WAY. LEAVING THE CENTER OF THE CHICKEN INCOMPLETELY COOKED.

HERE'S THE MENU FROM THE PRIVATE PARTY AT THE RESTAURANT WHERE THE CHICKEN WAS SERVED.

Private Party Menu

The Entrees
- Beef Sirloin $12.99
- Baked Chicken $12.99
- Eggplant Parmesan $12.99

Sides
(Choice of One)
- Salad
- Mashed Potatoes
- Garlic Bread

Dinner entrees are served with warmed rolls and butter and fresh roasted coffee and tea.
All Prices are subject to an 18% service charge and sales tax.
THANKS TO THESE FOOD HANDLING ERRORS, I SAFELY ARRIVED ON CUSTOMERS PLATES.

GON APPETITE!

ONCE YOU SWALLOW ME, STOMACH ACID DOESNT BOTHER ME TOO MUCH AND I CAN GET RIGHT TO WORK IN THE INTESTINES, REPRODUCING MYSELF AND CAUSING DIARRHEA, VOMITING, NAUSEA, AND ABDOMINAL CRAMPS. SOMETIMES, I CAN EVEN TRAVEL THROUGH THE BLOODSTREAM, CAUSING ALL KINDS OF MISHAffen.

MY FAMILY

OF THE 100 PEOPLE WHO ATTENDED THE PRIVATE PARTY AT THE RESTAURANT, 40 PEOPLE BECAME ILL WITH FOOD POISONING. THE HEALTH DEPARTMENT BEGAN AN INVESTIGATION TO FIGURE OUT WHICH FOOD ITEM WAS RESPONSIBLE FOR THE OUTBREAK.

EPIDEMIOLOGY, MY DEAR WATSON.

A FOODBORNE OUTBREAK INVESTIGATION INVOLVES THE FOLLOWING STEPS:

1. FIND CASES (INFECTED INDIVIDUALS).
2. COLLECT INFORMATION FROM CASES TO DETERMINE THE WHO, WHAT, WHEN, WHERE, AND HOW OF THE OUTBREAK.
3. GENERATE HYPOTHESES ABOUT WHAT CAUSED THE OUTBREAK AND IF ANY BEHAVIORS OR EXPOSURES PUT PEOPLE AT PARTICULAR RISK.
4. TEST HYPOTHESES WITH ADDITIONAL STUDIES (COMPARE WHAT SICK INDIVIDUALS ATE TO WHAT WELL INDIVIDUALS ATE).
5. COLLECT AND TEST ENVIRONMENT SAMPLES. TESTING LEFTOVER FOOD AND SCRAPS FROM KITCHEN EQUIPMENT MIGHT LEAD TO IDENTIFICATION OF THE GERM THAT CAUSED THE OUTBREAK.
6. PERFORM CONTROL MEASURES, SUCH AS THROWING AWAY THE SUSPECTED FOOD SO THAT NO ONE ELSE CAN EAT IT.
Now, you be the epidemiologist! Can you help public health officials figure out what may have caused the outbreak?

When conducting a foodborne disease outbreak investigation, one way in which to analyze the data is to calculate food-specific attack rates. Information considered by investigators can include the various food sources, what food was prepared, cases of illness versus well people, and who ate what, when did they eat, and how much did they eat.

Food-specific attack rates are calculated using the following formula:

$$\text{Food-specific Attack Rate} = \frac{\text{Number of persons who ate a specific food and became ill}}{\text{Total number of persons who ate a specific food}} \times 100$$

Example: At a fast food restaurant, of the 100 people who ate a hamburger, 45 became ill.

$$(45/100) \times 100 = 45\% \text{ attack rate for the hamburger}$$

What does this food-specific attack rate tell you?
If hamburger is the cause of the outbreak, then it made 45% of the hamburger eaters become ill. But the attack rate is not proof that a specific food is the cause. If just helps you decide if you think a specific food is probably the cause.

Public health officials surveyed those who had attended the event. They received the following results:

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Food Item</th>
<th>Baked Chicken</th>
<th>Beef Sirloin</th>
<th>Eggplant Parmesan</th>
<th>Mashed Potatoes</th>
<th>Salad</th>
<th>Garlic Bread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of persons exposed to food item who became ill</td>
<td>33</td>
<td>4</td>
<td>2</td>
<td>20</td>
<td>36</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Number of persons exposed to food item who did not become ill</td>
<td>5</td>
<td>41</td>
<td>8</td>
<td>30</td>
<td>33</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Number of persons not exposed to food item who became ill</td>
<td>7</td>
<td>36</td>
<td>38</td>
<td>20</td>
<td>14</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Number of persons not exposed to food item who did not become ill</td>
<td>55</td>
<td>19</td>
<td>52</td>
<td>30</td>
<td>17</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Calculate the food-specific attack rates for each food item:

- **Baked Chicken:**
- **Mashed Potatoes:**
- **Beef Sirloin:**
- **Salad:**
- **Eggplant Parmesan:**
- **Garlic Bread:**

Thought Questions:

1. Which food item was most likely responsible for the outbreak? Why do you think this is the case?

2. Is there another food item that also has a high attack rate? Why do you think this is?
Calculating the relative risk can help to inform the conclusion of what most likely caused a foodborne disease outbreak. Epidemiologists calls the subjects of this type of study a ‘cohort.’ For example, if a group of people attend a wedding reception and become sick, the epidemiologist calls this group a ‘cohort.’

Epidemiologists use the relative risk to determine if a certain factor (such as consuming a food) increases the probability of an event occurring (such as developing a disease). In this example, the act of consuming a certain food would be known as the ‘exposure’ and becoming ill would be the ‘outcome.’

The relative risk (RR) can be interpreted as a multiplicative increase or decrease in risk associated with an exposure. If RR=3 this means that those with the exposure are 3 times more likely to be diseased than those not exposed. If RR=1/3 this means that those with the exposure are 1/3 as likely to be diseased. Since 1/3 is less than 1, this means that the exposure is actually protective instead of making it more likely that people get disease.

One tool epidemiologists use to determine relative risk is called a 2x2 Table. This is because there are two boxes horizontally and two boxes vertically.

<table>
<thead>
<tr>
<th></th>
<th>Diseased</th>
<th>Non-diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumed food</strong></td>
<td>a. Number of diseased persons exposed to food item</td>
<td>b. Number of non-diseased persons exposed to food item</td>
</tr>
<tr>
<td><strong>Did not consume food</strong></td>
<td>c. Number of diseased persons not exposed to food item</td>
<td>d. Number of non-diseased persons not exposed to food item</td>
</tr>
</tbody>
</table>

Relative Risk Formula: \[ RR = \frac{a/(a+b)}{c/(c+d)} \]

Use the information on the previous page to calculate the relative risk associated with eating baked chicken and salad. One of the boxes has already been filled out for you.

<table>
<thead>
<tr>
<th>Chicken</th>
<th>Diseased</th>
<th>Non-diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumed</strong></td>
<td>33</td>
<td>a</td>
</tr>
<tr>
<td><strong>Did not consume</strong></td>
<td>c</td>
<td>b</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Salad</th>
<th>Diseased</th>
<th>Non-diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumed</strong></td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td><strong>Did not consume</strong></td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

**Thought Questions:**
3. How does this relative risk information impact which food item you think is most likely to have caused the outbreak?

4. Why didn’t everyone who consumed the contaminated food become sick? Why did some who did not consume the contaminated food become sick?
Outbreak Investigation Curriculum Definitions

Some of these terms may have other definitions; we have chosen to define the words only as they have been used in the educational comic book.

Animal husbandry - The branch of agriculture concerned with the care and breeding of domestic animals such as cattle, hogs, sheep, and horses.¹

Campylobacter [kam-uh-buh-bek-ter] - A spiral-shaped bacteria that can cause disease in humans and animals, one of the most common causes of diarrheal illness in the United States. An estimated 2 million cases of Campylobacter food poisoning occur annually in the United States.⁴

Case-control study - A study that compares two groups of people: those who do not have the disease or condition under study (cases) and a very similar group of people who do not have the disease or condition (controls). Researchers study the medical and lifestyle histories of the people in each group to learn what factors may be associated with the disease or condition.¹⁴

Clostridium [klo-strid-ee-uh m] - A rod-shaped bacteria, occurring mainly in soil but also in the intestines of humans and animals. Nearly one million estimated cases of Clostridium food poisoning occur annually in the United States.¹⁵

Colonize - To form compact population groups of the same type of microorganism. For example, a person's intestines may be colonized by bacteria such as Salmonella, potentially leading to foodborne disease if that person prepares food for others but does not wash their hands after a bowel movement.⁸

Cohort - A defined population group followed prospectively in an epidemiological study.⁹

Control measures - Any action and activity that can be used to prevent or a food safety hazard or reduce it to an acceptable level. Raw meat stored above ready-to-eat foods can drip, moving this meat to below the ready-to-eat foods is an example of a control measure.⁸

Cross-contamination - The process by which bacteria or other microorganisms are unintentionally transferred from one substance or object to another, with harmful effect. For example, when raw meat contaminated with germs is cut on a cutting board and right after that ready-to-eat food, such as a raw tomato, is cut on the same board the ready-to-eat food can become contaminated.⁵

Escherichia coli (es-uh-rih-kee-ee-coh koh-lee) [E. coli] - A bacteria normally found in the human gastrointestinal tract and existing as numerous strains, some of which are responsible for diarrheal diseases. An estimated 73,480 cases and 61 deaths due to E. coli food poisoning occurred annually in the United States between 1982 and 2002.¹²

Enteric - Of, relating to, or affecting the intestines <enteric diseases>.⁸

Environmental contamination - Introduction of any substance not intentionally added to food, which is present in such food as a result of the production.** Germs from animal feces on a farm may lead to environmental contamination of the melons grown there. ¹

Exposure - The condition of being subjected to something, as to infectious agents, extremes of weather, or radiation, which may have a harmful effect. The health department investigator wanted to determine which exposure caused the outbreak of foodborne illness.⁷

Feces - Waste matter eliminated from the intestinal tract.¹

Food poisoning - An acute gastrointestinal condition characterized by such symptoms as headache, fever, chills, abdominal and muscular pain, nausea, diarrhea, and/or prostration (total exhaustion or weakness), caused by foods that are contaminated by bacteria, their toxins, parasites, or viruses; naturally toxic, as poisonous mushrooms; or by vegetable foods that are chemically contaminated, as by insecticides.⁸

Food processing - A systematic series of mechanized or chemical operations that are performed in order to produce or manufacture a food product.⁴

Food-specific attack rate - The ratio of the number of people who ate a certain food and became ill to the total number of individuals who ate that food, used for comparing different specific food exposures.⁹

Foodborne disease outbreak - An event occurring when a group of people consume the same contaminated food and two or more of them come down with the same illness.⁷

Generate hypothesis - Creation of a proposed explanation made on the basis of limited evidence as a starting point for further investigation.³

**Production includes operations carried out in crop husbandry, animal husbandry, veterinary medicine, manufacture, processing, preparation, treatment, transport, or holding of such food.
Germ - A microscopic organism or agent, especially one that is pathogenic, such as a bacterium or virus.  

Internal temperature - The temperature of the internal portion of a food product.  

Listeria ([lit-ster-i-uh]- A type of bacteria found in soil, water, and sometimes on plants. Though Listeria is all around our environment, most Listeria infections in people are from eating contaminated foods. An estimated 2500 cases and 500 deaths due to Listeria occur annually in the United States. 

Metal stem thermometer - An object used to measure the internal temperature of foods which often has a round top with a long pointed sensor made of steel to stick into the food.  

Norovirus - A virus which is a common cause of diarrhea and vomiting. An estimated 2 million cases of Norovirus food poisoning occur annually in the United States.  

Outbreak - in epidemiology, an occurrence of infection with a particular disease that exceeds normal levels of disease in a small, localized group, such as the population of a village. The term is sometimes used more broadly to refer to an epidemic or a pandemic.  

Outcome - Something that follows as a result or consequence. In epidemiology an important outcome is disease or death.  

Pandemic - Occurring over a wide geographic area and affecting an exceptionally high proportion of the population.  

Pathogenic - Able to cause or produce disease.  

Pulse-field gel electrophoresis – A laboratory test that uses electric fields and large fragments of DNA from bacteria to create a pattern than can be seen and used to distinguish one strain of bacteria from another. This test is like fingerprinting for germs.  

Relative risk - The ratio of the probability of an event (developing a disease) occurring in exposed people compared to the probability of the event in non-exposed people. For example, in a foodborne disease outbreak the relative risk would be the probability of becoming sick with foodborne illness for those who ate contaminated food compared to the probability of becoming sick in those that did not eat that food. If RR=1 there is no effect, RR>1 suggests greater risk in exposed individuals, RR<1 suggests less risk in exposed individuals, indicating a protective effect.  

Salmonella [sal-muh-nel-uh]- A rod-shaped bacteria of the genus Salmonella that causes food poisoning and typhoid fever in humans and other mammals. Salmonella food poisoning results in an estimated 1.4 to 3 million cases and more than 500 deaths annually in the United States.  

Stature - A person’s natural height: a man of short stature, she was small in stature.  

Temperature abuse - Any time potentially hazardous food is exposed to the temperature danger zone of 41° to 135°F for a prolonged period of time. Food being prepared or cooked should pass through the temperature danger zone as quickly as possible. Temperature abuse of potentially hazardous food can cause the rapid growth of microorganisms, potentially causing foodborne illness.  

Unwittingly - Not done on purpose; unintentional.  

Wreak havoc - Disrupt, damage, or destroy something.  

References  
2. Centers for Disease Control 
6. Food and Agriculture Association of United Nations  
7. Dorland’s Medical Dictionary for Health Consumers. 2007  
14. National Cancer Institute  
APPENDIX F (continued)

National Outbreak Reporting System

Foodborne Disease Transmission, Person-to-Person Disease Transmission, Animal Contact

This form is used to report foodborne, person-to-person, and animal contact related disease outbreak investigations. The form is 6 pages. General Laboratory, Person-to-Person, Animal Contact, and Food, as indicated by text at the top of each page. Complete the General and Laboratory tabs for all modes of transmission and complete additional sections as indicated by mode of transmission. Please complete all of the sections as possible.

<table>
<thead>
<tr>
<th>CDC Report ID</th>
<th>State Report ID</th>
</tr>
</thead>
</table>

**General Section**

**Primary Mode of Transmission (check one):**
- Food (Complete General, Lab, and Food tabs)
- Water (Complete CDC 62.12)
- Animal contact (Complete General, Lab, and Animal Contact tabs)
- Indeterminate/Other/Unknown (Complete General and Lab tabs)

**Incubation Period, Duration of Illness, Signs or Symptoms for Primary Cases only**

<table>
<thead>
<tr>
<th>Incubation Period (circa appropriate units)</th>
<th>Duration of Illness (among recovered case/total appropriate units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortest</td>
<td>Shortest</td>
</tr>
<tr>
<td>Median</td>
<td>Median</td>
</tr>
<tr>
<td>Longest</td>
<td>Longest</td>
</tr>
<tr>
<td>Total # of cases for whom info is available</td>
<td>Total # of cases for whom info is available</td>
</tr>
<tr>
<td>Unknown incubation period</td>
<td>Unknown duration of Illness</td>
</tr>
</tbody>
</table>

**Signs and Symptoms**

Refer to forms in appendix, if appropriate, to understand symptom definitions (number of cases)

- Vomiting
- Diarrhea
- Bloody stools
- Fever
- Abdominal cramps
- HUS
- Asymptomatic
- ...
- ...

**Secondary Cases**

**Mode of Secondary Transmission (check all that apply):**
- Food
- Water
- Animal contact
- Person-to-person
- Environmental contamination other than food/water
- Indeterminate/Other/Unknown

<table>
<thead>
<tr>
<th>Environmental Health Specialists Network (if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHS-Net Evaluation ID: 1)</td>
</tr>
</tbody>
</table>

**Traceback** (for food and bottled water only, not public water)

- Please check if traceback conducted

<table>
<thead>
<tr>
<th>Source name</th>
<th>Source type</th>
<th>Location of source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(if publicly available)</td>
<td>(e.g., poultry farm, tomato processing plant, bottled water factory)</td>
<td>State</td>
<td>Country</td>
</tr>
</tbody>
</table>

**Recall**

- Please check if any food or bottled water product was recalled

<table>
<thead>
<tr>
<th>Type of item recalled:</th>
<th>Comments:</th>
</tr>
</thead>
</table>

**Reporting Agency**

<table>
<thead>
<tr>
<th>Agency name:</th>
<th>E-mail:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact name:</td>
<td>Contact title:</td>
</tr>
<tr>
<td>Phone no.:</td>
<td>Fax no.:</td>
</tr>
</tbody>
</table>

**Remarks**

Briefly describe important aspects of the outbreak not covered above. Please indicate if any adverse outcomes occurred in special populations (e.g., pregnant women, hematopoietic transplant patients).
ON A SEPARATE SHEET OF PAPER, COMPLETE THE FOLLOWING QUESTIONS ABOUT THE EDUCATIONAL COMIC BOOK AND NATIONAL REPORTING SYSTEM FORM.

1. NAME THREE FOOD SAFETY ERRORS THAT WERE AT THE END OF THE OUTBREAK INVESTIGATION COMIC AND DESCRIBE HOW THEY MAY HAVE CONTRIBUTED TO THE RESTAURANT FOODBORNE DISEASE OUTBREAK.

2. LIST, IN ORDER, THE STEPS INVOLVED IN GOOD HAND WASHING.

3. WHAT IS HEMOLYTIC UREMATIC SYNDROME (HUS) AND WHICH GERM IS IT ASSOCIATED WITH?

4. IN ADDITION TO DIARRHEA, WHAT ARE THE OTHER SIGNS OR SYMPTOMS THAT ARE COLLECTED ON THE NATIONAL OUTBREAK REPORTING SYSTEM FORM?

5. WHEN AN OUTBREAK INVESTIGATION OCCURS IN A SCHOOL, WHAT ARE THE SCHOOL CHARACTERISTICS THAT ARE COLLECTED ON THE NATIONAL REPORTING SYSTEM FORM?
Instructor:
This is a survey to determine baseline knowledge of students about food safety. Read the
ingstructions to the class. The information provided is completely confidential and will not be
shared with any link to students’ names.

Instructions to the class:
This is a knowledge survey that will take about 20 minutes to complete. Answer the questions
as best as you can, without guessing. If you don’t know the answer to a question, just answer
“don’t know.”

Please respond if you think the statement is true, false, or if you do not know.

Is it true or false that ...

<table>
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<tr>
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<td></td>
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<td></td>
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</table>
12. Raw meat can be stored anywhere in a refrigerator as long as it is wrapped in plastic.

Please answer this question to the best of your ability, if you do not know the answer please check ‘Don’t know.’ Do not guess.

13. In one or two sentences, explain cross-contamination in a kitchen.

Don’t know

Next, please answer the following questions about washing your hands

14. Is the temperature of the water important when washing your hands? (CHOOSE THE ONE BEST ANSWER.)
- Yes, and it should be cold
- Yes, and it should be warm
- No
- Don’t know

15. For how many seconds should you lather your hands with soap? (CHOOSE THE ONE BEST ANSWER.)
- 5 seconds is enough
- 10 seconds is enough
- 20 seconds is enough
- Until you see bubbles
- Don’t know

16. How should you turn off the water? (SELECT ALL THAT APPLY.)
- With your clothes
- With a paper towel
- With your bare hands
- Don’t know
- Other → SPECIFY: __________________________________________________________________

For these next questions, answer with numbers. If you don’t know the answer, check off “Don’t know.”
17. Germs that make people sick from food grow well between which temperatures? (Give the temperature range).
   ______ ˚F to ______ ˚F  OR  □ Don’t know

18. Hamburger and other ground beef mixtures, such as meatloaf, should be cooked to at least what internal temperature as measured by a meat thermometer?
   ______ ˚F  OR  □ Don’t know

This next group of questions is multiple choice. PLEASE SELECT THE ONE BEST ANSWER.

19. Which response is most true for you: I wash my hands after using the toilet never, rarely, sometimes, often, or always?
   □ Never
   □ Rarely
   □ Sometimes
   □ Often
   □ Always

20. You can be certain that a frozen chicken breast will be safe to eat if:
   □ You cook it for 30 minutes at 350˚F
   □ It reaches a high enough temperature as measured on a metal stem thermometer
   □ It looks completely cooked
   □ You cook the chicken at 375˚F for 10 minutes
   □ Don’t know

21. Which of these four terms represent the four major ways to prevent the transmission of foodborne disease?
   □ Scrub, thaw, clean, cook
   □ Clean, sanitize, separate, measure
   □ Clean, separate, cook, chill
   □ Don’t know

22. The difference between cleaning and sanitizing is...
   □ Cleaning is to remove food or other types of soil from a surface, but sanitizing is to reduce the number of germs on a clean surface to safe levels.
   □ Cleaning is to remove food or other types of soil from a surface but sanitizing is to wipe a wet surface dry.
   □ Cleaning and sanitizing mean the same thing.
   □ Don’t know

23. There is an outbreak of illness caused by food served at a restaurant. Health Department investigators interview individuals who have eaten at the restaurant in order to...
Determine if anyone observed that food handlers (such as the chef) did not wash their hands regularly.

Determine what individuals at the restaurant think was most likely responsible for the outbreak.

Compare what was eaten by sick individuals to what was eaten by individuals who did not become sick.

Don’t know

This next group of questions is multiple choice. PLEASE SELECT ALL THAT APPLY. Do not guess.

24. Which of the following are acceptable methods to thaw (defrost) beef?
   - In the refrigerator
   - On the counter
   - In cold water
   - In the microwave if it will be cooked right away
   - In the microwave if it will be cooked the next day
   - Don’t know

25. Meat and poultry that is not cooked well done is of relatively high risk to cause disease in which of the following groups?
   - The elderly
   - Young children
   - Pregnant women
   - Those infected with HIV/AIDS
   - Don’t know

26. Which of the following is/are true of Salmonella?
   - Salmonella can infect a chicken by contact from one chicken to another.
   - Salmonella can infect a chicken from an infected mother hen to her unlayed chick.
   - Salmonella can NOT cause bloody diarrhea.
   - Salmonella causes an estimated 1.4 to 3 million cases and more than 500 deaths in the United States annually.
   - Don’t know

27. What is your grade level?
28. Are you:  ☐ Male or  ☐ Female

29. With what racial or ethnic group do you identify yourself? Are you... (SELECT ALL THAT APPLY).

☐ American Indian or Alaskan Native,
☐ Asian or Pacific Islander,
☐ Hispanic or Latino origin,
☐ Black,
☐ White, or
☐ Are you multiracial?
☐ Something else → SPECIFY: __________________________________________

30. Are you or have you ever been employed in a restaurant or cafeteria handling food? (SELECT ONE ANSWER).

☐ Yes, I am currently employed in a restaurant or cafeteria handling food.
☐ Yes, but I am not currently employed in a restaurant or cafeteria handling food.
☐ No (SKIP TO QUESTION 32).
☐ Other → EXPLAIN: ____________________________________________________

31. If you answered that you have worked in a restaurant or cafeteria, was this a fast food restaurant (for example, McDonald’s or Church’s Chicken)? If you answered “No” to question 30 then skip to Question 32. (SELECT ONE ANSWER).

☐ Yes
☐ No
☐ Other → EXPLAIN: ____________________________________________________

32. In general, how frequently do you participate in food preparation by yourself (without parental supervision)? (SELECT ONE ANSWER).

☐ Never
☐ Rarely
☐ Sometimes
☐ Often
☐ Always

33. In general, how frequently do you participate in food preparation with parental assistance? (SELECT ONE ANSWER).

☐ Never
☐ Rarely
☐ Sometimes
☐ Often
☐ Always
34. If you answered ‘Never’ to both Question 32 and 33 then skip this question. In general, how often do you do the following tasks while cooking in the kitchen?

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<tr>
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*End of Survey*

Thank you for your participation
Instructor:
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Instructions to the class:
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13. In one or two sentences, explain *cross-contamination* in a kitchen. □ Don’t know

Next, please answer the following questions about washing your hands

14. Is the temperature of the water important when washing your hands? *(CHOOSE THE ONE BEST ANSWER.)*
   □ Yes, and it should be cold
   □ Yes, and it should be warm
   □ No
   □ Don’t know

15. For how many seconds should you lather your hands with soap? *(CHOOSE THE ONE BEST ANSWER.)*
   □ 5 seconds is enough
   □ 10 seconds is enough
   □ 20 seconds is enough
   □ Until you see bubbles
   □ Don’t know

16. How should you turn off the water? *(SELECT ALL THAT APPLY.)*
   □ With your clothes
   □ With a paper towel
   □ With your bare hands
   □ Don’t know
   □ Other → SPECIFY: ____________________________________________

For these next questions, answer with numbers. If you don’t know the answer, check off “Don’t know.”

17. Germs that make people sick from food grow well between which temperatures? *(Give the temperature range).*
   _______ °F to _______ °F  OR  □ Don’t know

18. Hamburger and other ground beef mixtures, such as meatloaf, should be cooked to at least what internal temperature as measured by a meat thermometer?
   _______ °F  OR  □ Don’t know
19. What is the temperature range of the “Danger Zone”?

_____ °F to _____ °F  OR  □ Don’t know

(CIRCLE THE APPROPRIATE UNITS, DO NOT LEAVE UNITS BLANK IF TEMPERATURES ARE GIVEN)

This next group of questions is multiple choice. PLEASE SELECT THE ONE BEST ANSWER.

20. Which response is most true for you: I wash my hands after using the toilet never, rarely, sometimes, often, or always?

□ Never
□ Rarely
□ Sometimes
□ Often
□ Always

21. You can be certain that a frozen chicken breast will be safe to eat if:

□ You cook it for 30 minutes at 350°F
□ It reaches a high enough temperature as measured on a metal stem thermometer
□ It looks completely cooked
□ You cook the chicken at 375°F for 10 minutes
□ Don’t know

22. Which of these four terms represent the four major ways to prevent the transmission of foodborne disease?

□ Scrub, thaw, clean, cook
□ Clean, sanitize, separate, measure
□ Clean, separate, cook, chill
□ Don’t know

23. The difference between cleaning and sanitizing is...

□ Cleaning is to remove food or other types of soil from a surface, but sanitizing is to reduce the number of germs on a clean surface to safe levels.
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□ Don’t know

24. There is an outbreak of illness caused by food served at a restaurant. Health Department investigators interview individuals who have eaten at the restaurant in order to...

□ Determine if anyone observed that food handlers (such as the chef) did not wash their hands regularly.
□ Determine what individuals at the restaurant think was most likely responsible for the outbreak.
□ Compare what was eaten by sick individuals to what was eaten by individuals who did not become sick.
□ Don’t know
This next group of questions is multiple choice. PLEASE SELECT ALL THAT APPLY. Do not guess.

25. Which of the following are acceptable methods to thaw (defrost) beef?
   - In the refrigerator
   - On the counter
   - In cold water
   - In the microwave if it will be cooked right away
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   - Don't know

26. Meat and poultry that is not cooked well done is of relatively high risk to cause disease in which of the following groups?
   - The elderly
   - Young children
   - Pregnant women
   - Those infected with HIV/AIDS
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27. Which of the following is/are true of Salmonella?
   - Salmonella can infect a chicken by contact from one chicken to another.
   - Salmonella can infect a chicken from an infected mother hen to her unlayed chick.
   - Salmonella can NOT cause bloody diarrhea.
   - Salmonella causes an estimated 1.4 to 3 million cases and more than 500 deaths in the United States annually.
   - Don't know

Finally, please answer some questions about yourself.

28. Are you: □ Male or □ Female

29. How frequently do you participate in food preparation by yourself (without parental supervision)? (SELECT ONE ANSWER).
   - Never
   - Rarely
   - Sometimes
   - Often
   - Always

   - Never
   - Rarely
   - Sometimes
   - Often
31. If you answered ‘Never’ to both Question 29 and 30 then skip this question. How often do you do the following tasks while cooking in the kitchen?

<table>
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</table>

32. In the time period since the food safety unit was taught, is it true or false that you wash your hands for a longer period than you did before?

- True
- False
- Does not apply

33. If you responded that the time you spend washing your hands has increased in Q32, which of the following represents how long you DO wash your hands?

- 5 seconds
- 10 seconds
- 20 seconds
- Until you see bubbles
- Does not apply

34. If you responded that the time you spend washing your hands has increased in Q32, how often are you washing your hands for a longer period of time?

- All of the time since completing the unit
- Most of the time since completing the unit
- Sometimes since completing the unit
- Rarely since completing the unit

35. In the time period since the food safety unit was taught, is it true or false that you have been more careful to keep raw meat from contaminating other foods?

- True
- False
- Does not apply

36. If you responded that you have been more careful to avoid cross contamination in Q35, how often have you been more careful to prevent raw meat from contaminating other foods?

- All of the time since completing the unit
- Most of the time since completing the unit
37. In the time period since the food safety unit was taught, is it true or false that you have been more careful to cook raw meat to the proper temperature?

☐ True
☐ False
☐ Does not apply

38. If you responded that you have been more careful to cook meat to the proper temperature in Q37, how often have you been more careful to cook meat thoroughly?

☐ All of the time since completing the unit
☐ Most of the time since completing the unit
☐ Sometimes since completing the unit
☐ Rarely since completing the unit.

39. Did you talk to any family or friends about what you learned from this curriculum?

☐ Yes → EXPLAIN: ____________________________
☐ No

40. If you responded “Yes” to Q39, do you think that your friends/family learned anything new about food safety?

☐ Yes → EXPLAIN: ____________________________
☐ No
☐ Don’t know

41. If you responded “Yes” to Q39, do you think that any of your friends/family changed their behaviors regarding food safety?

☐ Yes → EXPLAIN: ____________________________
☐ No
☐ Don’t know

End of Survey

Thank you for your participation.
Instructions:
This is an evaluation to determine your opinion of the comic book and curriculum. The information provided is completely confidential and will not be shared with any link to students’ names.

Please answer the following questions about the comic book and curriculum.

1. Would you say you read some or all of the comic book?
   - [□] Some
   - [□] All

2. Did you re-read part or all of the comic book?
   - [□] No – EXPLAIN
   - [□] Yes, part of it – EXPLAIN
   - [□] Yes, all of it – EXPLAIN

3. Please tell me generally what is your opinion of the comic book and curriculum?
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

4. Did you enjoy reading or looking through the comic book, or did you not enjoy it?
   - [□] Yes, enjoyed the comic book
   - [□] No, did not enjoy the comic book

5a. Did you have any favorite sections or pages, or did you not have any favorite sections or pages?
   - [□] Yes, did have favorite sections / pages
   - [□] No, did not have favorite sections / pages → (SKIP TO Q6)

5b. Please tell me which sections or pages were your favorites, and why you liked them.
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
6. In your opinion, should high schools provide this comic book and curriculum to students, or should they not?
   - Yes, should provide
   - No, should not provide → EXPLAIN: ________________________________

7. Might any of your behaviors related to food change as a result of your being taught this curriculum?
   - Yes
   - No
   - Unsure

8. If you responded 'Yes' to the previous question, state what behaviors may change:
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

9. What were the most helpful or enjoyable parts of the curriculum? (SELECT ALL THAT APPLY.)
   - Reading the educational comic book
   - Completing the epidemiology work pages (pages 5-6 of the comic book)
   - The group analysis of the MMWR reports
   - The group presentation of the MMWR reports
   - Discussing the educational comic book as a class
   - None of the above

10. What would you change to make the curriculum better?
    _______________________________________________________________
     _______________________________________________________________
     _______________________________________________________________
     _______________________________________________________________
     _______________________________________________________________
Please respond to the following statements.

11. The information in the curriculum was taught in a manner that I could understand.
   - [ ] Strongly agree
   - [ ] Somewhat agree
   - [ ] Neither agree nor disagree
   - [ ] Somewhat disagree
   - [ ] Strongly disagree

12. The classroom activities helped me to better understand the concepts taught in the curriculum.
   - [ ] Strongly agree
   - [ ] Somewhat agree
   - [ ] Neither agree nor disagree
   - [ ] Somewhat disagree
   - [ ] Strongly disagree

13. The comic book and curriculum taught me new information about **food safety** that I did not know before.
   - [ ] Strongly agree
   - [ ] Somewhat agree
   - [ ] Neither agree nor disagree
   - [ ] Somewhat disagree
   - [ ] Strongly disagree

14. The comic book and curriculum taught me new information about **epidemiology** that I did not know before.
   - [ ] Strongly agree
   - [ ] Somewhat agree
   - [ ] Neither agree nor disagree
   - [ ] Somewhat disagree
   - [ ] Strongly disagree
APPENDIX J

Instructions:
This is an evaluation to determine your opinion of the comic book and curriculum. The information provided is completely confidential and will not be shared with any link your name.

Please answer the following questions about the comic book and curriculum.

3. Please state generally what is your opinion of the comic book and curriculum?

______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________

4. Please describe the planning process prior to introducing the curriculum to your class?

______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________

5. Did you think there was adequate time allowed to complete each activity?
   □ Yes, there was adequate time allowed
   □ No, there was not adequate time allowed → EXPLAIN: ________________________________

______________________________________________________________________________________________

6. Were all of the activities in the curriculum completed?
   □ Yes, all of the activities in the curriculum were completed
   □ No, all of the activities in the curriculum were not completed → EXPLAIN: ________________

______________________________________________________________________________________________

7. Did the students generally stay focused and interested throughout the curriculum?
   □ Yes, students stayed focused and interested throughout the curriculum
   □ No, students did not stay focused and interested throughout the curriculum

______________________________________________________________________________________________
8. Was there anything missing from the lesson plan that would be useful?

____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

9. What are your observations/comments/opinions regarding the student’s reaction to the comic book and curriculum?

____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

10. Do you have any other comments or recommendations about the curriculum?

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

9. In your opinion, should high schools provide this comic book and curriculum to students, or should they not?

☐ Yes, should provide
☐ No, should not provide → EXPLAIN: __________________________________________________________________________

10. How many years have you been a teacher?

__________ YEARS (record less than 1 year as an approximate proportion of a year, such as 0.5 for half a year)
# APPENDIX K

## National Outbreak Reporting System

**Foodborne Disease Transmission, Person-to-Person Disease Transmission, Animal Contact**

This form is used to report on foodborne, person-to-person, and animal contact related disease outbreak investigations. This form has 5 sections: General, Laboratory, Person to Person, Animal contact, and Food, as indicated by tabs at the top of each page. Complete the General and Laboratory tabs for all modes of transmission and complete additional sections as indicated by the mode of transmission. Please complete as much of all sections as possible.

### General Section

**Primary Mode of Transmission (check one)**

- [x] Food (Complete General, Lab, and Food tabs)
- [ ] Water (Complete CDC 52.12)
- [ ] Animal contact (Complete General, Lab, and Animal Contact tabs)
- [ ] Person-to-person (Complete General, Lab, and Person-to-Person tabs)
- [ ] Environmental contamination other than food/water (Complete General and Lab tabs)
- [ ] Indeterminate/Other/Unknown (Complete General and Lab tabs)

### Investigation Methods (check all that apply)

- [x] Interviews only of ill persons
- [x] Case-control study
- [x] Cohort study
- [x] Food preparation review
- [x] Water system assessment: Drinking water
- [x] Water system assessment: Nonpotable water
- [ ] Treated or untreated recreational water venue assessment
- [ ] Investigation at factory/production/treatment plant
- [ ] Investigation at original source (e.g., farm, water source, etc.)
- [ ] Food product or bottled water traceback
- [ ] Environment/food/water sample testing
- [ ] Other

Comments:

Two hundred eighty-four students and ten teachers were absent from UC college prep January 20-21, prompting this investigation.

### Dates (mm/dd/yyyy)

- Date first case became ill (required): 1/20/12
- Date of last case became ill: 1/21/12
- Date of initial exposure: 1/19/12
- Date of last exposure: 1/19/12
- Date of report to CDC (other than this form): 2/1/12

### Geographic Location

- Reporting state: **Illinois**
  - Exposure occurred in multiple states
  - Exposure occurred in a single state, but cases resided in multiple states
  - Other states:

- Reporting county: **Cook**
  - Exposure occurred in multiple counties in reporting state
  - Exposure occurred in a single county, but cases resided in multiple counties in reporting state
  - Other counties:

City/Town/Place of exposure: **Chicago**

Do not include proprietary or private facility names

### Primary Cases

<table>
<thead>
<tr>
<th>Number of Primary Cases</th>
<th>Sex (estimated percent of the primary cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td># Lab-confirmed cases</td>
<td>Male 48%</td>
</tr>
<tr>
<td># Probable cases</td>
<td>Female 52%</td>
</tr>
<tr>
<td># Estimated total primary ill</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># Cases</th>
<th>Total # of cases for whom info is available</th>
<th>Approximate percent of primary cases in each age group</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>294 &lt;1 year 20–49 years 34%</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>294 1–4 years 50–74 years 9%</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>294 5–9 years 75 years 3%</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>294 10–19 years 96.6% 6% Unknown</td>
<td></td>
</tr>
</tbody>
</table>
### General

**Incubation Period, Duration of Illness, Signs or Symptoms for Primary Cases only**

<table>
<thead>
<tr>
<th>Incubation Period (circle appropriate units)</th>
<th>Duration of Illness (among recovered cases—circle appropriate units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortest</td>
<td>Min, Hours, Days Shortest</td>
</tr>
<tr>
<td>Median</td>
<td>Min, Hours, Days Median</td>
</tr>
<tr>
<td>Longest</td>
<td>Min, Hours, Days Longest</td>
</tr>
<tr>
<td>Total # of cases for whom info is available</td>
<td>Total # of cases for whom info is available</td>
</tr>
</tbody>
</table>

- Unknown incubation period
- Unknown duration of illness

**Signs or Symptoms** *(refer to terms from appendix, if appropriate, to describe other common characteristics of cases)*

<table>
<thead>
<tr>
<th>Feature</th>
<th># Cases with signs or symptoms</th>
<th>Total # cases for whom info is available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vomiting</td>
<td>218</td>
<td>294</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>255</td>
<td>294</td>
</tr>
<tr>
<td>Bloody stools</td>
<td>94</td>
<td>294</td>
</tr>
<tr>
<td>Fever</td>
<td>129</td>
<td>294</td>
</tr>
<tr>
<td>Abdominal cramps</td>
<td></td>
<td>294</td>
</tr>
<tr>
<td>HUS</td>
<td>0</td>
<td>294</td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>0</td>
<td>294</td>
</tr>
</tbody>
</table>

### Secondary Cases

**Mode of Secondary Transmission (check all that apply)**

- Food
- Water
- Animal contact
- Person-to-person
- Environmental contamination other than food/water
- Indeterminate/Other/Unknown

<table>
<thead>
<tr>
<th>Number of Secondary Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td># Lab-confirmed secondary cases (A)</td>
</tr>
<tr>
<td># Probable secondary cases (B)</td>
</tr>
<tr>
<td>Total # of secondary cases</td>
</tr>
<tr>
<td>Total # of cases (Primary + Secondary)</td>
</tr>
</tbody>
</table>

**Environmental Health Specialists Network (if applicable)**

| EHS-Net Evaluation ID: 1 | 2 | 3 |

**Traceback (for food and bottled water only, not public water)**

- Please check if traceback conducted

<table>
<thead>
<tr>
<th>Source name (if publicly available)</th>
<th>Source type (e.g., poultry farm, tomato processing plant, bottled water factory)</th>
<th>Location of source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>Country</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Recall

- Please check if any food or bottled water product was recalled

<table>
<thead>
<tr>
<th>Type of item recalled:</th>
<th>Comments:</th>
</tr>
</thead>
</table>

### Reporting Agency

<table>
<thead>
<tr>
<th>Agency name:</th>
<th>E-mail:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact name:</td>
<td>Contact title:</td>
</tr>
<tr>
<td>Phone no.:</td>
<td>Fax no.:</td>
</tr>
</tbody>
</table>

**Remarks**: Briefly describe important aspects of the outbreak not covered above. Please indicate if any adverse outcomes occurred in special populations (e.g., pregnant women, immunocompromised persons)
### Laboratory Section

- **Etiology known?**
  - □ Yes
  - ☑ No

- **If etiology is unknown, were patient specimens collected?**
  - ☑ Yes
  - □ No
  - □ Unknown

  - **If yes, how many specimens collected? (provide numeric value)**
    - 13

- **What were they tested for? (check all that apply)**
  - ☑ Bacteria
  - ☑ Chemicals/Toxins
  - ☑ Viruses
  - ☑ Parasites

### Etiology

*Name the bacterium, chemical/toxin, virus, or parasite. If available, include the serotype and other characteristics such as Phage type, virulence factors, and metabolic profile. Confirmation criteria available at [http://www.cdc.gov/foodborneoutbreaks/guide_1d.htm](http://www.cdc.gov/foodborneoutbreaks/guide_1d.htm) or [MMWR2000/Vol. 49/SS-1/App. B)*

<table>
<thead>
<tr>
<th>Genus</th>
<th>Species</th>
<th>Serotype</th>
<th>Confirmed outbreaks</th>
<th>Other Characteristics</th>
<th>Detected in*</th>
<th># Lab-confirmed cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>☑ yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>☑ yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>☑ yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Detected in (choose all that apply): 1. patient specimen 2. food specimen 3. environment specimen 4. food worker specimen*

### Isolates

*For bacterial pathogens, provide a representative for each distinct pattern; provide lab ID for all specimens submitted for virulence/sequencing.*

<table>
<thead>
<tr>
<th>State Lab ID</th>
<th>PulseNet Outbreak Code</th>
<th>CDC PulseNet Pattern Designation for Enzyme 1</th>
<th>CDC PulseNet Pattern Designation for Enzyme 2</th>
<th>Other Molecular Designation</th>
<th>Other Molecular Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Person to Person

#### Major setting of exposure (choose one)

- □ Camp
- □ Child day care
- □ Community-wide
- □ Hospital

- □ Hotel
- □ Nursing home
- □ Prison or detention facility
- □ Other, please specify:

- □ Private setting (residential home)
- □ Religious facility
- □ Restaurant

- □ School
- □ Ship
- □ Workplace

#### Attack rates for major settings of exposure

<table>
<thead>
<tr>
<th>Group (based on setting)</th>
<th>Estimated exposed in major setting*</th>
<th>Estimated ill in major setting</th>
<th>Grade attack rate (estimated ill / estimated exposed x 100)</th>
</tr>
</thead>
</table>

residents, guests, passengers, patients, etc.

staff, crew, etc.

*Note: number of persons on ship, number of residents in nursing home or affected ward

#### Other settings of exposure (choose all that apply)

- □ Camp
- □ Child day care
- □ Community-wide
- □ Hospital

- □ Hotel
- □ Nursing home
- □ Prison or detention facility
- □ Other, please specify:

- □ Private setting (residential home)
- □ Religious facility
- □ Restaurant

- □ School
- □ Ship
- □ Workplace

### Animals and their environment

#### Setting of exposure

<table>
<thead>
<tr>
<th>Type of animal</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

*CDC-52-12 Rev. 10-2008*

*Yarnell Outbreak Reporting District*
**APPENDIX K (continued)**

### Food-specific data

<table>
<thead>
<tr>
<th>Food vehicle undetermined</th>
<th>Total # of cases exposed to implicated food</th>
<th>294</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Food</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of food</td>
<td>Taco Salad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingredient(s)</td>
<td>Lettuce, tortilla chips, cheese, ground beef</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contaminated ingredients</td>
<td>Lettuce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reason(s) suspected (enter all that apply)</td>
<td>Food handler who prepared lettuce later required being ill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method of processing (enter all that apply)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method of preparation (select one from list in appendix)</td>
<td>Chopped and served raw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of preparation (select one from list in appendix)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contaminated food imported to US?</td>
<td>Yes, Country</td>
<td>Yes, Country</td>
<td>Yes, Country</td>
</tr>
<tr>
<td></td>
<td>Yes, Unknown</td>
<td>Yes, Unknown</td>
<td>Yes, Unknown</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Was product both produced under domestic regulatory oversight and sold?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Location where food was prepared (Check all that apply)

- Restaurant – ‘Fast-food’ (drive up service or pay at counter)
- Nursing home, assisted living facility, home care
- Restaurant – ‘Fast-food’ (drive up service or pay at counter)
- Nursing home, assisted living facility, home care
- Restaurant – Sit-down dining
- Hospital
- Restaurant – Sit-down dining
- Hospital
- Restaurant – Other or unknown type
- Child day care center
- Restaurant – Other or unknown type
- Child day care center
- Private home
- School
- Private home
- School
- Banquet Facility (food prepared and served on-site)
- Prison, jail
- Banquet Facility (food prepared and served on-site)
- Prison, jail
- Carterer (food prepared off-site from where served)
- Church, temple, religious location
- Carterer (food prepared off-site from where served)
- Church, temple, religious location
- Fair, festival, other temporary or mobile services
- Camp
- Fair, festival, other temporary or mobile services
- Camp
- Grocery store
- Picnic
- Grocery store
- Picnic
- Workplace, not cafeteria
- Other (describe in Prepared/Remarks)
- Workplace, not cafeteria
- Other (describe in Eaten/Remarks)
- Workplace cafeteria
- Unknown
- Workplace cafeteria
- Unknown

#### Location of exposure (where food was eaten) (Check all that apply)

- Restaurant – ‘Fast-food’ (drive up service or pay at counter)
- Nursing home, assisted living facility, home care
- Restaurant – ‘Fast-food’ (drive up service or pay at counter)
- Nursing home, assisted living facility, home care
- Restaurant – Sit-down dining
- Hospital
- Restaurant – Sit-down dining
- Hospital
- Restaurant – Other or unknown type
- Child day care center
- Restaurant – Other or unknown type
- Child day care center
- Private home
- School
- Private home
- School
- Banquet Facility (food prepared and served on-site)
- Prison, jail
- Banquet Facility (food prepared and served on-site)
- Prison, jail
- Carterer (food prepared off-site from where served)
- Church, temple, religious location
- Carterer (food prepared off-site from where served)
- Church, temple, religious location
- Fair, festival, other temporary or mobile services
- Camp
- Fair, festival, other temporary or mobile services
- Camp
- Grocery store
- Picnic
- Grocery store
- Picnic
- Workplace, not cafeteria
- Other (describe in Prepared/Remarks)
- Workplace, not cafeteria
- Other (describe in Eaten/Remarks)
- Workplace cafeteria
- Unknown
- Workplace cafeteria
- Unknown

#### Remarks:

- | Remarks: | |
- | | |

*Note: The document contains additional text and tables that are not fully visible in the image.*
## APPENDIX K (continued)

### Contributing Factors (Check all that contributed to this outbreak)

<table>
<thead>
<tr>
<th>Contamination Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ C1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proliferation/Amplication Factor (bacterial outbreaks only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ P1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Survival Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ S1</td>
</tr>
</tbody>
</table>

### The confirmed or suspected point of contamination (Check one)

- □ Before preparation  ✔ Preparation
- If before preparation: □ Pre-Harvest  □ Processing  □ Unknown

### Reason suspected (Check all that apply)

- □ Environmental evidence
- □ Laboratory evidence
- □ Epidemiologic evidence  ✔ Prior experience makes this a likely source

### Was food-worker implicated as the source of contamination?  ✔ Yes  □ No

If yes, please check only one of the following

- □ Laboratory and epidemiologic evidence
- □ Epidemiologic evidence
- □ Laboratory evidence  ✔ Prior experience makes this a likely source

### School Questions

COMPLETE THIS SECTION ONLY IF SCHOOL IS CHECKED IN EITHER SECTIONS "LOCATION WHERE FOOD WAS PREPARED" OR "LOCATION OF EXPOSURE (WHERE FOOD EATEN)"

1. Did the outbreak involve a single or multiple schools?  ✔ Single  □ Multiple (If yes, number of schools ___)

2. School characteristics (for all involved students in all involved schools)
   a. Total approximate enrollment □ 23 (number of students)
   □ Unknown or undetermined
   b. Grade level(s)
      □ Preschool
      ✔ Grade school (grades K-12)
   Please check all grades affected:
      □ K  □ 1st  □ 2nd  □ 3rd  □ 4th  □ 5th  □ 6th  □ 7th  □ 8th  □ 9th  □ 10th  □ 11th  □ 12th
   □ College/university/technical school
   □ Unknown or Undetermined
   c. Primary funding of involved schools
      ✔ Public
      □ Private
      □ Unknown

3. Describe the preparation of the implicated item:
   ✔ Heat and serve (item mostly prepared or cooked off site, reheated on-site)
   □ Served a-la-carte
   □ Served only (preheated or served cold)
   □ Cooked on-site using primary ingredients
   □ Provided by a food service management company
   □ Provided by a fast-food vendor
   □ Provided by a pre-plate company
   □ Part of a club or fundraising event
   □ Made in the classroom
   □ Brought by a student/teacher/parent
   □ Other (describe in General/Remarks)
   □ Unknown or Undetermined

4. How many times has the state, county or local health department inspected this school cafeteria or kitchen in the 12 months before the outbreak?  ✔ Once  □ Twice  □ More than two times  □ Not inspected  □ Unknown or Undetermined

5. Does the school have a HACCP plan in place for the school feeding program?  ✔ Yes  □ No  ✔ Unknown or Undetermined

*If multiple schools are involved, please answer according to the most affected school
### Food

6. Was implicated food item provided to the school through the National School Lunch/Breakfast Program? [ ] Yes [ ] No [X] Unknown or Undetermined

If yes, was the implicated food item donated/purchased by:
- [ ] USDA through the Commodity Distribution Program
- [ ] The state/school authority
- [ ] Other (describe in General/Remarks)
- [X] Unknown or Undetermined

### Ground Beef

1. What percentage of ill persons (for whom information is available) ate ground beef raw or undercooked?

2. Was ground beef case-ready?  [ ] Yes  [ ] No  [ ] Unknown

(Case-ready ground beef is meat that comes from a manufacturer packaged for sale that is not altered or repackaged by the retailer)

3. Was the beef ground or reground by the retailer?
   - [ ] Yes
   - [ ] No
   - [ ] Unknown

If yes, was anything added to the beef during grinding (such as trim or any product to alter the fat content)?

### Additional Salmonella Questions

(Complete this section for Salmonella outbreaks)

1. Phage type(s) of patient isolates:
   - If RDNC* then include #
   - If RDNC* then include #
   - If RDNC* then include #
   - If RDNC* then include #

* Reacts, Does Not Conform

### Eggs

1. Were eggs (check all that apply)
   - [ ] in shell, unpasteurized?
   - [ ] in shell, pasteurized?
   - [ ] packaged liquid or dry?
   - [ ] stored with inadequate refrigeration during or after sale?
   - [ ] consumed raw?
   - [ ] consumed undercooked?
   - [ ] pooled?

2. Was Salmonella enteritidis found on the farm?  [ ] Yes  [ ] No  [ ] Unknown

Comment (e.g., eggs and patients isolates matched by phage type):
CITED LITERATURE


Institute of Food Research. "*Salmonella*." Transmission Electron Microscope Image. 3 Nov. 2011.


Takeuchi, M. 2006. “Now you’re cooking… using a food thermometer” brochure (updated), Washington State University Extension, Pullman, WA and University of Idaho Extension, Moscow, ID.


VITA

NAME: Anne Jeanette Burke

EDUCATION: B.S., Zoology-Biomedical Sciences, magna cum laude, University of Oklahoma, Norman, Oklahoma, 2010.

M.S., Epidemiology, University of Illinois at Chicago, Chicago, Illinois, 2013.

HONORS: Phi Beta Kappa, University of Oklahoma, Norman, Oklahoma, 2011.


Congressional Award Gold Medal Recipient, 2009.


PROFESSIONAL MEMBERSHIPS

Golden Key International Honor Society
American Public Health Association
International Association for Food Protection

PROFESSIONAL PRESENTATIONS/ABSTRACTS

Burke, A., M. Manes, L. Liu, and M. S. Dworkin. Do restaurant food handler knowledge gaps predict violations identified during inspections?
Poster session presented at: 7th Annual School of Public Health Research and Practice Awards Day; 2012 April 3; Chicago, Illinois and 76th Annual Meeting of the National Environmental Health Association; 2012 June 28–30; San Diego, California.

Manes, M., A. Burke, L. Liu, and M. S. Dworkin. Lessons learned recruiting restaurant food handlers to participate in a food safety survey: implications for future research. Poster session presented at: 100th Annual Meeting of the International Association of Food Protection; 2011 July 31–August 3; Milwaukee, Wisconsin.

PROFESSIONAL PRESENTATIONS/
ABSTRACTS (CONTINUED)

Burke, A. The prevalence of the raccoon roundworm (*Baylisascaris procyonis*) in juvenile raccoons (*Procyon lotor*) in central Oklahoma. Powerpoint presentation presented at: University of Oklahoma Honors College thesis defense; 2010 August 3; Norman, Oklahoma.

Burke, A. The potential role of the brown-headed cowbird (*Molothrus ater*) in the transmission of the gulf coast tick (*Ambylomma maculatum*). Powerpoint presentation presented at: University of Oklahoma Honors College Undergraduate Research Day; 2010 March 27; Norman, Oklahoma.