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Increasing Knowledge with Food Safety Training at Public Health – Dayton & Montgomery County

ABSTRACT

Food safety training is an important tool in preventing foodborne illness (FI), which affects millions of people each year in the United States and around the world and costs billions of dollars. Training gives those working in the food service industry the knowledge and skills necessary to properly handle, cook and serve food. The objectives of this research was to assess changes in knowledge of Public Health – Dayton & Montgomery County's (PHDMC) Level One Food Safety Certification program participants, analyze which questions were most often answered incorrectly, and determine whether there was a relationship between quiz scores and primary job responsibility, using pre- and post-quiz training data. The course teaches food safety topics, including handwashing, employee hygiene, correct cooking and holding temperatures, sanitization duties of the person in charge, and others. The participants are offered a quiz at the beginning of the course, and the same quiz is offered after completion of the two-hour training.

Pre-training and post-training quiz score data were obtained from approximately 692 participants completing the PHDMC Level One Food Safety Certification program from 2011 to 2013. Paired t-tests were used to evaluate change in scores overall, on individual questions, and by job responsibility. Quiz scores significantly improved both aggregately (20.6%) and in nine out of the ten questions. The temperature-related questions had the most incorrect answers (score range: 38% – 71%) but also showed the most improvement (improvement range: 28% – 49%). This research shows that PHDMC's Level One Food Safety Certification class was associated with a change in knowledge of participants from pre- to post-training.

INTRODUCTION

In the United States (U.S.), an estimated 48 million people fall ill each year because of foodborne infections; of these, 128,000 are hospitalized and 3,000 die *(2)*. During 2012 in Ohio, 427 disease outbreaks occurred in 64 out of the 88 counties. Eighty-five of these outbreaks were foodborne, and 43 of the 85 were confirmed through laboratory testing *(11)*. Food safety training for workers is one method to increase worker knowledge and improve

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food safety practices throughout the industry and thereby decrease illnesses, hospitalizations and deaths. A number of ways can be used to increase knowledge, ranging from reading literature to classroom training and interactive demonstrations. Studies have shown that all of these approaches can be useful in increasing knowledge, at least in the short term *(3, 4, 8, 9)*.

Food safety certification is a standardized training program, and participants who complete these programs are documented as food safety certified *(1)*. Beginning in 2011, local health departments in Ohio were allowed to teach a Level One Food Safety Course upon final approval by the Ohio Department of Health (ODH). ODH requires a certain curriculum to be taught in the training course, including topics such as handwashing, responsibilities of the person in charge, employee hygiene, correct cooking and holding temperatures and sanitization, among others. Sanitarians at Public Health – Dayton & Montgomery County (PHDMC) in Dayton, Ohio, teach this food safety training course once a month and as requested. This two-hour basic food safety training course is meant for foodservice or retail food establishment employees, including owners, managers and persons in charge, but is open to the public as well.

In Ohio, Level One Certification in Food Protection training is mandated by the Ohio Department of Health (ODH) under Ohio Revised Code 3717.09. After March 1, 2010, one person-in-charge per shift of new food service operations (FSO) or new retail food establishments (RFE) is required to have Level One Certification, unless they have received other equivalent approved certification. Additionally, if a FSO or RFE has been implicated in a foodborne disease outbreak or has failed to maintain sanitary conditions, then one PIC per shift is required to have certification. Once completed, Level One Food Safety Certification in Ohio does not have an expiration date. The participants are offered a quiz at the beginning of the course and the same quiz again after completion of the two-hour training. The completion certificate is recognized throughout the state of Ohio *(14)*.

MATERIALS AND METHODS

This research was approved by both Wright State University's Institutional Review Board (exempt with regard to the use of human subjects) and PHDMC's Research Review Panel.

Both before and after completing PHDMC's Level One Food Safety Certification training, each trainee was asked, but not required, to complete a ten-question quiz *(Table 1)*. Information on each completed quiz included the name of the participant, date of training, instructor's name, participant's answers to the pre- and post- quiz, and the primary job responsibility of the trainee in food service. The ten questions on the quiz included topics on handwashing, temperature control and food storage.

For the current analysis, pre- and post-quiz data from 692 participants between 2011 and 2013 were collected and entered into an Excel spreadsheet and transferred to IBM SPSS *(6)*. Pre- and post-quiz scores were entered for each of the ten questions, using (1) to designate a correct answer and (0) an incorrect answer. Using SPSS, paired *t*-tests were used to analyze the pre- and post-quiz scores (%) and the change in pre- to post-quiz scores for each student. The change in quiz scores in aggregate was analyzed to see if the training course was associated with a change in knowledge of the participant during the course. The changes in scores for individual questions were analyzed to assess whether certain questions were answered incorrectly more often than others. Primary responsibilities of the foodservice worker were analyzed to assess relationships among quiz scores and job duties, e.g., if quiz scores differed between managers and cooks. A two-sided P-value of < 0.05 was considered significant.

Almost 100% of the quizzes from 2011 and 2013 and about half of those from 2012 were utilized for the analysis. Some quizzes were excluded because of missing or illegible information. The same quiz has been offered throughout the three-year history of the course, except for the job responsibility question, which was added was added in April 2012.

RESULTS

Quiz data were available for 692 participants; however, 506 participants answered all pre- and post- questions. Thus the percentage of total quizzes completed was 73% (506/692). *Table 1* presents the quiz questions. The aggregate results show that scores improved from pre- to post- quiz *(Table 2)*. The mean pre- and post-quiz scores were 7.56 (75.6%), and 9.62 (96.2%), respectively *(Fig. 1)*. The average improvement was 2.06 points (20.6%), which was statistically significant (P-value < 0.001).

The pre- and post-quiz data was broken down by question *(Table 3)*. The questions for which improvement was demonstrated as a result of taking the class were questions two, three, five, nine and ten. With the exception of question five, which dealt with the calibration of a metal-stem thermometer, all the questions showing the most improvement were associated with temperature.

Table 4 shows the average score, and change in score, for each individual question. The improvement was significant for all questions (P-value < 0.001) except for question one ($P = 0.08$). Scores for question three, "Minimum hold temperature for time temperature controlled for safety (TCS) foods," showed the greatest improvement, with a mean change in score of 0.49; question ten was a close second, with a mean change in score of 0.41. Scores for question one, "People get sick from food because of," showed the least improvement, with a mean change of 0.01 points.

TABLE 1. Public Health—Dayton & Montgomery County's Level One Food Certification Training Quiz

	Question	Answer Options
1	People get sick from food because of:	a) Improper food temperatures; b) Contaminating cooked foods by raw products, dirty equipment, utensils, or cutting boards; c) Failing to wash hands; d) All of the above
2	Foods must be rapidly reheated to at least:	a) 140°F; b) 165°F; c) 120°F; d) 212°F
3	What minimum temperature should hot time-temperature controlled for safety foods be held?	a) 135°F; b) 155°F; c) 165°F; d) 130°F
4	The safest way to thaw foods properly is:	a) In the steam table; b) In a pot of warm water; c) On the counter at room temperature; d) In the refrigerator
5	In order to make sure your metal stem thermometer is working correctly, you need to:	a) Thermometers never need to be calibrated; b) Immersing in the steam table water and adjusting it until it reads 180°F; c) Leave out on the counter and adjust to equal room air temperature; d) Placing it in a crushed ice water bath and adjusting it until it reads 32°F
6	Which of the following is not a way to prevent cross-contamination?	a) Store raw food below and/or away from cooked food; b) Use separate utensils and cutting boards for raw and cooked foods; c) Wash hands before and after purchasing raw food and before touching cooked food; d) Leave raw food uncovered in walk-in cooler
7	Which scenario represents proper hand washing techniques?	a) Wash in the food prep sink with soap and warm water for 20 seconds, dry hands with common cloth; b) Wash in a designated hand sink with soap and warm water for 20 seconds, dry with a paper towel; c) Use hand sanitizer at designated hand sink after handling raw/cooked foods and switching tasks; d) Wash hands in the wiping cloth bucket of sanitizer in-between tasks
8	The proper set up for a three-compartment sink is:	a) Pre-scrape, wash, sanitize, rinse, air dry; b) Pre-scrape, rinse, sanitize, wash, towel dry; c) Pre-scrape, wash, rinse, sanitize, air dry; d) Pre-scrape, rinse, sanitize, wash, towel dry
9	The temperature danger zone is a temperature range between ___ where bacteria reproduce rapidly:	a) 45°F–145°F; b) 41°F–135°F; c) 45°F–165°F; d) 40°F–165°F
10	To cool down hot foods properly:	a) Leave out at room temperature for 1 hour, then cover; b) Remove from hot stove, leave on counter overnight; c) Cool small batches rapidly in shallow pans in a cooler or freezer; d) Transfer to a large pot, cover, then place in cooler

TABLE 2. Aggregate Score on Pre-test and Post-test (2011–2013)

Characteristic	Mean ± Standard Deviation
Participants	506
Pre-test score	7.56 ± 1.57
Post-test score	9.62 ± 0.76
Improvement in score	2.06 ± 1.52
P-value	< 0.001

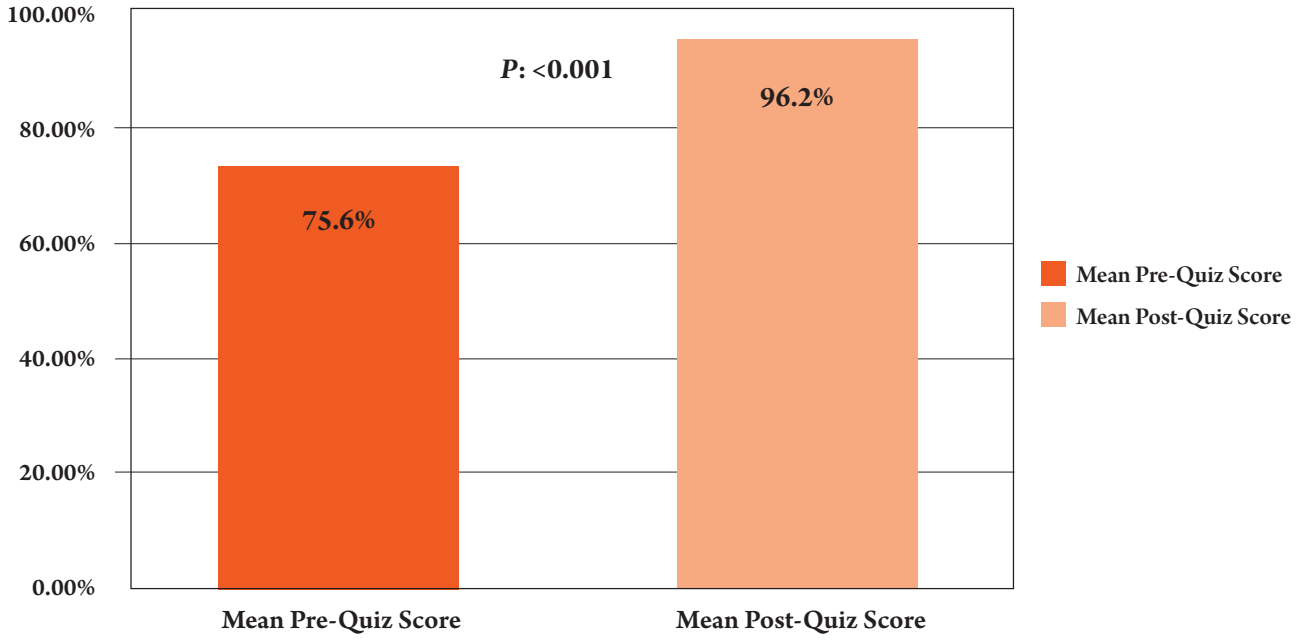

Figure 1. Mean pre- and post- quiz score results from PHDMC's Level One Food Safety Certification Training 2011–2013

TABLE 3. Individual Scores on Pre-Test and Post-Test (2011–2013)

Question	Total	Wrong Pre & Right Post	Wrong Pre & Wrong Post	Right Pre & Wrong Post	Right Pre & Right Post
	N	N (%)	N (%)	N (%)	N (%)
Question 1: People get sick from food because of:	536	9 (1.7)	2 (0.4)	3 (0.6)	522 (97.4)
Question 2: Foods must be rapidly reheated to at least:	547	156 (28.5)	4 (0.7)	1 (0.2)	386 (70.6)
Question 3: What minimum temperature should hot time-temperature controlled for safety foods beheld at?	556	280 (50.4)	64 (11.5)	6 (1.1)	206 (37.1)
Question 4: The safest way to thaw foods properly is:	538	50 (9.3)	5 (0.9)	3 (0.6)	480 (89.2)
Question 5: In order to make sure your metal stem thermometer in working correctly, you need to:	540	173 (32.0)	8 (1.5)	2 (0.4)	357 (66.1)
Question 6: Which of the following is not a way to prevent cross-contamination?	532	50 (9.4)	21 (3.9)	5 (0.9)	456 (85.7)
Question 7: Which scenario represents proper hand washing techniques?	532	21 (3.9)	1 (0.2)	3 (0.6)	507 (95.3)
Question 8: The proper set up for a three-compartment sink is:	540	73 (13.5)	11 (2.0)	2 (0.4)	454 (84.1)
Question 9: The temperature danger zone is a temperature range between ___ where bacteria reproduce rapidly:	541	196 (36.2)	29 (5.4)	7 (1.3)	309 (57.1)
Question 10: To cool down hot foods properly:	545	224 (41.1)	30 (5.5)	1 (0.2)	290 (53.2)

TABLE 4. Pre-test and Post-test scores on individual test questions (2011–2013)

Question	Total	Pre-test Score Mean	Post-test Score Mean	Change in Score	*P*-value
	N		Mean ± SD		
Question 1: People get sick from food because of:	536	0.98 ± 0.14	0.99 ± 0.10	0.01 ± 0.15	0.08
Question 2: Foods must be rapidly reheated to at least:	547	0.71 ± 0.46	0.99 ± 0.10	0.28 ± 0.46	< 0.001
Question 3: What minimum temperature should hot time-temperature controlled for safety foods be held?	556	0.38 ± 0.49	0.87 ± 0.33	0.49 ± 0.52	< 0.001
Question 4: The safest way to thaw foods properly is:	538	0.90 ± 0.30	0.99 ± 0.12	0.09 ± 0.30	< 0.001
Question 5: In order to make sure your metal stem thermometer is working correctly, you need to:	540	0.66 ± 0.47	0.98 ± 0.13	0.32 ± 0.47	< 0.001
Question 6: Which of the following is not a way to prevent cross-contamination?	532	0.87 ± 0.34	0.95 ± 0.22	0.08 ± 0.31	< 0.001
Question 7: Which scenario represents proper hand washing techniques?	532	0.96 ± 0.20	0.99 ± 0.09	0.03 ± 0.21	< 0.001
Question 8: The proper set up for a three-compartment sink is:	540	0.84 ± 0.36	0.98 ± 0.15	0.13 ± 0.35	< 0.001
Question 9: The temperature danger zone is a temperature range between ___ where bacteria reproduce rapidly:	541	0.58 ± 0.49	0.93 ± 0.25	0.35 ± 0.50	< 0.001
Question 10: To cool down hot foods properly:	545	0.53 ± 0.50	0.94 ± 0.23	0.41 ± 0.50	< 0.001

A total of 150 people submitted information about their primary job responsibility at the end of the quiz. Mean pre- and post- scores of these 150 participants were compared with job responsibility *(Table 5)*. Scores were fairly similar across the categories. Food establishment owners had the highest score on the pre quiz (8.2) but demonstrated a non-significant improvement on the post quiz (9.4) ($P = 0.109$). Food servers scored the highest on the post quiz (9.69) and also showed the highest improvement from pre to post quiz (2.00) ($P < 0.001$).

DISCUSSION

The aim of this analysis was to assess PHDMC's Level One Food Safety Certification program participants' change in knowledge, analyze which questions were most often answered incorrectly, and determine whether there was a relationship between primary job responsibilities and quiz scores, using pre- and post-quiz training data. To our knowledge, this is the first study evaluating short-term food safety training in a local U.S. public health department. The mean pre score was fairly high (75.7%). This could have been due to the majority of participants being from

TABLE 5. Aggregate Test Scores by Job Responsibility (2011–2013)

Job Responsibility	N	Pre Score	Post Score	Change in Scores	*P* (2-tailed)
			Mean ± SD		
Manager	50	7.94 ± 1.59	9.66 ± 0.63	1.72 ± 1.55	< 0.001
Owner	5	8.20 ± 1.30	9.40 ± 0.89	1.20 ± 1.30	0.109
Preparation	50	7.74 ± 1.41	9.58 ± 0.95	1.84 ± 1.39	< 0.001
Cook	29	7.31 ± 1.69	9.24 ± 0.91	1.93 ± 1.57	< 0.001
Server	16	7.69 ± 1.40	9.69 ± 0.70	2.00 ± 1.26	< 0.001

the food service industry and thus already having some food safety knowledge. Significant improvement occurred, with an average increase in score of 20.6% after training. These results are similar to those of other studies. A study in Chicago that asked questions similar to those in PHDMC's quiz reported a 6% increase in knowledge on a 40-question test to food handlers *(3)*. A similar study by Lilliquist, McCabe, and Church *(8)* examined test scores on a 20-question test. Those food handlers with no training had a mean score of 8.0 (40%), those with training had a mean score of 12.4 (62%) and who had both training and a participatory demonstration had a mean score of 15.8 (79%). These results seem to support that food safety training is associated with an increase in knowledge. These were the only comparable studies found in a literature review with associated quiz scores available.

Four out of the five most frequently missed questions (#2, 3, 5, 9, 10) on both the pre- and post-quiz were temperature related. Questions two, three, and nine were direct temperature questions, and question ten was about proper requirements with regard to time and temperature as food cools. This indicates a need to concentrate more on temperature-related issues during the food safety course or in the education process during inspections. An effort was made to find certification exam scores for Servsafe *(10)*, a nationwide certification provider, but they could not be accessed. Comparisons of other certification exam scores would be helpful to determine if their results are similar and understand what changes should be made, if any.

Our results did not show a large difference in quiz scores by job responsibility. Owners and managers had the highest pre-quiz scores. Servers had the highest post-quiz scores but servers, cooks and preparation workers all showed significant improvement, meaning that those workers might benefit most from food safety training. No published studies could be found that provided information about knowledge change by job responsibility. However, a study by Lynch et al. *(9)* found significant association among higher scores and years of experience. This same study, which was conducted on managers only, also reported that managers with food safety training given by a health department had higher survey scores than those with just corporate training; the highest scores were observed in managers who had both health department and corporate training.

An advantage of this study was the large data set available for analysis. A total of 692 quizzes were entered into the database out of about 850 quizzes taken by participants across three years, and most of the quizzes entered were usable in the analyses, with the exception of the job responsibility data.

One of the limitations of this study was that although the same presentation slides are used during the training classes, a number of different sanitarians teach the course, including the author of this study. Variations in teaching style from one sanitarian to another may somewhat alter the way the information is presented, possibly skewing the quiz results. Also, this analysis does not assess long-term knowledge retention or behavior changes of food safety workers.

Another limitation was the small number of participants who provided the job responsibility information, which was not requested in the quiz until April 2012. A small proportion of participants answered this question or answered it in a way that could be categorized into a specific job responsibility. One of the most common answers was "food safety" or "keeping people safe." A better description of this question could possibly improve responses.

As reported in literature, food safety training leads to significant short-term improvements in knowledge. However, the overall consensus of food safety training,

regarding its long-term effectiveness and how it impacts the real world in terms of FIs, is unclear. Most agree on a few points, including the importance of food safety training as a factor in combating the risk of FI and recognition of the fact that training has a limited effect and more research is needed to know the true impact *(5, 7, 12, 13)*.

CONCLUSION

PHDMC's Level One Food Safety Training Certification increases knowledge of the participants from pre- to post- quiz. However, more focus on temperature-related topics should be incorporated into the class, as questions related to temperature were most often missed on the quiz. PHDMC should continue to offer this course. Food industry personnel should be encouraged to participate in food safety training and certification as often as necessary to increase and maintain their food safety knowledge and impart their newly acquired knowledge to others as well. Food safety training will continue to be a common approach to preventing foodborne illness in the industry because, in the end, people and their food handling actions have the greatest impact on food safety.

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