



Food Safety Knowledge among Restaurant Food Handlers in *Neuchâtel, Switzerland*

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ABSTRACT

Few data have been published on restaurant food handler food safety knowledge in Switzerland. The objective of this study was to identify gaps in food safety knowledge among restaurant food handlers in Neuchâtel, Switzerland. Between November 2010 and January 2011, an oral 54-question survey, including 46 knowledge questions, was administered in French and English to 100 food handlers in 100 restaurants. Restaurants were selected if the local food safety officers believed the restaurant was likely to participate. The mean knowledge score of the participating food handlers was 71%. Bivariate analysis revealed restaurant cuisine as the only characteristic significantly associated with knowledge score ($P < 0.05$). None of the food handlers knew the correct temperatures for cooking chicken and holding potentially hazardous hot foods, the time and temperature recommendations for holding potentially hazardous cold foods without temperature control, and the range of temperatures for pathogen growth. We observed substantial food safety knowledge gaps among restaurant food handlers in Neuchâtel, Switzerland that may place restaurant consumers at risk for food poisoning. Data from this study demonstrate that time and temperature issues and understanding the consequences of consuming uncooked cooked meat and poultry should be priorities for food handler education.

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INTRODUCTION

Foodborne diseases pose a significant public health burden worldwide. The World Health Organization estimates that foodborne and waterborne illnesses, combined, cause 2.2 million deaths, including deaths of 1.9 million children, annually (17, 18). In Europe, salmonellosis and campylobacteriosis are important causes of morbidity and mortality. Eating establishments are a major source of foodborne outbreaks in both developing and developed countries. For example, in the United States, 41% of the 1,097 outbreaks reported during 2007 to the Centers for Disease Control and Prevention were associated with restaurants or delicatessens (1). Restaurants are therefore an important venue to consider in the prevention of foodborne diseases.

Few studies have been published on food safety knowledge of restaurant food handlers in Europe, and we are aware of no restaurant food handler knowledge studies in Switzerland. In the United Kingdom, a survey of food handlers' hygiene knowledge revealed that only 58% of the food handlers knew that food poisoning can be caused by cooked rice, and several food handlers did not know the temperature required to control the growth of bacteria (15). In the United States, a study assessing food safety knowledge among restaurant food handlers in Chicago, Illinois during 2009 revealed important knowledge gaps in areas including temperatures for cooking, holding, and storing foods and hygiene practices (11). Another restaurant food handler knowledge study performed in two counties in Oregon during 2000, demonstrated that the average scores was 68% in areas concerning food safety, correct hand washing and hygiene (2).

We sought to identify food safety knowledge gaps among Neuchâtel restaurant food handlers and risk factors associated with food safety knowledge in order to provide insight that may inform future educational efforts to prevent foodborne diseases.

MATERIALS AND METHODS

Sample

A list of 1,012 food establishments was obtained from the Service de la consommation et des affaires vétérinaires (SCAV) in the canton of Neuchâtel. To ensure feasibility, five food safety officers of the canton, each in charge of a district, selected a sample of 100 restaurants based on their expected compliance to participate in the study. Expectation of compliance was based on absence of history of conflict between the restaurant and SCAV. Restaurant managers were approached for verbal approval to interview food handlers at each restaurant. A signed consent form was obtained from each participant and confidentiality of food handler and restaurant name was assured. For each restaurant, the main chef was asked to complete the survey. When the main chef was not available, any available volunteering food handler was chosen. The food safety officers planned to exclude food handlers from the study if they did not speak either French or English or were younger than 18 years of age. However, none of the food handlers were excluded.

Instrument development and data collection

The survey provided for this study was pilot-tested, developed, and employed by the University of Illinois at Chicago School of Public Health (4, 10, 11). Questions and edits were added to ensure relevance to the local culture. The survey was administered orally, and responses were recorded on questionnaires by the interviewers. The survey included 53 questions that obtained information on restaurant and food handler demographics, food handler food safety knowledge, behaviors, and personal hygiene. The knowledge questions were in true-false, multiple-choice, and open-ended format. The primary subject areas in the questionnaire included appropriate temperatures for cooking, heating, and cooling foods, cross contamination, and behavioral questions such as working while ill and hand hygiene practices. Participants were also asked whether they had ever attended a food safety training course and the number of years of food handling experience. Data on restaurant characteristics such as type of cuisine and average entrée price were also collected. Restaurants were categorized by size: small (less than 10 tables or less than 40 seats [covers]), medium (10 to 30 tables or 40 to 120 seats [covers]), and large (more than 30 tables or more than 120 seats [covers]). We also asked three menu-related questions to explore the prevalence of availability of high-risk foods (unpasteurized cheese, raw meat, and raw seafood) and, for cheese, whether consumers were informed that it was unpasteurized. Approval from the University of Illinois at Chicago Institutional Review Board for the Protection of Human Subjects was received for data analysis before the initiation of the study.

Statistical methods

Statistical analysis was performed using SAS 9.2 for Windows (SAS, Chicago, IL). The overall mean knowledge score was determined by the sum of correct answers to 46 knowledge questions. Bivariate analysis was performed to identify potential food handler or restaurant variables that may be associated with the mean knowledge scores. T-tests and Analysis of Variance (ANOVA) models were performed to compare the mean knowledge scores between categorical variables with two or more groups, such as gender or age.

RESULTS

Between November 2010 and February 2011, 100 Neuchâtel restaurants were approached to participate in the study, and all consented (participation rate 100%). The largest proportion of the participating restaurants (66%) seated 10 to 30 tables, had informal dining (72%), served French cuisine (50%), and had an average entrée price between 10 and 20 Swiss Francs (CHF) (57%). Sixty-three restaurants (63%) gave food safety training periodically to their employees (Table 1).

The mean age of the participants was 43 years (range 18 to 65 years). More males (67%) participated than females (33%) (Table 2). Among the 100 participating food handlers, 91 (91%) food handlers were born in European countries and 93 (93%) stated that French was their main language. Eighty-nine (89%) had completed at least some college, university, or technical school. The mean number of years as a

TABLE 1. Characteristics of participating Neuchâtel restaurants (N = 100)

CHARACTERISTIC	FREQUENCIES	BIVARIATE ANALYSIS	
	N (%)	SCORE (%)	P-VALUE
RESTAURANT SIZE			
Small (≤ 9 tables or ≤ 39 covers)	5 (5)	32 (70)	0.4228
Medium (10–30 tables or 40–120 covers)	66 (66)	32 (70)	
Large (≥ 30 tables or seating ≥ 120)	29 (29)	33 (72)	
FOOD SERVICE STYLE			
Fast Food	3 (3)	31 (67)	0.1440
Informal (eating house, bar, pizzeria, or similar)	72 (72)	33 (72)	
Formal	25 (25)	32 (70)	
CUISINE			
French	50 (50)	34 (74)	0.0111
Italian	8 (8)	33 (72)	
Local	8 (8)	31 (67)	
Standard/International	22 (22)	31 (67)	
Other (Brazilian, Chinese, French Italian, Indian, and Thai sandwiches)	12 (12)	32 (70)	
FOOD SPECIALIZATION			
Meat or poultry	26 (26)	33 (72)	0.4115
Seafood	1 (1)	28 (61)	
No specialization but meat, poultry, and/or seafood served	68 (68)	33 (72)	
None of the above	5 (5)	32 (70)	
RESTAURANT LOCATED INSIDE A...			
Hotel or other lodging	19 (19)	33 (72)	0.1759
None of the above (e.g., self-standing structure)	81 (81)	32 (70)	
CHAIN OR INDEPENDENT			
Chain	10 (10)	32 (70)	0.4262
Independent	90 (90)	33 (72)	
AVERAGE ENTRÉE PRICE (SWISS FRANC)			
≤ 10 CHF	40 (40)	33 (72)	0.7175
≥ 11 CHF but ≤ 20 CHF	59 (59)	33 (72)	
≥ 21 CHF	1 (1)	34 (74)	

TABLE 1. Characteristics of participating Neuchâtel restaurants (N = 100) (cont)

CHARACTERISTIC	FREQUENCIES	BIVARIATE ANALYSIS	
	N (%)	SCORE (%)	P-VALUE
DO EMPLOYEES RECEIVE PERIODIC FOOD SAFETY TRAINING?			
Yes, internal	63 (63)	33 (74)	0.1026
Yes, external	3 (3)	32 (70)	
No	31 (31)	32 (70)	
Unknown	3 (3)	32 (70)	
DOES THE ENGLISH VERSION OF MENU INCLUDE UNCOOKED (RAW) CHEESE?			
Yes	3 (17)	--	--
No	15 (83)	--	--
IF THE ENGLISH VERSION OF MENU INCLUDES UNCOOKED (RAW) CHEESE, DOES IT SPECIFY CHEESE AS UNPASTERIZED (RAW)?			
Yes	0 (0)	--	--
No	3 (3)	--	--
IS STEAK TARTAR LISTED ON THE MENU?			
Yes	48 (48)	--	--
No	80 (80)	--	--
RAW SEAFOOD LISTED ON THE MENU?			
Yes	20 (20)	--	--
No	80 (80)	--	--
IF RAW SEAFOOD IS LISTED ON MENU, IS THERE A WARNING ABOUT CONSUMING RAW SEAFOOD?			
Yes, on French language menu	1 (5)	--	--
Yes, on English language menu	0 (0)	--	--
No	19 (95)	--	--

TABLE 2. Characteristics of participating Neuchâtel food handlers (N = 100)

CHARACTERISTIC	FREQUENCIES	BIVARIATE ANALYSIS	
	N (%)	SCORE (%)	P-VALUE
AGE			
18 – 29 years	11 (11)	33 (72)	0.5916
30 – 39 years	24 (24)	32 (70)	
40 – 49 years	32 (32)	33 (72)	
≥ 50 years	33 (33)	33 (72)	
GENDER			
Males (Overall)	67 (67)	33 (72)	0.4755
Males (French language)	64 (96)		
Males (Other language)	3 (4)		
Females (Overall)	33 (33)	33 (72)	
Females (French language)	29 (88)		
Females (Other language)	4 (12)		
COUNTRY OF BIRTH			
Switzerland	46 (46)	33 (72)	0.6959
France	34 (34)	32 (70)	
Other (Belgium, Cambodia, Croatia, Czech Republic, Italy, Pakistan, Portugal, Spain, Sri Lanka, Thailand, and Turkey)	20 (20)	33 (72)	
EDUCATION			
Higher than primary or elementary school	4 (4)	34 (74)	0.6398
Not more than secondary or high school	7 (7)	32 (70)	
Not more than some college or university or technical school	3 (3)	32 (70)	
A technical school degree obtained	73 (73)	33 (72)	
A university of college degree obtained	13 (13)	34 (74)	
LANGUAGES SPOKEN			
French	93 (93)	33 (72)	0.3187
Other (Chinese, Czech, German, Italian, Portuguese, Tamil)	7 (7)	34 (74)	

TABLE 2. Characteristics of participating Neuchâtel food handlers (N = 100) (cont)

CHARACTERISTIC	FREQUENCIES	BIVARIATE ANALYSIS	
	N (%)	SCORE (%)	P-VALUE
LEARNING PREFERENCE			
By illustrations	41 (41)	--	--
By listening	21 (21)	--	--
By reading	30 (30)	--	--
Other	8 (8)	--	--
PREFERENCE OF EDUCATIONAL MATERIAL			
Educational brochure	48 (48)	--	--
Educational comic book	51 (51)	--	--
Not sure	1 (1)	--	--
ATTENDED A FOOD SAFETY COURSE			
Yes, and in charge of food safety at the current restaurant	72 (72)	33 (72)	0.3857
Yes, but not in charge of food safety at the current restaurant	7 (7)	32 (70)	
No	21 (21)	32 (70)	

food handler in a restaurant was 21 (range 1 – 52 years). Seventy-two percent of the food handlers had received a certificate that included food safety training and were in charge of food safety in their respective restaurants.

Eighteen (18%) restaurants served raw (unpasteurized) cheese. Among these, only three (17%) had an English version of the menu available to the restaurant patrons and none of the 18 menus specified that raw cheese was served. Forty-eight (48%) restaurants served steak tartar. Among the 18 (18%) restaurants that served raw seafood, only one (0.06%) listed a warning on the menu to patrons concerning the dangers of consuming raw seafood (*Table 1*).

Identifying knowledge gaps

Overall, the mean knowledge score was 32.7 (71%) out of a possible 46 points (range: 23.0 [50%] to 37.0 [80%]). No one scored above 37 points. Bivariate analysis revealed that restaurant cuisine was the only characteristic significantly associated with the knowledge score. Restaurants serving primarily French cuisine had a significantly higher knowledge score than those that served Italian, local, standard/international, and other types of cuisines (75% versus 72%, 67%, 67%, and 70%, respectively; $P < 0.05$). Larger-sized restaurants had slightly higher knowledge scores than restaurants that were small or medium-sized (72% versus 70% and 70%, respectively). Restaurants

with an average entrée price of more than 21 CHF had a slightly higher knowledge score than those that had an average entrée price less than 10 CHF or entrée price between 11 and 20 CHF (74% versus 72% and 72%, respectively).

Regarding food handler characteristics, there was no difference in the knowledge scores between males and females (72% for both). Food handlers primarily speaking French had a slightly lower knowledge score than those who spoke other languages (72% versus 74%). Food handlers who had attended a food safety training course and were in charge of their restaurant had only a slightly higher score than other food handlers (72% versus 71%).

Substantial food safety knowledge gaps were seen concerning adequate temperatures required for cooking, cooling, and holding foods, hygiene, and cross-contamination (*Table 3*). None of the food handlers knew the range of temperatures at which germs proliferate or the safe minimum internal temperature to cook chicken. Similarly, none of the food handlers knew the temperature to hold potentially hazardous hot food such as cooked rice or the required number of hours to hold potentially hazardous hot or cold food when there is no temperature control. Only forty-three (43%) food handlers knew the holding temperature for potentially hazardous cold food such as cooked rice.

TABLE 3. Frequencies of correct responses to knowledge questions asked of Neuchâtel restaurant food handlers overall, 2010 (N = 100)

QUESTIONS (ANSWER)	FORMAT	N (% CORRECT)
TIME AND TEMPERATURE		
To properly cook chicken, its internal temperature needs to reach what temperature for at least 15 seconds? (74°C or 165°F)	Open/ended	0 (0%)
Potentially hazardous hot food such as cooked rice must be held at an internal temperature of ____ or higher. (57°C or 135°F)	Open/ended	0 (0%)
If you have been holding potentially hazardous hot food at the correct temperature or higher, you can hold it without temperature control for up to how many hours? (4 hours)	Open/ended	0 (0%)
Potentially hazardous cold food such as homemade mayonnaise or sauce that has been properly refrigerated can be held without temperature control if it does not exceed ____ for ____ hours. (21°C or 74°C ; 4 hours)	Open/ended	0 (0%)
Germs that make people sick grow well between which temperatures? Maximum (57°C or 135°F)	Open/ended	2 (2%)
Germs that make people sick grow well between which temperatures? Minimum (5°C or 41°F)	Open/ended	11 (11%)
Hamburger and other ground beef mixtures such as meatloaf should be cooked to at least what temperatures on a meat thermometer? (68°C or 155°F)	Open/ended	2 (2%)
In which case can rice that was completely cooked make people sick? If it was held at 50°C for 6 hours. (False)	True/False	19 (19.0)
Potentially hazardous cold food such as cooked rice must be held at the correct temperature of ____ or lower. (5°C or 41°F)	Open/ended	43 (43%)
A pot of thin food like vegetable broth will take longer to cool than a pot of thick food like melted cheese if they were both heated to 57°C when they began to cool. (False)	True/False	61 (61%)
If the hot food reached a temperature of 57°C and then was not cooled down to at least 21°C within 2 hours, it should be either thrown away or reheated and then cooled again. (True)	True/False	62 (62%)
In order to check the temperatures correctly, where should you insert a meat thermometer? (Into the thickest part of the meat)	Multiple-choice	92 (92%)
What kind of thermometer is most suitable to check the temperature of chicken breast? (A thermometer with a metal probe)	Multiple-choice	92 (92%)
If the hot food reached a temperature of 57°C, any germs that may have been food are killed and therefore it can be held at room temperature for 8 to 10 hours. (False)	True/False	96 (96%)
Chilled foods should be stored at 55°F (13°C) maximum (False)	True/False	98 (98%)

TABLE 3. Frequencies of correct responses to knowledge questions asked of Neuchâtel restaurant food handlers overall, 2010 (N = 100) (cont)

QUESTIONS (ANSWER)	FORMAT	N (% CORRECT)
HAND WASHING STEPS		
Is it better to wet your hands with warm or cold water? (<i>Warm</i>)	Multiple-choice	89 (89%)
About how many seconds should you lather your hands with soap? (<i>10 or more seconds</i>)	Open/ended	97 (97%)
On what should you dry your hands? (<i>Paper towel, Air dryer</i>)	Multiple-choice	88 (88%)
Should you wash your hands carefully if you use spatula or tongs to handle food? (<i>Yes</i>)	Yes/No	43 (43%)
Should you wash your hands carefully if you use disposable gloves to handle food? (<i>Yes</i>)	Yes/No	80 (80%)
Should you wash your hands carefully if you use food paper to handle food? (<i>Yes</i>)	Yes/No	89 (89%)
HYGIENE		
If you are ill with diarrhea, it is okay to work handling raw food as long as that food will be cooked? (<i>False</i>)	True/False	88 (88%)
You may work handling ready-to-eat food like sandwiches or salad on a day when you have had vomiting or diarrhea as long as you are not very ill. (<i>False</i>)	True/False	93 (93%)
Is it okay to put ice in a glass by scooping the glass into ice? (<i>No</i>)	Yes/No	96 (96%)
Is it okay to put ice in a glass by using an ice scoop? (<i>Yes</i>)	Yes/No	98 (98%)
Is it okay to put ice in a glass by using tongs? (<i>Yes</i>)	Yes/No	100 (100%)
Is it okay to put ice in a glass by picking up ice with your bare hands? (<i>No</i>)	Yes/No	100 (100%)
While at work, it is not necessary to wash your hands if you have urinated without defecating. (<i>False</i>)	True/False	98 (98%)
Gloves used to handle ready-to-eat food must be disposed of if the food-handling process is interrupted. (<i>True</i>)	True/False	100 (100%)
CLEANING AND SANITIZING		
The difference between cleaning and sanitizing is: (<i>Cleaning means removing food or other dirt from a surface, whereas sanitizing means reducing the amount of germs on a clean surface in order to reach the appropriate safety level</i>)	Multiple-choice	96 (96%)

TABLE 3. Frequencies of correct responses to knowledge questions asked of Neuchâtel restaurant food handlers overall, 2010 (N = 100) (cont)

QUESTIONS (ANSWER)	FORMAT	N (% CORRECT)
OTHER		
Please respond if it is true that if not completely cooked, these foods could cause hospitalization or even death: Raw Beef (<i>True</i>)	True/False	7 (7%)
It is not a safe food practice to transfer a large pot of hot soup into smaller containers and then place those smaller containers in a refrigerator to cool. That would make the refrigerator too hot. (<i>False</i>)	True/False	27 (27%)
Consuming ground meat that has not been properly cooked may cause bloody diarrhea. (<i>True</i>)	True/False	69 (69%)
Please respond if it is true that if not completely cooked, these foods could cause hospitalization or even death: Raw Chicken (<i>True</i>)	True/False	90 (90%)
It is perfectly safe to consume food that tastes and smells normal. (<i>False</i>)	True/False	74 (74%)
As long as it is wrapped in plastic film, raw meat may be stored anywhere inside a refrigerator. (<i>False</i>)	True/False	85 (85%)
If any raw chicken juice drips on to salad greens, they must be thrown away. (<i>True</i>)	True/False	88 (88%)
Eggs in shells may be stored above a prepared salad in the refrigerator (<i>False</i>)	True/False	88 (88%)
Raw fish such as tuna was not stored at the proper cold temperature. Then it was cooked and had the correct internal temperature. This fish is now safe to consume. (<i>False</i>)	True/False	89 (89%)
Please respond if it is true that if not completely cooked, these foods could cause hospitalization or even death: Raw Eggs (<i>True</i>)	True/False	90 (90%)
Thawing chicken breasts on counters is a safe procedure (<i>False</i>)	True/False	90 (90%)
A food handler who has a small infected cut on his or her finger prepares a sandwich that is kept warm but not hot. The person who eats that sandwich could become ill with vomiting and diarrhea. (<i>True</i>)	True/False	93 (93%)
Beef may be left to thaw on counters. (<i>False</i>)	True/False	93 (93%)
Beef may be thawed under hot running water. (<i>False</i>)	True/False	95 (95%)
Raw meat may be stored above food that is ready to be served. (<i>False</i>)	True/False	95 (95%)
As long as they are labeled correctly, chemical substances may be stored where food is prepared.	True/False	96 (96%)
You have several packages of a certain kind of cheese and some have different expiration dates. How should they be organized in the refrigerator when putting them in? (<i>First in, first out. Foods that expire early are kept in front</i>)	Open/ended	99 (99%)

Only two (2%) food handlers knew the correct temperature to which hamburgers or other ground beef items such as meatloaf should be cooked. Only 7% of the food handlers knew that improperly cooked raw beef could cause hospitalization or death and 19% correctly answered that completely cooked rice held at 50°C for 6 hours can make people sick. Twenty-seven percent of the food handlers knew that it is a safe food practice to transfer a large pot of hot soup into small containers and place those small containers in the refrigerator to cool.

Concerning working while ill with diarrhea, 88% of the food handlers answered that it is not okay to handle raw food when sick, even though the food will be cooked. Eighty-eight percent of food handlers responded correctly to the question that asked if salad greens dripped with raw chicken juice must be thrown away, and 74% of the food handlers knew that normal taste and smell cannot guarantee that food is “perfectly safe” to consume.

DISCUSSION

This study identified food safety knowledge gaps among restaurant food handlers in Neuchâtel, Switzerland. The food handlers in this study had an overall mean score of 71%, similar to scores reported in the United States (Chicago 71%, two Oregon counties 68%) (2, 11). The main knowledge gaps among Neuchâtel food handlers concerned the risk of consuming raw beef and of consuming improperly cooked ground meat, hand hygiene, and temperatures required for cooking, heating, cooling, and holding foods. The only characteristic associated with the knowledge score was restaurant cuisine. Among the cuisine styles examined, restaurants serving French cuisine had the highest knowledge score (74%). The lowest score was observed among the categories local and standard/international cuisines (67% and 67%, respectively). These results should be interpreted cautiously, because only one food handler per restaurant was interviewed, and the differences across the cuisine categories were not substantial.

In our study, a low proportion (7%) of food handlers knew that improperly cooked raw beef may lead to hospitalization and even death. More specifically, 31% of the food handlers did not know that consuming insufficiently cooked ground meat may result in bloody diarrhea, although nearly half the participating restaurants served steak tartar, a raw beef product. These results are similar to data obtained in Chicago, where 41% of the restaurant food handlers did not know that consuming uncooked ground meat may cause bloody diarrhea (9, 11). It has been well documented that consumption of ground meat products such as steak tartar or undercooked hamburgers has led to numerous foodborne illness outbreaks (3, 7, 8, 9). Raw and inadequately cooked beef may harbor pathogens such as *E. coli* O157, and lack of knowledge of such facts may lead to improper handling or cooking practices that could place restaurant patrons at risk of foodborne disease (14, 16). Our findings suggest that, overall, food handlers lack a strong foundation of knowledge concerning the risks of consuming insufficiently cooked ground meat, and food safety training should be focused on this area to prevent such outbreaks from occurring.

A relatively high proportion of food handlers (88%) considered it unacceptable for a food handler, who is ill with diarrhea, to handle raw food even though the food will be cooked. This is still an important

finding because it represents more than 1 out of 10 food handlers considering it an acceptable practice, and a very large number of food handlers work in restaurants. Several studies have observed an association between an ill worker handling food and foodborne illness when food was prepared by unwashed hands (1, 5). A cuisine-specific risk factor analysis study conducted by Gormley et al. found that of the 88 foodborne outbreaks associated with restaurants serving British cuisine, 24% were due to infected food handlers and 43% of the outbreaks associated with poultry meat consumption were due to poor personal hygiene practiced by food handlers (5). Although public health agencies recommend that food handlers not work while ill, many food handlers continue to do so, for several reasons (17). They may not have sufficient knowledge of foodborne illnesses or transmission of pathogens and hence may not appreciate the risk posed to others when they work while ill with diarrhea; a lack of paid sick leave may also influence worker behavior. This is more true for food handlers in the United States, who may work for low wages and not receive paid sick leave, than for food handlers in Neuchâtel, who get paid for sick leave and thus do not have a financial incentive to work while ill (5, 12). However, food handlers in small restaurants may be encouraged to come to work even if not feeling well because restaurants may need to close if they are insufficiently staffed. Because of these challenges, more research needs to be focused on increasing knowledge of restaurant food handlers concerning consequences related to working while ill and on decreasing the frequency of this behavior.

Food handlers in our study demonstrated an extremely low level of knowledge concerning adequate temperatures needed for cooking hamburger or ground meat and for holding potentially hazardous hot and cold foods. More specifically, none of the food handlers knew the correct range of the temperature zones in which germs proliferate. This finding was surprising, considering that 72% of the surveyed food handlers were in charge of their restaurants. The knowledge scores of those in charge were not significantly different from those of other food handlers, including those with no history of attending a food safety training course. Improper food safety practices related to insufficient temperatures needed for cooking and holding foods have led to several foodborne outbreaks. A U.S. study reviewing outbreaks associated with food handlers' errors found that 22 outbreaks were associated with insufficient time and temperature during initial cooking or heat processing, during reheating, during inadequate thawing followed by insufficient cooking, and other food preparation procedures that allow pathogenic bacteria to survive (13). Re-certification and training of managers and food handlers should emphasize information on temperature to reduce the burden of foodborne illnesses arising from lack of knowledge concerning temperatures for preparation of foods.

Among the open-ended questions that specifically addressed time and temperatures, all food handlers demonstrated remarkably low knowledge; for four questions, none of the food handlers answered correctly. While the food handlers on the job are able to consult with resource materials that may direct them regarding these time and temperatures, it is still concerning that so few of them had command of this information. These results suggest that future surveys should consider more open-ended questions to better determine and reveal true knowledge levels. A combination of open-ended and closed questions would better provide complete and accurate estimates of knowledge.

A potential limitation of our study is that the method for scoring answers to items on correct temperatures for cooking, storing, and holding foods was strict. For example, if a food handler stated that the safe minimum internal temperature to cook chicken for at least 15 seconds was 220°C, it was scored as incorrect because, although such cooking would not put a consumer at increased risk, it suggests they do not know the recommendations. This strict scoring method may have underestimated knowledge of food safety risk if the food handlers really practiced these more extreme temperatures and were not simply guessing. Another limitation of our study is related to generalizability due to selection bias. To maximize feasibility, the sample of restaurants was chosen based on their expected willingness to participate in the study. In addition, only one food handler per restaurant was interviewed, rather than a sample selected through a randomization method. This selection bias may have also led to an underestimate of knowledge, as more knowledgeable food handlers could have participated. This study was also limited by a low sample size, which decreased the statistical power.

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CONCLUSION

The data from this survey identify food safety knowledge gaps among restaurant food handlers in Neuchâtel, Switzerland and provide a foundation for future research to increase food safety knowledge and policies to promote good food safety practices among food handlers.

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In Memory

Richard K. Smith

We extend our deepest sympathy to the family of Richard K. Smith who recently passed away. Mr. Smith was a member of the Association since 1998 and worked with 3-A Sanitary Standards throughout his career. IAFP will always have sincere gratitude for his contribution to the Association and the profession.
