

## Effectiveness of HACCP-based Training on the Food Safety Knowledge and Behavior of Hospital Foodservice Employees

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To prevent food-borne diseases and ensure food safety, foodservice operators have been implementing the HACCP system in their facilities. Employees' knowledge of food safety can be improved through training and, as a result, their food safety behavior can be positively changed. A nonequivalent pretest and posttest control group model was designed to investigate the effectiveness of HACCP-based training on hospital foodservice employees' food safety knowledge and behavior, and to determine relationships between food safety knowledge and food safety behavior. The subjects used in this study were 84 hospital foodservice employees, assigned either to the intervention group (n=44) or the control group (n=40). Data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were computed, while the Student's t-test and ANCOVA (Analysis of Covariance) were used to investigate significant differences between groups, and the Pearson correlation was used to determine significant correlations. There were significant gains in both food safety knowledge and behavior, after the HACCP-based training. However, no significant correlation was found between food safety knowledge and food safety behavior. Based on this study we conclude that HACCP-based training is effective in improving both the food safety knowledge and food safety behavior of hospital foodservice employees.

### INTRODUCTION

As customers' expectations regarding high-quality and health-oriented food products have increased, a new management philosophy which has emphasized food quality and food safety has been rapidly introduced into the foodservice domain in Korea. More specifically, emphasis has been placed on the need for instituting a system aimed at developing strategies such as continuous improvements in process control, development of tools for quality improvements, and cooperative employee teamwork.<sup>1)</sup>

The December 24, 1995, revised Food Safety Code in Korea included the Hazard Analysis Critical Control Point (HACCP) system. In response to this institutional change, the Society for HACCP Research was inaugurated, and emphasized the application of the HACCP system to all foods from farm to table. Foodservice businesses have subsequently been concentrating their efforts on incorporating the HACCP system into their operations, and on training employees in food-safety.

However, some difficulties in implementing the HACCP system in the retail foodservice industry<sup>2)</sup> have

arisen due to: 1) a lack of professional staffing for food safety management, 2) limited understanding of the HACCP system by foodservice employees, and 3) a general lack of understanding of how to implement HACCP. Thus, a sound food safety training program, availability of professional staff, and development of a dedicated HACCP system, are needed to ensure food safety in retail foodservice.

The successful application of the HACCP system requires the full commitment and involvement of management, and continuous training of employees.<sup>3)</sup> Compared to the food processing industry, the foodservice industry has many difficulties in implementing the HACCP system due to the variety of menus, and the difficulties in setting standards for food processes. Therefore, after introducing the HACCP system into specific foodservice establishments, a tailored training curriculum should be developed.

Training is a process involving knowledge, attitudes, and behaviors (KAB); trainees should gain and understand knowledge, modify their attitudes and subsequently change their behavior.<sup>4-5)</sup> Thus, training programs should consider the special characteristics of the specific conditions of their foodservice operations and should judge the level of acceptance by trainees.<sup>6-7)</sup>

A number of studies have been conducted to assess

the needs for and methods of HACCP training. A six-hour training program using the tools developed at the National Restaurants Association in 1995<sup>6)</sup> was administered to foodservice operators, whose knowledge of HACCP and food safety was subsequently assessed. Post-training assessments of changes in knowledge of food safety have also been conducted for foodservice workers<sup>8,9)</sup> and restaurant operators.<sup>10)</sup> Another study evaluated the effectiveness of the between lecture method of teaching food safety and of a computer assisted interactive method.<sup>11)</sup> However, these studies have not investigated the relationship between sanitation behavior and knowledge, and have not evaluated the effectiveness of training using a nonequivalent pre-post test control group design.

The purposes of this study were to determine the effectiveness of HACCP-based training on food safety knowledge and behavior, and to determine relationships between food safety knowledge and food safety behavior for employees of food service operations.

We hypothesized that: (1) the intervention group with HACCP training will show higher levels of sanitation knowledge and behavior, and (2) there will be a positive relationship between sanitation knowledge and behavior after the HACCP-based training.

## MATERIALS AND METHODS

### 1. Sample and Data Collection

A pilot test for evaluating the effectiveness of the HACCP-based food safety training was conducted with the help of 13 food service workers in a school

foodservice facility during the period July 1 to July 5, 2000. The survey instrument was revised according to the results of the pilot test, and was reevaluated for accuracy by other food safety professionals.

The subjects of this study were all employees of four general hospitals that have a bed capacity of more than 550 in the cities of Cheonan, Incheon, and Seoul, Korea. The test method used was the nonequivalent pretest/posttest control group model.<sup>4),12)</sup> Participants were not randomly selected but chosen so that they could be available for as long as 2 consecutive weeks. Subjects were divided into two groups, a control group and an intervention group, in order to control the effects of both external and internal variables. The main survey was conducted twice, before and after the HACCP training. The pre-test was conducted at the beginning of the first day of the HACCP training and the post-test at the end of the last day of the HACCP training. Before completing the survey questionnaire, the examiners explained the purpose of this study, and gave guidelines and help for subjects in filling out the questionnaire. Employees were then left to fill out the questionnaires themselves.

The main questionnaire was administered to employees over one month period from July 21, 2000, to August 14, 2000. A total of 172 questionnaires (92 for the intervention group and 80 for the control group) were distributed, and 139 (85 for the intervention group and 54 for the control group) were returned. Complete responses were received from only 84 participants, 44 for the intervention group and 40 for the control group, and these were used for the analysis, giving an overall response rate of 49 percent.

**Table 1.** The HACCP training program content for foodservice employees

Categories	Content
Part 1 Introduction	- Definition of HACCP - Procedure of HACCP - Importance of HACCP
Part 2 Time & temperature/others	- Safe food sources including expiry dates, packing condition - Safe food handling for preventing cross-contamination - Safe food storage methods including stock rotation methods. - Time & temperature zone - Proper cooking method - Proper cooling method - Proper thawing methods - Proper hot-/cold-holding methods
Part 3 Personal hygiene	- Hand washing methods - Separate use of disposable gloves - Proper personal practices - Proper taste testing methods - Reporting personal health problems - Controlling methods of cross-contamination from hands, foods & equipment
Part 4 Equipment & facility hygiene	- General facility sanitation - Dishes & utensils sanitation - Supplies sanitation such as knives, cutting board and wiping clothes - Sanitation of working places - Insect and rodent control

## 2. Training and Survey tool

### 1) Development of the training material

HACCP based training materials were developed by reviewing the literature<sup>(3)</sup> and the database from the HACCP-based computer program developed by Lee *et al.*<sup>(14)</sup> for the contract foodservice business. The content of the training material is presented in Table 1.

The intervention group was trained by a senior dietitian who had already completed HACCP training. A total of 5 hours training was administered to the subjects during the period July 21 to August 14, and this consisted of lectures, slide presentations, and demonstrations of proper handling practices in foodservice operations.

### 2) Survey instrument

The survey questionnaire was developed based on the training materials used in this study and other relevant studies.<sup>(10,15)</sup> As presented in Table 2, the survey instrument consisted of 3 parts. The first part measured employees' knowledge of food safety. From literature

reviews, we divided the management of food safety into 3 categories: (1) time-temperature relationship and food handling practices by operational steps for 8 items, (2) personal hygiene practices for 6 items, and (3) equipment and facility hygiene for 6 items. The respondents were asked to answer the questions as true or false. If the answer was correct, they gained 1, if not, 0. The second part of the survey instrument consisted of 11 items related to employees' behaviors concerning food safety, where we employed the 5-point Likert scale (1 = perform less than 25%, 2 = perform 25 to 50%, 3 = perform 50 to 75%, 4 = perform 75 to 90%, and 5 = perform more than 90%). The third part of the survey instrument included demographic questions such as gender, age, education, total years of experience in the foodservice industry, years of experience in the current working place, and position.

### 3. Statistical Analyses

Statistical analyses were performed using the Statistical

**Table 2.** Question items related to sanitation knowledge and sanitation behavior

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#### Sanitation Knowledge

##### Time-Temperature

- K1: Eggs intended to be used today kept at room temperature. (F)  
 K2: I transferred the food I received with sanitary equipment which is above the ground. (T)  
 K3: I refroze the thawed meats and fish in order to keep the freshness, when the preparation was delayed. (F)  
 K4: I store sliced raw fish with salt on the upper shelf in the refrigerators. (F)  
 K5: I put sliced raw green onion into a hot soup for the purpose of enhancing customers' satisfaction. (F)  
 K6: I kept the whole volume of sandwich stuffing at room temperature during preparation. (F)  
 K7: I maintained the internal temperature of hot foods such as hard boiled food, hot soup in soy and hot soups above 60°C. (T)  
 K8: Right after I finished cooking the hot food, I put it into the refrigerator. (F)
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##### Personal hygiene

- K9: Employees should not wear any accessories and jewelry while working. (T)  
 K10: Generally, separate pairs of gloves are used for cooking, cleaning, and assembling. However, gloves for cleaning can be used for cooking. (F)  
 K11: If you cut your finger while at work, use first-aids to stop the bleeding, and you can work again. (F)  
 K12: For the proper hand-washing, first, use soap and foam completely. Second, wash thoroughly and scrub bottom of the nail with hand brush. Last, wash away with warm. (T)  
 K13: I use special equipment for a taste test. (T)  
 K14: The employee works on cardboard boxes in pre-preparation of spinach, to prevent the contamination from the floor. (F)
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##### Equipment & facility hygiene

- K15: It is not a concern if the kitchen floor is wet because it will be cleaned once a day. (F)  
 K16: Even the bottle water, it should be boiled before making cold soups. (F)  
 K17: Cucumbers were prepared on the same cutting board that was used to chop meat right before. (F)  
 K18: Garbage containers may be kept open, because waste is removed within 12 hrs. (F)  
 K19: Raw vegetables are washed several times in running water. (T)  
 K20: The doors with insect nets are opened in order to ventilate the storeroom. (F)
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#### Sanitation Behavior

- B1: I observe first in first out procedures in storing and issuing food products and verify the expiration date.  
 B2: I thaw frozen foods under potable running water and then I immediately wash the water from the floor.  
 B3: I do not place raw foods and cooked foods on the same working table.  
 B4: I keep hot food in steam tables and cold foods in the refrigerator right after cooking.  
 B5: When the cooling process is needed, I rapidly cool foods from 60°C to 4.4°C within 4 hours without holding it at room temperature.  
 B6: I verify the time from assembling to service to be less than 2 hours.  
 B7: When washing vegetables, I wash them 3 more times with the flowing water.  
 B8: I wash my hands with warm flowing water, soap, a hand brush and a hygiene towel before and after preparing meat and fish.  
 B9: I change into my indoor shoes when entering cooking area.  
 B10: I separately use knives, cutting boards, kitchen towel and gloves for each purpose of use, and store them separately.  
 B11: I promptly clean and sanitize the accessories of the equipment such as cutter and slice after each use.
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Package for the Social Sciences<sup>12),16)</sup>. The statistical tests used for analyses are presented in Table 3.

## RESULTS AND DISCUSSION

### 1. Characteristics of respondents

The demographic profiles of the employees who participated in this study are displayed in Table 4. All the respondents were female. Seventy percent for the control group and 59.1 percent for the intervention group belonged to the forty-one to fifty years age range. The average age for the control subjects was 45, and was 44 years for the intervention subjects. Education levels for the control group were as follows: completed middle school (50.0%), high school (37.5%), elementary school (10.0%), and college (2.5%); while for the intervention group were: completed middle school (56.8%), high school (25.0%), and elementary school (18.2%). In summary, about 84.5% of respondents had not obtained a high school education.

The total work experience of foodservices employees averaged 41.7 months for the control group, and 52.5% had worked in this field for more than 5 years. In the intervention group, the average work experience was 34.5 months and only 2.3% of workers had worked in this field for more than 5 years. The average length of present work place experience showed a different distribution between the intervention group and the control group. These apparent discrepancies in results were caused by the fact that the control group consisted of foodservice workers who had previously worked while the intervention group consisted of workers largely who had newly recruited in the contracts foodservice management company. The employees' were classified as either part time or full time workers. Sixty-one percent of respondents were found to be full time workers: 62.5% for the control group, and 59.1% for the intervention group.

### 2. Sanitation knowledge and behavior before the HACCP training

Sanitation behavior and knowledge prior to HACCP training were evaluated to test the internal validity of this research design. The results are presented in Table 5. By investigating the pre-test scores for sanitation knowledge and sanitation behavior, we could evaluate the baseline level of knowledge and behavior about food safety among hospital foodservice workers.

#### 1) Sanitation knowledge before HACCP training

The mean score for sanitation knowledge in hospital foodservice employees was 0.66 out of 1. The mean score for the time & temperature category was 0.57, for personal hygiene was 0.67, and for equipment & facility hygiene was 0.77. These results showed that employees' food safety knowledge for time and temperature was lower compared to that for equipment & facility hygiene. This result is in agreement with a study by Kwak *et al.*<sup>2)</sup> that was conducted for dietitians in school foodservices in Korea. Kwak's study suggested that dietitians' level of performance for the management of time and temperature was lower than that for equipment and facility hygiene; it was concluded that there was a need for foodservice managers to place greater emphasis on training for time and temperature management.

The lowest score item for the time and temperature relationship was "putting sliced raw green onion into hot soups" (K5, False, 0.15±0.36), and the highest score in this category was "I maintained the internal temperature of hot foods such as hard boiled food, hot soup in soy and hot soups above 60°C" (K7, True, 0.94±0.24). In the personal hygiene category, the overall mean score was 0.62; all the items except one, "employee works on cardboard boxes in pre-preparation of spinach, to prevent contamination from the floor" (K14, False, 0.15±0.36), were rated above the mean score for this category. The item which received the highest score in the personal hygiene category was related to the proper hand-washing method: "for proper hand-washing, first, use soap and

Table 3. Statistical tests for data analysis<sup>12)</sup>

Purpose	Data	Test
Knowledge, behavior demographic variables	- Pretest and posttest score knowledge and behavior - Demographic variables	- Mean - Percent - Frequency
Internal validity	- Knowledge and behavior pretest score of the control and intervention group	- t-test
Training validity	- Knowledge pre- and posttest score of the intervention group	- ANCOVA(Analysis of Covariance)
Transfer validity	- Behavior pre- and posttest score of the intervention group	- ANCOVA(Analysis of Covariance)
Relationship between knowledge and behavior	- Knowledge posttest score and behavior posttest score	- Pearson correlation

**Table 4.** Characteristics of respondents

Characteristics	Control	Intervention	Total	N(%)
Gender				
Male	0(0.0)	0(0.0)	0(0.0)	
Female	40(100)	44(100)	84(100)	
Age				
30 years below	1( 2.5)	0( 0.0)	1( 1.2)	
31-40 years below	3(27.5)	10(22.7)	13(15.5)	
41-45 years below	16(40.0)	11(25.0)	27(32.1)	
46-50 years below	12(30.0)	15(34.1)	27(32.1)	
50 years and over	8(20.0)	8(18.2)	16(19.0)	
Education				
Elementary school	4(10.0)	8(18.2)	12(14.3)	
Middle school	20(50.0)	25(56.8)	45(53.5)	
High school	15(37.5)	11(25.0)	26(31.0)	
College degree	1( 2.5)	-	1(1.2)	
Work experience (total)				
1 years below	14(35.0)	8(18.2)	22(26.2)	
1-2 years below	0( 0.0)	9(20.5)	9(10.7)	
2-3 years below	2( 5.0)	4( 9.1)	6( 7.1)	
3-4 years below	2( 5.0)	12(27.3)	14(16.7)	
4-5 years below	1( 2.5)	10(22.7)	11(13.1)	
5 years and over	21(52.5)	1( 2.3)	22(26.2)	
Work experience (present)				
1 years below	14(35.0)	11(25.0)	25(29.8)	
1-2 years below	0( 0.0)	10(22.7)	10(11.9)	
2-3 years below	2( 5.0)	3( 6.8)	5( 6.0)	
3-4 years below	2( 5.0)	11(25.0)	13(15.5)	
4-5 years below	1( 2.5)	9(20.5)	10(11.9)	
5 years and over	21(52.5)	0( 0.0)	21(25.0)	
Hiring condition				
Full time	25(62.5)	26(59.1)	51(60.7)	
Part time	15(37.5)	18(40.9)	33(39.3)	

**Table 5.** Sanitation knowledge of food service employees before HACCP training

Characteristics	Total (N=84)	Control group (N=40)	Intervention group (N=44)	P value
<b>Sanitation knowledge</b>				
<b>Time-Temperature</b>				
K1	0.49 ± 0.50	0.48 ± 0.51	0.50 ± 0.51	0.267
K2	0.87 ± 0.34	0.80 ± 0.41	0.93 ± 0.26	0.074
K3	0.17 ± 0.37	0.10 ± 0.30	0.23 ± 0.42	0.118
K4	0.64 ± 0.48	0.65 ± 0.48	0.64 ± 0.49	0.896
K5	0.15 ± 0.36	0.10 ± 0.30	0.20 ± 0.41	0.186
K6	0.48 ± 0.50	0.43 ± 0.50	0.52 ± 0.51	0.370
K7	0.94 ± 0.24	0.93 ± 0.27	0.95 ± 0.21	0.568
K8	0.82 ± 0.39	0.90 ± 0.30	0.75 ± 0.44	0.073
Sub-mean	0.57 ± 0.19	0.55 ± 0.18	0.59 ± 0.20	0.300
<b>Personal hygiene</b>				
K9	0.89 ± 0.31	0.95 ± 0.22	0.84 ± 0.37	0.106
K10	0.63 ± 0.49	0.53 ± 0.51	0.73 ± 0.45	0.055
K11	0.73 ± 0.45	0.65 ± 0.48	0.80 ± 0.41	0.135
K12	0.92 ± 0.28	0.85 ± 0.36	0.98 ± 0.15	0.035*
K13	0.71 ± 0.45	0.60 ± 0.50	0.82 ± 0.39	0.027*
K14	0.15 ± 0.36	0.15 ± 0.36	0.16 ± 0.37	0.908
Sub-mean	0.67 ± 0.20	0.63 ± 0.21	0.71 ± 0.18	0.065
<b>Equipment &amp; Facility hygiene</b>				
K15	0.83 ± 0.37	0.75 ± 0.44	0.91 ± 0.29	0.051
K16	0.00 ± 0.28	0.13 ± 0.33	0.00 ± 0.21	0.188
K17	0.96 ± 0.19	0.98 ± 0.16	0.95 ± 0.21	0.614
K18	0.92 ± 0.28	0.95 ± 0.22	0.89 ± 0.32	0.292
K19	0.99 ± 0.11	1.00 ± 0.00	0.98 ± 0.15	0.344
K20	0.83 ± 0.37	0.85 ± 0.36	0.82 ± 0.39	0.696
Sub-mean	0.77 ± 0.14	0.77 ± 0.13	0.77 ± 0.15	0.768
<b>Mean</b>	0.66 ± 0.13	0.64 ± 0.12	0.68 ± 0.14	0.125

\* p &lt; 0.05

foam thoroughly; second, wash thoroughly and scrub bottom of the nails with hand brush; last, wash away with warm water” (k12, True, 0.92±0.28). The equipment and facility hygiene category was rated the highest score in the other categories, and its mean score was rated as 0.77. The item, “raw vegetables are washed several times in running water” (K19, True, 0.99±0.11) rated the highest score, whereas the item “even the bottle water, it should be boiled before making cold soups” (k16, False, 0.00±0.28) was rated lowest in the other categories as well as in this category.

**2) Sanitation behavior before HACCP training**

As shown in Table 6, the mean score for sanitation behavior before the HACCP training was 3.86 out of 5 for hospital foodservice employees, and this is considered to be a comparatively good level.

The items rated as comparatively well performed by employees were “when washing vegetables, I wash them 3 more times with flowing water” (B7, 4.75), “I verify the time from assembling to service to be less than 2 hours” (B6, 4.24), and “I observe FIFO procedures in storing and issuing food products and in verifying the expiration date” (B1, 4.19). However the item, “I change into my indoor shoes when entering the cooking area” (B9, 1.75), was rated as the lowest level of performance.

A study by Howes *et al.*<sup>12)</sup> which evaluated changes in sanitation knowledge and behavior through home study, pointed out that even if employees had proper sanitation knowledge, they do not always practice what they know. Namely, sanitation knowledge is not always accompanied by the equivalent sanitation behavior. In addition, this result supported the results of Hus & Huang’s study,<sup>8)</sup> where employees in university foodservices showed poor sanitation behavior.

**3) Internal validity**

In order to test the internal validity of this study, we analyzed statistical differences using paired t-tests to see if the levels of sanitation knowledge and behavior between the control and the intervention groups were the same (Table 5 and Table 6).

There was no significant difference in sanitation knowledge between the intervention and the control group before HACCP training (control group = 0.64 ±0.12; intervention group = 0.68±0.14; P > 0.05). Sanitation behaviors also showed no significance differences (control group = 3.76±0.52; intervention group = 3.96±0.47; P > 0.05). These results suggested that our research design had internal validity.

**3. Sanitation knowledge and behaviors after the HACCP training**

**1) Testing training effects through measuring sanitation knowledge after the HACCP training**

In order to test the effects of training on sanitation knowledge between the control group and the intervention group, one-way analysis of covariance was used. The pre-test score for sanitation knowledge of the control group was used as a covariate. We presented the post-test sanitation knowledge scores, adjusted for the pre-test scores, in Table 7. As shown in Table 7, the sanitation knowledge of the intervention group that undertook the HACCP training scored 0.88, whereas the control group, which had not taken the HACCP training, scored 0.64.

The post-test knowledge scores for the intervention group were higher than those for the control group (Wald=99.542, P<0.001). In other words, this result showed that the HACCP training had a significant influence on sanitation knowledge. Especially, the time & temperature category showed great improvements in sanitation knowledge (Wald=114.602, P<0.001).

**Table 6.** Sanitation behavior of food service employees before HACCP training

Characteristics	Total (N=84)	Control group (N=40)	Intervention group (N=44)	P value
<b>Sanitation behavior</b>				
B1	4.19 ± 0.84	4.08 ± 0.92	4.30 ± 0.76	0.233
B2	4.18 ± 0.93	3.95 ± 0.96	4.39 ± 0.85	0.028*
B3	4.07 ± 0.89	4.08 ± 0.86	4.07 ± 0.93	0.972
B4	4.00 ± 1.01	3.78 ± 1.12	4.20 ± 0.85	0.050*
B5	3.49 ± 1.21	3.45 ± 1.01	3.52 ± 1.37	0.785
B6	4.24 ± 0.86	4.30 ± 0.85	4.19 ± 0.88	0.551
B7	4.75 ± 0.56	4.78 ± 0.53	4.73 ± 0.59	0.679
B8	3.73 ± 1.18	3.75 ± 1.15	3.70 ± 1.21	0.861
B9	1.75 ± 1.14	1.43 ± 0.84	2.05 ± 1.29	0.012*
B10	3.99 ± 1.15	4.15 ± 1.08	3.84 ± 1.20	0.219
B11	3.99 ± 1.14	3.78 ± 1.19	4.19 ± 1.07	0.102
<b>Mean</b>	<b>3.86 ± 0.00</b>	<b>3.76 ± 0.52</b>	<b>3.96 ± 0.47</b>	<b>0.062</b>

Note: Scores are based on a Likert type scale of 1 = perform less than 25%, 2 = perform 25 to 50%, 3 = perform 50 to 75%, 4 = perform 75 to 90%, and 5 = perform more than 90%

\* p < 0.05

When we investigated the result by category, the time and temperature question, "putting sliced raw green onion into bowls of hot soup" (K5, Wald=24.652,  $P<0.001$ ), showed the most improvement after the training. The next most improved question item was "storing sliced raw fish with salt on the upper shelf in refrigerators" (K4, Wald=14.283,  $P<0.001$ ), and this was followed by the item "prohibition of refreezing thawed meats and fish" (K3, Wald=14.098,  $P<0.001$ ). The question, "the employee works on cardboard boxes in pre-preparation of spinach to prevent contamination from the floors" (K14, Wald=20.410,  $P<0.001$ ) showed the most post-training improvement in the personal hygiene category. In the facility and equipment category, the item, "it is not a concern if the kitchen floor is wet because it will be cleaned once a day" (K15, Wald=8.277,  $P=0.01$ ), showed the most improvement after training.

## 2) Testing transition effects through sanitation behavior after the HACCP training

The purpose of a HACCP training is to improve the food handling practices of foodservice employees as well as their knowledge about food safety. It is anticipated that

sanitation knowledge should be translated into sanitation behavior. As shown in Table 8, the scores for sanitation behavior in the control group (4.57) rated significantly higher than those for the intervention group (Intervention 4.57, control 3.75; Wald =76.205,  $P<0.001$ ).

Nearly all items showed some transfer effects as a result of training. The most improvement in sanitation behavior was revealed as "I promptly clean and sanitize the accessories of the equipment such as cutter and slice after each use" (B11, Wald =37.372,  $P<0.001$ ) and followed by the items "When the cooling process is needed, I rapidly cool foods from 60°C to 4.4°C within 4 hours without holding them at room temperature" (B5, Wald =45.225,  $P<0.001$ ), and "I change into my indoor shoes when entering the cooking area" (B9, Wald =38.622,  $P<0.001$ ). Therefore, the first hypothesis was accepted.

This result was consistent with the study by Nies and Laanen,<sup>17</sup> which evaluated the food handling behavior of foodservice employees and showed that food safety training improved sanitation behavior, e.g., "hand-washing practices after preparation or cooking", "temperature management", "food handling practices",

**Table 7.** Adjusted posttest mean and the results of ANCOVA test between control and intervention group for sanitation knowledge of food service employees

Characteristics	Control group (N=40)	Intervention group (N=44)	Wald value
<b>Sanitation knowledge</b>			
<b>Time-T emperature</b>			
K1	0.53 ± 0.51	0.84 ± 0.37	9.583**
K2	0.83 ± 0.38	0.98 ± 0.15	4.267*
K3	0.00 ± 0.16	0.57 ± 0.50	14.098***
K4	0.48 ± 0.51	0.89 ± 0.32	14.283***
K5	0.00 ± 0.27	0.91 ± 0.29	24.651***
K6	0.55 ± 0.50	0.93 ± 0.26	12.501***
K7	0.90 ± 0.30	1.00 ± 0.00	0.026
K8	0.80 ± 0.41	1.00 ± 0.00	0.067
Sub-mean	0.52 ± 0.19	0.89 ± 0.12	114.602***
<b>Personal hygiene</b>			
K9	0.95 ± 0.22	0.89 ± 0.32	0.365
K10	0.68 ± 0.47	0.93 ± 0.26	5.307*
K11	0.55 ± 0.50	0.84 ± 0.37	5.952*
K12	0.90 ± 0.30	1.00 ± 0.00	0.048
K13	0.83 ± 0.38	0.98 ± 0.15	3.492
K14	0.28 ± 0.45	0.80 ± 0.41	20.410***
Sub-mean	0.70 ± 0.19	0.91 ± 0.13	29.207***
<b>Equipment-facility hygiene</b>			
K15	0.63 ± 0.49	0.98 ± 0.15	8.277*
K16	0.00 ± 0.27	0.00 ± 0.29	0.125
K17	0.98 ± 0.16	1.00 ± 0.00	0.016
K18	0.90 ± 0.30	0.98 ± 0.15	2.222
K19	0.98 ± 0.16	0.93 ± 0.26	0.792
K20	0.80 ± 0.41	0.98 ± 0.15	5.542*
Sub-mean	0.73 ± 0.16	0.83 ± 0.01	15.818***
<b>Mean</b>	0.64 ± 0.14	0.88 ± 0.01	99.542***

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

“separate use of knife and cutting board according to ingredient”, and “food-thawing methods in refrigerators”.

#### 4. The relationship between sanitation knowledge and sanitation behavior

Sanitation knowledge and behavior were found to be negatively correlated, but no significant differences (Coefficient = 0.054, P = 0.727) were found. Namely, higher sanitation knowledge was not associated with better sanitation behavior. Therefore, the second hypothesis was rejected in this study.

This study did not find significant differences between sanitation knowledge and sanitation behavior. This result agreed with Howes *et al.*'s study<sup>12)</sup> that supported the observation that knowledge about proper sanitation practices is not always put into practices. However, our results differed from the Hus & Huang study<sup>8)</sup> which pointed out that university food service workers who had more than 5 years' experience showed a significant positive correlation between sanitation knowledge and sanitation behavior. Some studies<sup>9,7,17)</sup> claimed that the levels of sanitation knowledge and sanitation behavior were improved, and that outbreaks of foodborne illness decreased after food safety training. These studies strongly supported the need for training to improve sanitation knowledge and sanitation behavior. However, Ehiri *et al.*<sup>18)</sup> pointed out that sanitation knowledge did not improve after training of elementary school students; they concluded that there was a need for interactive training that was not only giving information but also demonstrating how to implement, and also that sanitation- training programs should be designed according to the characteristics of the trainees.

## CONCLUSION

This study was conducted to evaluate changes in

sanitation behavior and sanitation attitudes, and to determine the relationship between sanitation behavior and sanitation knowledge after HACCP-based sanitation training in health care foodservices in Korea. The results can be summarized as follows:

1. This study was shown to be valid for evaluating changes in sanitation knowledge and sanitation behavior after HACCP training. There were no significant differences between the control and the intervention group in sanitation knowledge, and in sanitation behavior, before HACCP training.
2. Sanitation knowledge improved after the HACCP training. The training effect for the time & temperature category was the most prominent among the three categories of sanitation knowledge. The items showing highest improvement as a result of HACCP training were refrigerator storage methods, thawing methods for the time & temperature category, preparation methods for the personal hygiene category, and kitchen floor management for the equipment and facility category. Sanitation behavior also improved significantly after HACCP training, particularly for the practices of food cooling and sanitation of equipment.
3. The relationship between sanitation behavior and sanitation knowledge was positive, but was not found to be significant. This means that, unlike our hypothesis, knowledge of food safety had no positive effect on sanitation behavior in hospital employees.

#### According to these results, we make the following recommendations:

1. The study sample was small and was restricted to hospital facilities. Therefore, future studies should be conducted to determine the relationship between sanitation behavior and sanitation knowledge using a

**Table 8.** Adjusted posttest mean and the results of ANCOVA test between control and intervention group for sanitation behavior of food service employees

Characteristics	Control group (N=40)	Intervention group (N=44)	Wald value
<b>Sanitation behavior</b>			
B1	4.20 ± 0.76	4.68 ± 0.52	10.032**
B2	4.25 ± 0.84	4.70 ± 0.73	4.388*
B3	4.08 ± 0.92	4.67 ± 0.61	12.402**
B4	3.58 ± 1.08	4.52 ± 1.09	11.879**
B5	3.30 ± 0.94	4.57 ± 0.77	45.225***
B6	4.43 ± 0.68	4.88 ± 0.50	13.922***
B7	4.83 ± 0.45	4.95 ± 0.22	4.185*
B8	3.73 ± 1.09	4.59 ± 0.82	19.402***
B9	1.43 ± 0.96	3.34 ± 1.48	38.622***
B10	3.83 ± 0.96	4.39 ± 1.08	8.958**
B11	3.35 ± 1.27	4.70 ± 0.63	37.372***
<b>Mean</b>	3.75 ± 0.46	4.57 ± 0.36	76.205***

\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001



- larger sample. Also, standardized training programs need to be developed to reflect the characteristics of the specific operational type.
2. Outbreaks of food-borne disease can be prevented by continuous sanitation training. The food service needs to control the whole process of production from purchasing to delivery to a greater extent than other facilities. Therefore, repeated and periodic HACCP training is needed in retail foodservice operations. Moreover, action plans should be established to enable employees to put their sanitation knowledge into practice.
  3. Support is needed for enforcing systematic food safety management, such as sanitation inspections from the relevant authorities and the establishment of sanitation education centers. The government should establish action plans to ensure that foodservice operators and employees learn sanitation concepts both extensively and continuously.

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