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Knowledge, practices and attitudes of certified FOODSAFE food handlers – is retraining needed?

FINAL REPORT



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Executive Summary

Educating and training food workers provides a foundation for safe food handling. In British Columbia, a legislated food handler training requirement was established in 2000.¹ Operators of food service establishments, and at least one worker in every food service establishment (when the operator is away) must hold a certificate demonstrating successful completion of a food safety training course. This requirement consists of passing a food safety training program called "FOODSAFE®" or its equivalent. How long food workers retain food safety knowledge after FOODSAFE training and certification is not known. We examined if there was a decline in the ability of food workers to recall food safety knowledge after successfully taking FOODSAFE. We also examined the effects of workplace establishment, workplace duties (supervisory and non supervisory), age, experience and other influences on worker food safety knowledge and attitudes for FOODSAFE trained and untrained workers.

Trained FOODSAFE (test, n=499) and untrained (control, n=199) food workers participated in a survey in February 2009 to measure food safety knowledge, attitudes and practices at work and at home. Trained FOODSAFE participants who no longer worked in the food services industry were also surveyed and asked about home knowledge, practices and attitudes (n=393). Knowledge, attitude and practice results of trained and untrained food workers were scored, tallied and compared using t-test, means comparisons, and ANOVA. Regression was used to test the relationship between knowledge scores of trained workers and the time since their training was taken. Possible explanatory factors such as age, sex, years of experience working in the food industry, type of food premise, other food safety training taken, education level, ethnic background and position (supervisor or staff) were also compared for trained and untrained groups.

We found that during the last 15 years (from 1995 to 2009) knowledge scores of trained food workers decreased significantly over time after taking the FOODSAFE course ($p = 0.02$). The average scores of FOODSAFE trained participants one year after training was 70%, which is the passing mark for FOODSAFE. After one year, scores decreased gradually. The median score for all trained participants was 69%, and scores ranged from 19 – 100%. Knowledge scores ($p < 0.0001$), hand-washing practices ($p=0.03$), home practices ($p<0.0001$) and attitude scores ($p = 0.0006$) of trained food workers were statistically significantly higher than those of untrained food workers. This demonstrates that trained FOODSAFE workers better understand and practice principles of food safety in comparison to untrained food service workers who have not had FOODSAFE or other food safety education programs. Unfortunately, in both groups, approximately 60% stated they had never received any additional food safety training at work or school (aside from those who had taken FOODSAFE).

There were also statistically significant differences found in the food safety knowledge of food service workers (trained and untrained groups) based on position, education level, ethnic background, and in the categories of food premises where food service workers worked. Significant results were observed for greater knowledge of food safety principles in supervisors over staff, in college and university trained graduates over workers with high school education, in workers of British, North American, Eastern and Western European ethnicity over South and East Asian workers, and lower scores found in workers employed at fast food and retail stores.

Comparison of survey data on home based knowledge, practice and attitudes for trained FOODSAFE participants, untrained participants, and from data shared by Vancouver Coastal and Fraser Health authorities from a general population survey were also examined. Overall persons with a history of food handler food

safety training were more knowledgeable about home food safety practices than those persons surveyed in the general population. Untrained food service workers (those without food safety training) also scored higher than persons in the general population on home food safety practices, demonstrating that workplace exposure improves home food safety knowledge and practices.

This research supports the positive influence FOODSAFE training has on workers in the industry. Trained FOODSAFE workers are more knowledgeable about food safety principles than untrained workers in industry. However, knowledge retention in trained workers is an issue. Trained FOODSAFE workers, although more knowledgeable than untrained food service workers and the general population, do not retain this knowledge over the long-term. Of additional concern, more than half of the respondents to this survey did not receive food safety training nor reinforcement at their workplace. For these reasons, refresher training for previously trained workers is recommended. Based on the evidence gathered in this study, we recommend re-training take place every 3 years, and no later than 5 years from the first FOODSAFE or equivalent food safety training course for food service workers. As FOODSAFE training improves basic food safety knowledge for all categories of food workers, we also recommend that all food industry workers (such as those working in manufacturing and processing of foods) take FOODSAFE or equivalent training, even though there is no legislative requirement for these workers to take such training. Further, since (FOODSAFE) training also improves practices and food safety knowledge in the home, this study demonstrates the benefits and recommends food safety training for the general public.

Introduction

Food safety training has been a legislated standard in the province of BC under Division 2 of the Food Premises Regulation [BC Reg. 210/99] since July 1, 2000¹. The operator and at least one worker in every food service establishment (while the operator is away) must have a certificate demonstrating successful completion of either FOODSAFE or an equivalent food safety training course. This fully self-funded program was developed as a joint initiative between government and the food service industry. It is operated by the FOODSAFE Secretariat with direction provided by the FOODSAFE steering committee. The steering committee has representatives from a dozen organizations, and is chaired by the BC Center for Disease Control. The web-site, www.foodsafe.ca, provides information to prospective students about classroom and on-line training options. FOODSAFE is being used across Canada, and has been adopted by 7 provinces as either an acceptable program or their primary food safety training program of choice. Other than BC, these provinces include Alberta, Saskatchewan, Manitoba, Ontario, Nova Scotia and New Brunswick.

It is important to note that in BC, food service establishments only include restaurants and those premises serving food to the public but do not include businesses where food is manufactured, such as commissaries and factories who supply restaurants, and also do not include bakeries and delicatessens that sell food over the counter, but do not have food service (tables and seating for the public) in their stores.

FOODSAFE has been in operation since 1986 with over 725,000 people in BC holding (Level 1 and Level 2) certificates. However these certificates do not have an expiry date. How long do workers remember the basic principles of food safety taught in the course?

Purpose of Study

The main purpose of this study was to assess the knowledge retained by food service workers after FOODSAFE training and certification. This information was collected using a telephone survey. The information collected examined how food safety knowledge varied with time elapsed since FOODSAFE training and certification. The survey also inquired into food safety practices and attitudes both at work and at home.

To assess if workplace food safety knowledge (where a person works) rather than knowledge gained from FOODSAFE training influenced food service workers' knowledge, practices and attitudes an additional group was surveyed: persons who work in the food service sector, but who had not received FOODSAFE training. Trained FOODSAFE food service workers are described in this study as the test group. Untrained food service workers are described in this study as the control group.

A third group, FOODSAFE graduates who no longer work in the food industry, were only asked about food preparation practices and food safety knowledge at home. These same home questions were also asked of trained (test) and untrained (control) groups.

Finally, a fourth group of participants, who were not surveyed in this study, were compared to the respondents in this survey for a portion of the home based questions. The data for this fourth group was obtained from a prior survey conducted by Regional Health Authorities of the general population on their food safety knowledge and practices at home.

A secondary goal of this project is to evaluate the effectiveness of FOODSAFE retraining using either the on-line or classroom-based program. A group of participants from this survey will be offered free FOODSAFE retraining, and 9 months to one year after training, the same phone survey used in this report will be administered. The anticipated date of completion of this work is spring 2012. It is

hypothesized that retraining will improve knowledge. The results of these studies will inform recommendations regarding FOODSAFE recertification, and the knowledge generated from this survey will be useful in determining future policy and practice.

Study Phases

This study was designed to be rolled out in three separate phases. In phase 1, FOODSAFE Level 1 graduates were selected from the FOODSAFE registry (selection criteria are explained in more detail in the Methods section). The FOODSAFE registry data-base contains contact information for each student that includes the last known phone number, address, exam date and mark. A randomized sample of Level 1 trained FOODSAFE workers within the 5 BC Regional Health Authorities was selected from the data-base over a broad date range. In addition, a random selection of food premises was selected from lists of premises provided by the Health Authorities (for FS1, FS2 and FS-Other premises). Permission from the manager to have a staff member complete the survey was requested, and consent from the individual received prior to the phone survey.

Two to three weeks prior to the telephone survey, a letter informing participants (FOODSAFE graduates and premise owners) about the study was sent as per the UBC ethics protocol. The letter provided a contact name and phone number for further information and included information about the study, including a statement that survey participation was completely voluntary. The letter requested verification of the contact phone number and address for participation in an incentive gift draw.

The survey was conducted In February and March 2009. Participants were also asked if they would be interested to enroll in future studies (Phase 2 and 3), and a separate list of names and contact telephone numbers and addresses were collected by the survey company.

Phase 2 and Phase 3 represent a longitudinal study of food safety training. Phase 2 of the study will be contact 50 participants from Phase 1 and retrain them in FOODSAFE Level 1 using either on-line or classroom based training. In Phase 3, the participants of Phase 2 will be re-examined for food safety knowledge, practices and attitudes. Their overall score from the Phase 1 survey can be compared to their FOODSAFE Level 1 exam marks (from their original exam and exam after the retraining) and to the survey conducted in Phase 3. Individual responses to specific questions cannot be assessed from their original exam, but can be considered in the three phases of this study.

The aim of each phase is to answer specific questions about FOODSAFE training, as outlined below.

PHASE 1

1. Does the ability of employees (supervisory and non-supervisory) to enumerate principles of food safety decline in the years following FOODSAFE certification?
2. Does the workplace influence food safety knowledge and attitudes in workers?
3. Do food safety trained (FOODSAFE) food service workers have better food safety practices at home?

PHASE 2 and PHASE 3

4. Does retraining improve food safety knowledge?
5. Is there any difference between on-line and classroom based FOODSAFE training?

Funding

Funding was successfully secured from six stakeholder agencies to undertake this project. The funding was used to cover the costs of contracting the initial survey to a BC based clinical research company (ēnrg Research Group). The FOODSAFE Secretariat matched funds collected by other participating agencies and Food Protection Services, BCCDC also

contributed funds. Non-monetary contributors included in-kind contributions provided by Food Protection Services on project design, organization and time related expenses. Additional assistance for Phase 1 was found from a graduate student who analyzed results and conducted statistical analyses. Further assistance from graduate students will be sought for retraining in Phase 2 and resurvey in Phase 3.

Table 1 – Funding Partners

Contact:	Organization	Amount Donated
(1) Rose McDonald	WorkSafe BC	\$ 5,000
(2) Gary Gibson	Vancouver Island FOODSAFE Councils	\$ 6,000
(3) Brian Steeves	Northern FOODSAFE Council	\$ 500
(4) Kevin Touchet	Interior FOODSAFE Council	\$ 2,000
(5) Toni Burton	FOODSAFE Secretariat	\$13,000
(6) Lynn Wilcott	Food Protection Services, BCCDC	\$21,000
Total Collected:		\$ 47,500

Table 2 – Budget – Expenditures to Date (Phase 1)

Item Description	Cost	Balance
		\$ 47,500.00
Office Supplies & Postage	\$ 914.68	
Printing reproduction (pre-survey)	\$ 673.33	
Temporary Admin Help	\$ 1,228.90	
ēnrg Research Group Survey Costs	\$ 38,950.00	
i-Pod incentive gifts	\$ 1,259.20	
Printing reproduction (post-survey)	\$ 262.80	
		\$ 5,211.09

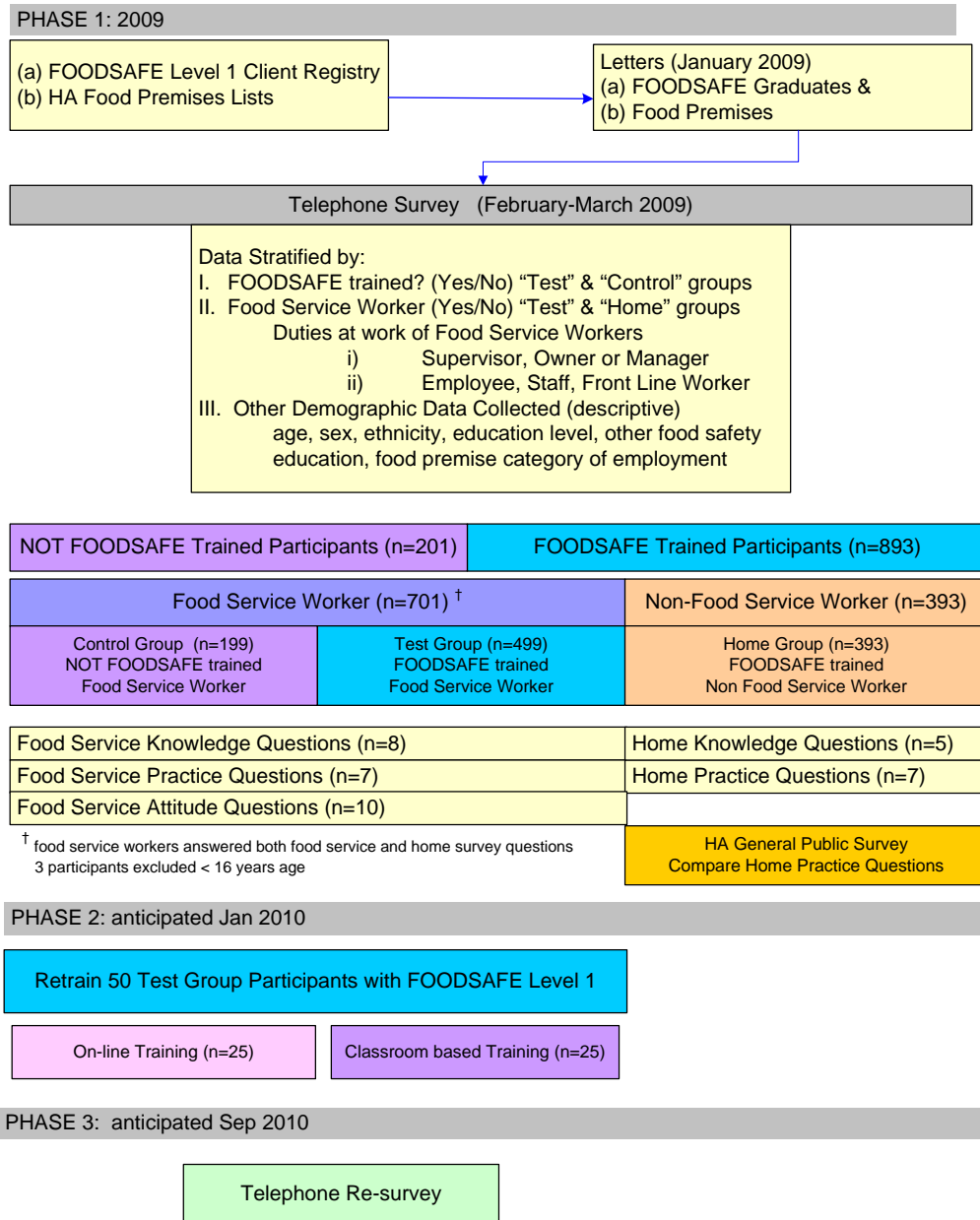
Table 3 – Budget – Projected Costs to Complete Phase 2 and Phase 3

Item Description	Cost	Balance
		\$ 5,211.09
Office Supplies & Postage	\$ 210.00	
FOODSAFE Level 1 instructor kit & workbooks	\$ 547.40	
FOODSAFE Level 1 on-line course costs	\$ 2,375.00	
FOODSAFE Level 1 classroom costs	\$ 2,000.00	
Printing Costs	\$ 200.00	
		\$ 3.59

Methods

I. Study Design

Figure 1 – Project Phases, Number of Study Subjects and Survey Summary



II. Recruitment Methods

A. FOODSAFE graduates identified from FOODSAFE registry

A comprehensive list of students who graduated from FOODSAFE Level 1 was requested from the Ministry of Healthy Living and Sport. Selection criteria and output parameters were chosen with the output style in excel.

Student Selection Criteria from FOODSAFE Registry

1. FOODSAFE Level 1 taken
2. Exam Score is 70% or higher (passing grade)
3. Language=English
4. Birth Date is 1990 or earlier (must be 18 or older to participate)
5. Exam Date is between Jan 1, 1998 to date of extraction (Dec 30, 2008)

Output from FOODSAFE Registry included:

1. Student Last Name
2. Student First Name
3. Street Address
4. City
5. Province
6. Postal Code
7. Phone Number
8. Exam Score
9. Exam Date
10. Area of Employment
11. Occupation

Based on these criteria, 405,173 records were received from the registry. We gratefully acknowledge the helpful assistance of Ling Shen from the Ministry for this extraction.

When these records were reviewed, two items of concern were identified in the data-set:

1. Many records did not contain an accurate birth-date, which would not allow us to properly exclude by age, and,
2. Duplicate names and birth-dates occurred in the registry extraction for persons who had taken FOODSAFE more than once.

A decision was made to ignore these issues as only 1.2% of the total, or, 5000 names would be initially selected. Duplicates could be removed from the list after names had been selected. A further issue identified was the number of students, and not the target group, food service workers that occurred in the first extraction. On review it was found that 2000 of the 5000 subjects self identified their occupation as students, while only 1000 self identified their occupation as a food service worker, the main target of the survey. Although the initial exclusion criteria included birth-date, many students take FOODSAFE as part of their junior and high school curricula. After consultation with Carol Wyatt (FOODSAFE secretary with VIHA) we learned that school FOODSAFE courses are entered (in her Health Authority) as "Area of Employment" = educational institution, and "Occupation" as student. A decision was made to exclude all records where Occupation was identified as "student" to encourage selection of food service workers from the registry.

In summary, exclusion criteria included:

1. Born 1990 or later
2. Non-English
3. Student
4. Fail (mark below 70% or passing grade)

Random numbers were generated for 5,003 subjects as described below. All names without phone numbers or addresses were removed, yielding a total number of 4,803 participants. The method employed to find 5000 random selections from 405,173 records follows:

1. Created 7 Excel spreadsheets for the data by exam date and by last name alphabetically. This was necessary because a limiting factor for Excel is that the maximum number of row records permitted is 65,536 rows.
2. To maximize chance of contacting earlier FOODSAFE graduates (e.g., from 10 or more years ago) a higher percentage of random numbers from earlier graduates were chosen (20% from 1998 and, 1999; 12.5% from 2000 to 2002; 10% from 2003 to 2004; 7.5% 2005 to 2006; and 5% from 2007 to present).
3. Based on percent and number of rows per year a calculation was made for the total random number selection required s per spreadsheet.
4. A free on-line program was employed to generate random numbers, <http://www.random.org> integer number generator. Any duplicate random numbers were removed.
5. A macro file was employed to match numbers in the spreadsheet to the random numbers generated.

B. Control group premises identified from Food Premises Lists from Health Authorities

An e-mail request was sent to all HA directors requesting a list of FS1, FS2 and FS-Other premises on Dec 1, 2008. All lists received from each HA were copied onto a single excel spreadsheet and arranged alphabetically. Premises without a phone number or address were deleted. A total of 27,503 premises were identified. The random.org web-site was used to generate 5000 integers (many were duplicates), the final number of premises randomly chosen from this list were n=3,880. Addresses without postal codes were manually looked up on Canada post on-line.

C. Letter Mail-out and Final Lists to NRG Research Company

The letters to premises and FOODSAFE graduates were sent out January 12, 2009. Phone calls and e-mails were received within a few days of the mail-out, and persons and premises indicating they did or did not wish to participate in the survey were noted in the excel sheets. Those who declined to participate were excluded from the lists forwarded to the research company. Returned letters were counted to estimate the return rate for defunct contact addresses. During the research company survey, an additional two thousand (2,000) phone numbers were requested by the research company for FOODSAFE graduates. In this set a higher percentage of contacts were chosen from more recent graduates (20% from 2007-8; 15% from 2004-6; 10% from 1998-2003).

Survey Design

The survey (refer to Appendix I) consisted of 44 questions separated into 5 sections: demographic (n = 7), knowledge (n = 13), attitude (n = 10), practice (n = 7) and general information (n = 6). The knowledge questions are identified as questions 4 through 11, 27, 29, 30, 32, and 33 (maximum score possible was 62). Food safety principles covered in the knowledge section asked about food storage, thawing, cooking, hot holding, temperature control questions, and two questions on cleaning and sanitizing food contact surfaces. The questions were multiple choice and asked respondents to choose the best response from four choices, with each question allowing a choice of "don't know".

Practice question numbers 23 through 33 followed the same format and asked questions about hand washing, thawing, cooling and thermometer use (maximum score possible was 55). Attitude questions (numbered 35, 38, 39, 41 through 44), asked respondents whether they agreed or disagreed with food safety statements (maximum score possible was 50). A sub-set of

knowledge, attitude and practice questions were asked of FOODSAFE trained participants no

longer working in the industry, starting at question #27.

Table 4 – Recruitment Statistics

	FOODSAFE Registry	Premises (FS1, FS2, other)
Total number in list	405,173	27,503
Letters mailed out Jan 12/09	4,803	3,880
Returned Letters	809	125
Return Rate	16.8 %	3.2%
Do not contact (phone/e-mail)	319	70
OK to contact	24	45*
Total no. responded to letter	343	115
Response rate	7.1%	3.0%
Contacts to research company	4,034	3,662
Additional contacts sent	2,000	
Final completed surveys	668	428
Response rate	1.1%	11.7%
FOODSAFE trained FSWs	273	227
Untrained FSWs		201
FOODSAFE trained non-FSWs	395	

* note: 29 premises indicated all staff were FS trained, but willing to do survey as part of test group.

Ethical Considerations

This project was subject to the UBC ethics review board, the survey was reviewed by the Behavioural Research Ethics Board, and ethics approval granted on December 15, 2008. The research company hired to perform the survey were subject to the BC Statistics Act. All data was stored on a secure server at BCCDC.

Participants in the survey were offered a chance to win one of 5 i-PODs, and were also asked if they wanted to see results from the survey. The winners of the i-PODS were selected randomly from a list of names (using <http://www.random.org> integer number generator). A two-page colour-flyer was created with partial results of the survey as an educational tool and was mailed out to 721 survey participants who requested the

information on November 6, 2009 (Appendix 3). A new web-page was also created to describe the results of the project for the public, on the BCCDC web-site:

<http://www.bccdc.ca/foodhealth/foodguidelines/FOODSAFE+Knowledge+Retention+Study.htm>

Survey Analysis

The survey occurred in February 2009. Results were received in three separate (Excel) spreadsheets with participant numbers (no names) so that responses were kept confidential. One spreadsheet explained the survey company data-coding system, one contained results, and the final spreadsheet contained any "verbatim" responses recorded for questions where survey respondents provided alternate responses to choices listed (i.e. a record of the detail responses to "other" choice).

Data-cleaning was performed and descriptive results generated in Excel. Some raw data was adjusted based on the interpretation of the verbatim responses received in two areas: food worker place of employment (premise category), and ethnicity. In the survey, there were 25 choices when survey participants were asked to describe their ethnic background. These were amalgamated into 7 categories based on geographic area as follows: (1) East Asian: East Indian; (2) South Asian: Asian/Other + Chinese + Japanese + Korean + Filipino + Vietnamese; (3) British = British; (4) East European = East European + Greek; (5) West European = Dutch + French + German + Italian + Scandinavian; (6) North American = American + Canadian + Native Indian; (7) Other = African + Australia + Latin American + South American + Spanish + Other.

Scoring for multiple choice questions was based on assigning higher marks for answers most in keeping with food safety principles. Best answers were scored 5 points, nearly best, 2 points, and not acceptable or "don't know" answers, 0 points. In some questions, more than one best or nearly best answer was awarded points. Scores assigned to individual questions are shown in the questionnaire (Appendix 1). For practice questions, data cleaning included adjustment of denominators downwards by subtracting the value of question from total possible score when participants indicated the question "does not apply to me". For example, when asked if they wash hands after handling pets, or after handling raw meats. Similarly, for attitude questions, when participants answered "don't know/refused to answer", the denominator was adjusted. Practice and attitude score comparisons were based on ratio results.

Statistical analyses were performed in JMP ver. 7.0 (SAS Institute Inc.). Univariate analyses such as student t-tests were used to separately compare knowledge scores against sex, worker position (manager or staff), and other food safety training. Multivariate analyses such as ANOVA were used to compare knowledge score

against variables with 3 or more groups such as type of food premise, ethnic background and education. When differences in groups of data were demonstrated using ANOVA, t-tests were used to compare within groups to identify significant differences. For example, within the food premise group category comparisons between the individual premises of "Fast Food" and "Institution", within the ethnic background group category, such as "British" and "South Asian", and within the education group category such as "College" and "High School". Ratio data, based on percentage scores correct, between test and control groups for practice and attitude scores were compared using Kruskal-Wallis, Chi-squared tests.

Linear regression was used to separately compare knowledge score against age, and years of experience (for test and control groups), and time since FOODSAFE training (for test group only). Multiple regression was used to analyze knowledge score against all possible explanatory factors: age, years of experience, ethnic background, education level, other food safety training, training in Canada, position (manager or staff), sex and time since training. Exclusions for the regression based on age were made for those who refused to give a date of birth, and one participant who was aged at 109 years. Similarly, with years of experience, those who did not answer, and those with a result that were not reasonable were excluded. For example, age of 73 years, and 65 years of experience (started career at 8 years old). Persons with less than 10 years separating age and years of experience were excluded from the regression. The final model considered only those variables associated with the outcome, worker knowledge.

Health Authority Home Practices Survey

Vancouver Coastal and Fraser Health Authorities (HA) conducted a phone survey of residential homes to assess food safety behaviors. The survey, "Food Safety in the Home Baseline

Survey #1 (October 2008) was conducted 3 months prior to the FOODSAFE survey. We were able to procure a draft copy of the survey prior to its implementation, and chose to incorporate 4 practice questions from the HA survey (questions 10, 11, 12, 13 in the home survey in Appendix 2). After the HA survey, a formal request was made to receive the results from those 4 practice questions, further, an additional 4 practice questions about use of a thermometer were assessed for comparison with the FOODSAFE survey (question 3 in the home survey in Appendix 2). Data from this survey was stratified based on response to one other question: "have you ever taken any food handler training". There were 1101 persons contacted in this survey.

Data was cleaned and denominators adjusted downwards for questions answered as "does not apply to me", for example, when asked about hand-washing after handling of pets. Direct comparisons between results from the HA survey were made to the results of the FOODSAFE survey respondents. Comparisons on this sub-set of home practice questions were made between the 3 groups in the FOODSAFE survey (trained (test), and untrained (control) food workers and trained home) and the 2 groups from the HA survey (with and without food handler training) using ANOVA. Further, results from the 2 separate surveys were pooled into 2 groups – those with food safety training, and those without, and compared using student t-test. To correct for variations in the populations sampled, groups with food safety training were weighted with a correction factor of 0.096069 (proportion of population working in food industry from Statistics Canada) in the model platforms.²

Results

I. Description of Survey Participants

There was a total of 500 FOODSAFE trained food service workers recruited from either the food premises registry or from directly contacting food premises in BC (Table 5). An additional 393 FOODSAFE trained persons who indicated they no longer work in the food services industry agreed to participate in the survey, and they were asked a sub-set of "home" based questions that were given to all participants. Control participants were identified solely from direct contact with food premises, 201 individuals agreed (with their supervisors' permission) to participate in the survey. Three individuals were later excluded from analyses because they were under 16 years of age. The final data set from this survey was based on 499 (FOODSAFE) trained food service workers (the "test" group), 199 untrained food service workers (the "control" group), and an additional 393 FOODSAFE trained persons no longer working in the industry (the "CDC-home" group). An additional data set was received from a separate survey conducted by Vancouver Coastal Health and Fraser Health. This survey was administered to the general public (the "HA-home" group).

There was very little variation in the sex and ethnicity demographic data when trained and untrained (test and control) food workers were stratified by group (Table 6). The sex for all food service workers surveyed was predominantly female (62%, n=434) over male (38%, n=264). The majority of food service workers in the survey self-identified themselves as belonging to the following ethnic groups: British (30%), West European (19.2 %), South Asian (16.2%), North American (12.9 %), East European (10.2%), and below 10% included East Asian (4.4%), other (3.9%) and unknown (4%). This compares fairly closely with 2006 BC census data collected for population diversity³ (Figure 2), thus the food

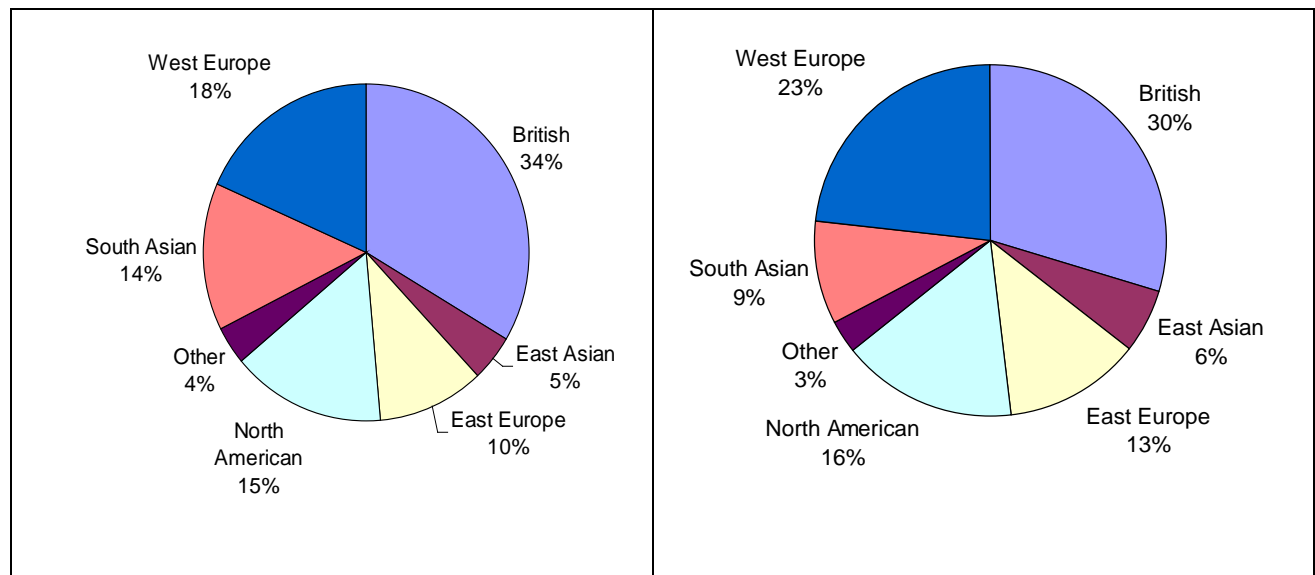
service workers surveyed in this study are representative of the overall population in BC.

Table 5 – Who was surveyed and included in the analyses

Group Description	Number surveyed	Final number included in analyses *
Trained food service workers (FOODSAFE) <i>Test group</i>	500	499
Untrained food service workers <i>Control group</i>	201	199
Trained non-food service workers (FOODSAFE) <i>CDC-home group</i>	393	393
General population (VCH/FH survey) <i>HA-home group</i>	1099	1099

* Persons under 16 excluded

Figure 2 – BC Population Ethnic Diversity[†] (left) and Food Service Workers Ethnic Diversity (right)



[†] Based on 2006 Census data, Statistics Canada

Some variation was seen when participants were asked their highest level of education. More test workers (63%) received college and university training than control workers (54%). However, when asked about additional food safety training, 60% of all workers responded that they

had received no other food safety education (other than FOODSAFE) either on the job or in school.

Table 6 – Proportion of managers and staff identified by sex for the food service worker group

Sex	Manage % (n)	Staff % (n)	Total % (n)
Male	60.6 (160)	39.4 (104)	38 (264)
Female	44.9 (195)	55.1 (239)	62 (434)

Approximately half of the participants indicated they had supervisory level responsibility (50.8%), and half were staff (49.1%). However, there were proportionally fewer staff enrolled in the trained group (44.5%) than in the untrained group (60.8%), and this difference was significant ($p < 0.001$, Chi-squared). There were also proportionally fewer supervisors enrolled in the untrained group (39%) than in the trained group (55%).

Although males comprised only 38% of the group, 61% indicated they managed the establishment. There were a higher proportion of females who indicated they were staff (Table 7).

The food service workers' place of employment included a wide variety of premises, such as family restaurants, retail food stores, fast-food or take-out restaurants, cafeterias, institutional premises such as hospitals and care facilities, food manufacturers, church and community hall volunteer servers, bars, fine-dining, ethnic restaurants, hotels, caterers and other premises such as children camps and golf courses (less than 5%) as shown in Figure 3.

Figure 3 – Food service workers' place of employment

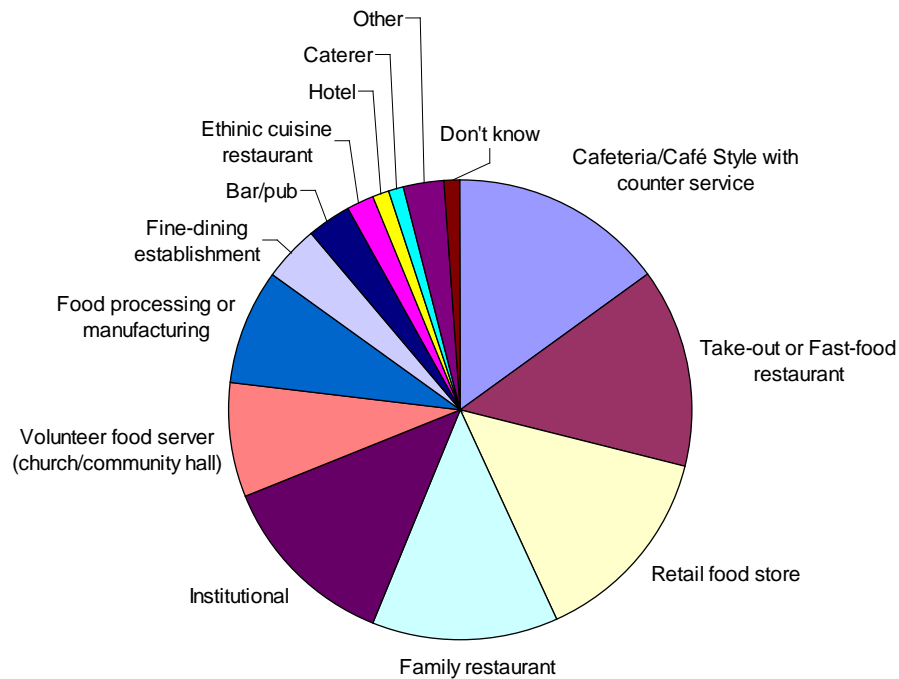


Table 7 – Demographic information of participants

	FS Trained Workers % (n)	Untrained Workers % (n)	Food Workers Total % (n)	FS Trained – Home % (n)
Sex				
▪ Male	39 (194)	35 (70)	38 (264)	21 (81)
▪ Female	61 (305)	65 (129)	62 (434)	79 (312)
Ethnicity				
▪ East Asian	4.2 (21)	5.0 (10)	4.4 (31)	4.6 (18)
▪ British	30.3 (151)	29.6 (59)	30.1 (210)	36.1 (142)
▪ East European	9.8 (49)	11.1 (22)	10.2 (71)	10.0 (39)
▪ West European	18.8 (94)	20.1 (40)	19.2 (134)	15.3 (60)
▪ South Asian	16.2 (82)	15.6 (31)	16.2 (113)	9.2 (36)
▪ North American	12.4 (62)	11.0 (22)	12.9 (90)	19.3 (76)
▪ Other	3.8 (19)	4.0 (8)	3.9 (27)	2.5 (10)
▪ Unknown	4.2 (21)	3.5 (7)	4.0 (28)	3.0 (12)
Education				
▪ High school	36.1 (180)	45.2 (90)	38.7 (270)	28.0 (110)
▪ College	35.0 (175)	29.1 (58)	33.4 (233)	35.9 (141)
▪ University	27.8 (139)	24.6 (49)	26.9 (188)	35.3 (139)
▪ Unknown (other/refused)	1.0 (5)	1.0 (2)	1.0 (7)	0.7 (3)
Other food safety education				
▪ Yes	40.0 (200)	34.2 (68)	38.4 (268)	20.6 (81)
▪ No	59.3 (296)	64.3 (128)	60.7 (424)	79.3 (312)
▪ Unknown	0.6 (3)	1.5 (3)	0.8 (6)	
Position				
▪ Manager	55.5 (277)	39.2 (78)	50.8 (355)	N/A
▪ Staff	44.5 (222)	60.8 (121)	49.1 (343)	
Workplace Activities				
▪ Cleaning	64.9 (324)	72.4 (144)	67.0 (468)	N/A
▪ Prepare food	65.9 (329)	57.8 (115)	63.6 (444)	
▪ Serve food	62.3 (311)	62.8 (125)	62.5 (436)	
▪ Handle cash	46.3 (231)	70.8 (141)	53.3 (372)	
▪ Manage	50.5 (252)	35.2 (70)	46.1 (322)	
▪ Own	22.6 (113)	12.6 (25)	19.8 (138)	

II. Survey Results

Knowledge scores comparison between trained and untrained groups

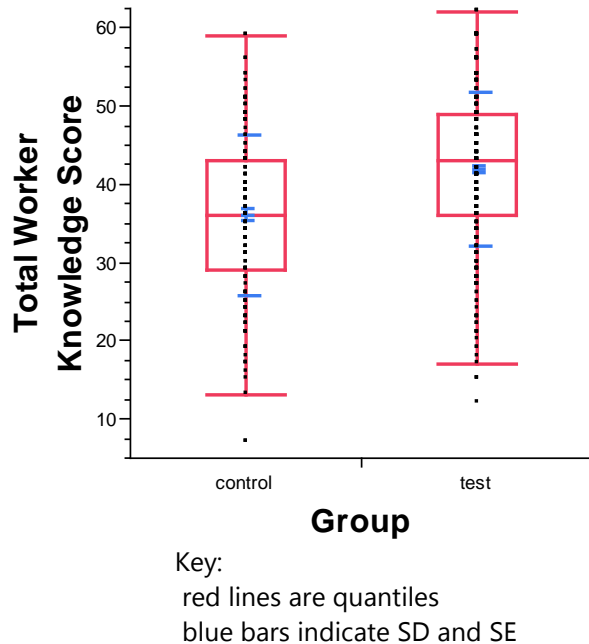
The responses of trained and untrained food service workers to the individual knowledge questions are shown as percentages correct in Table 8. In all but one question, FOODSAFE trained food service workers scored higher than untrained food service workers. Some questions proved difficult for both groups, for instance, when asked the safest way to cool a pot of soup, 55% of FOODSAFE graduates, and only 26% of untrained food service workers answered this question correctly. Most participants had problems with temperature control issues such as reheating, cooling and identifying the danger zone temperatures. The method for sanitizing food surfaces and bleach formulations were also identified as a knowledge gap in this survey for both groups.

The total average score of FOODSAFE trained food service workers was 42 points out of a possible 62, and was significantly higher than those of untrained food workers, 36 points out of a possible 62; $p < 0.0001$, t-test as illustrated in Figure 4 and Table 9.

On average, FOODSAFE trained workers scored nearly 6 points higher than untrained workers (the mean difference was 5.95); however the standard deviation for both groups was approximately 10. The passing score for a FOODSAFE exam is 70% (in this survey equivalent to a score of 44 or more points), an average score that neither group met. If a 70% passing grade criterion was applied to the respondents participating in this survey, only 46.5% ($n=232$) of trained and 23% ($n=46$) of untrained workers would have passed the test.

When all trained and untrained food service workers were considered together (test and control), supervisors knowledge scores were

Figure 4 – Knowledge scores in untrained (control) and FOODSAFE trained (test) groups.



significantly higher than staff ($p = 0.0001$, t-test). No differences were found when sex was assessed. When knowledge scores were regressed against other food safety training, age, and years of experience (after excluding rows of data where either no years of experience were given, or less than 10 years separated age and years of experience), two factors, age and years of experience were important to increasing food worker knowledge.

A closer examination of years of experience and age was conducted for FOODSAFE trained and untrained food workers separately. For both groups' years of experience improved knowledge scores: FOODSAFE trained test group $F=0.0042$ and untrained control group $F=0.0029$ and combined food workers, $F < 0.0001$ (Figure 5, assessed by linear regression). When age was examined, improved food safety knowledge was only a factor for the control group ($F=0.0015$) and not the test group ($F=0.2372$).

Table 8 – Knowledge questions and answers of food service workers [†]

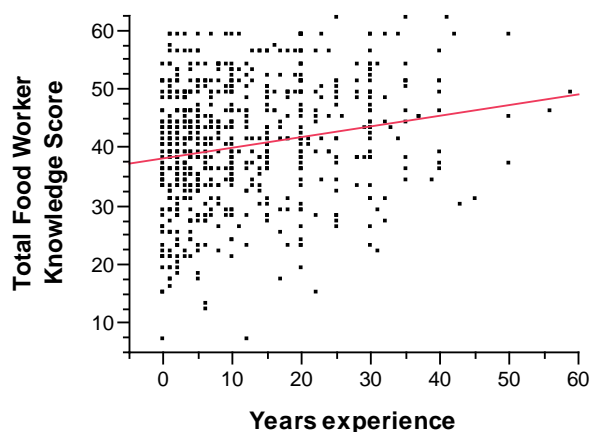
Knowledge Questions	Knowledge Answers (%)	
	FS Trained % Correct	Untrained % Correct
1. What is the minimum safe temperature to hold hot foods?	71	61
2. When reheating leftovers, what minimum internal temperature should leftovers be reheated to before serving?	58	57
3. When cooling a cooked food that will be stored in the refrigerator, how long do you have to get it to the cold food storage temperature?	81	72
4. What is the safest way to cool a large pot of soup?	55	26
5. The correct way to determine the temperature of cooked food is to?	92	88
6. The “Danger Zone” refers to what range of temperatures?	61	43
7. What is the best way to clean dishes?	85	81
8. To sanitize a food surface, like a cutting board, the correct amount of domestic bleach to water is?	64	55
9. Reason why perishable foods must be refrigerated below 4 degrees Celcius or 40 degrees Fahrenheit?	79	72
10. What is the recommended final internal temperature for cooking a stuffed turkey or stuffed chicken safely?	74	68
11. What is the recommended final internal temperature for cooking foods, for example, red meats like hamburger?	93	93
12. After you prepare a family dinner, how long do you generally leave the leftovers out on the counter?	97	98
13. What is the best way to thaw frozen foods, for example, red meats like hamburger?	95	85

[†] The % shown in this table is based on the sum of the best and second best answer in the multiple choice selection. To see a breakdown of the answers for each of these questions, consult Appendix 4.

Table 9 – Average knowledge scores of trained and untrained food service workers by sex and by position (supervisors and staff).

FS Trained Workers	n	Average (Range)	Median (SD/SE)
Total for all workers	499	42.0 (12-62)	43 (9.8 / 0.4)
Supervisors	277	43.2 (15-62)	44 (9.9 / 0.6)
Staff	222	40.5 (12-59)	41 (9.5 / 0.6)
Male	194	41.9 (15 – 59)	43 9/6 / 0.69
Female	305	42.0 (12 – 62)	43 10.0 / 0.6
Untrained Workers	n	Average (Range)	Median (SD/SE)
Total for all workers	199	36.1 (7 – 59)	36 (10.3 / 0.7)
Supervisors	78	38.2 (7 – 59)	38 (10.5 / 1.2)
Staff	121	34.8 (7 – 59)	36 (9.9 / 0.9)
Male	70	36.6 (7 – 59)	38 11.8 / 1.4
Female	129	35.8 (15 – 59)	36 9.4 / 0.8

Figure 5 – Knowledge score of all food workers based on years of experience in the food service industry



Knowledge retention in FOODSAFE trained (test) group

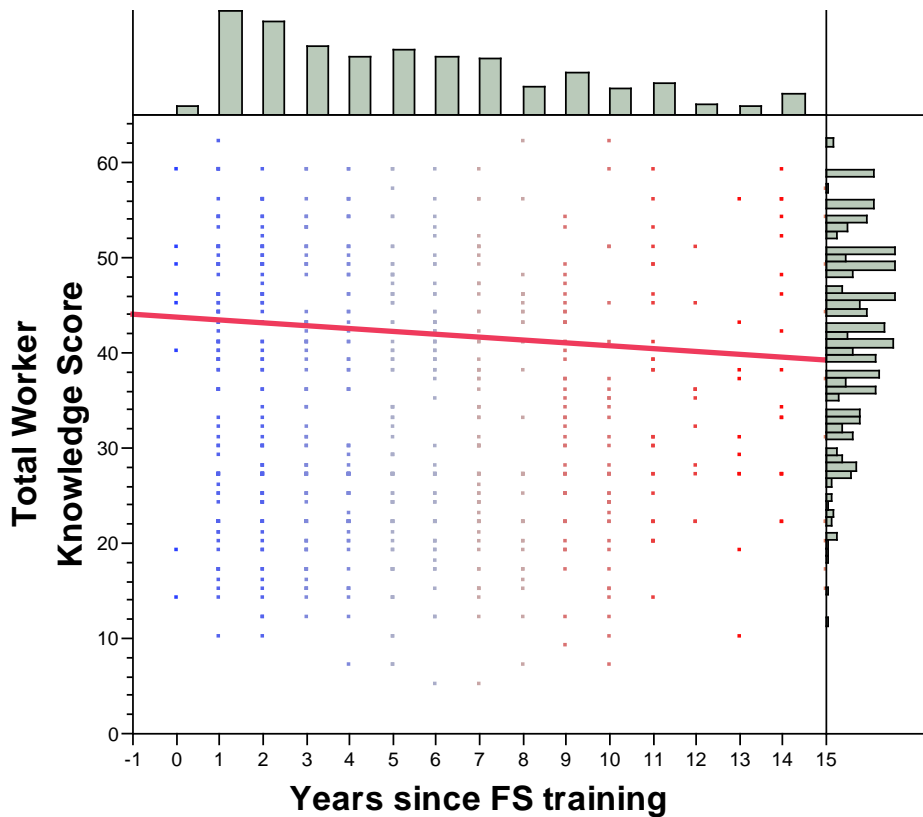
A linear regression of knowledge scores over time in FOODSAFE workers found that knowledge scores decreased over the 15 year period for food workers who had taken FOODSAFE training from 1995 to 2009, shown in Figure 6 (p = 0.02, n=412). From 15 to 25 years after training there was little change in knowledge scores. Histograms (green bars at the top and right of the chart) indicate the frequency of values. As expected, more surveys were completed by recent graduates (years 1 and 2 since FOODSAFE training), with declining numbers of surveys received from later graduates, even though a greater proportion of survey letters and follow-up phone calls were given to older graduates.

A further multivariate regression model of knowledge scores revealed the following explanatory factors: years of experience, education level, position and ethnicity, although these factors did not account for much of the variation in the model (RSquare Adjusted = 0.105, F Ratio = 4.3919, p<0.0001).

Knowledge scores of food workers compared to place of employment, to educational background and to ethnicity

Differences in knowledge scores achieved by food service workers were seen when workers were separated into categories by type of premise (place of employment), worker ethnic background and education level (p<0.0001, ANOVA).

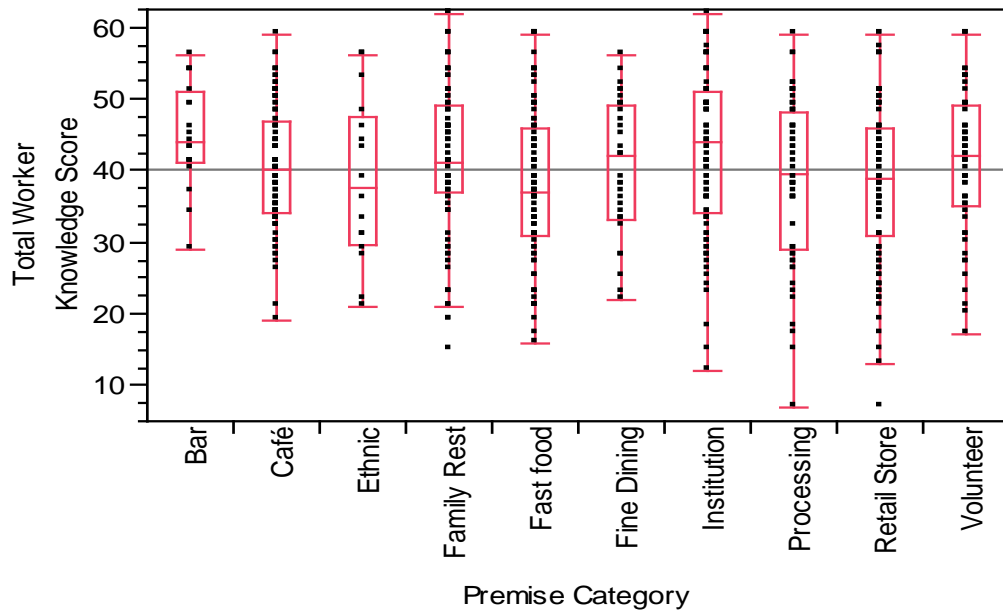
Figure 6 – Retention of food-safety knowledge after time elapsed (in years) since FOODSAFE training (linear regression)



Within the types of food premises both fast food workers and retail stores scored significantly lower than workers at bars ($p=0.0079$ and $p=0.0138$ respectively, paired student t-test); significantly lower than workers in institutions ($p = 0.0013$ and $p=0.0040$, respectively, paired student t-test); and significantly lower than workers in family restaurants ($p=0.0120$ and $p=0.0295$, respectively, paired student t-test) when both trained and untrained groups were assessed together (Figure 7). Workers in processing operations also scored significantly lower than those in bars and institutions ($p=0.0292$ and $p=0.0247$, respectively, paired student t-test).

Caterers scored highest in both test and control groups when compared to worker scores in other groups (Table 10). However, only 6 survey participants self-identified as caterer, numbers were too low to assess statistically against other groups, and this result may not be truly representative of this group. The lowest scoring worker groups were all control (untrained) workers, and included volunteers, ethnic restaurant and fast food workers. However, few survey participants self-identified as belonging to the volunteer or ethnic restaurant group, and these results may not truly represent actual findings (refer to Table 10 for details).

Figure 7 – Effect of place of employment on knowledge scores of food service workers



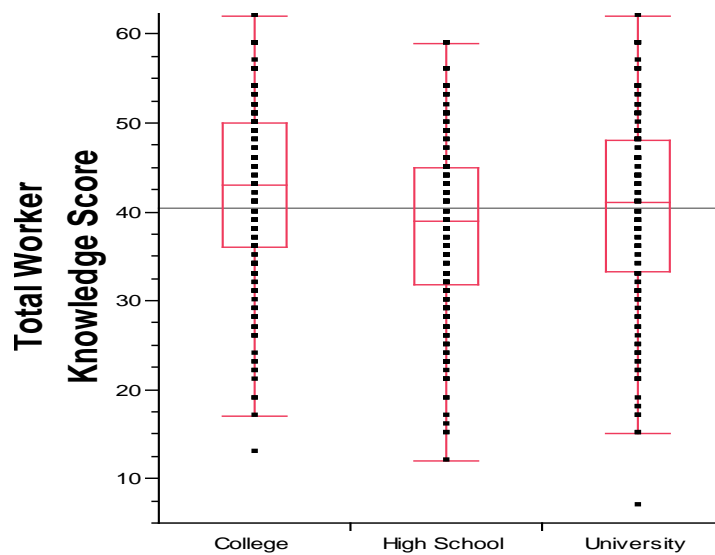
Type of Premise	Average score for pooled food worker knowledge			
Bar	A			44.8
Institution	A			42.7
Family Rest	A	B		41.7
Volunteer	A	B	C	41.1
Café	A	B	C	40.6
Fine Dining	A	B	C	40.5
Processing		B	C	38.8
Ethnic	A	B	C	38.5
Retail Store			C	38.4
Fast food			C	37.9

Levels not connected by the same letter are significantly different. Premise categories with 10 or less values excluded from this analysis were "caterer", "hotel", "don't know" and "other" categories.

When food worker knowledge scores were compared to education level, as expected, workers with college and university education scored higher than those with some or completed high-school (Table 11 and Figure 8). College workers scored the highest, and scores were significantly higher than those with university ($p=0.0152$, t-test) and high-school ($p<0.001$, t-test) education. University trained food workers also scored significantly higher than high-school trained workers ($p=0.0440$, t-test).

When food workers were asked if they had received any other food safety training (other than FOODSAFE training), the majority of workers in both groups said “no” (Table 11). Overall 61% of food workers declared they had not received “any other food safety training, either on the job or in school” (Question 39 on survey – Appendix 1).

Figure 8 – Effect of education on knowledge scores of food service workers



<i>Education Level</i>	<i>Average score for pooled food worker knowledge</i>	
College	A	42.8
University	B	40.4
High School	C	38.5

Levels not connected by the same letter are significantly different. Education level categories excluded were “refused” and “other”.

Table 10 – Knowledge scores of FOODSAFE trained (test) and untrained (control) food service workers in different food service premises

Premise Category	FS Trained Workers (test group)			Untrained Workers (control group)		
	n	Average (Range)	Median (SD /SE)	n	Average (Range)	Median (SD/SE)
Total for all premises	499	42.0 (12-62)	43 (9.8 / 0.44)	199	36.1 (5 – 59)	36 (10.3 / 0.73)
Take-out or fast food	65	40.4 (19-59)	40 (9.8 / 1.21)	35	33.3 (16 – 59)	33 (9.8 / 1.6)
Cafeteria style or café with counter service	67	41.9 (27-59)	41 (7.8 / 0.96)	40	38.5 (19 – 56)	39 (8.2 / 1.3)
Family restaurant	76	43.1 (19-62)	44.5 (10.0 / 1.14)	16	34.9 (15 – 50)	37.5 (10.4 / 2.6)
Ethnic cuisine restaurant	14	39.4 (21-56)	41 (11.8 / 3.16)	2	32.0 (28 – 36)	32 (5.7 / 4.0)
Fine-dining establishment	26	40.3 (22-56)	42 (10.1 / 2.0)	5	41.2 (32 – 49)	39 (7.2 / 3.2)
Food processing or manufacturing	39	40.3 (15-56)	43 (11.1 / 1.77)	19	35.9 (7 – 59)	36 (12.2 / 2.8)
Institutional (e.g. hospitals)	80	43.8 (12-62)	45.5 (11.3 / 1.26)	11	35.3 (18 – 54)	34 (9.9 / 3.0)
Retail food store	49	41.5 (15-59)	43 (9.9 / 1.41)	50	35.4 (7 – 56)	36 (11.4 / 1.6)
Volunteer food server	52	42.6 (20-59)	43 (9.0 / 1.25)	7	30.4 (17 – 44)	27 (10.7 / 4.0)
Bar/pub	13	44.6 (29-56)	44 (7.9 / 2.2)	6	45.2 (37 – 54)	44.5 (6.5 / 2.6)
Hotel	4	36.8 (28-51)	34 (9.9 / 4.95)	2	45.0 (43 – 47)	45 (2.8 / 2.0)
Caterer	4	45.5 (41-49)	46 (4.1 / 2.06)	2	51.0 (51)	51 (0 / 0)
Other	10	41.2 (30-51)	41 (8.0 / 2.53)	4	34.3 (24 – 43)	35 (8.2 / 4.1)

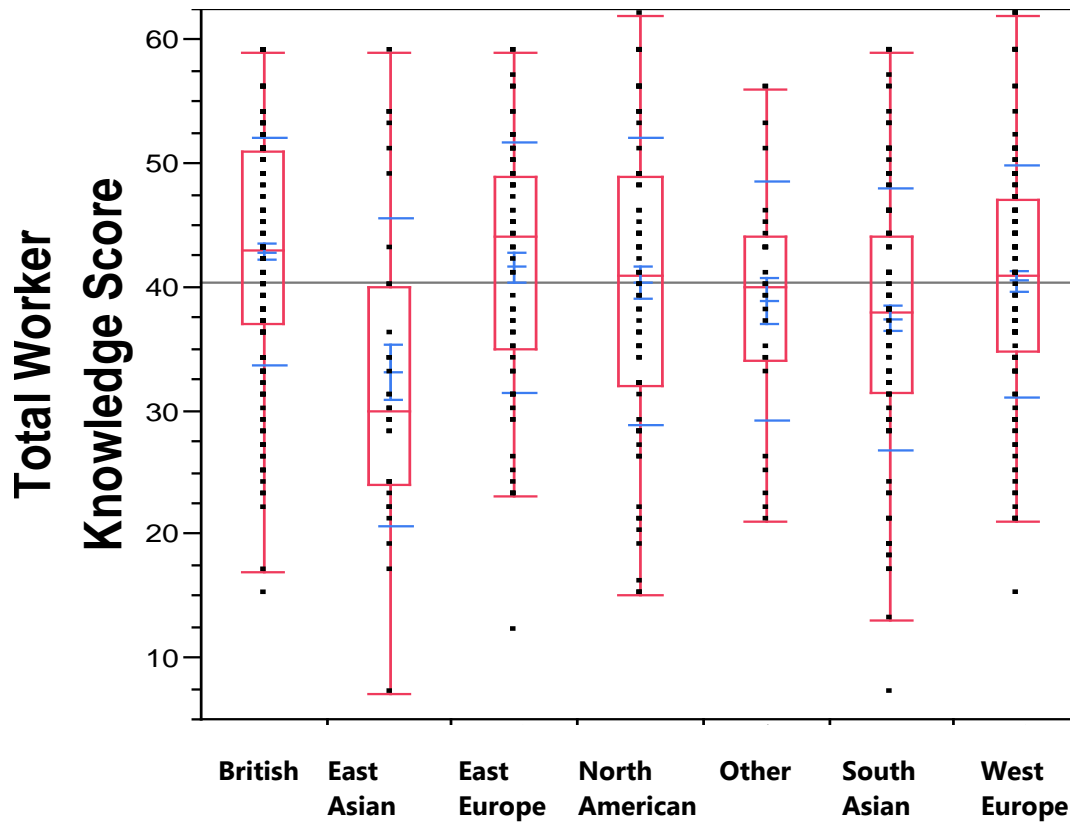
Table 11 – Knowledge scores of food service workers separated by duties at work, education, receipt of other food safety training, and ethnicity

Category	FS Trained Workers (test group)			Untrained Workers (control group)		
	n	Average (Range)	Median (SD/SE)	n	Average (Range)	Median (SD/SE)
Activities at Work						
Cleaning	324	42.6 (12 – 62)	43.5 9.8 / 0.54	144	36.5 (7 – 59)	37 10.3 / 0.85
Prepare food	329	43.2 (15 – 67)	44 9.7 / 0.53	115	36.9 (7 – 59)	37 10.2 / 0.95
Serve food	311	42.3 (12 – 62)	43 10.3 / 0.59	125	37.4 (15 – 59)	38 9.6 / 0.86
Handle cash	231	42.4 (15 – 62)	43 9.9 / 0.65	141	36.4 (15 – 59)	36 9.8 / 0.83
Supervisor	252	43.1 (15 – 62)	44 10.0 / 0.63	70	38.0 (7 – 56)	38.0 10.2 / 1.22
Owner	113	43.8 (18 – 62)	45 9.9 / 0.93	25	40.1 (18 – 59)	40 12.4 / 2.48
Education						
High School	180	40.2 (12 – 59)	41 9.34 / 0.70	90	35.0 (15 – 53)	36.9 9.3 / 0.98
College	175	43.9 (19 – 62)	45 9.2 / 0.69	58	39.5 (13 – 59)	38.5 10.8 / 1.41
University	139	42.3 (15 – 62)	43 10.5 / 0.89	49	35.0 (7 – 54)	36.0 9.9 / 1.42
Other food safety training						
Yes	200	34.3 (30 – 35)	35 1.4 / 0.1	68	33.8 (27.5 – 35)	35 1.8 / 0.22
No	296	33.9 (22.5 – 35)	35 2.0 / 0.16	128	33.8 (25 – 35)	35 2.1 / 0.18
Ethnic Background						
East Asian	21	37.1 (17 – 59)	34 12.2 / 2.67	10	24.5 (7 – 36)	24 8.0 / 2.54
South Asian	82	40.2 (18 – 59)	39 9.4 / 1.03	31	30.2 (7 – 51)	31 10.5 / 1.88
British	151	44.2 (15 – 59)	45 8.8 / 0.72	39	39.6 (17 – 56)	39 9.4 / 1.23
East European	49	42.0 (29 – 59)	44 10.6 / 1.51	22	40.8 (23 – 56)	43.5 9.3 / 1.99
West European	94	42.1 (21 – 62)	43 9.1 / 0.94	40	36.6 (15 – 59)	36 9.0 / 1.42
North American	62	42.4 (15 – 62)	43.5 11.5 / 1.47	22	34.8 (16 – 59)	36.5 10.2 / 2.17
Other	19	40.7 (21 – 56)	41 10.0 / 2.29	8	34.5 (22 – 43)	34.5 7.8 / 2.74

The ethnic background of food workers also affected the average food worker score (Table 11 and Figure 9). East Asian and South Asian workers scored lower, overall, than European, British and North American workers. Workers who declared British ancestry scored significantly higher than South and East Asian workers

($p < 0.0001$, t-test), and Western European workers ($p = 0.0334$, t-test). Eastern European, Western European and North American workers also scored significantly higher than South and East Asian workers ($p < 0.05$, t-test), and South Asian workers scored significantly higher than East Asian workers ($p = 0.0320$, t-test).

Figure 9 – Effect of ethnicity on knowledge scores of food service workers



Level	Average score for pooled food worker knowledge			
British	A			42.9
East Europe	A	B		41.6
West Europe	A	B		40.5
North American	A	B		40.4
Other	A	B	C	38.9
South Asian	C			37.4
East Asian	D			33.0

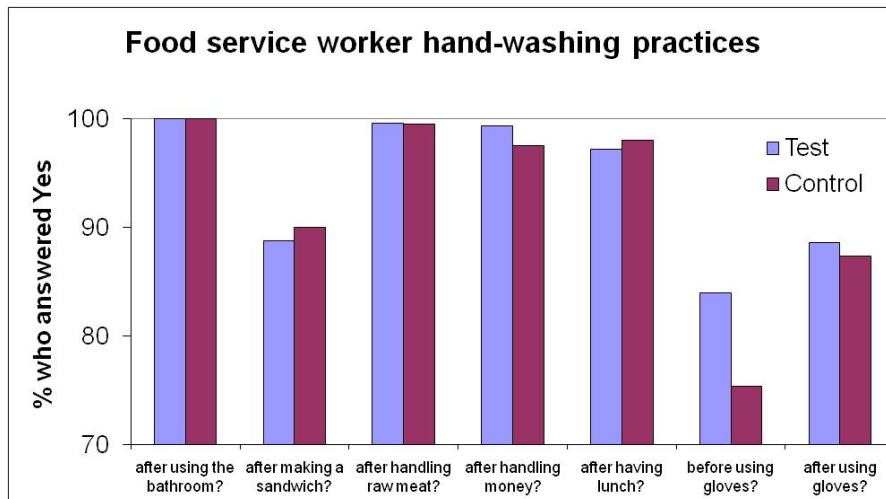
Levels not connected by the same letter are significantly different. Ethnicity categories excluded were "don't know".

Food worker hand-washing practices

Both trained (test) and untrained (control) participants reported consistently safe hand washing practices with scores above 90% except for one question that asked if hand washing was necessary before using gloves (Table 12, question 6). In this question 84% of trained workers thought washing hands before using gloves was important compared to 75% of untrained workers. Less than 90% of either group felt it was necessary to wash hands after

using gloves. Food service worker hand-washing practice scores are shown in the figure below. Although overall differences in the percentage of scores achieved seemed small between the groups (test workers scored an average 97.3% and control workers scored 96.5%), test workers did score significantly higher when all 7 worker hand-washing practice questions were considered together ($p=0.0371$, Chi-squared). However, when one question regarding washing of hands before glove use was excluded, these results were not significant.

Figure 10 – Food service worker hand-washing practices



Availability of hand-washing facilities

Two other questions were asked of all food service workers about hand-washing facilities in their workplace. When asked if there was a sink designated specifically for hand-washing in the kitchen, 84% replied there was.

When prompted if the sink had soap, hot-water and towels available, 93% reported these were available all of time, 5% most of the time, and less than 1% reported some, rarely, or never were these available.

Table 12 – Practice questions responses and overall scores of FOODSAFE trained (test) and untrained (control) food service workers

Practice Questions	Practice Answers	
	Trained Yes (%)	Untrained Yes (%)
Questions asked in work survey:		
When do you have to wash your hands?		
1. After going to the bathroom?	100	100
2. After making a sandwich?	89	90
3. After handling raw meat?	100	100
4. After handling money?	99	98
5. After having lunch?	97	98
6. Before using gloves?	84	75
7. After using gloves?	89	87
Questions asked in home survey:		
8. Do you use a food thermometer to check if foods have been cooked enough?	63	50
9. Do you keep a thermometer in your refrigerator?	54	44
10. I wash my hands with soap and warm running water before preparing foods	100	99
11. After playing with a pet and before getting a snack, I wash my hands with soap and warm running water	97	96
12. After cutting raw meat, chicken, or seafood I wash all items that came in contact with the raw food	98	97
13. After you prepare a family dinner, how long do you leave the leftovers out on the counter?		
▪ 2 hours	85	85
▪ 4 hours	4	8
▪ Overnight	1	2
▪ Thrown out	8	5
14. What is the best way to thaw frozen foods?		
▪ Under warm water	2	8
▪ Under cold running water	15	21
▪ On counter overnight	8	5
▪ In the refrigerator	76	58
▪ In the microwave	4	6

Food worker practices

When food worker practices were assessed at home (Table 12, questions 8 to 14), trained food workers scored significantly higher than untrained workers ($p < 0.0001$, Chi-squared). Trained food workers used thermometers more often to check foods and to monitor their refrigerators, and they were better able to answer questions about how to thaw foods and handle left-over foods. This result remained significant when tallied together with hand washing practice scores.

Food worker attitudes

Attitude scores for trained and untrained workers are shown in Table 13. Both trained and untrained workers had average scores above 90% on individual answers such as: "You have to make sure that prepared food is safe for customers", "Improper storage of foods can be hazardous to health", and "Raw foods should be kept separate from cooked foods". Trained food

workers demonstrated positive attitudes, with average scores above 90% on individual answers about responsibilities, learning about food safety, hand washing, and vulnerable groups. In comparison, untrained workers scored lower on these questions (however all average scores were still above 90%).

Three specific examples of questions answered poorly by both groups are noted below.

1. Eighty five percent of trained workers and 92 percent of untrained workers believe that gloves should be worn to touch raw food.
2. Ninety percent of trained workers and only 77% of untrained workers agreed that "If you go to work with diarrhea you might make other people sick".
3. Only 89% of trained and 85% of untrained workers thinks that the refrigerator temperature should be checked at least once a day.

Table 13 – Attitude questions responses and overall scores of FOODSAFE trained (test) and untrained (control) food service workers

Attitude Question	Attitude Answer	
	Trained % Agree	Untrained % Agree
1. Safe food handling is an important part of your job responsibilities.	96	91
2. Gloves should be worn by those involved in touching raw foods.	85	92
3. You have to make sure that prepared food is safe for customers.	99	98
4. Learning more about food safety is important to you.	96	95
5. If you go to work with diarrhoea you might make other people sick.	90	77
6. Improper storage of foods can be hazardous to health.	98	96
7. Raw foods should be kept separate from cooked foods.	98	98
8. Other employees who prepare food wash their hands where you work.	95	93
9. Food-borne disease is more dangerous for vulnerable groups (i.e. children, older people and pregnant women).	95	92
10. The temperature of refrigerators should be checked at least once per day.	89	85

Trained food workers had higher overall average attitude scores (95.5%) than untrained workers (93.8%) and they answered correctly more often ($p=0.0006$, Chi-squared).

Work-place injuries

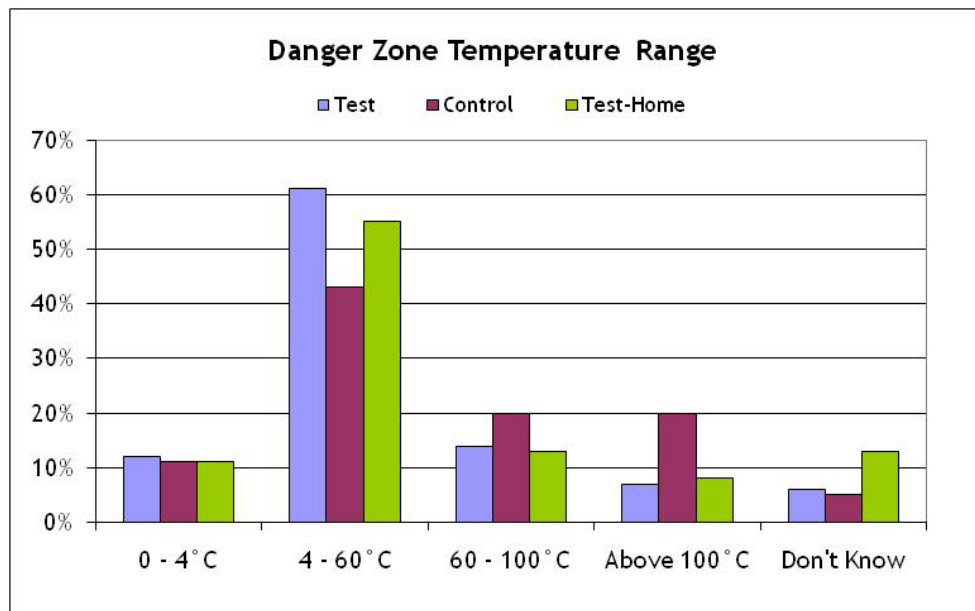
Overall, 23% of food service workers reported receiving an injury at work. The types of injuries food service worker sustained included cuts (75%) burns (49%), sprains and strains (26%), slips/falls (23%) and other types of injuries (5%), such as items falling on head, back injury from lifting heavy objects, neck injury, catching fingers in freezer door, fractures and crushed hand.

Practices at home

At home, few participants in any group reported using a thermometer to check the internal temperature of foods (63% trained, 50% untrained, 46% home-trained), and fewer keep a

thermometer in their refrigerator (54% trained, 44% untrained, 23% home-trained). Small differences were seen between groups when asked about hand-washing practices at home, and how leftovers were handled. More trained workers correctly answered the best way to thaw frozen foods (in the refrigerator) compared to untrained workers (Table 12). The home group (FOODSAFE trained, non-food service workers) did better on some, but not all questions that demonstrated knowledge of food safety principles over the untrained control group – such as identification of the “danger zone” shown in Figure 11. When practice scores were compared between all groups, a significant difference was detected ($p < 0.0001$, Chi-squared). When mean home practice scores were compared, trained workers scored significantly higher than both untrained food workers ($p<0.0001$, t-test) and the trained home group ($p<0.0001$, t-test), while untrained workers scored significantly higher than the home group ($p=0.0226$, t-test).

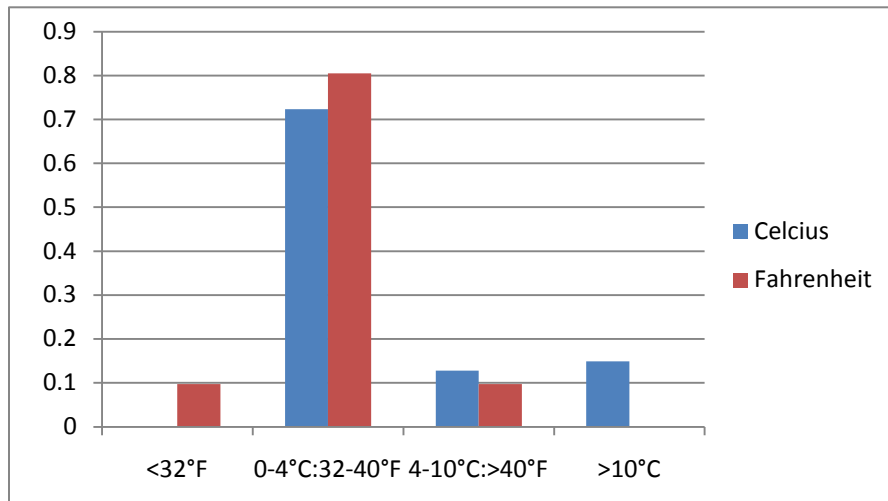
Figure 11 – Responses to “The Danger Zone” refers to what range of temperatures?



During the survey, respondents who answered the survey at home were asked “what temperature is your refrigerator?” Between 70 to 80% of respondents had their home refrigerator set within the correct temperature range, that is, between 1 and 4° Celsius, or between 32 and 40° Fahrenheit. Another 10% had their refrigerators at too warm of a temperature, between 4 and 10°C, or greater than 40°F (Figure 12). However,

based on the responses the final 10% of people answering the survey did not know how to correctly read the thermometer in their home refrigerator, stating their refrigerator was either under 32°F (freezing) or was >10°C. Examples of these answers included declaration of home refrigerators at either 18°F (freezing point) or 60°C (a hot-holding temperature).

Figure 12 – Observed temperatures of home refrigerators



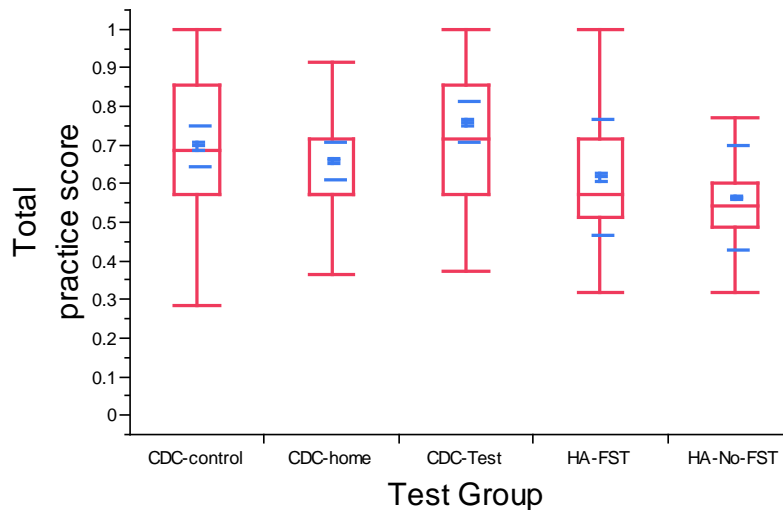
Comparison of FOODSAFE Survey and Health Authority Survey Data

The results of this data comparison were quite interesting: all participants in the FOODSAFE survey scored higher than those in the general population survey.

Questions evaluated thermometer use, hand-washing before handling foods, after handling pets, and cleaning after preparing meats and before eating fresh vegetables.

As depicted in Figure 13, FOODSAFE trained workers scored the highest overall (CDC test group – 76%), followed by persons working in the food industry (CDC control group – 70%), persons who identified they had taken FOODSAFE training (CDC home group – 66%), then persons who had some formal food handler training (HA FST group – 62%), and persons who scored lowest had no food safety training or exposure at work (HA no FST – 56%).

Figure 13 – Comparison of home practice scores between all survey groups¹



¹ – Abbreviations: “CDC” – BC Centre for Disease Control FOODSAFE survey, “HA” – Health Authority Food Safety in the Home Baseline Survey; “FST” – food safety training

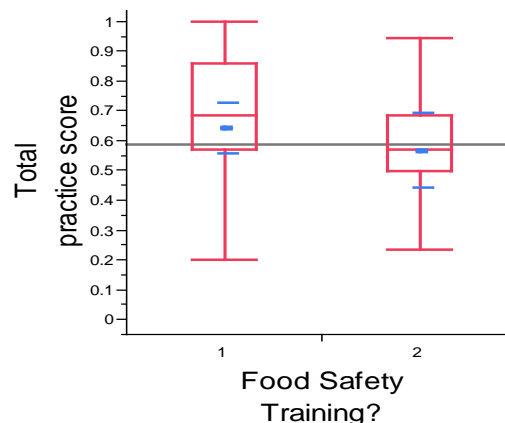
Level	Average Practice Score		
CDC-Test	A		0.76
CDC-control	A	B	0.70
CDC-home		B	0.66
HA-FST		C	0.62
HA-No-FST		D	0.56

Levels not connected by same letter are significantly different.

This indicates that FOODSAFE training does have a positive influence on food safety behavior at home, and that working in the food industry also conveys knowledge of correct food safety practices ($p < 0.0001$, Chi-squared).

When groups with food safety training from both surveys were pooled together, the differences noted were more transparent: those with food safety training in their history scored significantly higher than those with no food safety training (Figure 14, $p < 0.0001$, t-test).

Figure 14 – Comparison of home practice scores between participants with food handler training (Group 1) and without food handler training (Group 2)



Discussion

Current evidence suggests that a substantial number of food poisoning illnesses occur through poor food handling practices involving food workers. In documented reports of food handler related outbreaks from around the world between 2000 and 2006, there were 233 outbreaks resulting in 16,028 cases of food poisoning.⁴ Most of these outbreaks occurred in food service facilities such as restaurants (46%) and catering facilities (15.4%). The root causes of these outbreaks were traced to poor food handling practices, such as cross contamination of raw and cooked products, slow cooling and inadequate refrigeration of foods, and poor worker hygiene such as a failure to wash hands. Many outbreaks were caused by infected food workers handling ready-to-eat foods.⁵

How many illnesses can be attributed to food-borne gastroenteritis? In 2003 it was estimated that in BC, between 1 in 19 and 1 in 6 residents became ill due to food poisoning.⁶ Recently, evidence collected in BC suggests that for every single case of infectious gastroenteritis reported, another 347 go unreported.⁷ It has also been projected that approximately 1 million cases of food-borne acute gastroenteritis occur annually in BC, translating into annual provincial costs of \$100 million.⁸⁻¹² These food poisoning costs are largely associated with missed employment.¹⁰

Food handlers in BC are of particular concern. They are less likely than workers in other high-risk occupations (such as health care and day care workers) to exclude themselves from work if they have gastroenteritis.¹³ As many of the root causes of foodborne illnesses outbreaks have been traced to poor food handling practices, this segment of the population requires education about food safety, proper food handling practices and the importance of hand-washing to avoid spreading infectious diseases while at work. The 2005 Provincial Health Officer's Report states that food safety needs to be addressed in a coherent food safety management system, and recommends that all food handlers should be

encouraged to take FOODSAFE.¹⁴ The requirement for food safety education is recognized as one of the four main program components for establishing food safety in BC. The other three components include a food premises inspection program; food-borne illness investigations, food seizures and recalls; and surveillance and ongoing evaluation of food safety.⁶

The importance of training on the principles of food safety for food handlers has been recognized in BC for many decades as evidenced by the introduction of the FOODSAFE training program in 1985. The requirement for food safety training became a legislated standard under the BC Food Premises Regulation [BC Reg. 210/99] on July 1, 2000.¹ Over 725,000 people have successfully completed the FOODSAFE course since its inception. In this survey, over 400,000 successful graduates were selected from the FOODSAFE registry as potential participants. The results of this survey were based on responses received from 499 FOODSAFE trained food workers, and these responses were compared to another 199 untrained food workers.

The FOODSAFE program is directed by a steering committee comprised of industry and government, chaired by the BCCDC with day to day operations being the responsibility of an independent Secretariat. FOODSAFE has invested in several program improvement initiatives, such as course renewal and updating, translation activities, instructor certification and implementation of on-line training. However, no formal evaluation of program effectiveness has ever been undertaken.

The initial purpose of this study was to discover if knowledge retention in FOODSAFE graduates decreased over time, with an aim to collect evidence to support the need for periodic retraining and recertification. The study also examined if other factors, such as position (supervisors versus staff), education level (college versus high-school), age, experience,

Key Results of this Study:

- Knowledge retention of food safety principles in FOODSAFE trained workers decreases over time.
- FOODSAFE trained workers have significantly higher food safety knowledge scores when compared to untrained food workers.
- FOODSAFE trained workers have significantly better hand-washing practices and attitudes when compared to untrained food workers.
- FOODSAFE trained persons have significantly higher home food safety knowledge and practice scores compared to untrained food workers.
- Persons with any food safety training have significantly better home food safety practices when compared to persons without any food safety training.

sex, ethnicity or if place of employment affected food safety knowledge. Other questions that were also addressed in this study included differences in trained and untrained food workers' food safety knowledge, food safety practices and food safety attitudes. These differences were also assessed for home food safety knowledge and practices.

As anticipated, we found FOODSAFE trained food worker knowledge retention did decrease over time. The average knowledge scores of 412 FOODSAFE trained workers significantly decreased over a 15 year period (1995 to 2009) between their initial FOODSAFE training and this survey ($p=0.02$). Another study evaluating the knowledge of restaurant managers found there was no significant difference in food safety knowledge for managers who had received recent training over those who received training more than 2 years previously.¹⁵ This was also observed in FOODSAFE trained workers from Edmonton, Alberta that found length of time since certification did not significantly influence a passing score.¹⁶ In our study, knowledge decrease was gradual and likely only detectable by using data accumulated up to 15 years from initial FOODSAFE certification. A multivariate regression of worker knowledge against nine possible explanatory factors found that position (managers), education, ethnicity and years of

experience increased worker knowledge, but did not explain much of the variation in the model ($R^2_{\text{adjusted}}=0.105$, $p<0.0001$). This is consistent with a previous survey that found decreased knowledge retention in previously certified (FOODSAFE) food handlers in the Fraser Health Authority.¹⁷

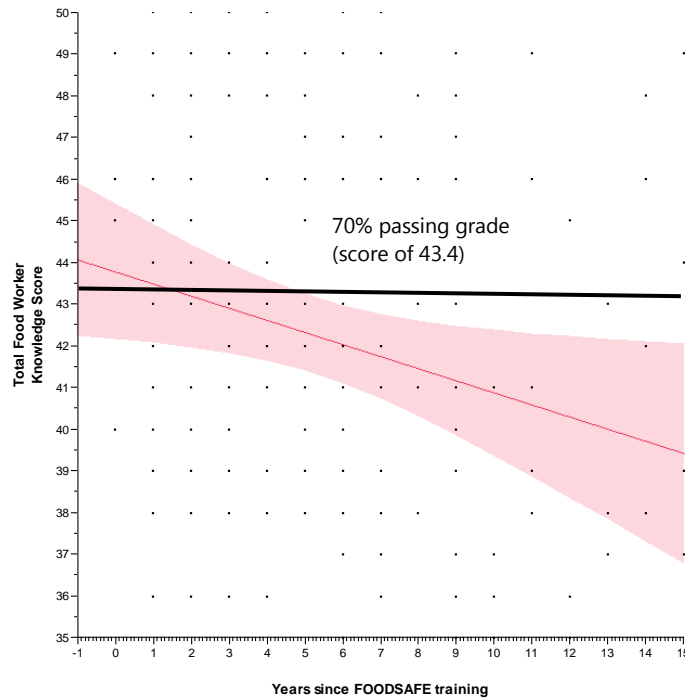
Less than half of the FOODSAFE trained workers (46.5%) in this study achieved a passing grade for FOODSAFE certification, set at 70%. The average mark was 67.7%, and is considered a failing grade unsatisfactory to meet the regulation standard. Would refresher training improve knowledge and behavior? In studies of previously trained food workers, food safety knowledge scores and behaviors did show improvement after refresher training, and included observations such as increased use of thermometers, correct temperature holding of foods and reduced bacterial counts on food surfaces indicating improved premise sanitation.^{18,19} An earlier study in BC restaurants found that food safety training resulted in fewer violations of time and temperature abuse.²⁰ Food safety training can also result in a reduction of worker related injuries.²¹

To ensure food workers who hold FOODSAFE certification are knowledgeable in the principles of food safety we recommend that periodic

refresher training take place at 3 years post-certification. In this survey group, five years after receiving FOODSAFE certification, we found 95% of trained workers achieved scores between 66.8% and 69.8% (this is based on the predicted score achieved at 5 years post-certification \pm 2 standard errors around the regressed linear mean). The passing grade for FOODSAFE is set at 70%, and based on the data from this study, at 5 years post-certification, we can predict that 95% of food service workers would fail the test if re-examined. Knowledge scores continue to decrease downwards as time elapses from the

point of training and certification. This is depicted in Figure 15 in pink upper and lower confidence intervals around the mean regression line. At 3 years post-certification, we can predict that 95% of food service workers would score between 67.7% and 70.7% if re-examined. Refresher retraining at 3 years from initial training is recommended to ensure the majority of food handlers still understand the principles of food safety. This would require that FOODSAFE certificates be issued with a date and expiry date.

Figure 15 – When to require FOODSAFE retraining



FOODSAFE trained food handlers' knowledge of food safety principles, hand-washing practices and attitudes were superior to food handlers who had not received any food safety training. When we compared the results of 13 knowledge questions between the trained and untrained groups, FOODSAFE trained workers answered correctly more often on 12 of 13 questions. The one exception was a question about handling left-over foods (trained workers scored 97%,

untrained workers scored 98%). Overall, trained workers scored an average of 10% higher than untrained workers, and this difference was significant ($p < 0.0001$). This is consistent with other studies that showed food handlers with training score higher than food handlers without any training.^{16,22-24}

In addition, trained food workers had significantly better hand-washing practices

Other Significant Results of this Study:

- Overall supervisors were better able to enumerate the principles of food safety over staff in both trained and untrained food worker groups.
- The number of years working in the food industry, or years of experience, was significant in improving food safety knowledge for both trained and untrained groups.
- Age (life experience) was also significant to improved food safety knowledge, but only in the untrained group.
- There was no difference in food safety knowledge based on sex.
- Significant differences were seen in pooled worker scores based on education level, ethnicity and type of employment premise.
- Education level: the highest scores were observed in college trained workers, and scores were significantly higher when compared to university trained workers, and to workers with some or completed high-school education.
- Ethnicity: East Asian workers scored significantly lower than all other groups. South Asian workers also scored significantly lower than other groups, such as British, European and North American workers.
- Fast food and retail workers scored lower than workers from bars, institutions and family restaurants. Workers from processing plants also scored lower than workers from bars and institutions, while no significant differences were seen between the workers from many other premises, such as cafés, ethnic and fine-dining restaurants, and volunteer workers.

($p=0.037$) and attitudes ($p=0.0009$) when responses were compared to untrained food workers. It is well known that improper hand-washing practices can lead to food contamination and illness.

In a comprehensive summary of foodborne outbreaks caused by food handlers, 94% (767 of 816) of all outbreaks were attributed to infected food handlers, and 73 were directly attributable to worker failure to wash hands.²⁵ Training has led to greater compliance with hand-washing,^{26,27} and when persons in charge are trained this has also increased compliance in untrained workers.²⁶ Knowledge, especially when supplemented with hands-on training and training in the workplace can increase hand-washing compliance rates.²⁸⁻³² In this study, more untrained (than trained) food workers

reported they did not wash hands before glove use, an area of instruction requiring improvement. When this question was removed, there was no significant difference between the self reported hand washing practices of trained and untrained workers. However, when the sum of all practices, those at home as well as hand washing at work were assessed, trained food workers scored significantly higher than untrained workers ($p<0.0001$, Chi-squared). Positive attitudes towards food safety have also been found to improve the intent of food managers to train staff.³³

Many other studies, however, have found that knowledge alone does not necessarily translate into improved practices.^{24,31,34-40} While food safety knowledge is important, on-site training, management support, monetary awards,

inspections, removal of perceived barriers and co-worker peer pressure assist in improving practices.^{30,40-43} Understanding social contexts, attitudes and influences on workers is also important.^{44,45} Other studies have found intervention tools, such as posting of food safety information sheets, targeted messaging, repeated and frequent messaging, messaging sensitive to worker education level and attitudes, and interactive media use, such as computer assisted learning, especially with younger adults, to be valuable.^{40,46-52} Several studies have also found on-line education to be effective.^{51,53-56}

When evaluating the place of employment of food workers, two of the lowest scoring categories (ranked 7th and 9th overall out of 10 employment categories) included retail store workers and workers from processing plants. There is no BC requirement that all food workers, regardless of place of employment, receive food safety training.

The European Union set out new hygiene regulations in 2004 (Regulation (EC) No 852/2004)⁵⁷, with the objective that all food production, from the primary producer to the consumer, comply with best practice guidelines that include training of food workers. Unlike the BC Food Premises Regulation that recommends only workers in food service establishments (e.g., restaurants) receive food safety training, this regulation includes food workers in all processing areas, such as caterers, meat, eggs, milk, dairy and fish products.^{1,58} In contrast to restaurants that serve a defined public from a single outlet, processing premises often make large quantities of food that are widely distributed to the public through a variety of distribution networks. These premises will pose a greater overall risk than individual (smaller volume) restaurant premises. Lack of food safety training in food workers at these premises, and existing BC legislation, does not adequately protect public health in the area of food safety. Given the low scores many food workers from retail stores and food processing facilities

received, these workers would benefit from food safety training.

Our survey also captured food safety knowledge and practices in the home. When previously certified FOODSAFE subjects were contacted, 393 indicated they no longer worked in the food industry. We compared responses in this group (home-trained) against the trained and untrained food workers for home food safety knowledge and practices. Trained FOODSAFE food workers scored highest, followed by untrained food workers, and last, persons not working in the food industry with previous FOODSAFE training. This suggests that untrained food workers are learning some food safety knowledge from their place of employment that is practiced at home. However, few participants in any group reported using a thermometer to check the internal temperature of foods at home, and even fewer monitored the temperature of their home refrigerator. In this study, between 23% (of home-trained) and 55% (trained food worker) of participants stated they had a thermometer in their refrigerator. This is, however, more than double the number of persons having thermometers in their refrigerator in a domestic survey in the US (11%).⁵⁹ Further, more participants in this survey had their refrigerator set at the correct temperature when compared to those in the US survey (70%).⁵⁹ This may be an indication that exposure to food safety training improves home practices. Unfortunately, of those people who were at home when contacted, and then asked to check the temperature of their refrigerator, 10% gave an answer that suggested they did not know how to read their refrigerator thermometer.

During the period of this survey, two health authorities (Fraser and Vancouver Coastal) also conducted a home-based survey of food safety practices. When we compared respondents of both surveys, we found that the groups in our survey scored higher than the general population. When data was pooled from both surveys into 2 groups (those with any food

safety training and those without) we were able to show that food safety training does improve food safety behaviors at home ($p < 0.0001$). These results suggest that food safety training is also of benefit to the general population.

There were several limitations to this study. By blinding the results to protect confidentiality of the participants, we were only able to ask people when they last took FOODSAFE, but were unable to verify the actual date of their training, or to compare their initial FOODSAFE exam score to the survey scores. The survey was administered orally in English language only. Persons participating who did not have English as a first language may be disadvantaged. Also, we did not ask participants if English was their first language, which would have been equally valuable as collecting information about ethnicity to stratify responses. As all the responses were gathered by a phone survey, behaviors and attitudes were self-declared and may not truly reflect the actual behaviors and attitudes of the participants. Although every effort was made to select an equal number of participants from trained and untrained groups, significantly more staff (fewer supervisors) in the untrained group took the survey in comparison to the FOODSAFE trained group, where there were a higher proportion of supervisors to staff. This is not surprising as the regulations require the operator (often the supervisor) to have FOODSAFE training. However, this is actually encouraging as it demonstrates the commitment of food service supervisors in BC to have food safety training. Finally, in some statistical analyses, student t-tests were used to identify significant differences among variables initially tested with multivariate analyses (ANOVA). In these tests, where differences were noted in educational background, ethnicity and food premises where food workers were employed there is a probability of increased Type 1 error, or of finding significance where none in truth exists.

Future studies planned include assessing the effectiveness of FOODSAFE refresher training in

improving the scores of food workers who have already received this survey. Retraining was conducted in April/May 2011 (approximately 2 years after this survey), and the survey will be conducted again in January/February 2012 (9 months after retraining). It is hypothesized that knowledge scores on the second phone survey will be higher than on the initial phone survey. Further work assessing the effectiveness of FOODSAFE will ideally include observational studies, to inquire if the food safety principles taught in the course translate into safer food behaviors in the workplace.

Conclusions and Recommendations

Based on the survey findings, it is clear that food safety training (FOODSAFE) slowly declines over time. Of concern, although the decline is gradual, much of the knowledge is lost within a few months to a year after the initial training, as evidenced by average scores of 70%, the minimum score for a passing grade on the FOODSAFE exam, from persons taking the phone survey one year after their FOODSAFE training. FOODSAFE certificates should have an expiry date, and periodic retraining should be implemented for food workers of food service establishment to ensure they do not forget important principles of food safety. The data would suggest that refresher retraining be taken before 5 years has elapsed from the date of initial certification.

Food safety training does confer a better understanding of food safety principles in the workplace and at home, as demonstrated by the better knowledge, practice and attitude scores of FOODSAFE trained persons when compared to untrained persons, both at work and at home. We also recommend that all food workers take FOODSAFE or an equivalent food safety course, and that members of the general public are encouraged to take FOODSAFE or an equivalent food safety course to improve food safety knowledge and practices at home.

Specific recommendations based on this research are:

1. Holders of all existing FOODSAFE certificates who received training 3 or more years ago take a refresher FOODSAFE course.
2. FOODSAFE certificates should be issued with a date of certification and an expiry date.
3. All food workers in food service establishments should take FOODSAFE or an equivalent food safety training program.
4. Legislation should be revised to include FOODSAFE or equivalent training for food workers at other premises not currently covered under the Food Premises Regulation. These would include processing plants such as bakeries, meat and fish plants, and other premises making ready-to-eat products.
5. There should be a higher priority placed on training of staff, in addition to supervisors.
6. The food industry should place a higher priority on "on-the job training".
7. Resources for training should be prioritized to establishments with higher risk and lower knowledge scores. These include take-out/fast food, food processors/manufacturers, and retail food stores.
8. Linguistically and culturally-sensitive training materials for certain ethnic groups, (South Asian and East Asian) need to be developed

to help improve food-safety knowledge of these food workers. Although FOODSAFE curricula already includes these ethnic translations (Mandarin, Cantonese and Punjabi) further efforts may be necessary to convey food safety messaging to these groups within their place of employment.

9. As the benefits of food safety training include better home food safety practices, strategies for delivering food safety training to the general public should be encouraged.
10. Food safety educators should include explanations of how to read thermometers during food safety campaigns that promote thermometer use.

Additional recommendations include:

11. Industry and government should promote and implement on-the-job food-safety training to reinforce food safety principles learned during FOODSAFE.
12. Effective food worker training should include motivational strategies, such as management support, use of co-worker peer-pressure, and appropriate communication intervention tools (e.g., food safety infosheets).
13. Further research, including observational studies, is needed to assess behaviors and practices at the workplace. This research should also explore how to effectively translate worker food-safety knowledge into safe food-handling.

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Appendix 1 Final version of survey given to food service workers (after coding) conducted by NRG Research Company

Survey A – Currently Working in Food Service Establishment – Test and Control Groups

Indicate: 1- Test Group (FS Training)

2. Control Group (No FS Training)

[FS = FOODSAFE]

1. How many years have you been working in the food service industry? ____
2. What best describes the type of establishment you currently work in:

Read list (1 reply)

- a. Take-out or fast-food restaurant
 - b. Cafeteria style or café with counter service
 - c. Family restaurant
 - d. Ethnic cuisine restaurant
 - e. Fine-dining establishment
 - f. Food processing or manufacturing (e.g., bakery, making cheese or tofu)
 - g. Institutional, like hospitals
 - h. Retail food store
 - i. Volunteer food server at church or community hall
 - j. Other (**specify**) _____
3. What kinds of activities and position do you have at work?

Read list. Check all that apply.

- a. Serve food to customers
- b. Prepare food
- c. Handle cash transactions
- d. Cleaning
- e. Manager, supervise staff, may or may not be involved in food preparation directly.
- f. Owner of the business. May or may not be involved in food preparation directly.

The next part of the survey asks questions about your knowledge and normal practices regarding food and worker safety. Please pick the best possible answer for each question.

4. What is the minimum safe temperature to hold hot foods at? Or, put another way, above what temperature should hot foods be held in the food warmer?

Read codes a-d. 1 reply.

4a=0
4b=5
4c=2
4d=0
4e=0

- a. 50 degrees Celsius
- b. 60 degrees Celsius
- c. 80 degrees Celsius
- d. 100 degrees Celsius
- e. Don't Know

5. When reheating leftovers, what minimum internal temperature should leftovers be re-heated to before serving?

Read codes a-d. 1 reply.

5a=0
5b=2
5c=5
5d=0
5e=0

- a. 100 degrees Celsius
- b. 85 degrees Celsius
- c. 74 degrees Celsius
- d. 60 degrees Celsius
- e. Don't Know

6. When cooling a cooked food that will be stored in the refrigerator, how long do you have to get it to the cold food storage temperature?

Read codes a-d. 1 reply.

6a=0
6b=0
6c=2
6d=2
6e=0

- a. 12 hours or overnight
- b. 8 hours, or cooling down to 60 degrees Celsius in 4 hours and to 4 degrees Celsius in the next 4 hours
- c. 6 hours, cooling down to 60 degrees Celsius in 2 hours and to 4 degrees Celsius in the next 4 hours
- d. 4 hours, cooling down to 60 degrees Celsius in 2 hours and to 4 degrees Celsius in the next 2 hours
- e. Don't Know

7. What is the safest way to cool a large pot of soup?

Read codes a-d. 1 reply.

7a=0
7b=0
7c=5
7d=0
7e=0

- a. Heat the soup to boiling, then place into the freezer and cover it when it stops steaming
- b. Heat the soup to boiling, then place into the refrigerator and cover it when it stops steaming
- c. Heat the soup to boiling, cool the soup to room temperature in an ice bath, cover it, then place into the refrigerator
- d. Heat the soup to boiling, cool the soup at room temperature, measure the temperature with a thermometer and when it reaches 60 degrees Celsius, cover it, then place into the refrigerator
- e. Don't Know

8. The correct way to determine the temperature of cooked food is to:

Read codes a-d. 1 reply.

8a=2
8b=0
8c=0
8d=5
8e=0

- a. Use a thermometer to check the oven temperature
- b. Look to see if steam is rising from the food
- c. Touch the food with your finger
- d. Insert a metal probe thermometer into the centre of the food
- e. Don't Know

9. The "Danger Zone" refers to what range of temperatures?

Read codes a-d. 1 reply.

9a=0
9b=5
9c=0
9d=0
9e=0

- a. 0 to 4 degrees Celsius
- b. 4 to 60 degrees Celsius
- c. 60 to 100 degrees Celsius
- d. Above 100 degrees Celsius
- e. Don't Know

10. What is the best method to clean dishes?

Read codes a-d. 1 reply.

10a=0
10b=5
10c=0
10d=2
10e=0

- a. Sanitize, wash, rinse, air dry
- b. Wash, rinse, sanitize, air dry
- c. Rinse, sanitize, wash, air dry
- d. Wash, sanitize, rinse, air dry
- e. Don't Know

11. To sanitize a food surface, like a cutting board, the correct amount of domestic bleach to water is

Read codes a-d. 1 reply.

11a=5
11b=2
11c=0
11d=0
11e=0

- a. 1 ounce (or 2 tablespoons) of bleach to one gallon of water to equal 200 parts per million
- b. ½ cup of bleach to one gallon of water to equal 1000 parts per million
- c. 1 cup of bleach to one gallon of water to equal 2000 parts per million
- d. Bleach solutions should not be used on food contact surfaces
- e. Don't Know

12. When do you have to wash your hands? **Read and randomize list**

12a to g
Yes=5

- | | |
|--------------------------------|-----------------------|
| a. After going to the bathroom | Yes / No / Don't Know |
| b. After making a sandwich | Yes / No / Don't Know |
| c. After handling raw meat | Yes / No / Don't Know |
| d. After handling money | Yes / No / Don't Know |
| e. After having lunch | Yes / No / Don't Know |
| f. Before using gloves | Yes / No / Don't Know |
| g. After using gloves | Yes / No / Don't Know |

13. Do you have a sink specifically for hand-washing in the kitchen?

Yes
No

14. Does the sink you use to wash your hands have soap, hot water and paper towels available:

Read codes a-e. 1 reply.

- a. All of the time
- b. Most of the time
- c. Some of the time
- d. Rarely; or
- e. Never
- f. Does not apply to me

15. Have you been injured at work?

Yes

No

If yes: Was it one of the following: **Read list. Check all that apply.**

a) cut

b) burn

c) slip, trip or fall on the same level

d) sprain or strain (e.g., back, arm, or hand)

e) Other, please specify _____

I will now read you some statements about how you do things and feel about food safety. Please answer using a scale of 1 to 5 where 1 means you disagree completely, 2 you disagree somewhat, 3 you're undecided, 4 you agree somewhat and 5 you completely agree.

Randomize Q16-26

[Ask Q16, of Test Group only]

16. The WorkSafe safety information in the FOODSAFE course helped to increase your awareness of potential hazards at work.
17. Safe food handling is an important part of your job responsibilities
18. Gloves should be worn by those involved in touching raw foods
19. You have to make sure that prepared food is safe for customers
20. Learning more about food safety is important to you
21. If you go to work when you have diarrhea you might make other people sick
22. Improper storage of foods can be hazardous to health
23. Raw foods should be kept separate from cooked foods
24. Other employees who prepare food wash their hands where you work
25. Foodborne disease is more dangerous for vulnerable groups of people (e.g. children, older people and pregnant women).
26. The temperature of refrigerators should be checked at least once a day

Finally, we would like to ask some more questions about your food handling practices and food safety knowledge at home.

27. Perishable foods must be refrigerated below 4 degrees Celsius or 40 degrees Fahrenheit to:

Read a-d. 1 reply

- | | |
|-------|--|
| 27a=5 | a. Slow down the growth of pathogens |
| 27b=2 | b. Destroy pathogens |
| 27c=0 | c. Keep them separate from non-hazardous, non-perishable foods |
| 27d=0 | d. Improve their flavor |
| 27e=0 | e. Don't Know |

28. Do you use a food thermometer to check if foods have been cooked enough?

- | | |
|-------|-----|
| 28 | Yes |
| Yes=5 | No |

If yes: What foods do you use a food thermometer for?

Read list. Check all that apply.

- | | |
|----------|----------------------|
| 28a to d | a. Turkey |
| Yes=5 | b. Hamburger patties |
| | c. Fish |
| | d. Egg Dishes |

29. What is the recommended final internal temperature for cooking a stuffed turkey or stuffed chicken safely?

Read a-c. 1 Reply

- | | |
|-------|--|
| 29a=5 | a. To 85 degrees Celsius or 185 degrees Fahrenheit |
| 29b=5 | b. To 74 degrees Celsius or 165 degrees Fahrenheit |
| 29c=0 | c. To 71 degrees Celsius or 160 degrees Fahrenheit |
| 29d=0 | d. Don't Know |

30. What is the recommended final internal temperature for cooking foods, for example, red meats like hamburger?

Read a-c. 1 Reply

- | | |
|-------|--|
| 30a=2 | a. To 77 degrees Celsius or 170 degrees Fahrenheit |
| 30b=2 | b. To 74 degrees Celsius or 165 degrees Fahrenheit |
| 30c=5 | c. To 71 degrees Celsius or 160 degrees Fahrenheit |
| 30d=0 | d. Don't Know |

31. Do you keep a thermometer in your refrigerator?

- | | |
|--------|-----------|
| 31 | Yes |
| Yes=5 | No |
| No=0 | Sometimes |
| Some=3 | |

If yes to Q31: Could you please check it and tell me what the temperature is?

Record in either Celsius or Fahrenheit ____C ____F

If sometimes to Q31: Do you know what temperature your refrigerator is at?

Yes (specify) Record in either Celsius or Fahrenheit ___C ___F

No

32. After you prepare a family dinner, how long do you generally leave the leftovers out on the counter?

Read a-d. 1 Reply

32a=5
32b=2
32c=0
32d=5

- a. Usually for about 2 hours before putting in the refrigerator
- b. Usually for about 4 hours before putting in the refrigerator
- c. Usually it's longer than 4 hours or overnight before putting in the refrigerator
- d. Leftovers are always thrown out.

33. What is the best way to thaw frozen foods, for example, red meats, like hamburger?

Read a-e. 1 Reply

33a=0
33b=2
33c=0
33d=5
33e=2
33f=0

- a. Under warm water in the sink
- b. Under cold running water in the sink
- c. On a counter overnight
- d. In the refrigerator
- e. In the microwave
- f. Don't Know

The next few questions are about the way you usually do things. The choices for each question are

- never,
- rarely,
- some of the time,
- most of the time,
- always, or
- does not apply to me

34. I wash my hands with soap and warm running water before preparing food.
Is your response

- 1= never,
- 2= rarely,
- 3 =some of the time,
- 4= most of the time,
- 5=always, or
- 6= does not apply to me

35. After playing with a pet and before getting a snack, I wash my hands with soap and warm running water.

Read scale if necessary.

- 1= never,
- 2= rarely,
- 3 =some of the time,

- 4= most of the time,
- 5=always, or
- 6= does not apply to me?

36. After cutting raw meat, chicken, or seafood, I wash all items that came in contact with the raw food (e.g., cutting board, knife, countertop) with hot, soapy water before I continue to cook.

Read scale if necessary.

- 1= never,
- 2= rarely,
- 3 =some of the time,
- 4= most of the time,
- 5=always, or
- 6= does not apply to me?

37. I thoroughly rinse fresh vegetables under running water before eating them. Is your response

Read scale if necessary.

- 1= never,
- 2= rarely,
- 3 =some of the time,
- 4= most of the time,
- 5=always, or
- 6= does not apply to me?

Before we finish, I'd like to ask you a few questions about yourself that will help us understand the results of this survey.

[Ask Q38, of Test Group only]

38. a. How many times have you taken the FOODSAFE course? ____

b. In what year were you FOODSAFE certified? Note; If took FOODSAFE more than once, record year of most recent certificate. _____

c. Why did you take the FOODSAFE course? **Probe. Record Verbatim**

39. Have you received any other food safety training, either on the job or in school?

- Yes
- No

40. What best describes your highest level of education?

Read a-d. 1 reply.

- a. Some high school
- b. Completed high school
- c. Some or completed College or trade school

[If yes or maybe:]

If you wish to participate we can take your name and you may be contacted in a few months. After the retraining you will be asked the same questions in this survey six months to a year after the retraining."

Confirm name: _____

Telephone number: _____

And if you win 1 of the 5 IPODS in the draw, can we contact you at this same number?

If no, record different number: _____

End: If you have any questions about this survey, you are welcome to contact the Principal Investigator, Dr. Ray Copes (604.660.6628). For further information you can contact the Research Associate, Lorraine McIntyre at 604.775.0763, or lorraine.mcintyre@bccdc.ca .

If No to Q44: Before I let you go, I would just like to confirm your name and telephone number to enter you into the draw for one of the five IPODs

Confirm name: _____

Telephone number: _____

Read to all: You will be sent a summary of the study results in the mail in a few months. These will also be posted onto the BCCDC website at www.bccdc.ca . If you would like a copy mailed to you, could I please confirm your mailing address:

No, don't mail

Street: _____

City: _____

PC: _____

This concludes the survey. Thank you for your time.

Appendix 2 – Home Survey to FOODSAFE trained participants

Feb 2, 2009 – FINAL Questionnaire

Survey B – Home Food Preparation – Certified FOODSAFE Survey Participant

1. Do you prepare food for yourself or your family at home or as a volunteer?

Yes

No >> *thank them for their participation, this concludes the survey*

Good, we would like to ask you a few questions about your food handling knowledge and practices in the home.

2. The reason perishable foods must be refrigerated below 4 degrees Celcius or 40 degrees Fahrenheit is to: **Read a-d. 1 reply**

- a. Slow down the growth of pathogens
- b. Destroy pathogens
- c. Keep them separate from non-hazardous, non-perishable foods
- d. Improve their flavor
- e. Don't Know

3. Do you use a food thermometer to check if foods have been cooked enough?

Yes

No

If yes: What foods do you use a food thermometer for? **Read list. Check all that apply.**

- a. Turkey
- b. Hamburger patties
- c. Roasts
- d. Fish
- e. Egg Dishes

4. What is the recommended final internal temperature for cooking a stuffed turkey or stuffed chicken safely? **Read a-c. 1 Reply**

- a. To 85 degrees Celsius or 185 degrees Fahrenheit
- b. To 74 degrees Celsius or 165 degrees Fahrenheit
- c. To 71 degrees Celsius or 160 degrees Fahrenheit
- d. Don't Know

5. What is the recommended final internal temperature for cooking foods, for example, red meats like hamburger? **Read a-c. 1 Reply**

- a. To 77 degrees Celsius or 170 degrees Fahrenheit
- b. To 74 degrees Celsius or 165 degrees Fahrenheit
- c. To 71 degrees Celsius or 160 degrees Fahrenheit

d. Don't Know

6. Do you keep a thermometer in your refrigerator?

Yes

No

Sometimes

If yes to Q6: Could you please check it and tell me what the temperature is?

Record in either Celsius or Fahrenheit ____ C ___F

If sometimes to Q6: Do you know what temperature your refrigerator is at?

Yes (specify) Record in either Celsius or Fahrenheit ____ C ___F

No

7. After you prepare a family dinner, how long do you generally leave the leftovers out on the counter? **Read a-d. 1 Reply**

- a. Usually for about 2 hours before putting in the refrigerator
- b. Usually for about 4 hours before putting in the refrigerator
- c. Usually it's longer than 4 hours or overnight before putting in the refrigerator
- d. Leftovers are always thrown out.

8. What is the best way to thaw frozen foods, for example, red meats, like hamburger?

Read a-e. 1 Reply

- a. Under warm water in the sink
- b. Under cold running water in the sink
- c. On a counter overnight
- d. In the refrigerator
- e. In the microwave
- f. Don't know

9. The "Danger Zone" refers to what range of temperatures? **Read a-d. 1 Reply**

- a. 0 to 4 degrees Celsius
- b. 4 to 60 degrees Celsius
- c. 60 to 100 degrees Celsius
- d. Above 100 degrees Celsius
- e. Don't Know

The next few questions are about the way you usually do things. The choices for each question are:

- never,
- rarely,
- some of the time,
- most of the time,
- always, or
- does not apply to me

10. I wash my hands with soap and warm running water before preparing food. Is your response.

Read scale if necessary.

- 1= never,
- 2= rarely,
- 3 =some of the time,
- 4= most of the time,
- 5=always, or
- 6= does not apply to me

11. After playing with a pet and before getting a snack, I wash my hands with soap and warm running water. **Read scale if necessary.**

- 1= never,
- 2= rarely,
- 3 =some of the time,
- 4= most of the time,
- 5=always, or
- 6= does not apply to me?

12. After cutting raw meat, chicken, or seafood, I wash all items that came in contact with the raw food (e.g., cutting board, knife, countertop) with hot, soapy water before I continue to cook. **Read scale if necessary.**

- 1= never,
- 2= rarely,
- 3 =some of the time,
- 4= most of the time,
- 5=always, or
- 6= does not apply to me?

13. I thoroughly rinse fresh vegetables under running water before eating them. **Read scale if necessary.**

- 1= never,
- 2= rarely,
- 3 =some of the time,
- 4= most of the time,
- 5=always, or
- 6= does not apply to me?

Before we finish, I'd like to ask you a few questions about yourself that will help us understand the results of this survey.

14. How many times have you taken the FOODSAFE course? ____

a. In what year were you FOODSAFE certified? Note; If took FOODSAFE more than once, record year of most recent certificate. _____

If you have any questions about this survey, you are welcome to contact the Principal Investigator, Dr. Ray Copes (604.660.6628). For further information you can contact the Research Associate, Lorraine McIntyre at 604.775.0763, or lorraine.mcintyre@bccdc.ca .

Before I let you go, I would just like to confirm your name and telephone number to enter you into the draw for one of the five IPODs

Confirm name: _____

Telephone number: _____

You will be sent a summary of the study results in the mail in a few months. These will also be posted onto the BCCDC website at www.bccdc.ca . If you would like a copy mailed to you, could I please confirm your mailing address:

No, don't mail

Street: _____

City: _____

PC: _____

This concludes the survey. Thank-you for your time.

Appendix 3 - Letter and Flyer of Results of the 2009 FOODSAFE © Knowledge Retention Study mailed to survey participants November 2009.

November 6, 2009

Dear Food Safety Colleague!

Earlier this year you were contacted about the FOODSAFE Knowledge Retention Survey. The survey was conducted in February and March 2009, and included over 1000 participants. The purpose of the survey was to find out if FOODSAFE graduates could recall food safety knowledge after taking the course (and to find out if knowledge declines over time). The survey was also given to persons who hadn't taken the FOODSAFE course to see if the workplace affected knowledge, attitudes and practices in food workers. Since some FOODSAFE graduates no longer work in the food industry, the survey was also designed to capture information about food safety at home.

What did we find out? Enclosed with this letter is a flyer that describes the survey results that have been analyzed so far. We discovered that, as we expected, knowledge retention of food safety principles does decline over time. FOODSAFE trained workers generally scored higher than untrained workers, so food safety knowledge was not solely dependant on workplace. Where people worked also made a difference with overall scores being higher in certain types of workplaces - see the flyer for more details.

We still have more data to analyze, such as the differences in home based knowledge between the groups. We will be posting this flyer and other information onto our web-site. You can find more information about this study posted under the Food and Your Health page at <http://www.bccdc.ca>

Thank you for your interest and participation in this study. Should you have any questions you may contact me at 604.707.2458.

Yours truly,



Lorraine McIntyre, MSc
Food Safety Specialist
Food Protection Services, Environmental Health



Results of the 2009 FOODSAFE® Knowledge Retention Study

A phone survey of FOODSAFE graduates was conducted in the spring of 2009. Questions were asked about food handler knowledge, practices and attitudes of 500 FOODSAFE graduates working in the food services industry, 395 FOODSAFE graduates no longer working in the food services industry and 201 food workers who had not taken the FOODSAFE course before.

The survey purpose was to find out -

- if the ability of FOODSAFE graduates to remember principles of food safety from the course declined over time,

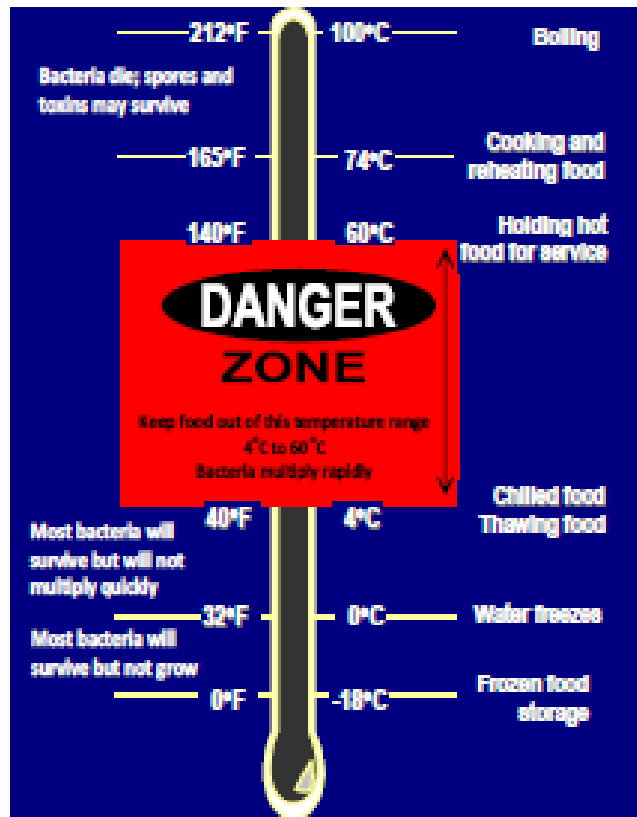
The Danger Zone – where bacteria grow – is between 4°C and 60°C

- if the workplace influences food safety knowledge and attitudes in workers, and
- if trained (FOODSAFE) food service workers have better food safety practices at home

What did we find?

FOODSAFE graduates did have significantly higher scores than untrained workers, but this knowledge decreased over time. After only 6 months, FOODSAFE graduates had forgotten key food safety principles and on average, most scored less than 70%. However, FOODSAFE graduates had better attitudes and practices in comparison to untrained food workers, and also had better practices at home. Where people worked also made a difference, food workers surveyed from institutions (for e.g. hospitals) and caterers had higher food safety knowledge scores than food workers surveyed from fast food premises, take-outs and resorts. Knowledge scores increased with age,

years of experience and for supervisors, although not for university educated food workers.



Key messages for food safety

TEMPERATURE CONTROL

1. The temperature range that bacteria can grow in is called the "The Danger Zone" – this is between 4°C (40°F) and 60°C (140°F). To minimize bacterial growth keep foods refrigerated below 4°C (40°F) and held hot above 60°C (140°F).

2. Check the Temperature!



Always use a thermometer at work and at home to check the internal temperature of foods and the refrigerator. In this survey, only 63% of trained food workers and 50% of untrained food workers would use a food thermometer to check if foods were cooked enough. 49 to 55% of untrained and trained food workers would take the internal temperature of a hamburger patty – remember, *Your Burger's Done at 71°C!*



3. Cooling. To keep foods out of the danger zone, cool after cooking to 20°C within 2 hrs, then to 4°C within 4 hrs. Using an ice bath is a good idea, or transfer foods from big pots into smaller shallow pans, so the food cools faster. Measure the internal temperature of the food.

4. Reheating. To properly reheat foods, they should be cooked to an internal temperature of at least 74°C (165°F).

HAND WASHING AND HYGIENE



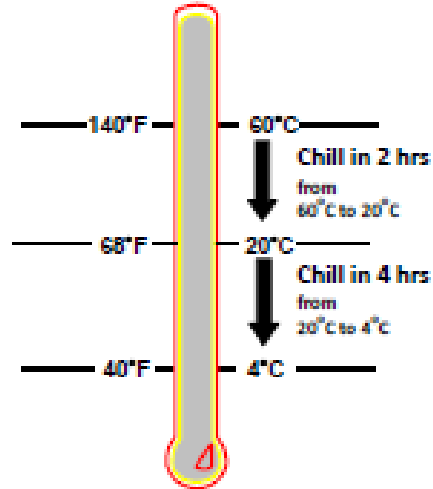
All of the food workers in the survey correctly answered that they would wash their hands after going to the bathroom or handling raw meat. But not

everyone would wash hands after using gloves, handling money, making a sandwich, or at home after handling their pet. Frequent hand-washing is important to remove soil and germs that may spread illness and contaminate food. Use regular soap (NOT antimicrobial soap).

DON'T GO TO WORK SICK!

77% of untrained food workers (and 90% of trained food workers) agreed with the statement "If you go to work with diarrhea you might make other people sick".

FOOD COOLING PROCEDURE



SANITIZING

The correct way to wash dishes is to **WASH → RINSE → SANITIZE → AIR DRY**

The correct amount of household bleach to sanitize surfaces is one ounce per gallon (or 5 mL per litre) to achieve at least 200ppm (the desired range is between 100 and 200ppm, household bleach can vary between 3.25% and 5%). Only 64% of trained workers and 55% of untrained workers answered this correctly!



Why is food safety important?

No one wants to get sick after eating food. Food safety is important to control hazards in food. In reported outbreaks, food handlers were linked to over 16,000 cases of illness between 2000 and 2006, usually due to poor hygiene or poor food handling practices

(Greig et al 2007; JFP 70(7):1752-61).

Understanding potential hazards in food, and how to control them is one way food handlers can prevent illness.

For more information about this study go to <http://www.bccdc.ca> or call Food Protection Services, BCCDC at 604.707.2440

Appendix 4 – Percentage of best and second best answer choices made by food service workers on knowledge questions *

Knowledge Questions	Knowledge Answers (%)			
	FS Trained		Untrained	
	Total % Correct	Best % 2 nd best %	Total % Correct	Best % 2 nd best %
1. What is the minimum safe temperature to hold hot foods?	71	42.7 28.2	61	30.6 31.1
2. When reheating leftovers, what minimum internal temperature should leftovers be reheated to before serving?	58	31.7 26.3	57	30.1 27.6
3. When cooling a cooked food that will be stored in the refrigerator, how long do you have to get it to the cold food storage temperature?	81	80.8	72	71.8
4. What is the safest way to cool a large pot of soup?	55	54.7	26	26.1
5. The correct way to determine the temperature of cooked food is to?	92	91.9 6.2	88	87.4 6.5
6. The "Danger Zone" refers to what range of temperatures?	61	61.1	43	43.2
7. What is the best way to clean dishes?	85	55.9 28.7	81	41.2 40
8. To sanitize a food surface, like a cutting board, the correct amount of domestic bleach to water is?	64	52.7 13.4	55	40.2 14.6
9. Reason why perishable foods must be refrigerated below 4 degrees Celcius or 40 degrees Fahrenheit?	79	67.7 11.0	72	60.3 11.6
10. What is the recommended final internal temperature for cooking a stuffed turkey or stuffed chicken safely?	74	74.7	68	67.3
11. What is the recommended final internal temperature for cooking foods, for example, red meats like hamburger?	93	21.4 71.5	93	24.1 68.8
12. After you prepare a family dinner, how long do you generally leave the leftovers out on the counter?	97	93.6 3.4	98	90.0 8.0
13. What is the best way to thaw frozen foods, for example, red meats like hamburger?	95	75.7 19.2	85	58.8 27.6

* not all questions had a 2nd best answer