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Food Safety Self-Reported Behaviors and Cognitions of Young Adults: Results of a National Study

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ABSTRACT

With limited opportunities to learn safe food handling via observation, many young adults lack the knowledge needed to keep them safe from foodborne disease. It is important to reach young adults with food safety education because of their current and future roles as caregivers. With a nationwide online survey, the demographic characteristics, self-reported food handling and consumption behaviors, food safety beliefs, locus of control, self-efficacy, stage of change, and knowledge of young adults with education beyond high school (n = 4,343) were assessed. Young adults (mean age, 19.92 ± 1.67 SD) who participated were mainly female, white, never married, and freshmen or sophomores. Participants correctly answered 60% of the knowledge questions and were most knowledgeable about groups at greatest risk for foodborne disease and least knowledgeable about common food sources of foodborne disease pathogens. They reported less than optimal levels of safe food handling practices. Young adults generally had a limited intake of foods that increase the risk of foodborne disease, positive food safety beliefs, an internal food safety locus of control, and confidence in their ability to handle food safely, and they were contemplating an improvement in, or preparing to improve, their food handling practices. Females significantly outperformed males on nearly all study measures. Future food safety educational efforts should focus on increasing knowledge and propelling young adults into the action stage of safe food handling, especially males. Efforts to improve knowledge and, ultimately, food safety behaviors are essential to safeguard the health of these young adults and enable them to fulfill the role of protecting the health of their future families.

Avoiding foods contaminated with harmful bacteria, viruses, parasites, toxins, and chemical and physical contaminants is vital for safe and healthy eating. Despite significant public health advances, foodborne disease caused by microbial pathogens remains a significant public health problem in the 21st century. In fact, every year, an estimated 76 million people in the United States become ill from pathogens in food; of these, about 5,000 die *(47)*.

The importance of foodborne disease as a current public health concern is underscored by the increasing numbers of ''at-risk'' populations *(8, 23)*. In the United States, one-fourth of the population is considered at increased risk for a severe outcome in the event of a foodborne disease *(66)*. At-risk individuals include those with weakened immune systems due to disease (e.g., HIV/AIDS) or pharmaceutical or radiological treatments, pregnant women and their fetuses, lactating mothers, infants and young children, and elderly persons *(8)*. Others who may be at a disproportionately greater risk include those living in institutional settings and those who are financially disadvantaged, such as homeless persons and migrant farm workers *(68)*.

The discovery of pathogenic microbes not previously known to cause foodborne disease (e.g., Norwalk virus, *Campylobacter jejuni, Escherichia coli* O157:H7) further highlights the importance of this public health concern *(39, 66, 67)*. Today, we are aware of over five times more foodborne pathogens than just 50 years ago *(66)*. These pathogenic microbes have made cooking and eating practices that were once considered safe, such as eating rare ground beef or raw eggs, particularly dangerous because it is difficult to convince consumers that it is no longer safe to continue a behavior when they feel they have ''always done it and never gotten sick.''

Lifestyle changes over the last quarter century also have contributed to the opportunities for foodborne disease caused by the mishandling of food and cross-contamination *(8)*. For example, eating occasions have proliferated. Each American eats an average of four times daily; thus, there could be a billion opportunities each day for someone to transmit or contract a foodborne disease *(26)*. The foods we eat and where we eat them have changed, too. They may be stashed unrefrigerated in the car, a sports bag, or a desk drawer for a quick snack or meal on the go *(26)*.

Mothers who work outside the home, coupled with the increased consumption of preprepared foods, have reduced the opportunities for children to learn safe food handling via observation *(9)*. Home economics courses in which food safety was traditionally taught are increasingly rare or optional in school systems around the United States *(15, 64)*. As a result, a large proportion of adults have limited food preparation experience, have never learned basic food safety principles, and thus, may lack the knowledge needed

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to keep themselves and their families safe *(7, 10, 37, 39, 51, 57, 60, 63).*

Clearly, opportunities to learn how to practice safe food handling are needed. Surveys indicate that young adults (ages 18 to 29), especially those with education beyond high school, are the most likely to engage in risky food handling *(7, 38, 42, 51, 62).* Reaching this population with food safety educational efforts is vital, given the current and future roles of young adults as caregivers for household members at increased risk, such as infants, young children, elderly parents, and themselves during pregnancy.

Marketing experts tell us that educational programs and materials directed to ''everyone'' actually meet the needs of few *(19, 24, 68, 70)*; therefore, to make food safety education most effective, messages should be tailored to the needs of a specific audience *(7, 30, 46, 49, 50).* At this point, however, a lack of data precludes the development of food safety education interventions that are specifically targeted to young adults. Thus, the purpose of this two-phase study was first to investigate the food safety knowledge, psychosocial factors, and self-reported behaviors of young adults with education beyond high school. Then, in phase two, the purpose was to use the data from phase one to develop and implement a social marketing campaign to increase the safety of food handling in this population. This article will describe the results of phase one. This study was approved by the authors' institutional review boards.

MATERIALS AND METHODS

Sample. College and university instructors from across the United States were invited via e-mail to recruit students in their introductory level general education courses to complete an online food safety survey. In return for their participation in the study, students who completed the survey were awarded extra credit points or research credits required by the course by most participating instructors.

Questionnaire development. The study instrument, administered as an online survey, had four parts. A panel of eight experts in food safety and sanitation, health behavior change, tests and measurements, and psychology developed the survey. All parts of the survey were pretested or pilot tested with young adults from a variety of majors enrolled in freshman and sophomore general education courses at Rutgers University during spring and fall semester 2005. Students who participated in the pretest did not participate in the pilot test.

Demographic questionnaire. Part 1, demographics, included questions that established the participant's basic demographic characteristics, such as age, gender, race, marital status, year in college, college major, and health status. In addition, items were included to assess prior exposure to food safety information, such as work experience related to food handling and completion of college level courses in nutrition, microbiology, and food science. Participants also were asked to self-assess their food safety knowledge and food safety (food disease prevention) skills and to indicate where they first learned about safe food handling.

Behavior measures. Part 2 of the survey investigated self-reported food handling and consumption behaviors with two questionnaires: best practices and risky food consumption. Both questionnaires were based on previously reported research *(6, 29, 36, 38, 69)* and were pilot tested with 127 young adults and refined. The expert panel reviewed these questionnaires for clarity, completeness, and content validity.

TABLE 1. *Self-reported behavior best practices questionnaire sample items*

Topic	Sample item
Cross-contamination prevention	When purchasing raw meat or poultry at the grocery store, do you put it in a separate plastic bag before putting it in the cart? A. Yes B. No C. I don't buy raw meat or poultry
Disinfection and cleaning	How often do you wash your kitchen counters or table? A. Every time I use them B. Once a day C. 4 to 6 times a week D. 2 to 3 times a week E. Once a week F. A few times a month G. Only when they need it
Thermometer use and temperatures for cooking, reheating, and storing food	Thinking of your usual habits over the past year, how often do you use a thermometer when you prepare hamburgers? A. Always B. Often C. Sometimes D. Never E. I never cook this food
Food storage	How long do you usually keep leftover meat and then eat it? A. 1 day or less B. 2 days C. 3 days D. 4 days E. 5 to 7 days F. More than a week G. I don't keep leftover meat at all
Hand washing	Before you begin preparing food, how often do you wash your hands with soap? A. All of the time B. Most of the time C. Some of the time D. Rarely E. Never F. I never prepare food

Best practices questionnaire. The best practices questionnaire examined self-reported food handling behaviors related to practices for preventing cross-contamination; cleaning and disinfecting practices; thermometer use and cooking, reheating, and storage temperatures; food storage practices; and hand washing practices. Sample items from this survey instrument are shown in Table 1. One answer choice for each item was identified by the panel of experts as the ''best practice.'' One point was awarded for each best practice reported; all other responses received no points. To adjust for behaviors that did not apply to certain participants (e.g., handling, purchasing, and storing animal protein), a participant's score on each scale was computed by summing the

points earned for a best practice reported for each applicable behavior, dividing this sum by the number of behaviors that applied to the participant, and multiplying the result by 100.

Risky food consumption questionnaire. The risky food consumption questionnaire asked participants to indicate which of 26 foods they consume. The food list included a randomly ordered sequence of 6 foods that are safe to eat, such as boxed rice in a box without a U.S. Department of Agriculture inspection stamp, and 20 foods that are risky to eat, such as raw oysters and rare hamburgers. This questionnaire was modified from earlier studies that asked only about the consumption of unsafe food items *(29, 74).* Both high- and low-risk foods were included to prevent a response set. The seven other items in this section assessed how completely cooked (i.e., raw to well done) participants chose to eat animal protein (e.g., beef, pork, bacon). Each risky behavior (i.e., eating a risky food from the list; eating bacon, chicken, pork, fish, and hamburger that was cooked less than well done; and eating large cuts of beef cooked less than medium well) was awarded one point. The risky eating score was calculated by summing points earned; thus, risky eating behavior scores could range from 0 to 27, with higher scores indicating more risky behaviors than lower scores. Note that safe foods served as distracters and were not included in score calculations.

Psychosocial measures. Part 3 of the survey assessed four psychosocial aspects of food safety: beliefs, locus of control, self-efficacy, and stage of change. These psychosocial measures were included because they are associated with a wide array of personal health choices and are thus key to understanding current food safety practices and creating interventions to change them *(2–5, 13, 32, 44, 59).* A detailed description of the developmental process used to create the psychosocial measures has been published previously *(21, 22).* In brief, a pool of statements for each psychosocial measure was identified from the literature *(11, 18, 20, 28, 31, 33, 35, 40, 41, 44, 48, 53, 56, 69, 71, 73),* created de novo, or both. The item pool was reviewed by the panel of experts for clarity, comprehensiveness, and contextual value and for establishing content validity. The measures were pretested ($n = 180$) during spring semester 2004 and revised. To further refine the beliefs and self-efficacy questionnaire, a pilot test was conducted ($n = 77$) during fall semester 2004.

Food safety belief scales. Belief constructs (scales) were identified that provide insight into how food safety behavior change programs should be framed to evoke improved behaviors *(27).* The belief instrument was composed of 27 Likert-type items divided into five a priori scales: (i) interest in learning about avoiding food poisoning, (ii) the importance of cleanliness and sanitation, (iii) susceptibility to food poisoning, (iv) the threat of food poisoning in the United States, and (v) the personal threat of food poisoning. For each statement, a score of 5, 4, 3, 2, or 1 was assigned to responses of strongly agree, agree, uncertain, disagree, or strongly agree, respectively, for positively worded statements, with scoring reversed for negatively worded statements. The score for each scale was computed by summing the score of the scale items and dividing by the number of items in the scale. Thus, scale scores ranged from 5 (strongly positive) to 1 (strongly negative). Statements from the belief scales were mixed throughout the belief section of the survey to prevent a response set.

Locus of control scales. Locus of control is the degree to which people view the attainment of a particular outcome as being either within their control (internal) or outside their control and determined by powerful others or chance *(1, 17).* Locus of control is a construct that may assist health educators in understanding learners' beliefs regarding their personal responsibility and ability to influence their own health *(17).* The health locus of control questionnaire *(71, 73),* modified to focus on food safety, had three scales (i.e., internal, external: powerful others, and external: chance) with a total of 12 Likert-type items, which were scored from 1 to 6 (i.e., strongly disagree, disagree, slightly disagree, slightly agree, agree, and strongly agree). A score for each scale was calculated by summing the score of each item and dividing by the number of items on the scale. Thus, scale scores could range from 1 to 6. To prevent a response set, statements from the locus of control scales were mixed throughout the locus of control section of the survey.

Self-efficacy scale. Self-efficacy is an individual's confidence in his or her ability to perform a particular recommended health behavior or abstain from an unhealthy behavior *(35).* Self-efficacy is thought to influence which health behaviors will be initiated, the degree of effort expended, and the persistence of the behavior *(12, 28, 34, 40, 41, 45, 58).* The 24 Likert-type items were scored from 1 to 5 for the following responses: "I am sure I could not do it," "I could not do it," "I don't know if I could do it," "I could do it," and "I am sure I could do it," respectively. The self-efficacy score was computed by summing the score of each item and dividing by the total number of items on the scale. Thus, scores could range from 1 to 5.

Stage of change measure. Stage of change is a construct of the transtheoretical model, which describes behavior change as a process in which an individual moves through a series of stages (i.e., precontemplation, contemplation, preparation, action, and maintenance) with the possibility of recycling through the stages *(52, 53, 55).* A single item asked participants to identify which statement best described them: (i) I have no intention of changing the way I prepare food to make it safer to eat in the next 6 months; (ii) I am aware that I may need to change the way I prepare food to make it safer to eat and am seriously thinking about changing my food preparation methods in the next 6 months; (iii) I am aware that I may need to change the way I prepare food to make it safer to eat and am seriously thinking about changing my food preparation methods in the next 30 days; (iv) I have changed the way I prepare food to make it safer to eat, but I have been doing so for less than the past 6 months; and (v) I have changed the way I prepare food to make it safer to eat, and I have been doing so for more than the past 6 months.

Knowledge measure. The knowledge questionnaire was designed to assess the full range of safe food handling knowledge, ranging from food purchasing to preparation to storage. This criterion-referenced questionnaire contained five scales: (i) cross-contamination prevention and disinfection procedures, (ii) safe times and temperatures for cooking and storing food scale, (iii) groups at greatest risk for foodborne disease, (iv) foods that increase risk of foodborne disease, and (v) common food sources of foodborne disease pathogens. The 89-item knowledge questionnaire included objective items (e.g., multiple choice, true or false) that were scored by awarding one point for each correctly answered question. Thus, scores could range from 0 to 89. The expert panel reviewed each draft of the questionnaire for intended purpose, ambiguity, usefulness, and comprehensiveness. Subsequently, the knowledge questionnaire was pretested with 180 young adults and revised. The refined questionnaire was pilot tested ($n = 77$) to identify any other needed refinements, to verify the accuracy of the answer key, and to confirm the content validity of the five knowledge scales. A detailed description of the development of the questionnaire is available elsewhere *(21).*

Data collection. The survey instrument was administered online from January to October 2005. Study participants signed on to the website at a time convenient to them and completed all parts of the instrument in a single session that lasted approximately 40 min. Participants older than the age criterion set in this study for young adults (i.e., 17 to 26 years) were eliminated from the analysis.

Statistical analysis. Statistical analyses were completed by the Statistical Package for the Social Sciences (version 14.0, SPSS, Inc., Chicago, Ill.). Analyses of central tendency and dispersion (e.g., means and standard deviations) were conducted to describe the study participants and mean scores for each behavior, psychosocial, and knowledge measure. To identify demographic characteristics that were associated with performance on behavior, psychosocial, and knowledge measures, backward stepwise regression with an exclusion criterion set at an F value ≥ 25 was conducted. This low P value was chosen because of the large size of the survey sample. Scores of these 13 study measures served as the dependent variables in separate models: best practices, risky food consumption, five belief scales, three locus of control scales, self-efficacy, stage of change, and knowledge. Independent variables included these demographic factors: gender; race (white and nonwhite); geographic location of the college or university where the participant was enrolled (eastern, midwestern, and western United States); number of meals cooked weekly (0, 1 to 10, and >10); number of nutrition, microbiology, and food science courses completed in college; stage of change (except when it was a dependent variable); and whether the participant had ever worked as a food server or preparer, believed he or she had experienced food poisoning before, and had changed eating habits because of food safety concerns. The predominating locus of control (internal, external: powerful others, external: chance, or none) was another independent variable used in all models, except in those with a locus of control scale score as the dependent variable. A participant's predominating locus of control was the locus of control scale with the highest score; when no one scale score exceeded the others, individuals were assigned to the ''none'' group. For demographic factors found to be consistently and significantly related to scores on study measures, analysis of variance and post hoc Fisher's protected least significant difference follow-up procedures were used to investigate how the mean scores of demographic groups differed; the criterion for significance was set at $P \leq 0.02$ because of the large sample size.

RESULTS

From January to October 2005, 4,343 eligible young adults enrolled at 21 colleges and universities completed the survey. The colleges and universities were located throughout the United States and included missions ranging from community college to research institutions.

The sample had a mean age of 19.92 ± 1.67 standard deviation (range, 17 to 26) years and was from a wide array of college majors, with no major predominating. The majority (n = 3,659 [84%]) prepared at least one meal every week. Most were female, white, never married, and freshmen or sophomores (Table 2). Participants were nearly evenly divided in terms of the geographic location of their institution of higher education. Most had never held a job serving or preparing food, did not hold a food safety certification, and had never completed a college course in nutrition, food science, or microbiology. The vast majority of participants self-rated their food safety knowledge level and

TABLE 2. *Young adult demographic characteristics*

Characteristic	n (%)
Gender	
Male	1,502 (35)
Female	2,841 (65)
Race	
White	3,059 (70)
Black	234 (5)
Hispanic	186 (4)
Asian/Pacific Islander	768 (18)
American Indian	36 (1)
Multiracial	42 (1)
Other	18 (<1)
Marital status	
Single, never married	4,091 (94)
Other	252 (6)
Year in college	
Freshman	1,760 (41)
Sophomore	1,205 (38)
Junior	774 (18)
Senior	575 (13)
Other	29 (<1)
Location of university/college by geographic region of United States	
East	1,326 (31)
Midwest	1,502 (35)
West	1,515 (35)
Self-rated food safety knowledge	
Excellent	273 (6)
Good	2,040 (47)
Fair	1,767 (41)
Poor	263 (6)
Self-rated food safety (food poisoning prevention) skill	
Excellent	402 (9)
Good	2,365 (55)
Fair	1,352 (31)
Poor	224 (5)
No. of nutrition courses completed	
0	3,338 (77)
1	795 (18)
2 or more	210 (5)
No. of food science courses completed	
0	3,807 (88)
1	432 (10)
2 or more	104 (2)
No. of microbiology courses completed	
0	3,660 (84)
1	574 (13)
2 or more	109 (3)
Has held job as food server	
No	2,602 (60)
Yes	1,741 (40)
Has held job as food preparer	
No	3,315 (76)
Yes	1,028 (24)
Has food safety certification (e.g., sanitarian, ServSafe)	
No	4,080 (94)
Yes	263 (6)

TABLE 3. *Where young adults first learned about food safety*[a]

Person/place	*n* (%)
Never learned	211 (5)
Mother	3,338 (77)
Father	1,453 (34)
Cooking classes at school	1,076 (25)
Television shows	910 (21)
Grandmother	790 (18)
Magazine articles	464 (11)
Female friend	411 (10)
Other female relative (not mother or grandmother)	298 (7)
Cookbooks	284 (7)
Other person (not further specified)	240 (5)
Male friend	200 (5)
Grandfather	194 (5)
Job training	112 (3)
Other male relative (not father or grandfather)	111 (3)
Teacher (not further specified)	140 (3)
Spouse or companion	98 (2)
Cooking classes in the community	65 (2)
Babysitter	31 (1)
Miscellaneous (e.g., self-taught, Internet, physician)	56 (1)

[a] Participants could select more than one answer choice.

food safety skill (food poisoning prevention) level as at least fair.

When asked to identify where they first learned about food safety, the overwhelming majority named their parents (see Table 3). Only 5% indicated that they never learned about food safety.

Regression analyses showed that none of these demographic characteristics were significantly related to any study measure: geographic location of the higher education institution where the participant was enrolled (eastern, midwestern, and western United States), number of nutrition, microbiology, and food science courses the participant completed in college, and whether the participant had ever worked as a food server or preparer. The only demographic characteristics that were consistently and significantly associated with performance on the study measures were gender (related to 11 measures) and stage of change (related to 9 measures). All other demographic characteristics were significant at the criterion level set in this study in six or fewer of the regression models.

Behavior measures. The Cronbach alpha coefficients of internal consistency for the best practices and risky food consumption questionnaires were 0.65 and 0.76, respectively, indicating that both scales were reliable for assessing intended measures. Overall, participants' best practices scores were poor, averaging less than 50%. To identify specific problem areas, subscores were calculated for items that measured similar practices (see Table 4). These subscores ranged from a high of 49% on cross-contamination prevention practices to a low of 34% on food storage. Although best practices scores were low, higher self-rated food safety skill levels corresponded with significantly higher best practices scores (see Table 5).

Risky food consumption scores indicated that participants ate few "high-risk" foods. Commonly eaten high-risk foods included raw bivalve shellfish, raw sprouts, sushi, fried eggs with soft yolks, and raw cookie dough, which were consumed by 11, 29, 29, 33, and 53% of the participants, respectively. Eating undercooked bacon, pork, chicken, and hamburger was reported by 43, 44, 51, and 60%, respectively.

A comparison of the best practices and risky food consumption scores by gender showed that females scored significantly better than males on all scales (Table 4). Overall, females handled food more safely and ate fewer risky foods than males.

An examination of behavior measures by stage of change (see Table 6) indicates that those in lower stages had significantly poorer best practices scores than those in higher stages. Likewise, those in preaction stages tended to eat significantly more risky foods than those in the action or maintenance stage.

Psychosocial measures. As reported previously, factor analysis confirmed the unidimensionality (i.e., ability of both measures to measure a similar characteristic) of the food safety belief and locus of control scales *(22)*. The belief and self-efficacy scales were judged to be valid and reliable *(22)* (see Table 4). The locus of control scales exhibited the same high qualities of validity; however, the reliability coefficients were somewhat lower. Nonetheless, the locus of control reliabilities was similar to that reported for the instrument on which it was modeled, namely the health locus of control *(22, 72)*.

Table 4 presents the mean psychosocial scale scores. In general, participants had positive food safety beliefs. The strongest positive beliefs were associated with the importance of cleanliness and sanitation. Participants were most uncertain about whether food poisoning was a personal threat for them, with males tending to somewhat disagree with the belief that food poisoning is a personal threat. Females had significantly more positive belief scores than males. In addition, those in the precontemplation and contemplation stages tended to have significantly lower belief scores than those in higher stages, whereas those in the maintenance stage tended to have significantly higher mean belief scores than those in lower stages.

A comparison of locus of control scores indicated that regardless of stage of change, most believed that their actions affected their likelihood to avoid foodborne disease. For most, the predominant locus of control was internal (n = 2,386 [54.9%]), followed by external: powerful others (n = 1,234 [28.4%]), external: chance (n = 539 [12.4%]). Few (n = 184 [4.2%]) had no single predominant locus of control. Participants had a significantly higher ($P < 0.0001$) mean score on the internal scale than the external: powerful others and external: chance scales (Table 6). In addition, the mean external: powerful others scale score was significantly higher ($P < 0.0001$) than the mean external: chance scale score. Females and males scores differed significantly on only the external: chance scales. Those in the precontemplation stage tended to have significantly lower exter-

TABLE 4. *Mean food safety behavior, psychosocial, and knowledge scores by gender*

Measure	Reliability[a]	Total group (n = 4,343), mean ± SD	Gender (mean ± SD)		F value
			Males (n = 1,502)	Females (n = 2,841)	
Behavior measures					
Best practices[b]	0.65	44.5 ± 12.0	41.0 ± 11.7	46.4 ± 11.7	209.4[j]
Cross-contamination prevention		49.1 ± 26.7	43.6 ± 27.3	52.1 ± 25.9	101.2[j]
Disinfection and cleaning		48.3 ± 17.5	44.0 ± 17.3	50.5 ± 17.2	141.1[j]
Thermometer use and temperatures for cooking, reheating, and storing food		42.6 ± 15.3	40.2 ± 14.9	43.9 ± 15.4	57.7[j]
Food storage		33.5 ± 17.1	30.8 ± 17.5	34.9 ± 16.7	57.4[j]
Hand washing[c]		52.2 ± 27.7	45.3 ± 28.9	55.9 ± 26.4	148.1[j]
Risky food consumption[d]	0.76	5.1 ± 3.6	5.9 ± 4.3	4.7 ± 3.1	100.3[j]
Psychosocial measures					
Food safety beliefs[e]					
Interest in learning about avoiding food poisoning	0.86	3.65 ± 0.72	3.40 ± 0.77	3.79 ± 0.66	298.6[j]
Cleanliness/sanitation is important	0.81	4.48 ± 0.55	4.26 ± 0.64	4.60 ± 0.46	423.6[j]
Food poisoning susceptibility	0.76	3.88 ± 0.56	3.80 ± 0.62	3.92 ± 0.53	44.2[j]
Food poisoning is a threat in the United States	0.87	3.69 ± 0.62	3.52 ± 0.62	3.78 ± 0.57	192.6[j]
Food poisoning is a personal threat	0.87	3.12 ± 0.81	2.90 ± 0.80	3.24 ± 0.79	181.9[j]
Food safety locus of control[f]					
Internal	0.63	3.72 ± 0.81	3.79 ± 0.82	3.69 ± 0.81	14.6
External: powerful others	0.63	3.34 ± 0.83	3.36 ± 0.86	3.34 ± 0.82	0.60
External: chance	0.59	2.88 ± 0.76	3.00 ± 0.77	2.81 ± 0.74	57.5[j]
Food safety self-efficacy[e]	0.93	4.13 ± 0.55	3.94 ± 0.61	4.24 ± 0.48	314.0[j]
State of change[g]	[h]	2.65 ± 1.21	2.43 ± 1.23	2.77 ± 1.18	77.1[j]
Knowledge[i]	0.92	53.7 ± 10.5	51.3 ± 11.3	55.0 ± 9.7	128.9[j]
Cross-contamination prevention and disinfection procedures		17.8 ± 3.5	16.8 ± 3.5	18.3 ± 3.3	192.2[j]
Safe times/temperatures for cooking/storing food		8.3 ± 2.8	8.0 ± 3.0	8.5 ± 2.7	41.5[j]
Groups at greatest risk for foodborne disease		7.1 ± 1.9	6.8 ± 2.0	7.2 ± 1.9	61.5[j]
Foods that increase risk of foodborne disease		17.9 ± 4.8	17.2 ± 5.3	18.3 ± 4.5	53.3[j]
Common food sources of foodborne disease pathogens		2.6 ± 1.6	2.6 ± 1.6	2.7 ± 1.6	2.1

[a] Cronbach alpha coefficients were calculated for all measures, except knowledge for which Livingston reliability coefficients for criteron-referenced tests were calculated.
[b] Score on total and subscores normalized to 100. Possible range of scores is 0 to 100.
[c] Composite subscore composed of two items from preventing cross-contamination and four items from cleaning and disinfecting.
[d] Possible range of scores is 0 to 27, low scores indicate less risky eating.
[e] Scores could range from 1 (most negative) to 5 (most positive).
[f] Scores could range from 1 (most negative) to 6 (most positive).
[g] Scores could range from 1 (precontemplation) to 5 (maintenance).
[h] Reliability cannot be computed for this one-item, single-administration measure.
[i] Scores could range from 0 to 89. Subscore scales could range from 0 to 29 (cross-contamination), 0 to 14 (safe times), 0 to 10 (groups at greatest risk), 0 to 28 (foods that increase risk), and 0 to 8 (common food sources).
[j] Significantly different ($P < 0.0001$); degrees of freedom = 4,341.

nal: powerful others scores and higher external: chance scores.

Self-efficacy scores were high, indicating participants had a high level of confidence in their ability to handle food safely. Females significantly outscored males on this scale. In addition, those in higher stages tended to have significantly greater self-efficacy scores than those in lower stages.

An examination of stage of change data indicates that young adults hover between the contemplation and preparation stage when it comes to preparing food to make it safe to eat. Overall, females had a significantly more advanced stage of change. As can be seen in Table 5, stage of change had many significant effects on behavior, psychosocial, and knowledge measures.

Knowledge measure. The reliability of the knowledge test was high (0.92 as computed by Livingston's coefficient for criterion-referenced tests) *(16, 25, 43)*. Overall, participants correctly answered 60% of the questions on the knowledge measure. As with the best practices measure, knowledge subscores were calculated for items measuring

TABLE 5. *Mean food safety knowledge scale scores*

Measure	Self-rating (mean ± SD)				*F* value
	Excellent	Good	Fair	Poor	
Best practices					
Self-rated food safety skill	51.40 ± 13.00 (n = 402)	45.87 ± 11.63 (n = 2,365)	41.13 ± 11.14 (n = 1,352)	37.90 ± 10.04 (n = 224)	122.01[a]
Knowledge					
Self-rated food safety knowledge	55.80 ± 11.64 (n = 273)	55.53 ± 10.19 (n = 2,040)	51.94 ± 10.13 (n = 1,767)	49.25 ± 10.28 (n = 263)	59.49[b]

[a] All self-ratings differ significantly from all other self-ratings ($P < 0.0001$).
[b] All self-ratings differ significantly from all other self-ratings ($P < 0.0001$), except for excellent and good ratings.

similar concepts (see Table 5). The subscores showed that participants were most knowledgeable about groups at greatest risk for foodborne disease and were least knowledgeable about common food sources of foodborne disease pathogens.

Females scored significantly higher than males on all areas of knowledge except for the common food sources of foodborne disease pathogens. Participants in the maintenance stage of change significantly outperformed all other stages on the knowledge measures. Although food safety knowledge is limited, higher self-rated food safety knowledge levels tended to correspond with significantly higher mean knowledge scores (see Table 5).

DISCUSSION

This study provides insights into the food safety self-reported behaviors and cognitions of young adults enrolled in college. Overall, young adults have less than optimal levels of food safety knowledge and safe food handling best practices. Interestingly, best practices and knowledge mean scores declined significantly as self-rated food safety skill and self-rated food safety knowledge levels declined, respectively. However, even those with excellent self-ratings achieved mean scores of only about 50 and 60% on best practices and knowledge measures, respectively. These findings suggest that young adults accurately assess their food safety skills and knowledge relative to peers, but most overestimate their actual abilities. On the plus side, young adults, particularly females, generally have a limited intake of foods that increase the risk of foodborne illness, positive food safety beliefs, an internal locus of control, and positive feelings of self-efficacy, and they are contemplating an improvement in, or preparing to improve, their food handling practices. Those in higher stages of change tended to perform better on all measures than those in lower stages of change.

A limitation of this study is that the sample was restricted to young adults enrolled in a small sampling of colleges in the United States. However, these students were distributed across the nation, attended colleges and universities of varying sizes with widely varying admission requirements, and had a similar age and demographic breakdown compared with recent postsecondary education enrollment statistics *(65)*.

This study supports the limited research exploring the food safety practices and cognitions of young adults. For example, in both this study and a study of college students from three universities in the western and midwestern United States *(69),* females significantly outperformed males on food safety attitudes and self-reported food handling practices. Although the rate at which college students from the previously reported study *(69)* handled food safely exceeded that of this study (~80% versus 42%), this difference likely occurred because the current study examined a broader array of food handling practices (34 versus 11). Regardless of methodological differences, the rate at which young adults are engaging in safe food handling practices needs improvement.

Aside from poor food handling behaviors and knowledge, young adults also engage in risky eating behaviors. Our sample reported consuming several other risky foods, including raw cookie dough (53%), fried eggs with runny or soft yolks (33%), sushi or raw sprouts (29%), raw oysters, clams, or mussels (11%), and undercooked beef (7%). The poor food safety knowledge reported by young adults likely contributes to their decision to consume risky foods.

The most encouraging findings from this research are the generally positive food safety attitudes, the predominance of an internal locus of control, and the positive self-efficacy scores of the young adults. According to many cognitive-behavioral theories, cognitions such as beliefs, locus of control, and self-efficacy have an important impact on whether individuals adopt recommended health behaviors or abstain from nonrecommended behaviors *(1–5, 12–14, 33, 44, 53–55, 59, 61, 62)*. Their positive food safety beliefs, confidence they can handle food safely, and position between the contemplation and preparation stage suggest that these young adults are ready to learn about food safety and apply their knowledge.

Although there are many studies on this general topic, few studies focus on the age group described in this study. This study is useful in providing baseline data regarding the food safety knowledge of young adults, an audience that is important to reach with safe food handling education messages because of their current and future roles as caregivers for household members. Efforts to improve knowledge and, ultimately, food safety behaviors are essential to safeguard the health of these young adults and enable them

TABLE 6. *Mean food safety behavior, psychosocial, and knowledge scores by food safety stage of change*

Measure	Stage of change (mean ± SD)					F value
	Precontemplation (n = 666)	Contemplation (n = 1,625)	Preparation (n = 1,189)	Action (n = 291)	Maintenance (n = 572)	
Behavior measures						
Best practices	41.10 ± 11.64	42.84 ± 11.07	44.00 ± 11.39	46.60 ± 12.34	53.12 ± 12.03	107.10 [a]
Risky food consumption	6.44 ± 4.6	5.19 ± 3.33	5.00 ± 3.52	4.60 ± 3.55	4.08 ± 2.99	37.29 [b]
Psychosocial measures						
Food safety beliefs						
Interest in learning about avoiding food poisoning	3.04 ± 0.81	3.67 ± 0.64	3.82 ± 0.63	3.79 ± 0.69	3.90 ± 0.65	179.70 [c]
Cleanliness/sanitation is important	3.45 ± 0.63	3.66 ± 0.56	3.74 ± 0.59	3.75 ± 0.55	3.91 ± 0.59	51.60 [d]
Food poisoning susceptibility	4.27 ± 0.62	4.48 ± 0.52	4.51 ± 0.56	4.49 ± 0.60	4.69 ± 0.42	47.97 [e]
Food poisoning is a threat in the United States	3.78 ± 0.64	3.89 ± 0.53	3.91 ± 0.55	3.83 ± 0.56	3.93 ± 0.60	8.04 [f]
Food poisoning is a personal threat	2.54 ± 0.78	3.12 ± 0.76	3.29 ± 0.76	3.27 ± 0.75	3.35 ± 0.83	122.10 [g]
Food safety locus of control						
Internal	3.77 ± 0.85	3.70 ± 0.79	3.66 ± 0.79	3.78 ± 0.87	3.81 ± 0.84	4.48 [h]
External: powerful others	3.16 ± 0.91	3.36 ± 0.80	3.43 ± 0.79	3.42 ± 0.85	3.29 ± 0.85	13.16 [i]
External: chance	3.03 ± 0.85	2.89 ± 0.73	2.87 ± 0.74	2.85 ± 0.75	2.71 ± 0.72	14.34 [j]
Food safety self-efficacy	3.89 ± 0.64	4.08 ± 0.48	4.17 ± 0.53	4.19 ± 0.57	4.48 ± 0.44	107.00 [k]
Knowledge	52.94 ± 11.24	52.96 ± 10.10	52.97 ± 10.28	53.12 ± 11.53	58.51 ± 9.08	35.84 [l]

[a] All stages differ significantly from all other stages ($P \leq 0.01$).
[b] Precontemplation is significantly higher than all other stages ($P < 0.0001$). Contemplation is significantly higher than action and maintenance ($P < 0.0001$). Preparation is significantly higher than maintenance ($P < 0.0001$). (Note lower scores indicate less risky behavior).
[c] Precontemplation is significantly lower than all higher stages ($P < 0.0001$). Contemplation is significantly lower than all higher stages ($P < 0.001$).
[d] All stages differ significantly from all other stages ($P \leq 0.02$), except for preparation and action.
[e] Precontemplation is significantly lower than all higher stages ($P < 0.0001$). Maintenance is significantly higher than all other stages ($P < 0.0001$).
[f] Precontemplation is significantly lower than all higher stages ($P < 0.0001$), except for action. Maintenance is significantly higher than precontemplation and action ($P < 0.01$).
[g] Precontemplation is signficantly lower than all higher stages ($P < 0.0001$). Contemplation is significantly lower than all higher stages ($P < 0.01$).
[h] Preparation is significantly lower than precontemplation and maintenance ($P \leq 0.01$). Maintenance is significantly higher than contemplation and preparation ($P \leq 0.01$).
[i] Precontemplation is significantly lower than all other stages ($P \leq 0.005$). Preparation is significantly higher than maintenance ($P < 0.001$).
[j] Precontemplation is significantly higher than all other stages ($P \leq 0.0005$). Maintenance is significantly lower than all other stages ($P < 0.02$).
[k] All stages differ significantly from all other stages ($P \leq 0.02$), except for preparation and action.
[l] Maintenance is significantly higher than all other stages ($P < 0.0001$).

to fulfill the role of protecting the health of their future families. Bridging the gap between what young adults know and do in relation to food safety and their positive psychosocial characteristics is the next step in food safety education efforts directed to young adults *(69)*.

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REFERENCES

1. AbuSabha, R., and C. Achterberg. 1997. Review of self-efficacy and locus of control for nutrition- and health-related behavior. *J. Am. Diet. Assoc.* 97:1122–1132.
2. Ajzen, I. 2002. Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *J. Appl. Soc. Psychol.* 32:665–683.
3. Ajzen, I., and M. Fishbein. 1980. Understanding attitudes and predicting social behavior. Prentice Hall, Englewood Cliffs, N.J.
4. Ajzen, I., and M. Fishbein. 2000. Attitudes and the attitude-behavior relation: reasoned and automatic processes, p. 1–33. *In* W. Stroebe and H. Hewstone (ed.), European review of social psychology, vol. 11. Wiley, Chichester, UK.

5. Ajzen, I., and M. Fishbein. 2005. The influence of attitudes on behavior, p. 173–221. *In* D. Albarracín, B. Johnson, and M. Zanna (ed.), The handbook of attitudes. Erlbaum, Mahwah, N.J.
6. Altekruse, S., D. Street, S. Fein, and A. Levy. 1995. Consumer knowledge of foodborne microbial hazards and food-handling practices. *J. Food Prot.* 59:287–294.
7. Altekruse, S., S. Yang, B. Timbo, and F. Angulo. 1999. A multistate survey of consumer food-handling and food-consumption practices. *Am. J. Prev. Med.* 16:216–221.
8. American Dietetic Association. 1997. Position of the American Dietetic Association: food and water safety. *J. Am. Diet. Assoc.* 97: 1048–1053.
9. Anderson, L. 1988. Attitudes and their measurement, p. 421–428. *In* J. Keeves (ed.), Educational research, methodology, and measurement. An international handbook. Pergamon Press, Oxford.
10. Anonymous. 2002. Checking on changes: consumer research. *Food Saf. Educ.* 7:1–2.
11. Auld, G., S. Nitzke, J. McNulty, M. Bock, C. Bruhn, K. Gabel, G. Lauritzen, Y. Lee, D. Medeiros, R. Newman, M. Ortiz, M. Read, H. Schutz, and E. Sheehan. 1997. A stage-of-change classification system based on actions and beliefs regarding dietary fat and fiber. *Am. J. Health Promot.* 12:192–201.
12. Bandura, A. 1986. Social foundations of thought and action: a social cognitive theory. Prentice Hall, Englewood Cliffs, N.J.
13. Bandura, A. 1991. Self-efficacy mechanism and physiological activation and health promotion behavior, p. 229–269. *In* V. Madden (ed.), Neurobiology of learning, emotion and affect. Raven, New York.
14. Bandura, A. 2000. Health promotion from the perspective of social cognitive theory, p. 299–339. *In* P. Norman, C. Abraham, and M. Conner (ed.), Understanding and changing health behaviour. Harwood Academic Publishers, Amsterdam.
15. Beard, T. 1991. HACCP and the home: the need for consumer education. *Food Technol.* 45:123–124.
16. Berk, R. A. 1986. A consumer's guide to setting performance standards on criterion referenced tests. *Rev. Educ. Res.* 56:137–172.
17. Brown, K. 1999. Health locus of control. University of South Florida, Tampa. Available at: www.med.usf.edu/~kmbrown/Locus_of_Control.htm. Accessed 4 May 2005.
18. Browne, J. 2003. Creating health: osteoporosis. The Pennsylvania State University, Information and Communication Technologies in the College of Agricultural Sciences, University Park.
19. Bruhn, C. 1997. Consumer concerns: motivating into action. *Emerg. Infect. Dis.* 3:4. Available at: ftp.cdc.gov/pub/EID/vol3no4/ascii/bruhn.txt. Accessed 30 March 2000.
20. Byrd-Bredbenner, C. 2004. Food preparation knowledge and attitudes of young adults: implications for nutrition practice. *Top. Clin. Nutr.* 19:154–163.
21. Byrd-Bredbenner, C., V. Wheatley, D. Schaffner, C. Bruhn, L. Blalock, and J. Maurer. Development and implementation of a food safety knowledge instrument. *J. Food Saf. Educ.*, in press.
22. Byrd-Bredbenner, C., V. Wheatley, D. Schaffner, C. Bruhn, L. Blalock, and J. Maurer. 2007. Development of food safety psychosocial questionnaires for young adults. *J. Food Saf. Educ.* 6:30–37.
23. Cohen, M. L. 2000. Changing patterns of infectious disease. *Nature* 406:762–767.
24. Contento, I., G. Balch, Y. Bronner, D. Paige, S. Gross, L. Bisignani, L. Lytle, S. Maloney, S. White, C. Olson, and S. Swadener. 1995. Special issue, the effectiveness of nutrition education and implications for nutrition education policy, programs, and research: a review of research, chap. V. Nutrition education for adults. *J. Nutr. Educ.* 27:312–328.
25. Coscarelli, W., and S. Shrock. 2002. The two most useful approaches to estimating criterion-referenced test reliability in a single test administration. *Perform. Improve. Q.* 15:74–85.
26. Coulston, A. 1999. President's page: personal responsibility and food safety. *J. Am. Diet. Assoc.* 99:236.
27. DeVellis, R. 2003. Scale development: theory and applications, 2nd ed., vol. 26. Sage Publications, Thousand Oaks, Calif.
28. Etter, J. F., M. M. Bergman, J. P. Humair, and T. V. Perneger. 2000. Development and validation of a scale measuring self-efficacy in current and former smokers. *Addiction* 95:901–913.
29. Fein, S., C.-T. Lin, and A. Levy. 1995. Foodborne illness: perceptions, experience, and preventive behaviors in the United States. *J. Food Prot.* 58:1405–1411.
30. Fischer, A. R., L. J. Frewer, and M. J. Nauta. 2006. Toward improving food safety in the domestic environment: a multi-item Rasch scale for the measurement of the safety efficacy of domestic food-handling practices. *Risk Anal.* 26:1323–1338.
31. Glanz, K., R. Patterson, A. Kristal, C. DiClemente, J. Heimendinger, L. Linnan, and D. McLerran. 1994. Stages of change in adopting healthy diets: fat, fiber, and correlates of nutrient intake. *Health Educ. Q.* 21:499–512.
32. Glanz, K., B. Rimer, and F. Lewis (ed.). 2002. Health behavior and health education: theory, research, and practice, 3rd ed. Jossey-Bass, San Francisco.
33. Greene, G., S. Rossi, G. Reed, C. Willey, and J. Prochaska. 1994. Stages of change for reducing dietary fat to 30% of energy or less. *J. Am. Diet. Assoc.* 94:1105–1110.
34. Hallam, J. S., and R. Petosa. 2004. The long-term impact of a four-session work-site intervention on selected social cognitive theory variables linked to adult exercise adherence. *Health Educ. Behav.* 31:88–100.
35. Healey, K., and D. Thombs. 1997. Fruit-vegetable consumption self-efficacy in youth. *Am. J. Health Behav.* 21:172–177.
36. Jay, L., D. Comar, and L. Govenlock. 1999. A national Australian food safety telephone survey. *J. Food Prot.* 62:921–928.
37. Kennedy, J., V. Jackson, I. S. Blair, D. A. McDowell, C. Cowan, and D. J. Bolton. 2005. Food safety knowledge of consumers and the microbiological and temperature status of their refrigerators. *J. Food Prot.* 68:1421–1430.
38. Klontz, K., B. Timbo, S. Fein, and A. Levy. 1995. Prevalence of selected food consumption and preparation behaviors associated with increased risks of food-borne disease. *J. Food Prot.* 58:927–930.
39. Knabel, S. 1995. Foodborne illness: role of home food handling practices. Scientific status summary. *Food Technol.* 49:119–131.
40. Lev, E. L., and S. V. Owen. 1996. A measure of self-care self-efficacy. *Res. Nurs. Health* 19:421–429.
41. Lev, E. L., D. Paul, and S. V. Owen. 1999. Age, self-efficacy, and change in patients' adjustment to cancer. *Cancer Pract.* 7:170–176.
42. Li-Cohen, A. E., and C. M. Bruhn. 2002. Safety of consumer handling of fresh produce from the time of purchase to the plate: a comprehensive consumer survey. *J. Food Prot.* 65:1287–1296.
43. Livingston, S. A. 1972. Criterion-referenced applications of classical test theory. *J. Educ. Meas.* 9:13–26.
44. Lorig, K., A. Stewart, P. Ritter, V. Gonzalez, D. Laurent, and J. Lynch. 1996. Outcome measures for health education and other health care interventions. Sage Publications, Thousand Oaks, Calif.
45. McAuley, E., and B. Blissmer. 2000. Self-efficacy determinants and consequences of physical activity. *Exerc. Sport Sci. Rev.* 28:85–88.
46. McMahon, K. 1996. Will pending health claims regulations motivate consumers to change behaviors. *J. Nutr. Educ.* 28:254–257.
47. Mead, P. S., L. Slutsker, V. Dietz, L. F. McCaig, J. S. Bresee, C. Shapiro, P. M. Griffin, and R. V. Tauxe. 1999. Food-related illness and death in the United States. *Emerg. Infect. Dis.* 5:607–625.
48. Medeiros, L., V. Hillers, G. Chen, V. Bergmann, P. Kendall, and M. Schroeder. 2004. Design and development of food safety knowledge and attitude scales for consumer food safety education. *J. Am. Diet. Assoc.* 104:1671–1677.
49. Medeiros, L. C., V. N. Hillers, P. A. Kendall, and A. Mason. 2001. Food safety education: what should we be teaching to consumers? *J. Nutr. Educ.* 108:108–113.
50. Nayga, R. 1996. Sociodemographic influences on consumer concern for food safety: the case of irradiation, antibiotics, hormones, and pesticides. *Rev. Agric. Econ.* 18:467–475.
51. Patil, S. R., S. Cates, and R. Morales. 2005. Consumer food safety knowledge, practices, and demographic differences: findings from a meta-analysis. *J. Food Prot.* 68:1884–1894.
52. Prochaska, J., and C. DiClemente. 1982. Transtheoretical therapy:

toward a more integrative model of change. *Psychother. Theory Res. Pract.* 20:161–173.

53. Prochaska, J., J. Norcross, and C. DiClemente. 1994. Changing for good. William Morrow and Company, Inc., New York.
54. Prochaska, J., C. Redding, and K. Evers. 2002. The transtheoretical model and stages of change, p. 99–120. *In* K. Glanz, B. Rimer, and F. Lewis (ed.), Health behavior and health education: theory, research, and practice. Jossey-Bass, San Francisco.
55. Prochaska, J., and W. Velicer. 1997. The transtheoretical model of health behavior change. *Am. J. Health Promot.* 12:38–48.
56. Read, M., G. Auld, M. Bock, C. Bruhn, K. Gabel, G. Lauritzen, Y. Lee, D. Mederios, J. McNulty, R. Newman, S. Nitzke, M. Ortiz, H. Schutz, and E. Sheehan. 1996. Age, dietary behaviors and the stages-of-change model. *Am. J. Health Promot.* 20:417–424.
57. Redmond, E. C., and C. J. Griffith. 2003. Consumer food handling in the home: a review of food safety studies. *J. Food Prot.* 66:130–161.
58. Rejeski, W. J., W. T. Ambrosius, P. H. Brubaker, B. C. Focht, C. G. Foy, L. R. Brawley, and L. D. Fox. 2003. Older adults with chronic disease: benefits of group-mediated counseling in the promotion of physically active lifestyles. *Health Psychol.* 22:414–423.
59. Rollnick, S., P. Mason, and C. Butler. 1999. Health behavior change: a guide for practitioners. Churchill Livingstone, Edinburgh.
60. Roseman, M., and J. Kurzynske. 2006. Food safety perceptions and behaviors of Kentucky consumers. *J. Food Prot.* 69:1412–1421.
61. Strecher, V., and I. Rosenstock. 2002. Health belief model, p. 45–66. *In* K. Glanz, F. Lewis, and B. Rimer (ed.), Health behavior and health education: theory, research, and practice. Jossey-Bass, San Francisco.
62. U.S. Department of Agriculture, Food Safety and Inspection Service. 1998. FDA: consumers are changing. *Food Saf. Educ.* 3:4.
63. U.S. Department of Agriculture, Food Safety and Inspection Service. 2002. Changes in consumer knowledge, behavior, and confidence since the 1996 PR/HACCP Final Rule. Available at: http://www.fsis.usda.gov/OA/research/haccpimpacts.pdf. Accessed 22 February 2003.
64. U.S. Department of Agriculture and U.S. Food and Drug Administration. 1998. USDA/FDA education initiative: evaluating the placement of food safety education in American Schools. Available at: http://vm.cfsan.fda.gov/~dms/fseduin2.html. Accessed 24 February 2003.
65. U.S. Department of Education and Institute of Education Services. 2005. Table 171. Total fall enrollment in degree-granting institutions, by control and type of institution: 1965 through 2004 National Center for Education Statistics. Available at: http://nces.ed.gov/programs/digest/d05/tables/dt05_171.asp. Accessed 22 August 2006.
66. U.S. Department of Health and Human Services. 2001. Healthy People 2010, vol. 1. Available at: www.health.gov/healthypeople/Document/tableofcontents.htm. Accessed 23 November 2001.
67. U.S. Environmental Protection Agency, U.S. Department of Agriculture, Center for Food Safety and Applied Nutrition, Food and Drug Administration, National Institutes of Health. Division of Nutrition Research Coordination, National Center for Health Statistics, National Center for Environmental Health, National Center for Infectious Diseases, National Center for Chronic Disease Prevention and Health Promotion, and Centers for Disease Control and Prevention. 1999. Achievements in public health, 1900–1999: safer and healthier foods. *Morb. Mortal. Wkly. Rev.* 48:905–913.
68. U.S. Food and Drug Administration, U.S. Department of Agriculture, U.S. Environmental Protection Agency, and Centers for Disease Control and Prevention. 1997. Food safety from farm to table: a new strategy for the 21st century. Available at: http://vm.cfsan.fda.gov/~dms/fs-draft.html. Accessed 4 February 2003.
69. Unklesbay, N., J. Sneed, and R. Toma. 1998. College students' attitudes, practices, and knowledge of food safety. *J. Food Prot.* 61:1175–1180.
70. Viscusi, W. K., W. A. Magat, and J. Huber. 1986. Informational regulation of consumer health risks: an empirical evaluation of hazard warnings. *Rand J. Econ.* 17:351–365.
71. Wallston, B. S., K. A. Wallston, G. D. Kaplan, and S. A. Maides. 1976. Development and validation of the health locus of control (HLC) scale. *J. Consult. Clin. Psychol.* 44:580–585.
72. Wallston, K. 1993. Frequently asked questions: multidimensional health locus of control scales. Available at: http://www.vanderbilt.edu/nursing/kwallston/FAQMHLC.htm. Accessed 21 November 2001.
73. Wallston, K., B. Wallston, and R. DeVellis. 1978. Development of the multidimensional health locus of control (MHLC) scales. *Health Educ. Monogr.* 6:160–170.
74. Yang, S., M. Leff, D. McTague, K. Horvath, J. Jackson-Thompson, T. Murayi, G. Boeselager, T. Melnik, M. Gildemaster, D. Ridings, S. Altekruse, and F. Angulo. 1998. Multistate surveillance for food-handling, preparation, and consumption behaviors associated with foodborne diseases: 1995 and 1996 BRFSS food-safety questions. Appendix. *Morb. Mortal. Wkly. Rev.* 47:55–57.