

Status of Prerequisite and HACCP Programs Implementation:

College and University Foodservice

Lynn D. Riggins, MBA

Assistant Sanitarian
Kansas State University

Kevin R. Roberts, MS

Instructor
Kansas State University

Elizabeth Barrett, PhD

Associate Professor
Kansas State University

**Status of Prerequisite and HACCP Programs Implementation:
College and University Foodservice**

Abstract

The objectives of this research were to determine the status of prerequisite and HACCP programs implemented in college and university foodservices and to identify barriers to implementation. Survey results revealed that thermometers in freezers, procedures for chemical storage, and policies for handwashing were the three most implemented prerequisites, that 73% of managers are interested in implementing HACCP, and lack of or time for employee training was the greatest barrier to HACCP implementation. Recommendations include developing foodservice specific HACCP training materials and providing more HACCP and food safety training opportunities for employees.

Keywords: HACCP, foodservice, barriers

**Status of Prerequisite and HACCP Program Implementation:
College and University Foodservice**

INTRODUCTION

The safety of food served in college and university foodservices should be of major concern to university officials, foodservice operators, parents, students, and the community. In a university setting, where thousands are served daily, a food safety outbreak could cause sickness or death of many students and the financial ramifications could be devastating (National Restaurant Association Educational Foundation, nd). University foodservice managers should control food safety using the best possible methods. However, little research has been published that examines HACCP implementation in college and university foodservices.

LITERATURE REVIEW

Research has been conducted on implementation of HACCP and prerequisite programs in restaurants (Almanza & Ghiselli, 1998; Roberts & Sneed, 2003) and school foodservices (Giampaoli, Sneed, Cluskey, & Koenig, 2002; Henriod & Sneed, 2004; Hwang, Almanza, & Nelson, 2001; Youn & Sneed, 2002, 2003). Roberts and Sneed found that of 131 restaurant managers surveyed; only 10 (7.6%) had HACCP programs in place. Additionally, less than half (43.9%) of the restaurants had an individual responsible for food safety, which has been found to be a significant factor in increasing the number of food safety programs implemented (Roberts & Sneed, 2003).

In school foodservice, Hwang et al. (2001) indicated that only 14% of their sample had HACCP programs in place. Of those who did not currently have a HACCP plan, only 28% had plans to implement HACCP in the near future, and 69% either did not know what HACCP was or had no plans of implementing a HACCP plan.

Several studies have identified barriers to HACCP implementation in foodservice. Time, money, and resources have been cited as management barriers, employee barriers identified included time and training (Barrett, Penner, & Blakeslee, 1996; Giampaoli et al., 2002; Hwang et al., 2001; Youn & Sneed, 2002, 2003).

The National Association of College and University Foodservices (NACUFS) encourages its member institutions to promote the highest standards of food safety and sanitation. Members are required to adhere to federal and state regulations and NACUFS recommends that a HACCP or similar food safety program be implemented (NACUFS, 1998). However, Sauer (1998) found evidence that suggested NACUFS foodservice directors felt only moderately knowledgeable about HACCP and were even less confident that HACCP would prevent a foodborne illness. Based on a five-point Likert scale, with one meaning no knowledge to five meaning full knowledge, foodservice directors rated their knowledge at a mean of 3.6 and rated the effectiveness of HACCP to prevent foodborne illness at a mean of 3.0.

In college and university foodservice, the decision to outsource foodservices has been driven by several trends including food safety programs, service bundling, investment, culinary influences, and technology. Moreover, contract management companies that can demonstrate effective HACCP programs have a clear advantage (Lawn & Buzalka, 1998).

The goals of this research were to determine the status of prerequisite and HACCP programs implemented in college and university foodservices, to identify potential barriers to

implementing prerequisite and HACCP programs, and determine if there were differences in implementation based on management structure. Research questions addressed by this study included:

1. What is the extent of prerequisite and HACCP program implementation?
2. What barriers to prerequisite and HACCP program implementation exist in college and university foodservice?
3. What is the level of perceived HACCP knowledge of NACUFS foodservice managers?
4. What is the level of perceived HACCP ability of NACUFS foodservice managers?
5. Do differences exist in prerequisite and HACCP program implementation based on the management structure (self-op vs. contract)?
6. Does number of meals served effect prerequisite and HACCP program implementation?
7. Does size of student population effect prerequisite and HACCP program implementation?

METHODOLOGY

Sample

A total of 677 college and university foodservice managers listed in the NACUFS Membership Directory (2002) were solicited to participate in this study. College and university foodservices included two- and four-year post-secondary schools.

Electronic mail (e-mail) was utilized to distribute the survey instrument (Cobanoglu, Warde, & Moreo, 2001; Dillman, 2000). E-mail selection was based on job title and included foodservice director, manager, or auxiliary contact. If the institution had multiple campuses, one e-mail was sent to the director at each campus.

Instrument

A modified version of the Roberts and Sneed (2003) and Sauer (1998) instruments were used in this study. Part I determined if any prerequisite or HACCP programs had been implemented, Part II determined barriers related to food safety, and Part III determined attitudes of food service managers. Parts IV and V explored HACCP knowledge level and ability of managers. Part VI contained demographic questions about the institution and manager.

A pilot test was conducted with college and university managers to assure questions were worded correctly and easily understood. Minor changes were made to the questionnaire based on responses from the pilot test. Pilot tests responses were not included in the final data analysis.

DATA COLLECTION AND ANALYSIS

An e-mail introducing the survey and its research goals was sent to 677 NACUFS member institution managers. E-mails contained a cover letter asking the managers to participate in the survey and a link was provided to the survey site. After initial mailing of the survey, reminder e-mails were sent once a week for two weeks.

The Statistical Package for the Social Sciences 11.5 was used to analyze data. Descriptive statistics including frequencies, means, and standard deviations were calculated. T-tests determined if there were differences in prerequisite and HACCP program implementation by management structure, student population, and meals served per day. A type I error level of .05 was considered significant in analyzing results.

RESULTS AND DISCUSSION

Of the original 677 e-mail addresses, 156 were returned undeliverable. Of those, correct e-mail addresses were located for 36 and resent. The remaining 120 addresses, utilizing online college and university directories, revealed that the individuals were no longer employed at the college or university. The adjusted sample size was 557, with 112 completed questionnaires

returned, resulting in a response rate of 20.1%. While this response rate is low, it is comparable to other studies that utilized NACUFS members as the sampling frame. Utilizing traditional paper surveys distributed by mail, Perdue and Woods (2000) reported a response rate of 27%, Horton and Schmidgal (2001) 15.3%, and Schmidgal and Haskell (2000) 21.8%. Additionally, email surveys are relatively new to NACUFS research, only one other study could be found that utilized email surveys with a NACUFS sampling frame. Sauer (1998) had a response rate of 27%.

Characteristics of College and University Foodservices and Managers

Analysis of the characteristics of foodservice facilities found that 49% of institutions had student populations less than 10,000 and 79% were self-operated. The majority (62.5%) of respondents were younger than 50 years old, 62% were male, 49% had 26 or more years of foodservice experience, and 79% were food safety certified. These findings are similar to the findings of Sauer (1998) where 52.6% had student populations less than 10,000, 88% were self-operated, and 57% of respondents were male.

This study indicated 28% of NACUFS managers had fully implemented a HACCP program. Sauer (1998) found that NACUFS directors were in various stages of HACCP implementation with 5.3% reporting that implementation was complete and 51.3% had partially implemented plans. Results indicate that HACCP implementation in college and university foodservices has increased.

Status of Prerequisite and HACCP Programs

This study explored 10 prerequisite programs identified by the National Advisory Committee on the Microbiological Criteria for Food (1998). These included: cleaning and sanitizing, chemical control, facilities, personal hygiene, pest control, production equipment,

receiving, storage and shipping, specifications, supplier control, and training. These areas were subdivided into 32 specific characteristics to measure implementation of prerequisite and HACCP programs.

The three prerequisite and HACCP programs most implemented were thermometers in refrigerators, thermometers in freezers, and routine spraying by a pest control operator (Table 1). The three least implemented prerequisite and HACCP programs equipment temperature calibration schedules, food product flow charts, and a HACCP team.

T-test results show significant differences existed between self-operated and contract-managed facilities in 23 of 32 variables. In each of these instances, contract-managed facilities had significantly higher means than the means of self-operated facilities (Table 1).

Barriers to Food Safety Program Implementation

In this study, training was identified as the top barrier, which is consistent with what has been found in the literature (Sauer, 1998; Barrett et al., 1996) (Table 2). Seventy-one percent of respondents agreed or strongly agreed that the most significant barrier was the lack of opportunities for in-house employee training followed by lack of opportunities for outside training with 83% agreeing or strongly agreeing. Respondents disagreed that food safety would improve if more money were devoted to it because 30% of respondents disagreed or strongly disagreed. T-tests determined that there were no significant differences among food safety barriers based on management structure (Table 2).

Food Safety Knowledge and Ability of Managers

Perceived knowledge of food safety and HACCP principles among managers is presented in Table 3. Two areas that managers reported being most knowledgeable about were factors of personal hygiene essential for employees to prevent foodborne illness and recognizing potential

food safety hazards and their severity in a foodservice operation. Managers reported being least knowledgeable about HACCP corrective actions and HACCP record keeping systems.

T-test results show food safety knowledge of foodservice managers were significantly different in five areas: critical control point requirements, monitoring critical control points, the HACCP system, corrective actions, and record keeping. Managers of contract-managed facilities had significantly higher means than managers of self-operated facilities (Table 3).

This study explored perceived abilities (Table 4) of foodservice managers to act on their knowledge of prerequisite and HACCP programs, because ability of the foodservice managers would have an influence on types of programs implemented. Perceived abilities with highest overall means were taking corrective actions and recognizing food safety hazards and assessing their severity. Perceived abilities with lowest overall means included training employees to implement a HACCP system and developing flow charts.

Contract-managed facilities had significantly higher means than those of self-operated facilities in two areas: taking corrective actions, recognizing food safety hazards and assessing their severity.

Interestingly, while 34% of manager's indicated that their level of knowledge about HACCP corrective actions was moderate or lower, 85% indicated that they had much to full ability to take corrective actions if a food safety violation occurs. This inconsistency may be due to foodservice manager's not having a clear understanding about HACCP.

Meals Served and Student Population

T-tests were conducted to determine if there were significant differences in prerequisite and HACCP implementation based on number of meals served or the institutions' student population. The only prerequisite program that was significantly different based on number of

meals served was procedures to assure potentially hazardous foods are put under refrigeration quickly upon receiving ($t = 2.12, p=0.037$); indicating that small operations (less than 2500 meals per day) implemented this characteristic more often than larger operations (more than 2500 meals per day). A reason for this could be that smaller operations have lower volume, resulting in delivers having small amounts of potentially hazardous foods and employees being able to refrigerate items quickly.

Two significant differences in prerequisite and HACCP implementation were found based on student population. Results showed that institutions with student populations less than 10,000 have a higher mean for routine pest control ($t=2.442, p=.018$); however, the reverse is true for preventative maintenance ($t=-2.217, p=.029$).

CONCLUSIONS

Even though NACMCF (1998) identified HACCP as a proactive program that could alleviate many food safety outbreaks, 72% of college and university foodservice managers have not fully implemented HACCP. Moreover, prerequisite programs necessary for HACCP implementation have not been initiated in many operations. The majority of the prerequisite programs are inexpensive and easy to implement, yet had not been done. Survey responses indicated that 73% of managers were interested in implementing HACCP, but have not taken time to ensure that prerequisite programs have been put into practice. Results also suggest that even though managers have knowledge of basic food safety principles, they lack specific knowledge about HACCP systems and its components.

As indicated, there is a significant difference in the extent to which prerequisite and HACCP programs have been implemented between self-operated and contract-managed facilities. Contract-managed facilities had higher means for all items where a significant

difference was found. In view of the fact that contract-managed facilities are part of larger organizations, they may have a HACCP plan developed at the corporate level, which can be adapted by individual units with only minor modifications needed. Self-operated facilities do not have this advantage; therefore it would be beneficial for NACUFS operators to band together and develop a HACCP plan that could be adapted by colleges and universities in order to eliminate this competitive edge. NACUFS would then be able to disseminate this information and offer support to member schools.

These results show that further training in food safety practices and HACCP are needed in self-operated facilities. Managers of self-operated facilities rated themselves as having less knowledge and ability than their counterparts. This may be due to contract management companies having extensive and ongoing training programs for their managers. Food safety training is essential for safe food production is a significant issue that should be addressed by NACUFS, who could offer training to employees about HACCP and implementation of a HACCP program.

Limitations to this study include the low response rate and ambiguity in self-reported data. These results should not be generalized for use outside the college and university setting. Further research is needed to identify knowledge, attitude, and behavioral barriers and effective training strategies for college and university foodservice personnel.

References

- Almanza, B., & Ghiselli, R. (1998). Implementation and cost of HACCP in a grill type operation. *Journal of Foodservice Systems*, 10, 107-124.
- Barrett, E., Penner, K., & Blakeslee, K. (1996). Hazard analysis critical control point system implementation of foodservice operators. *Journal of the American Dietetic Association*, 96, (Suppl), A-41.
- Cobanoglu, C., Warde, B., & Moreo, P. (2001). A comparison of mail, fax, and web-based survey methods. *International Journal of Market Research* 43, 441-452.
- Dillman, D. (2000). *Mail and internet surveys: The tailored design method* (2nd ed.). New York, NY; John Wiley & Sons, Inc.
- Food and Drug Administration (FDA). (2001). *Food Code*. [Electronic Version] U.S. Department of Health and Human Services, Public Health Services. Washington, DC: Author (NTIS No. PB 2002100819)
- Giampaoli, J., Sneed, J., Cluskey, M., & Koenig, H. (2002). School foodservice directors' attitudes and perceived challenges to implementing food safety and haccp programs. *The Journal of Child Nutrition & Management*, 26. Available: <http://www.asfsa.org/childnutrition/jcnm/02spring/giampaoli1/>. Accessed: February 11, 2003
- Henriod D., & Sneed, J. (2004). Readiness to implement hazard analysis critical control point (HACCP) systems in Iowa schools. *Journal of the American Dietetic Association*, 104, 180-185.
- Horton, B., & Schmidgall, R. (2001). Evaluation of college and university foodservice managers. *Journal of the National Association of College & University Food Services*, 23, 8-17
- Hwang, J., Almanza, B., & Nelson, D. (2001). Factors influencing Indiana school foodservice directors/managers' plans to implement a hazard analysis critical control point (haccp) program. *The Journal of Child Nutrition & Management* 25, 24 -29.
- Lawn, J., & Buzalka, M. (1998). Eight trends that drive the contract market. [Electronic version] *Food Management*, 33(4), 54-58.
- National Advisory Committee on the Microbiological Criteria for Food. (1998). Hazard analysis and critical control point principles and application guidelines. *Journal of Food Protection*, 61, 1246-1259.
- National Association of College and University Food Service (NACUFS). (2002). *Membership Directory*. East Lansing, MI: NACUFS.

- National Association of College and University Food Service (NACUFS). (1998). *Professional practices in college and university food service*. 3d ed. East Lansing, MI: NACUFS.
- National Restaurant Association Educational Foundation. (no date). Industry related food safety faq. Available: http://www.nraef.org/faq/faq_industry.asp?head_id=6&sub_id=1 . Accessed May 1, 2003
- Perdue, J., & Woods, R. (2001). Are NACUFS managers satisfied with their jobs? *Journal of the National Association of College & University Food Services*, 23, 28-36.
- Roberts, K., & Sneed, J. (2003). Status of prerequisite and HACCP program implementation in Iowa restaurants. *Food Protection Trends*. 23, 808 - 813.
- Sauer, K. (1998). Development and evaluation of an internet-based hazard analysis critical control point (HACCP) resource for college and university foodservice operators. *Master's Thesis*, Kansas State University.
- Scheule, B., Miller, J., McCahon, C., & Johnson, D. (1995). Use of the NACUFS professional standards manual as reported by NACUFS members [Electronic Version]. *Journal of the National Association of College & University Food Services*, 17. Available: <http://www.nacufs.org/template.asp?page=resources>. Accessed: January 31, 2005.
- Scheule, B., Miller, J., McCahon, C., & Johnson, D. (1996). Influence of the NACUFS professional standards manual on human resource development and customer focus in college and university dining operations [Electronic Version]. *Journal of the National Association of College & University Food Services*, 18. Available: <http://www.nacufs.org/template.asp?page=resources>. Accessed: January 31, 2005.
- Schmidgall, R., & Haskell, B. (2000). Use of operational ratios by college and university foodservice managers [Electronic Version]. *Journal of the National Association of College & University Food Services*, 22. Available: <http://www.nacufs.org/template.asp?page=resources>. Accessed: January 31, 2005.
- Woods, R., Cho, S., & Johnson, M. (1999). The use of performance appraisals among NACUFS managers operations [Electronic Version]. *Journal of the National Association of College & University Food Services*, 21. Available: <http://www.nacufs.org/template.asp?page=resources>. Accessed: January 31, 2005.
- Woods, R., & Perdue, J. (2000). The effectiveness of alternative training methods in college and university foodservices. *Journal of the National Association of College & University Food Services*, 22, 64-70.
- Youn, S., & Sneed, J. (2003). Implementation of HACCP and prerequisite programs in school foodservice [Electronic version]. *Journal of the American Dietetic Association*, 103, 55 - 60.

Youn, S., & Sneed, J. (2002). Training and perceived barriers to implementing food safety practices in school foodservice. *The Journal of Child Nutrition & Management*, 26. Available: <http://asfsa.org/childnutrition/jcnm/02fall/youn> . Accessed: February 20, 2003

Table 1. Status of Prerequisite and HACCP programs among Colleges and Universities, Self-operated versus Contract-managed

Characteristic ^a	Overall (n=112)		Self Operated (n=87)		Contract- Managed (n = 25)		t	Sig.
	Mean	± SD	Mean	± SD	Mean	± SD		
Thermometers in refrigerators	4.97	0.16	4.98	0.16	4.95	0.21	0.4336	0.6680
Thermometers in freezers	4.97	0.16	4.98	0.16	4.95	0.21	0.4336	0.6680
Routine spraying by a pest control operator	4.94	0.28	4.93	0.31	4.95	0.21	-0.5034	0.6170
A policy on handwashing	4.88	0.44	4.84	0.51	5.00	0.00	-2.8221	0.0060*
Procedures to check the final internal temperature of cooked food	4.84	0.45	4.79	0.51	5.00	0.00	-3.6460	0.0005*
A policy on the use of gloves	4.82	0.47	4.80	0.49	4.95	0.21	-2.2688	0.0260*
A policy on the use of hair restraints	4.80	0.62	4.78	0.63	4.82	0.66	-0.2226	0.8253
All employees trained on personal hygiene	4.79	0.45	4.76	0.49	4.86	0.35	-1.1673	0.2492
All employees trained on cleaning and sanitation procedures	4.76	0.45	4.71	0.48	4.95	0.21	-3.4934	0.0008*
Procedures to assure potentially hazardous foods are put under refrigeration quickly upon receiving	4.70	0.74	4.70	0.66	4.95	0.21	-3.0173	0.0032*
All employees trained on safe food handling practices	4.64	0.63	4.61	0.64	4.77	0.53	-1.2237	0.2283
Equipment that is certified by NSF, Inc.	4.53	1.08	4.49	1.11	4.82	0.66	-1.7609	0.0837
Written procedures for cleaning and sanitizing all equipment	4.39	0.83	4.26	0.89	4.77	0.43	-3.8570	0.0002*
Documented procedures for chemical storage	4.37	0.96	4.24	1.00	4.71	0.78	-2.3100	0.0263*
Traffic flow of food that minimizes cross contamination	4.31	0.91	4.18	0.96	4.73	0.46	-3.8030	0.0003*
Procedures for checking the internal temperature of foods while cooling	4.25	0.95	4.09	1.01	4.82	0.50	-4.7482	0.0000*
Written procedures for cleaning the operation	4.25	0.99	4.11	1.03	4.73	0.55	-3.7775	0.0003*
Temperature logs to record end-point cooking temperatures	4.16	1.10	4.06	1.17	4.55	0.67	-2.5143	0.0147*

Table 1. Status of Prerequisite and HACCP programs among Colleges and Universities, Self-operated versus Contract-managed (cont)

Characteristic ^a	Overall (n=112)		Self Operated (n=87)		Contract- Managed (n = 25)		t	Sig.
	Mean	± SD	Mean	± SD	Mean	± SD		
Assurance from suppliers that they follow HACCP or good manufacturing practices	4.11	1.19	3.93	1.21	4.73	0.88	-3.4735	0.0012*
Procedures to take and record the temperatures of all potentially hazardous foods as they flow through the operation	4.07	1.11	3.98	1.12	4.64	0.66	-3.5284	0.0008*
Preventive maintenance schedules	4.06	1.03	3.98	1.05	4.32	0.95	-1.4727	0.1495
Procedures to check temperatures when receiving food	4.06	1.04	3.94	1.06	4.55	0.80	-2.9321	0.0054*
Written specifications for all ingredients and food products	4.00	1.14	3.82	1.20	4.62	0.74	-3.8416	0.0003*
Temperature logs for all cooling equipment	3.94	1.20	3.77	1.25	4.55	0.74	-3.7112	0.0005*
Standardized recipes with critical control points	3.83	1.09	3.72	1.08	4.09	1.02	-1.4981	0.1431
Procedures for checking the condition of the supplier's delivery trucks (i.e. sanitation, temperature)	3.70	1.21	3.48	1.21	4.64	0.58	-6.3722	0.0000*
Thermometers in dry storage	3.62	1.30	3.45	1.31	4.14	1.17	-2.3824	0.0225*
A comprehensive Hazard Analysis Critical Control Point (HACCP) plan	3.57	1.19	3.33	1.17	4.43	0.75	-5.2946	0.0000*
Temperature logs for all heating equipment	3.53	1.34	3.30	1.36	4.41	0.85	-4.6810	0.0000*
Equipment temperature calibration schedules	3.53	1.28	3.32	1.28	4.14	1.13	-2.9450	0.0056*
Food product flow charts	3.39	1.15	3.26	1.13	3.91	1.11	-2.4423	0.0200*
A HACCP team	3.33	1.29	3.11	1.26	4.05	1.07	-3.4241	0.0016*

^a The statement "Please indicate the food safety practices that you have or plan to implement within your operation." was used for all items.

^b Likert scale: 1 = don't know, 2= no plans to implement, 3 = plan to implement, 4 = partially implemented, and 5 = fully implemented

* Indicated significance level of $\alpha < .05$

Table 2. Food Safety Barriers among College and University Foodservices in relation to HACCP and Prerequisite Programs (n=108)

Characteristic ^a	Mean \pm SD ^{bc}	Frequency of Responses (%) ^d				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Employees had training opportunities outside of operation.	4.0 \pm 0.92	26 (24%)	53 (49%)	19 (18%)	10 (9%)	0 (0%)
Employees had more opportunities for training at the operation conducted by a manager.	3.9 \pm 0.88	31 (29%)	55 (51%)	11 (10%)	10 (9%)	1 (1%)
Employees had more time to implement food safety practices.	3.8 \pm 1.09	17 (16%)	35 (32%)	27 (25%)	26 (24%)	3 (3%)
Employees were more motivated to implement food safety practices.	3.7 \pm 1.11	30 (28%)	45 (42%)	15 (14%)	15 (14%)	3 (3%)
We did not have high levels of turnover.	3.7 \pm 1.03	23 (21%)	40 (37%)	24 (22%)	17 (16%)	4 (4%)
Managers had more time to implement food safety practices.	3.6 \pm 1.01	28 (26%)	40 (37%)	20 (18%)	17 (16%)	3 (3%)
We could hire a consultant.	3.6 \pm 0.99	7 (7%)	25 (24%)	26 (24%)	37 (35%)	13 (12%)
We had a model HACCP plan to follow.	3.6 \pm 1.10	20 (19%)	47 (44%)	23 (21%)	16 (15%)	2 (2%)
Our facilities were designed differently.	3.5 \pm 1.07	20 (19%)	37 (35%)	31 (28%)	17 (16%)	3 (3%)
We had more money to devote to food safety.	3.3 \pm 1.10	17 (16%)	30 (29%)	30 (27%)	28 (27%)	3 (3%)
We documented food flow and temperatures.	3.3 \pm 1.12	18 (17%)	45 (42%)	30 (27%)	12 (11%)	3 (3%)
We could implement our HACCP program.	2.8 \pm 1.15	21 (20%)	47 (44%)	25 (23%)	11 (10%)	4 (4%)

^a The stem "Food safety in my operation would improve if. . ." was used for all questions

^b Mean \pm Standard Deviation

^c Likert scale: 1 = strongly disagree, 2= disagree, 3 = neutral, 4 = agree, and 5 = strongly agree

^d Percentages may not add to 100% due to rounding

Table 3. Food Safety Knowledge among College and University Foodservice Managers' (n=112)

Characteristic ^a	Overall (n=112)		Self Operated (n=87)		Contract-Managed (n=25)		t	Sig.
	Mean	±SD	Mean	±SD	Mean	±SD		
Factors of personal hygiene essential for employees to prevent foodborne illness.	4.53	0.60	4.48	0.63	4.73	0.46	-2.1092	0.0406*
Potential food safety hazards and their severity in a foodservice operation	4.31	0.65	3.82	0.85	4.05	0.84	-1.3001	0.2038
Environmental conditions that encourage growth of microorganisms	4.20	0.65	4.19	0.63	4.32	0.72	-0.7626	0.4517
Characteristics of potentially hazardous foods (PHF)	4.16	0.76	4.13	0.76	4.36	0.73	-1.3252	0.1939
Requirements that must be met at each critical control point	4.19	0.85	3.93	0.85	4.50	0.67	-3.3494	0.0018*
Procedures to monitor critical control points	3.99	0.85	3.90	0.84	4.43	0.75	-2.7988	0.0084*
The Hazard Analysis Critical Control Point System	3.85	0.92	3.82	0.85	4.05	0.84	-2.6564	0.0114*
Microorganisms that cause foodborne illness	3.94	0.69	3.90	0.65	4.14	0.83	-1.21	0.2364
HACCP corrective actions	3.77	1.01	3.63	1.00	4.36	0.85	-3.4893	0.0012*
HACCP record keeping systems	3.58	1.04	3.46	1.02	4.14	0.94	-2.9275	0.0060*

^a The stem "I feel knowledgeable about. . ." was used for all questions.

^b Likert scale: 1 = no knowledge, 2 = little knowledge, 3 = moderate knowledge, 4 = much knowledge, and 5 = full knowledge

* Indicated significance level of $\alpha < .05$.

Table 4. Abilities of College and University Managers' Related to Implementing Food Safety Practices (n=112)

Characteristic ^a	Overall (n=112)		Self Operated (n=87)		Contract-Managed (n=25)		t	Sig.
	Mean	±SD	Mean	±SD	Mean	±SD		
Take corrective action if a food safety violation occurs	4.34	0.74	4.25	0.78	4.64	0.49	-2.8323	0.0066*
Recognize potential food safety hazards and assess their severity	4.21	0.74	4.13	0.76	4.55	0.6	-2.7357	0.0092*
Identify critical control points	4.19	0.77	4.14	0.78	4.45	0.67	-1.8735	0.0689
Modify recipes so that critical control points are identified	3.95	0.85	3.89	0.86	4.18	0.8	-1.4897	0.1452
Implement a HACCP system	3.86	0.85	3.82	0.85	4.05	0.84	-1.1061	0.2767
Develop a basic record keeping system for HACCP	3.87	0.98	3.81	1.02	4.09	0.81	-1.3668	0.1792
Verify that the HACCP system is working	3.89	0.98	3.82	1.02	4.18	0.8	-1.7775	0.0829
Train employees to implement a HACCP system	3.84	0.96	3.78	0.97	4.14	0.77	-1.8162	0.0767
Develop flow charts for a HACCP system	3.72	1.01	3.67	1.03	4	0.87	-1.5319	0.1338

^a The stem "My ability to. . ." was used for all questions.

^b Likert scale: 1 = no ability, 2 = little ability, 3 = moderate ability, 4 = much ability, and 5 = complete ability

* Indicated significance level of $\alpha < .05$.