Food Safety Educational Intervention Positively Influences College Students' Food Safety Attitudes, Beliefs, Knowledge, and Self-Reported Practices

Linda Yarrow, Ph.D., R.D./L.D., CDE
Valentina M. Remig, Ph.D., R.D., F.A.D.A.
Mary Meck Higgins, Ph.D., R.D./L.D., CDE

Abstract

In this study, the authors evaluated college students' food safety attitudes, beliefs, knowledge, and self-reported practices and explored whether these variables were positively influenced by educational intervention. Students (n = 59), were mostly seniors, health or non-health majors, and responsible for meal preparation. Subjects completed a food safety questionnaire (FSQ) prior to educational intervention, which consisted of three interactive modules. Subjects completed module pre-, post-, and post-posttests. The FSQ was also administered after exposure to intervention and five weeks later to determine changes in food safety attitudes, beliefs, knowledge, and self-reported practices. Students' FSQ attitude scores increased from 114 to 122 ($p \leq .001$); FSQ belief and knowledge scores improved from 86 to 98 ($p \leq .001$) and from 11 to 13 ($p \leq .001$), respectively. Food safety knowledge was also measured by module pre- and posttests, and improved significantly after intervention for all students, with health majors having the greatest increase. Intervention resulted in improved food safety self-reported practices for health majors only. The educational intervention appeared effective in improving food safety beliefs and knowledge. For health majors, attitudes and some self-reported practices improved. For all areas, the strongest effects were seen in health majors.

Introduction

Foodborne illness is a major health threat in the United States, resulting in economic burdens for individuals and their employers and in severe cases, even death. Statistics support the seriousness of the threat. Each year, foodborne illnesses cause an estimated 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths in the United States (Mead et al., 1999).

Limited research about college students has been published describing their risk of foodborne illness. Previous research has primarily focused on the general population and food industry (Altekruse, Street, Fein, & Levy, 1995; American Dietetic Association, 2003; Cody & Hogue, 2003; Food Safety and Inspection Service [FSIS], 2002; Redmond & Griffith, 2003). Within the limited data focusing on college students, food safety researchers concluded that undergraduate students engage in unsafe practices, including risky food handling and food consumption (Li-Cohen & Bruhn, 2002; Morrone & Rathbun, 2003; Unklesbay, Sneed, & Toma, 1998). A search of the scientific literature found no studies that provided food safety education intervention to improve food safety behaviors of college students.

One purpose of this study was to explore relationships among food safety attitudes, beliefs, knowledge, and self-reported practices of current college students in health and non-health majors. An additional purpose was to determine whether an educational intervention could improve variables of interest.

Methods

Subjects

Approval was obtained from the university's Institutional Review Board for Research Involving Human Subjects before commencing the research. Seventy-one college students initiated participation with 59 college students, 38 females and 21 males aged 21–49 years, voluntarily completing all required steps. Subjects with non-health majors had a higher drop-out rate from the study, with 21 of 32 completing all components of the research compared to 38 of 39 health majors. Data were eliminated for the students who did not view the educational modules (i.e., planned intervention). Students were recruited by in-class invitations. The stu-

TABLE 1

Characteristics of Subjects, Health Majors vs. Non-Health Majors

Characteristics of Subjects	Major		X^2	*p*-Value
	Health Majors (n = 38)	Non-Health Majors (n = 21)		
Held job as a food server such as waiter or waitress	29	15	0.17	.68
Held job as a food preparer (cook)	24	8	3.42	.064
Food safety certification	22	6	4.66	.031
Average # meals prepared/week	6-10 (n = 16)	1-5 (n = 13)		
Average # college nutrition courses completed	2 or more (n = 36)	0 (n = 14)		
Average # college food science courses completed	1 (n = 17)	0 (n = 18)		
Average # college microbiology courses completed	0 (n = 31)	0 (n = 20)		

dents were seniors, plus one graduate student, living in a house or apartment rather than residence halls or Greek housing. Health majors were enrolled in Human Nutrition 630 (Clinical Nutrition) and non-health majors were enrolled in Mass Communications 645 (Public Relations Campaigns).

Questionnaire Administration and Scoring

A food safety questionnaire (FSQ) previously used by this research team to conduct a telephone survey with older adults was adapted for use with college students. The majority of questions were taken from a preexisting validated scale developed by Medeiros and coauthors (Medeiros, Kendall, Hillers, Chen, & DiMascola, 2001). The university survey system, an online platform for conducting surveys, was used to administer the FSQ. Study participants completed the FSQ three times: preintervention (prior to viewing educational food safety modules), postintervention (up to one week after module completion), and post-postintervention (five weeks after module completion).

The survey questions were grouped by the evaluated dependent variables: food safety attitudes, beliefs, and knowledge, and self-reported practices to include high-risk food intake. Index scales were developed to determine a score for each of the variables. Index score ranges were: attitudes (21–147), beliefs (17–119), knowledge (0–14), three-point self-reported practices scale (9–27), and high-risk food intake (13–39).

Intervention

Interactive instructional materials were developed and pilot tested. A lesson-building program that lets the user create engaging, interactive Web lessons was used (Softchalk, 2002). The three educational 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. Each module was designed to require 30–60 minutes for completion, followed by a posttest lasting 10–15 minutes. Delivering instruction in an online format gave students flexibility in when and where they completed the modules. Previous focused food safety discussions held with other junior- and senior-level college students contributed to decisions about which food safety topics were included and emphasized in the educational modules.

Module One provided a food safety overview with incidence and prevalence of foodborne illnesses in the United States, emerging and common pathogens, and recommended food handling guidelines. Module Two presented a brief review of food safety literature and information on common food safety beliefs, knowledge, and food handling practices. The use of food thermometers, popular attitudes about food safety, and information about industry requirements and standards were also included. Module Three focused on older adults' foodborne illness risks and preferred food safety handling practices.

Pre-, post-, and post-postmodule tests assessed food safety knowledge, using multiple choice, true/false, or rank option questions. Students completed a pretest (active online for two days) prior to viewing each online module, which was active for one week. During the last two days that the module was available for viewing, a posttest was activated via the survey system. Additional post- and post-postmodule questions assisted researchers in evaluating students' self-reported behaviors. Students answered behavior change questions during the postmodule test and a second time with the post-postquestionnaire five weeks after completion of modules.

Statistical Analyses

The majority of FSQ response options were seven-point Likert scales with assigned values. When Likert scales included a response of *not applicable*, those responses were not used in analysis. Some response scales included *don't know* as an option. Since a response of *don't know* on the consumption of high-risk foods scale indicated some risk (e.g., students might eat rare hamburger, which may put them unknowingly at foodborne illness risk), this response was scored to represent risk.

FSQ responses were analyzed for each administration: Time 1 (preintervention), Time 2 (postintervention), and Time 3 (five week post-postintervention). Results of the intervention pre-, post-, and post-postmodule tests were also analyzed. Response frequencies resulted in nonnormal distributions. The small sample size, nonnormal distributions, and high predominance of ordinal information supported the use of nonparametric testing. Statistical analyses used Wilcoxin Signed Rank, Friedman, Mann-Whitney *U*, McNemar, Cochran Q, Chi-square, and Spearman's rho tests. To test internal consistency reliability of the FSQ, Cronbach's alpha was performed for each index.

Results

Characteristics of the subjects are presented in Table 1. The number of participants who held food safety certification was significantly different according to their major. Fifty-eight percent of health majors were certified compared to just 29% of the non-health students (p = .03). These differences were not surprising since for the health majors, food safety certification was required in one of their previous classes.

Index scores for the total group were analyzed for comparison over time, before and after food safety educational intervention.

As a group, students' food safety attitudes improved from 114.5 to 122.2 out of 147 possible ($p \leq .001$) from pretest to post-posttest. The reported changes can be attributed to improvements in health majors' FSQ attitude scores, which increased ($p \leq .001$) from preintervention to post-postintervention, while non-health majors did not show improvement. Attitude questions were also examined individually. The most significant changes occurred between pre- and postintervention. Students from both groups became more concerned about eating eggs that did not have firm yolks ($p \leq .001$), drinking unpasteurized apple juice ($p \leq .001$), eating alfalfa sprouts ($p \leq .001$), eating hotdogs right out of the package ($p \leq .001$), thawing perishable foods on the counter ($p = .001$), and not refrigerating foods such as rice and beans ($p = .007$).

Students' FSQ belief index scores increased from 85.8 to 97.6 of 119 ($p \leq .001$) from Time 1 to Time 3, representing more positive food safety beliefs after intervention. When belief questions were examined individually, three beliefs had the strongest change. Students' mean rating of the statement, "If I follow safe food handling practices, my chances of sickness would decrease," increased from 1.4 (strongly disagree) to 6.7 (strongly agree) ($p \leq .001$). After intervention, students also indicated belief that they were more likely to get sick if they did not wash their hands prior to cooking ($p \leq .001$) and if they left cooked food out of the refrigerator for more than two hours ($p = .005$). Students exhibited increased belief that eating or handling raw sprouts ($p \leq .001$), raw vegetables ($p \leq .001$), raw beef ($p = .011$), raw chicken ($p = .035$), and raw shellfish ($p = .049$) could be harmful to health. Students became less concerned with risks associated with raw fruits ($p = .004$). Students also increased in the belief that it was common for people in the United States to become sick because of the way that food is prepared or handled in the home ($p = .001$) and that contamination of food by microorganisms was a greater problem than previously recognized ($p \leq .001$). As subgroups, both health majors ($p \leq .001$) and non-health majors ($p = .018$) increased in belief scores. Non-health majors significantly increased ($p \leq .001$) in the belief that the home was a primary source of foodborne illness.

Immediately after intervention, students' FSQ score for total knowledge increased ($p \leq .001$), with scores changing from 11.2 to 12.6 out of 14 possible points. The most significant changes were found in responses to four questions. More students became aware that they should not prepare food for others if they have diarrhea (correct responses increased from 49% to 88%). Students learned that hamburger patties should be cooked to an internal temperature of 160°F (correct responses increased from 39% to 64%). Students also increased in knowledge that cooking egg yolks and whites until firm killed harmful organisms (61% correct increased to 81%). Finally, students learned that nonpink hamburger meat does not guarantee safeness to eat (75% correct increased to 93%). As subgroups, both health and non-health majors had increased FSQ knowledge scores ($p \leq .001$) for each group from preintervention to post-postintervention.

Self-reported safe food practices became more frequent. Scores increased from 19 to 21 of 27 possible points ($p = .001$). Specifically, students became less likely to prepare food for others if they had diarrhea ($p \leq .001$), and more likely to use food thermometers ($p = .01$). The reported changes can be attributed to the health majors' improvement in not preparing food for others if they had diarrhea ($p = .002$), thermometer use ($p = .006$), and not leaving cooked items out for use later in the day ($p = .046$) such as at a buffet or party. As a subgroup, non-health majors did not improve in self-reported practices. As a total group and subgroups, no significant changes occurred among the students' self-reported practices for food sanitation, hygiene, storage, thawing, or high-risk food intake.

Index scores were compared between groups. Health majors scored higher than non-health majors for all indices for each time period (Table 2) except for high-risk food intake. The strongest differences were for food

TABLE 2

Comparison of Health and Non-Health Students' Food Safety Index Scores for 5 Variables for Time 1, Time 2, Time 3[a]

Variable	Index Scores					
	Mean ± Standard Deviation			*p*-Value		
	Time 1	Time 2	Time 3	Time 1	Time 2	Time 3
Attitude				≤.001	≤.001	≤.001
Health	120.3 ±11.4	128.7 ±14.9	130.8 ± 9.0			
Non-health	104.0 ± 13.8	108.8 ± 16.5	106.6 ± 21.9			
Beliefs				.030	.004	.003
Health	87.9 ± 10.5	100.3 ± 9.3	100.8 ± 9.9			
Non-health	82.1 ± 7.4	88.7 ± 15.8	92.0 ± 11.8			
Knowledge				.001	.002	≤.001
Health	11.8 ± 1.9	13.1 ± 1.0	13.1 ± 0.9			
Non-health	10.2 ± 1.7	11.6 ± 2.3	11.7 ±1.6			
SRP[b] 3 pt. scale				.001	≤.001	≤.001
Health	20.2 ± 3.0	21.9 ± 2.7	22.9 ± 2.7			
Non-health	18.0 ± 2.5	18.1 ± 3.3	14.62 ± 3.2			
High-risk food intake				.146	.086	.101
Health	33.4 ± 3.8	34.2 ± 3.9	34.5 ± 3.7			
Non-health	31.9 ± 4.5	32.6 ± 4.0	33.0 ± 3.7			

Note. $N = 38$ health and 21 non-health majors.
[a] Time 1 = preintervention, Time 2 = postintervention, and Time 3 = post-postintervention.
[b] SRP = Self-reported practices, including thermometer use.

TABLE 3

Comparison of Health Majors' and Non-Health Majors' Average Module Knowledge Test Score

Modules	Health	Non-Health	*p*-Value
	Mean ± Standard Deviation		
Module 1 average score			
Time 1	39.7 ± 13.5	40.8 ± 12.9	.854
Time 2	77.4 ± 18.2	46.9 ± 17.5	≤.001
Time 3	55.5 ± 14.9	40.9 ± 13.7	≤.001
Module 2 average score			
Time 1	44.3 ± 12.6	35.0 ± 9.1	.025
Time 2	82.5 ± 14.5	46.8 ± 19.0	≤.001
Time 3	55.9 ± 13.6	38.1 ± 13.8	.001
Module 3 average score			
Time 1	55.0 ± 12.3	49.9 ± 16.9	.587
Time 2	78.0 ± 10.7	62.1 ± 44.3	.021
Time 3	64.4 ± 13.6	52.8 ± 14.8	.009

Note. $N = 38$ health, 21 non-health majors; Time 1 = preintervention, Time 2 = postintervention, and Time 3 = post-postintervention.

safety attitudes and self-reported food safety practices, with health majors scoring much higher at all three time periods ($p \leq .001$).

The strongest relationships among the indices of attitudes, beliefs, knowledge, and self-reported practices were between Time 2 and Time 3 for food safety attitudes and beliefs. Those students who had more positive food safety beliefs also had more positive food safety attitudes immediately after educational intervention (r [39] = .63, $p \leq .001$). The effect size is larger to much larger than typical (per Cohen's [1988] guidelines). Forty-three percent of the variance in food safety beliefs at Time 2 was predicted by food safety attitudes. For Time 3, the correlation direction was again positive (r [42] = .74, $p \leq .001$), with effect size being much larger than typical. Food safety attitudes predicted 55% of the variance in food safety beliefs at Time 3.

Improvements in educational module knowledge scores after intervention were found for all three food safety modules (Table 3). On a scale of 1–100, Module One mean scores increased from 40.1 to 66.5 ($p \leq .001$). For Module Two, mean scores increased from 41.0 to 69.8 ($p \leq .001$). For Module Three, mean scores increased from 53.2 to 72.3 ($p < .001$).

Health majors had significantly higher module test scores than non-health majors, except for Module One pretest and Module Three pretest. While all mean scores dropped from the postintervention to the post-postintervention measurement, they remained higher than the preintervention scores ($p \leq .001$). This result can be attributed to health majors' knowledge scores, which at post-postintervention dropped but were still higher than preintervention scores. Knowledge scores for non-health majors dropped at post-postintervention, with no scores higher than preintervention scores, indicating they did not retain the newly acquired information.

A notable distinction between the groups was the amount of time students spent completing the modules. Approximately three-fourths of non-health majors spent 30 minutes or less on each educational module, while all health majors spent 30 minutes to two hours. Health majors also referred back to the educational materials while completing posttests, unlike non-health majors. Both groups had equal access to materials during posttests. Health majors strongly indicated that the module information was important to their future profession (74%) compared to non-health majors (9.5%).

Effectiveness of educational content was supported when students indicated they could *likely* achieve most of the module objectives. Students also reported that the interactive educational programs and variety of learning activities enhanced their learning and understanding. Students indicated the Web-based delivery was convenient and that they would recommend this type of course material presentation to other students.

Discussion

Relationships among attitudes, beliefs, knowledge, and self-reported practices of college students before and after food safety education intervention were explored in a nonrepresentative small sample of college students. A review of literature found one other study that focused specifically on food safety knowledge of college students (Unklesbay, Sneed, & Toma, 1998). In that study, health majors scored higher than non-health majors, a finding that was supported in this research.

The educational intervention led the college health majors to have more positive attitudes concerning food safety practices. Measuring food safety attitudes is important, since, according to the *Theory of Planned Behavior* (Aizen, 2006), people act in accordance with their intentions, and intentions are influenced by attitudes. Thus, improving college students' attitudes about food safety may be a first step towards influencing their food safety behaviors. Indeed, two of their self-reported food practices did improve for this group. Health majors reported decreased consumption of some high-risk foods and reported increased usage of thermometers, both of which are important practices to prevent foodborne illness (FSIS, 2007).

The educational modules had a positive impact on food safety knowledge, as all scores increased immediately after intervention. At post-postintervention, however, non-health majors' food safety knowledge showed no improvement, indicating they did not retain newly acquired information five weeks after intervention. Regarding how individuals learn, the *Constructivism Theory* states that the learner constructs or builds new ideas or concepts based upon past knowledge and past experiences (Bush, 2006). In this case, non-health students had the least food safety exposure and training prior to educational intervention, which may have limited their ability to learn food safety concepts. Similarly, although health majors had received

food safety information in previous college courses, FSQ and premodule test scores indicated that much of this type of information was not retained. Our results indicate that consideration should be given to providing a review of food safety information in upper-level courses for health majors.

Previous research has indicated that knowledge does not always correspond to improved food safety behaviors (Redmond & Griffith, 2003). This finding was supported in the current study. Even after their food safety beliefs and knowledge improved with exposure to the study's educational intervention (which emphasized importance of checking end-point temperatures of leftovers and meat items in particular), non-health majors were not more inclined to use thermometers or decrease consumption of risky foods. The *Behaviorism Theory* states that behaviors will increase or decrease based upon positive or negative reinforcement (Bush, 2006). If students do not recognize positive reinforcements associated with proper food handling techniques, such as good health, or do not recognize negative reinforcements, such as diarrhea or vomiting related to foodborne illness, then they may not be motivated to change.

Several theoretical frameworks addressing relationships between attitudes and behaviors have been described (Ajzen, 2001; Crano, 2005; Petty, 1997). Resistance to behavioral change is likely related to attitude strength or attitude ambivalence or both. While food safety attitudes became more positive in this study, they may not have become strong enough to facilitate more behavior change. Even when attitudes change, the new attitude overrides but may not replace the old attitude, which is habitual (Ajzen, 2001).

Potential weaknesses of the current study include internal validity threats related to testing and mortality (drop-out rate). Students may have become sensitized to food safety issues due to repeated multiple testing (although both groups had the same exposures), and the non-health majors had a higher drop-out rate. Possible external validity threats include interaction of testing and treatment (intervention). All subjects received intervention in the same order but performance from earlier treatment could have affected test performance from later treatment. Reactivity could also pose a threat because incentive to complete all required steps may have differed between health and non-health majors. Other possible validity threats were assessed and found to not be a concern. No significant outbreaks of foodborne illness were reported nationally or locally during the study, and no major local news articles discussed food safety issues. The subjects did not mature at different rates and were not tested differently (Jones, 1996).

Conclusion

This research has demonstrated that an interactive food safety education intervention resulted in improved food safety knowledge and beliefs for college students. The strongest effects were seen in students who described that food safety principles were important to their future professions, i.e., health majors. Educational intervention resulted in health majors' improvement in food safety attitudes and in the self-reported practices of thermometer use and consumption of some high-risk foods, and not preparing food for others when diarrhea was present. The interactive educational modules were received positively by both groups of students and this type of educational program can be considered a valuable tool for food safety education of college students.

Because college students' behaviors place them at increased risk for foodborne illness, educational interventions, such as the one developed for this study, are needed. Many college students are preparing meals for themselves and others for the first time. Additionally, many students represent future practicing professionals responsible for delivery of food safety education to the public. College students will benefit from exposures to safe food handling instruction and effective practices for preventing foodborne illnesses. Additional research is needed to better examine specific barriers to changing food safety behaviors of college students.

Corresponding Author: Linda Yarrow, Instructor, Kansas State University, Dept. of Human Nutrition, 255 Justin Hall, Manhattan, KS 66506-1407. E-mail: lyarrow@ksu.edu.

REFERENCES

Aizen, I. (n.d.) *Theory of planned behavior.* Retrieved January 25, 2006, from http://www-unix.oit.umass.edu/~aizen/tpb.diag.html

Ajzen, I. (2001). Nature and operation of attitudes. *Annual Review of Psychology, 52,* 27–58.

Altekruse, S.F., Street, D.A., Fein, S.B., & Levy, A.S. (1995). Consumer knowledge of foodborne microbial hazards and food-handling practices. *Journal of Food Protection, 59*(3), 287–294.

American Dietetic Association. (2003). Food and water safety. *Journal of the American Dietetic Association, 103*(9), 1203–1218.

Bush, G. (2006). Learning about learning: From theories to trends. *Teacher Librarian, 34*(2), 14.

Cody, M.M., & Hogue, M.A. (2003). Results of the home food safety—it's in your hands 2002 survey: Comparisons to the 1999 benchmark survey and healthy people 2010 food safety behavior objectives. *Journal of the American Dietetic Association, 103*(9), 1115–1125.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Crano, W.D. (2005). Attitudes and persuasion. *Annual Review of Psychology, 57,* 345–374.

Food Safety and Inspection Service, U.S. Department of Agriculture. (n.d., updated March 16, 2007). *Kitchen thermometers.* Retrieved May 17, 2007, from http://www.fsis.usda.gov/Fact_Sheets/Kitchen_Thermometers/index.asp

Food Safety and Inspection Service, U.S. Department of Agriculture. (2002). *PR/HACCP rule evaluation report: Changes in consumer knowledge, behavior, and confidence since the 1996 PR/HACCP final rule.* Retrieved March 15th, 2006, from http://www.fsis.usda.gov/oa/research/behavior_haccp.htm

Jones, R.A. (1996). *Research methods in the social and behavioral sciences* (2nd ed.). Sunderland, MA: Sinauer Associates.

REFERENCES

Li-Cohen, A.E., & Bruhn, C.M. (2002). Safety of consumer handling of fresh produce from the time of purchase to the plate: A comprehensive consumer survey. *Journal of Food Protection, 65*(8), 1287–1296.

Mead, P., Slutsker, L., Dietz, V., McCaig, L., Bresee, J., Shapiro, C., Griffin, P., & Tauxe, R. (1999). Food-related illness and death in the United States. *Emerging Infectious Disease, 5*, 607–625.

Medeiros, L.C., Kendall, P., Hillers, V., Chen, G., & DiMascola, S. (2001). Identification and classification of consumer food handling behaviors for food safety education. *Journal of the American Dietetic Association, 101*(11), 1326–1339.

Morrone, M., & Rathbun, A. (2003). Health education and food safety behavior in the university setting. *Journal of Environmental Health, 65*(7), 9–15.

Petty, R.E. (1997). Attitudes and attitude change. *Annual Review of Psychology, 48*, 609–647.

Redmond, E.C., & Griffith, C.J. (2003). Consumer food handling in the home: A review of food safety studies. *Journal of Food Protection, 66*(1), 130–161.

Softchalk, L. (2002). *Lesson builder*. Retrieved January 10th, 2005, from http://www.softchalk.com/

Unklesbay, N., Sneed, J., & Toma, R. (1998). College students' attitudes, practices, and knowledge of food safety. *Journal of Food Protection, 61*(9), 1175–1180.