

Evaluation of the food safety training for food handlers in restaurant operations

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Abstract

This study examined the extent of improvement of food safety knowledge and practices of employee through food safety training. Employee knowledge and practice for food safety were evaluated before and after the food safety training program. The training program and questionnaires for evaluating employee knowledge and practices concerning food safety, and a checklist for determining food safety performance of restaurants were developed. Data were analyzed using the SPSS program. Twelve restaurants participated in this study. We split them into two groups: the intervention group with training, and the control group without food safety training. Employee knowledge of the intervention group also showed a significant improvement in their score, increasing from 49.3 before the training to 66.6 after training. But in terms of employee practices and the sanitation performance, there were no significant increases after the training. From these results, we recommended that the more job-specific and hand-on training materials for restaurant employees should be developed and more continuous implementation of the food safety training and integration of employee appraisal program with the outcome of safety training were needed.

Key Words: Restaurants, effectiveness of the food safety training, hygiene knowledge, hygiene practice, on-site safety inspection

Introduction

The hospitality industry, in Korea, has been dramatically expanded since 1970, with market sales showing 51 trillion Won in 2006 [1]. With the increase in national income, economic activities of women, and various demands for diet, Korea consumers experienced an enormous change in dietary life and have increasingly dined out more often [2]. The expenditure on eating out has been rapidly increasing with an annual average increase of 18.5 percent from 1982 to 2004 [3]. Despite this rapid expansion of the market, sanitation management lags behind the growth compared with other markets such as school foodservice or health-care foodservice establishments [4].

When selecting restaurants, customers increasingly perceive the hygiene and price as the critical determinant. Similar to customers, the owners of restaurants also pointed out that, in selecting the strategic plans for surviving the competitive markets, food quality and hygiene have been regarded as the top priority [5]. In fact, according to the Korean Food and Drug Administration in 2007, 510 foodborne disease outbreaks with 9,686 patients were reported, of which approximately 75.9 percent (387 outbreaks) were attributed to food service establishments. In particular, outbreaks in the foodservice sector reached 108

commercial foodservice settings and 93 institutional foodservice operations [6]. Now that these food safety problems in the foodservice operation sectors can lead to detrimental results on the customers' health as well as enormous economic loss when improperly managed, sanitation matters have received continuous attention and now require high standards for improvement.

The previous studies pointed out that the factors most commonly associated with foodborne illness outbreaks include food purchases from unsafe sources; inadequate cooking or reheating; holding at room temperature in advance service; cross-contamination from other foods or food contact surfaces; poor personal hygiene; or improper food handling practices [7-8].

In Korea, 56.0 percent of the foodborne outbreaks (286 out of 510 cases) was caused by the microbial infection [6]. In the case of microbial substances, time and temperature control and prevention of cross-contamination could be effective methods for the prevention of foodborne illness. Therefore the reinforcement of safety education for food handlers and manager in foodservice establishments is on the rise. Due to, in Korea, having small scale facilities and capital [9], low education/low technical skill of employees [10], and a high turnover rate of employees, effective safety training programming should be developed. Studies for testing the effectiveness of hygiene education pointed

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out that hygiene knowledge education alone was not sufficient to improve the hygiene attitude and practices of foodservice worker [11-12] and a discrepancy between hygiene attitudes and practices existed [13]. For inducing foodservice workers to positive changes in hygiene attitude and behavior through the safety training, hands-on training materials should be equipped and the training program should be angled towards worker viewers with various activities. A design for planning, implementing, and evaluating a safety training program appropriate for employees' characteristics in the organization is necessary.

On these points, this paper proposed the sanitation education plans with demonstration techniques and hands-on activities (e.g.: microbial plate kit, testing sanitizer concentration) and examined the extent that food safety knowledge and practices of employees improved before and after a food safety training program. Specifically, the purposes of the study were as follows: [1] the effectiveness of the safety training programs was tested in terms of food safety knowledge and practices of employees, and the inspection of food safety performance. Employee knowledge and practice for food safety were evaluated before and after a food safety training program, and [2] the relationships among food safety knowledge, food safety practice, and food safety scores were determined. For this we set the hypothesis as follows:

- 1) Hypothesis 1: Employee received the sanitation training will have a more knowledge on food safety than no-trained group.
- 2) Hypothesis 2: Employees' hygiene practices will be increased more after training than no-trained group.
- 3) Hypothesis 3: Sanitation management performances in restaurants which employees received sanitation trainings will be improved.
- 4) Hypothesis 4: There will be positive correlations among employees' sanitation knowledge and practices, and sanitation performance score of restaurant.

Materials and Methods

Research design and samples

Research design was the nonequivalent pretest and posttest control group method [14]. A control group and an intervention group were used for the test of internal validity for the training effect. Seven small franchise restaurants were invited to participate voluntarily as the intervention group which received our sanitation trainings. Five other Korean style restaurants also were invited as the control group which was not given the training. The procedures of the study are depicted at Fig 1. One hour safety trainings were carried out, with an interval 2 weeks. Two types of questionnaires for measuring employees' food safety knowledge and safety practices were administrated to the control and the intervention group before and after food safety training. Food safety performances of the restaurants were also

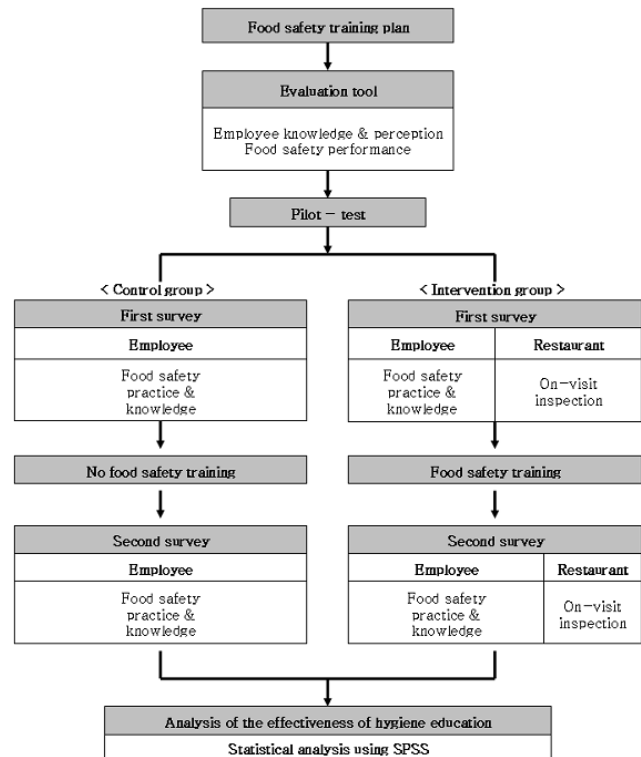


Fig. 1. Procedures of the study

evaluated by the trained panelists through the on-site inspection with the food safety monitoring tool.

The pilot tests of the sanitation management evaluation sheet and a questionnaire for this study were conducted by distributing the evaluation sheet and questionnaire to restaurant managers and food handlers, 12 in all, as the study subjects. Questionnaire and the evaluation sheet were revised for clarity.

A pre-test was implemented from September 1 to September 30, 2006 with 41 food handlers from 7 restaurants (6 Korean style restaurants, 1 Japanese style restaurant) in Seoul who had accepted the training program as the intervention group and 49 food handlers from 5 restaurants as the uneducated control group. The post test was carried out from October 1 to October 31, 2006.

In case of the control group, to enhance the respondent rates (100%), the panel directly visited the restaurants and asked the employees to finish the two types of questionnaires. Education to the intervention group was given with an interval of 2 weeks, for the purpose of evaluating the sanitary education effect on food handlers.

Food safety training plan and training materials

The education plan was presented at Table 1. Lecture and demonstration techniques were selected as the training method for the intervention group. The safety training material was made based on previous works such as "the hygiene education manual

Table 1. Food safety training plan

Lesson	Topics	Goal	Training method ¹⁾	Education contents	Activity	Material
First	Food safety related to restaurant's employee	When employees perform their jobs related to food safety, they must practice hygienically proper operating procedures	1. Introduction 2. Demonstration & Lecture	First survey	- Complete questionnaire - Food safety perception & practice - Food safety knowledge test	Questionnaire
				Food safety training	- Testing microbial levels of employees' hands - Demonstrating the proper method for measuring temperature of foods - Demonstrating the proper concentration of sterilizer using test paper	Training booklet Microbial plate kit Test paper, Thermometer Sanitizing detergent
				Conclusion	- Wrap up	
Second	Food safety related to restaurant's employee	When employees perform their jobs related to food safety, they must practice hygienically proper operating procedures.	1. Introduction 2. Visual materials & Lecture	Food safety training	- Confirmation of microbial plate kit's result - Check health condition, Employees' clothing, proper hand-washing - Purchase & inspection, temperature, preparation, refrigeration, thawing, cooking & reheating, serving, prevention of cross-contamination, proper labeling, cleaning & sanitation - Pest controlling, equipment & utensil	Training booklet Microbial plate kit Poster
				Conclusion	- Wrap up	
				Second survey	- Complete questionnaire - Food safety & practice - Food safety knowledge test	Questionnaire

¹⁾ Participants: intervention group of 41 subjects, control group of 49 subjects

for restaurant food handlers" [15], "self-managed sanitation module for Korean food restaurants" [10,16] and other materials [8,17]. Demonstrations of "microbial plate kit" and "adjustment for the proper concentration of sanitizer" to employees were carried out during the training.

At the first visit, the pre-test was conducted. The observational food safety inspection was completed, and then the managers were asked to fill out the survey and the evaluation sheets. After that, we asked the food handlers to fill out the survey, and then 30-minute food safety training was done. After the training, the managers were asked for feedback on how to improve tailor-make the training materials for their specific needs. Approximately 2 weeks after that, a retraining-program was implemented, using the hygiene management posters which had the same contents as the first one. The post-test using the questionnaire was done after training.

In the case of the control group, a pre-test was carried out by distributing evaluation papers and questionnaires through the on-site visits. After 2 weeks, the post-test was done without implementing a training program. An observational food inspection was not carried out.

Questionnaire for food safety knowledge

The questionnaire for examining the knowledge of food safety consisted of 20 multiple choice questions and was comprised of 3 sections: personal hygiene (4 items); food hygiene (11 items); and environmental hygiene (5 items). It was set up with 5 points for correct answers and 0 points for wrong answers, with a total possible score of 100 points. Through the pilot test carried out using this questionnaire, 56 percent answered the

question correctly. This gave the support for the questionnaire being not easy as well as not difficult, and being an adoptable tool for research.

Questionnaire for food safety practices

Questionnaires used in this study were made based on the training material for the restaurant food handlers and previous studies [18-19]. Safety management performance was measured using a 5-point Likert scale, from 1 point for very poor practice of food safety to 5 points for excellence in meeting food safety standards. Possible total score for 25 questions was 125 points which were given when all were answered correctly. The content of the questionnaire consisted of 3 divisions: personal hygiene (Cronbach $\alpha=0.381$), food hygiene (Cronbach $\alpha=0.803$), and environmental hygiene (Cronbach $\alpha=0.825$).

Sanitation performance by on-site observational inspection

For the evaluation the performance of food sanitation management of restaurants the sanitation audit tool for restaurant operators was developed using literature reviews of previous works [15,20-23].

The sanitation inspection tool was divided into 3 sections: personal hygiene; food hygiene; and environmental hygiene. Food hygiene and environmental hygiene are divided again into the specific areas: 4 sub-sections of "approved food source", "food storage", "safe handling of food", and "serving" in the food hygiene section; and 3 sub-sections of "cleaning and sanitation", "physical facilities in kitchen", and "physical facilities in other places" in the environmental hygiene.

The number of items for each area and their grading are composed of a total of 34 items with 100 points: 18 points from 5 items for the personal hygiene, 50 points from 16 items for the food hygiene, and 32 points from 13 items for the environmental hygiene. Items were also weighted higher (1, 2, or 3), based on importance.

Statistical analysis

Statistical analyses were performed using the statistical package for the social sciences (SPSS version 12.0). The average and the standard deviation were calculated as the general hygiene management performance. For the evaluation of food handlers' pre/post food safety knowledge and performance, the average and the standard deviation were calculated, and t-test was carried out for testing levels of significance. Pearson correlation test was done to identify the correlation among food handlers' food safety knowledge, behavior and on-visit inspection scores.

Results

Characteristics of the respondents

The general characteristics of the control and intervention groups are presented at Table 2. There were no significant differences in terms of profiles of the control and intervention groups except restaurant type, hygiene education experience and education frequency, partially supporting that the intervention and the control groups have similar characteristics. These results come from including of one Japanese restaurant in the intervention group and employees of one restaurant have never given hygiene education. The ratio of males to females was approximately 1:2.

A significant point was that the group aged over 50 showed the highest proportion of respondents, showing 11 persons (26.8%) of the intervention group, and 16 persons (32.7%) of the control group. In the case of education levels, 17 persons (41.5%) of the intervention group and 26 persons (53.1%) of the control group had high school graduation certification, followed by college degree, and middle school, respectively.

The majority of the respondents listed their working experience as either one year or less or more than 4 years. In the case of the intervention group, 31 persons engaged in Korean-style food cooking, and 10 employees in Japanese style cooking. Among them, ten cooks (24.4%) had a chef certificate and the remainders who did not have qualifications supported the cook or conducted less skillful tasks such as washing dishes, serving, and so on. In the case of employment status of the intervention group, 37 persons (90.2%) belonged to regular full-time job employees, and only 4 workers were part-time employees. All of intervention group of 41 persons had experienced hygiene training, and among them 48.8% of the respondents answered training frequencies as once a month.

In respect of the restaurants features for the intervention group, the average space of the restaurants was 548.8m²; average amount spent per customer was 15,500 Won, equivalent of \$14; and the average number of customers was 574 persons. The number of employees was 25 persons on average.

Food safety knowledge

The scores from food safety knowledge testing before and after the training are presented at Table 3. On comparison of the pre-test scores between the intervention and the control group, the t-test analysis showed no significant difference in the level of food safety knowledge between the two groups. Test scores

Table 2. Demographic characteristics of respondents

Category	N (%)		χ^2	Category	N (%)		χ^2	
	Intervention Group	Control Group			Intervention Group	Control Group		
Gender	Male	15 (36.6)	16 (32.7)	Restaurant type	Korean-style food	31 (75.6)	49 (100)	13.445***
	Female	26 (63.4)	33 (67.3)		Japanese-style food	10 (24.4)	-	
Age	25 years less	10 (24.4)	3 (6.1)	Hygiene education experience	Yes	41 (100)	42 (85.7)	6.351*
	25~30 years	6 (14.6)	7 (14.3)		No	-	7 (14.3)	
	30~35 years	3 (7.3)	4 (8.2)	Education frequency	Once a month	20 (48.8)	-	23.851***
	35~40 years	1 (2.4)	3 (6.1)		Once a 3 months	7 (17.1)	-	
	40~45 years	3 (7.3)	8 (16.3)		Once a 6 months	8 (19.5)	27 (55.1)	
	45~50 years	7 (17.1)	8 (16.3)		Once a year	6 (14.6)	8 (16.3)	
50 years over	11 (26.8)	16 (32.7)	Others	-	-			
Education level	Elementary school	4 (9.8)	6 (12.2)	Working experience	1 years or less	16 (39)	9 (18.4)	5.557
	Middle school	6 (14.6)	8 (16.3)		1~2 years	7 (17.1)	8 (16.3)	
	High school	17 (41.5)	26 (53.1)		2~3 years	3 (7.3)	7 (14.3)	
	College	9 (22.0)	8 (16.3)		3~4 years	3 (7.3)	4 (8.2)	
	University	4 (9.8)	1 (2.0)		More than 4 years	12 (29.3)	21 (42.9)	
Position	Cook	10 (24.4)	16 (32.7)	Employment type	Full-time workers	37 (90.2)	41 (83.7)	2.626
	Assistant cook	31 (75.6)	33 (67.4)		Part-time workers	4 (9.8)	8 (16.3)	

* $P < 0,05$ *** $P < 0,001$

Table 3. Effects of food safety training on food safety knowledge scores (Mean \pm SD)

Category		Before training	After training	t-value
PH ¹⁾ (20) ²⁾	Intervention group (n=41)	11.5 \pm 5.0	15.4 \pm 5.0	-3.506*
	Control group (n=49)	11.9 \pm 3.9	10.7 \pm 5.0	1.348
	t-value	0.616	NA ³⁾	
FH	Food supply & storage (10)	5.0 \pm 3.5	5.0 \pm 3.3	0.000
	Control group	5.5 \pm 3.7	4.8 \pm 3.9	0.922
	t-value	0.509	NA	
EH	Handling of food & serving (45)	19.6 \pm 10.3	32.1 \pm 9.2	-5.753*
	Control group	19.3 \pm 9.8	16.7 \pm 8.6	1.368
	t-value	0.870	NA	
EH	Cleaning & sanitation (10)	5.7 \pm 3.8	6.3 \pm 3.5	-0.752
	Control group	7.6 \pm 2.9	6.3 \pm 3.8	1.945
	t-value	0.008	NA	
EH	Working environment (15)	7.4 \pm 5.4	7.8 \pm 4.5	-0.335
	Control group	7.3 \pm 4.1	7.2 \pm 4.6	0.116
	t-value	0.927	NA	
Total (100)	Intervention group	49.3 \pm 19.5	66.6 \pm 16.5	-4.345*
	Control group	51.7 \pm 17.4	45.8 \pm 18.8	1.613
	t-value	0.528	NA	

* $P < 0,05$ ¹⁾ PH: Personal Hygiene; FH: Food Hygiene; EH: Environmental Hygiene²⁾ Possible score ³⁾ NA : not applicable**Table 4.** Comparison of employees' hygiene knowledge scores before and after food safety training

Category	Total		t-value		
	Before	After			
PH ²⁾	Q1. Which of the following is needed for handwashing?	78.0 \pm 42.9 ³⁾	78.0 \pm 41.9	0.000 ¹⁾	
	Q2. Which of the following is the most outbreaks of food-borne illness?	12.2 \pm 33.6	68.3 \pm 47.1	-6.237*	
	Q3. Which of the following is not a proper activity of employee before work?	61.0 \pm 48.5	63.4 \pm 48.8	-0.225	
	Q4. What do you need to do when workers have a fever and cough severely?	78.0 \pm 37.3	97.6 \pm 15.6	-2.794*	
	Sub - total (20 points)	11.5 \pm 5.0 ³⁾	15.4 \pm 5.0	-3.506*	
FS	Q5. Which of the following is proper method for refrigerator?	56.1 \pm 50.1	78.0 \pm 41.9	-2.148*	
	Q6. Which of the following is the item needed for proper labeling?	43.9 \pm 50.3	22.0 \pm 41.9	2.148	
	Sub - total (10 points)	5.0 \pm 3.5	5.0 \pm 3.3	0.000	
FH	Q7. Which of the following is necessarily needed for wearing disposable gloves?	26.8 \pm 44.9	75.6 \pm 43.5	-5.000*	
	Q8. Which of the following is the temperature affecting the most rapid growth of bacteria?	22.0 \pm 42.9	78.0 \pm 41.9	-6.061*	
	Q9. Which of the following is the proper internal temperature in cooking ?	46.3 \pm 50.4	70.7 \pm 46.1	-2.285*	
	Q10. Which of the following is the proper holding temperature of cooked foods?	58.5 \pm 49.8	58.5 \pm 49.9	0.000	
	Q11. Which of the following is the proper thawing method of frozen foods?	58.5 \pm 48.5	75.6 \pm 43.4	-1.652	
	HS	Q12. Which of the following is not a potentially hazardous food?	68.3 \pm 45.8	80.5 \pm 40.1	-1.262
		Q13. What is that germ is transmitted from uncooked food to cooked food by through employees' hand or food contact surfaces?	26.8 \pm 46.6	80.5 \pm 40.1	-5.709*
	Q14. Which of the following is a improper practices of employees in preparation process?	63.4 \pm 48.5	73.2 \pm 44.9	-0.943	
	Q15. Which of the following is a proper cleaning method of vegetables and fruits?	22.0 \pm 42.9	48.8 \pm 50.6	-2.615*	
	Sub - total (45 points)	19.6 \pm 10.3	32.1 \pm 9.2	-5.753*	
CS	Q16. Which is not a proper practice in cleaning and sterilizing of equipments and utensils?	56.1 \pm 49.0	56.1 \pm 50.2	0.000	
	Q17. Which of the following is an improper in methods of sterilization?	58.5 \pm 49.8	70.7 \pm 46.1	-1.150	
	Sub - total (10 points)	5.7 \pm 3.8	6.3 \pm 3.5	-0.752	
EH	Q18. Which of the following is the improper activity for controlling pests in restaurant?	61.0 \pm 49.0	58.5 \pm 49.9	0.222	
	WE	Q19. Which of the following is not the proper method for equipment and facility management about hygiene supervision of equipment/utensils?	39.0 \pm 49.4	26.8 \pm 44.9	1.170
		Q20. Which statement below describes the improper method for equipment/facility management?	48.8 \pm 50.3	70.7 \pm 46.1	-2.054*
Sub - total (15 points)	7.4 \pm 5.4	7.8 \pm 4.5	-4.345*		
Total (100 points)	49.3 \pm 19.5	66.6 \pm 16.5	-4.345*		

* $P < 0,05$ ¹⁾ T value was not computed because the standard error of the difference was zero.²⁾ PH: Personal Hygiene; FH: Food Hygiene; EH: Environmental Hygiene; PH: Personal Hygiene; FS: Food supply & Storage; HS: Handling of food & Serving; CS: Cleaning and Sanitation; WE: Working Environment³⁾ Question items: correction rate; Sub-total and total: scores (Mean \pm SD)

Table 5. Effects of food safety training on food safety practices (Mean \pm SD)

Category		Food safety practice score		t value	
		Before training	After training		
Personal hygiene (15) ¹⁾	Intervention group (n=41)	13.1 \pm 2.3	13.1 \pm 2.2	0.000	
	Control group ²⁾ (n=49)	13.2 \pm 2.1	12.2 \pm 2.6	2.064	
	t value	0.825	NA ³⁾		
Food hygiene (65)	Intervention group	23.3 \pm 4.6	22.4 \pm 4.5	0.970	
	Food supply & storage (30)	Control group	25.9 \pm 13.6	27.9 \pm 27.1	-0.447
	t value	0.240	NA		
Environmental hygiene (45)	Intervention group	29.8 \pm 4.5	29.4 \pm 4.3	0.327	
	Handling of food & serving (35)	Control group	29.3 \pm 5.5	28.6 \pm 6.2	0.552
	t value	0.663	NA		
Environmental hygiene (45)	Intervention group	16.9 \pm 2.7	16.8 \pm 3.3	0.182	
	Cleaning & sanitation (20)	Control group	17.8 \pm 2.8	16.4 \pm 3.7	2.135
	t value	0.155	NA		
Total (125)	Intervention group	20.0 \pm 4.2	20.6 \pm 3.8	-0.653	
	Working environment (25)	Control group	21.3 \pm 3.8	20.3 \pm 4.5	1.224
	t value	0.137	NA		
Total (125)	Intervention group	103.2 \pm 14.7	102.4 \pm 16.4	0.241	
	Control group	107.5 \pm 20.4	105.4 \pm 32.2	0.397	
	t value	0.252	NA		

¹⁾ Possible score ²⁾ No hygiene education ³⁾ NA: Not applicable

between pre and post tests of the control group, in addition, showed no significant differences. These results gave support that this research was well-designed for finding the training effects of the intervention.

In the case of the intervention group, after training, sanitation knowledge of employees increased to a total score of 66.6 points at post-test; up from 49.3 points at pre-test. However, there was still room for improvement. Specifically, the section on personal hygiene, and handling of food and serving in food hygiene showed significant increases of knowledge ($P < 0.05$).

In the total score, the intervention group showed the greater increase with the score of 49 and 66 in the pre/post training respectively. As shown at Table 4, the total 8 items showed significant increases in score of “Q2: outbreaks of food-borne illness” and “Q4: a first action for sick workers” in the personal hygiene, food supply and storage area of “Q5: proper refrigeration method”, handling of food and serving area “Q7: proper use of disposable gloves”, “Q8: bacteria growth temperature”, “Q9: cooking temperature”, “Q13: cross-contamination”, “Q15: proper cleaning method for vegetables and fruits”, and working environment area “Q20: proper maintenance method for equipment/facility”. Based on this study, we accepted the hypothesis 1 that the trained group would have a more knowledge on food safety than no-trained group.

Food safety practices

The scores of food handlers' food safety practice before and after treatment are presented at Table 5. In the case of the food safety practices evaluation, the first time showed similar levels

of practices on food safety between the intervention group and control group before the training. Food safety practices of the control group in the post-test did not improve, compared to that of the pre-test ($P > 0.05$).

Contrary to our expectations, the intervention group didn't show any significant changes in the practices after training. Safety practices showed minor positive changes, but non-significant: indicated as ‘health checking before work’ (4.4, $t=0.907$), ‘washing hands before work’ (4.5, $t=0.341$), ‘separate handling of raw materials and cooked foods’ (4.4, $t=1.406$), ‘handling methods of cooked foods’ (4.3, $t=1.492$), ‘proper storage of sanitizer and cleaner’ (4.3, $t=1.376$), ‘proper ventilation’ (4.3, $t=0.830$), and ‘cleaning and maintaining toilet facilities’ (4.2, $t=0.523$).

In the total score, it appeared that, there was not any significant increase in the intervention group, showing 103 points in the pre-test and 102 points in the post-test (Table 6). From this result, the hypothesis 2 that the food handlers' hygiene practices would be increased after training according to the increases of hygiene knowledge in the trained group was rejected.

Sanitation management performances rated by the on-site inspection

The result of observational inspection on sanitation management is presented at Table 7. According to the result of the observational inspection by the trained evaluators, the score of the sanitation performance of the intervention group before training was a low 57.2 out of 100 points. The scores were, in particular, low in the items of “employees food safety training (1.4)” and

Table 6. Comparison of employees' hygiene practices score before and after food safety training (Mean \pm SD)

Category		Total		
		Before	After	t-value
PH ¹⁾	11. Checking self-health condition (fever, diarrhea, injury) every working day.	4.2 \pm 1.1	4.4 \pm 0.8	-0.907
	12. Checking cleanness of clothes, hair restraints and shoes before work	4.6 \pm 0.8	4.4 \pm 0.7	0.913
	13. Washing hands before food handling	4.5 \pm 0.8	4.5 \pm 0.8	-0.341
	Sub - total (15) ²⁾	13.1 \pm 2.3	13.1 \pm 2.2	0.000
Food supply & storage	14. Receiving, foods right after delivery and storing them in store area after removing their package.	4.2 \pm 0.9	4.1 \pm 0.8	0.746
	15. Checking temperatures of the frozen /refrigerated foods and if having problems, rejecting them.	4.4 \pm 0.9	4.3 \pm 0.8	0.600
	16. Checking and verifying whether temperatures of refrigerators and freezers in appropriate.	4.2 \pm 1.0	4.3 \pm 0.9	-0.193
	17. Recording the temperature log of refrigerators and freezers for managing temperature control.	3.1 \pm 1.3	3.1 \pm 1.1	0.000
	18. Taking temperature of the foods in cooking/reheating process with thermometer	3.4 \pm 1.2	3.1 \pm 1.1	0.937
FH	19. Storing separately raw foods and cooked foods in refrigerator and freezers	4.5 \pm 0.8	4.4 \pm 0.8	0.665
	Sub - total (30)	23.3 \pm 4.6	22.4 \pm 4.5	0.970
Handling of food & serving	110. Thawing foods, as much as a need.	4.8 \pm 0.6	4.5 \pm 0.7	1.837
	111. Cooking it immediately, if not, storing it in refrigerator after thawing	4.7 \pm 0.6	4.4 \pm 0.9	1.700
	112. Washing and sanitizing fresh vegetables and fruits before use.	4.4 \pm 0.8	4.2 \pm 1.0	1.051
	113. Labeling foods with use-by date in storing the RTE foods and processed foods.	4.1 \pm 0.9	3.8 \pm 1.2	1.362
	114. Using separately the equipment and supplies of the raw food and RTE food	4.1 \pm 0.9	4.4 \pm 0.7	-1.406
	115. Not handling RTE foods with bare hand.	4.0 \pm 1.0	4.3 \pm 0.8	-1.492
	116. Not holding foods or utensils on the kitchen floor	4.3 \pm 0.9	4.4 \pm 0.7	-0.629
Sub - total (35)	29.8 \pm 4.5	29.4 \pm 4.3	0.327	
Cleaning & sanitation	117. Labeling cleaning and sanitizing chemicals and storing them at safer place away from foods.	4.1 \pm 0.8	4.0 \pm 1.0	0.590
	118. Screening all windows and vents for controlling pest, and verifying if there are gaps and cracks in walls and ceilings	4.4 \pm 0.8	4.3 \pm 1.0	0.728
	119. Cleaning and sanitizing knives, cutting boards and wiping cloths	4.5 \pm 0.8	4.4 \pm 0.9	0.608
	120. Clean and sanitize properly storing sanitized/cleaned equipments and utensils using shelving unit.	4.0 \pm 0.9	4.4 \pm 0.8	-1.948
Sub - total (20)	16.9 \pm 2.7	16.8 \pm 3.3	0.182	
EH	121. Verifying if the plumbing system installed well and maintained it properly	4.1 \pm 0.9	4.3 \pm 0.8	-1.376
	122. Seeing if equipments and facilities work well and maintaining them properly	4.3 \pm 0.8	4.2 \pm 0.8	0.520
	123. Verifying heat and water vapor in the kitchen are removed immediately through hood exhaust system and maintaining it properly	4.1 \pm 0.9	4.3 \pm 0.8	-0.830
	124. Verifying if lightness and illumination of working area are appropriate and managing them properly	4.1 \pm 1.0	4.1 \pm 0.9	-0.113
	125. Cleaning and maintaining toilet facility regularly	4.1 \pm 1.1	4.2 \pm 0.9	-0.523
Sub - total (25)	20.0 \pm 4.2	20.6 \pm 3.8	-0.653	
Total (125)		103.2 \pm 14.7	102.4 \pm 16.4	0.241

¹⁾ PH: Personal Hygiene; FH: Food Hygiene; EH: Environmental Hygiene

²⁾ Possible score

“proper hand washing/hand washing facilities supplied (1.4)” in personal hygiene. In the dimension of food hygiene, “proper receiving practices (0.3)”, “checking and recording of temperatures of food (0.0)”, and “preventing contamination by holding foods off the floor (0.3)” were needed to improve the practices. Lastly, environmental hygiene: of most importance, the items “floors, walls and ceiling undamaged (1.3)”, “pest control: no existence of insects and rodent (0.9)”, and “toilet properly equipped and cleaned (0.4)” were urgently needed to improve.

As for the result from examining pre/post score change, after

training the score was increase as 63.7 points, but no significant difference indicated. Little improvement was indicated in the following 14 items, and there were not significant differences between two. Therefore the hypothesis 3 was rejected.

Correlations among knowledge, practices and performances on food safety

Correlations among hygiene knowledge, practice and the inspection scores are presented at Table 8. According to the

Table 7. Effects of food safety training on sanitation management performance (Mean \pm SD)

Dimensions	Item	Possible score	Score		t-value	
			Before	After		
PH ¹⁾	Employee hygiene education	4	1.4 \pm 0.9	1.4 \pm 0.9	0.000 ²⁾	
	Checking health examination of employees	3	3.0 \pm 0.0	3.0 \pm 0.0	0.000	
	Employees health policy for excluding and restricting ill employees	4	3.7 \pm 0.8	4.0 \pm 0.0	-1.000	
	Employees dress code for good personal hygiene	3	2.1 \pm 0.8	2.8 \pm 0.6	-1.732	
	Proper hand-washing/ hand-washing facilities supplied	4	0.3 \pm 0.8	1.4 \pm 1.5	-1.789	
	Sub - total score	18	10.6 \pm 2.5	12.6 \pm 2.1	-1.677	
Approved food source	Proper receiving practices	4	0.3 \pm 0.8	0.3 \pm 0.7	0.000	
	Checking and recording of temperatures of frozen and refrigerated foods	4	0.0 \pm 0.0	0.0 \pm 0.0	0.000	
Food Storage	Maintaining proper refrigerator (below 5°C) and freezer (below -18°C) temperature	4	2.0 \pm 0.0	2.0 \pm 0.0	0.000	
	Keeping clean and organized refrigerator, freezer/pantry	4	2.3 \pm 0.8	2.3 \pm 0.7	0.000	
	Preventing contamination by holding foods off the floor	2	0.0 \pm 0.0	0.3 \pm 0.7	-1.000	
	Labeling on date mark and use-by date of food	4	2.0 \pm 1.6	2.0 \pm 1.6	0.000	
	Storing chemicals away from foods and food related supplies	2	2.0 \pm 0.0	2.0 \pm 0.0	0.000	
FH	Preventing cross-contamination of foods (from cutting board, gloves, and knives)	4	2.9 \pm 1.1	3.4 \pm 0.9	-1.044	
	Thawing food in the refrigerator, cold running water, or the microwave	2	1.7 \pm 0.8	2.0 \pm 0.0	-1.000	
	Preventing cross-contamination of ready-to eat foods from raw foods	3	2.6 \pm 1.1	3.0 \pm 0.0	-1.000	
	Safe handling of food tasting	Proper washing of fruits and vegetables with running water properly	4	1.7 \pm 0.8	2.3 \pm 0.7	-1.414
		Cooking and reheating foods to 74°C	4	2.0 \pm 0.0	2.0 \pm 0.0	0.000
	Serving	No holding food or utensils on the kitchen floor	2	1.4 \pm 0.9	1.7 \pm 0.7	-0.612
		Tasting food the correct way	2	1.7 \pm 0.8	2.0 \pm 0.0	-1.000
		Not allowing access into the kitchen to outsiders	1	1.0 \pm 0.0	1.0 \pm 0.0	0.000
	Sub - total score	50	26.4 \pm 3.7	29.3 \pm 3.6	-1.459	
Cleaning & Sanitation	Cleaning and sanitizing knives, cutting boards, and wiping cloths	3	2.1 \pm 0.8	2.3 \pm 0.8	-0.500	
	Cleaning and sanitizing shelving units for equipments and utensils after each use	2	1.4 \pm 0.5	1.9 \pm 0.4	-1.732	
	Labeling cleaners and sanitizers properly	2	1.1 \pm 1.1	2.0 \pm 0.0	-2.121	
	Planning and supervising cleaning/sanitizing of programs	4	2.0 \pm 0.0	2.0 \pm 0.0	0.000	
EH	Equipments and facilities work well and maintain them properly	2	2.0 \pm 0.0	2.0 \pm 0.0	0.000	
	Physical facilities in kitchen	Floors, walls and ceiling undamaged	2	1.3 \pm 0.5	1.3 \pm 0.5	0.000
		Plumbing system installed and maintained it properly	3	1.5 \pm 0.0	1.7 \pm 0.6	-1.000
	Proper illumination of food preparation areas	2	2.0 \pm 0.0	2.0 \pm 0.0	0.000	
	Ventilation system equipped and maintained well for removing heat and water vapor	2	1.3 \pm 0.5	1.3 \pm 0.5	0.000	
	Pest control: no existence of insects and rodent	2	0.9 \pm 1.1	0.9 \pm 1.1	0.000	
	Physical facilities in other place	Toilet properly equipped & cleaned	3	0.4 \pm 0.7	0.4 \pm 0.7	0.000
Existence of a employee locker room and toilet		2	1.1 \pm 0.7	1.1 \pm 0.7	0.000	
Cleanliness of the dining area		3	3.0 \pm 0.0	3.0 \pm 0.0	0.000	
	Sub - total score	32	22.1 \pm 4.5	20.5 \pm 1.9	0.892	
	Total Score	100	57.2 \pm 7.8	63.7 \pm 7.6	-1.578	

¹⁾ PH: Personal Hygiene; FH: Food Hygiene; EH: Environmental Hygiene²⁾ Value could not compute because the standard deviations of both groups were zero

statistics, first, the correlation between the food safety knowledge score and food safety practices showed negative correlation in the working environment ($r=-0.235$, $P<0.05$). This meant that employees tended to evaluate their food safety practices as high regardless of their sanitation knowledge. Second, the correlation between food safety knowledge and sanitation management performances did not show a significantly positive correlations ($r=0.360$, $P>0.05$). Third, the correlation between food safety practice and observational food inspection proved to be negative,

but showed no significant differences ($r=-0.191$, $P>0.05$). It is presumably because the food safety professionals evaluated personal hygiene, food hygiene during the production process, and environmental hygiene of food facilities at a low level, while food handlers themselves scored their food safety practices as high. Therefore, hypothesis 4 was rejected.

Table 8. Correlation of employees' food safety knowledge, practices and on-visit inspection scores

		Food safety practice						Sanitation management performance					
		PH	FS	HS	CS	WE	Total	PH	FS	HS	CS	WE	Total
Food safety knowledge	PH ¹⁾	0.180	-	-	-	-	-	0.150	-	-	-	-	-
	FS	-	0.091	-	-	-	-	-	0.036	-	-	-	-
	HS	-	-	-0.087	-	-	-	-	-	0.171	-	-	-
	CS	-	-	-	-0.017	-	-	-	-	-	0.295	-	-
	WE	-	-	-	-	-0.235*	-	-	-	-	-	0.428	-
	Total	-	-	-	-	-	-0.041	-	-	-	-	-	-
Food safety practice	PH	-	-	-	-	-	-	-0.128	-	-	-	-	-
	FS	-	-	-	-	-	-	-	-0.078	-	-	-	-
	HS	-	-	-	-	-	-	-	-	-0.514	-	-	-
	CS	-	-	-	-	-	-	-	-	-	0.048	-	-
	WE	-	-	-	-	-	-	-	-	-	-	-0.161	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-

* $P < .05$ ¹⁾ PH: Personal Hygiene; FS: Food supply & Storage; HS: Handling of food & Serving; CS: Cleaning and Sanitation; WE: Working Environment

Discussion

With food safety knowledge after training, our results showed that the level of knowledge on food safety from the trained group improved more than that of the no-trained group. According to the precedent study [24-25], it was reported that after training, the considerable increase of knowledge from the intervention group showed. The study conducted at the day-care centers also reported that hygiene knowledge effects appeared only in the dimension of "kitchen equipment and suppliers", but not in other dimensions of the hygiene training effect [26].

During the food safety practice evaluation, self-evaluation by food handlers was conducted. The scores for the sanitation practices rated highly at 102.4 out of 125 points, equivalent to 81.9 percent, and no significant difference between the pre and post training. Hence, this result supported the possibility that employees evaluated their food safety practices as higher than their actual practices deserved. The similar result reported that foodservice workers responded their practice toward food-borne disease prevention as always in terms of washing hands, use of gloves and use of protective clothing in work [13].

In the case of the intervention group, there was a significant increase in knowledge in the personal hygiene dimension, and handling methods on finished products and service in food hygiene dimension, while in the safety practices of the hygiene-related work, no improved behaviors were found in spite of the high scores in sanitation behavior. This pointed out that employees evaluated themselves as having high sanitation practices regardless of their level of sanitation knowledge.

In our study, even though no significant changes in the practices were detected, the potential effect of training was verified. If continuous and specific-goal oriented training is provided to employees, sanitation practices such as health checking, proper hand-washing, observation of uniform code, prevention of cross-contamination, or proper sanitation techniques could be easily improved.

In the evaluation of sanitation performance for the intervention group, performance scores increased from 57.2 to 63.7 after training, but did not show statistically significant differences between the two. Especially, "proper receiving practices (0.3)", "checking and recording of temperatures of food (0.0)", "preventing contamination by holding foods off the floor (0.3)", "pest control: no existence of insects and rodent (0.9)", and "toilet properly equipped and cleaned (0.4)" urgently needed to improve. The result from the FDA's inspection reports [27] showed that the violation rate of "improper and insufficient hand washing" was the highest at 31%, and Noh's study [15] also pointed to low performances of hygiene management of "proper hand-washing and its facilities supplied". In our study, employees stated they do wash their hands properly, but the panels evaluated them as having a low score of 1.4 points. This means that for the formation of proper procedures for employees' job performance, more concrete standards or guideline should be given.

In the evaluation of the correlation among sanitation knowledge, sanitation practice, and sanitation inspection results, sanitation practice and sanitation inspection results had the tendency negatively correlate to sanitation knowledge. In fact, only one dimension in the work environment between food safety practices and food safety knowledge showed significant negative correlation ($r = -0.235$, $P < 0.05$). However, this fact gave us a very important managerial implication. This pointed out the problem that employees had a misperception regarding their own sanitation practices. Employees felt their practices were sound, but in fact their knowledge was substantially lacking. To solve this problem, management activities and a hands-on training approach are needed for informing employees about sanitation knowledge and practices where there are gaps between them. One possible method for management is for sanitation practice outcomes such as the sanitation knowledge and on-site sanitation performance to be included in the employees' performance appraisal system to positively promote advances in safety practices.

Even though no statistical significance was shown, the fact

that sanitation management performance had a positive correlation with sanitation knowledge of work employees, meant that the change of behavior came from acquiring knowledge. Considering that 100% of the subjects in the intervention group had received hygiene education and 48% of them received training once a month, it is concluded that the education implemented in the restaurants was no more than a knowledge-delivery; and therefore did not bring about behavioral change. Similar results were found in two other studies. One was from the comparative study on the hygiene practice and hygiene knowledge of the food handlers from the non-commercial foodservices in Incheon [28], finding no significant correlations between them. The other is in the study evaluating an effect of the HACCP training; no significant changes in knowledge resulted after training [29]. In addition, the result from the study on the hygiene management practice and hygiene knowledge with the hospital food handlers showed that the effect of hygiene knowledge on food safety management practice was minor [11,30-31].

It is concluded from this study, that due to the limitation on the training time and frequency of training, an education effect could affect the improvement of hygiene knowledge, but the food safety practice and hygiene management performances were not improved. However, considering the fact that there were some significant increases in knowledge, it is concluded that practicing continual and repetitive hygiene education could be effective even in improving the sanitation management level as well as the hygiene knowledge and sanitation practices. To do this, the frequency of food safety training reinforced through specific goal setting, and more concrete training programs suitable for the employees' educational background should be designed. In addition, designing the program to motivate employees to maintain and self-regulate proper practices should be required.

This study has two limitations. First, we designed this study as the nonequivalent pretest and posttest using the control and intervention group. The assumption was that the control group had the similar characteristics as the intervention, but our study partially supported it. The two groups in this study showed different feature in terms of hygiene education experience and frequency due to the participation of subjects from different type and scale of restaurants. Another limitation was that t-test instead of paired t-test was employed for the testing of the training validity of knowledge between before and after training, because of the withdrawal of employee and, with the consequence of that, small sample size. Ideally future research need to build on the conclusion with the larger sample size and the analysis of paired t-test.

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