**Factors Associated with Effective Cross-Contamination Prevention in Restaurants**

by

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## ACRONYMS

| | |
|---|---|
| CDC | Centers for Disease Control and Prevention |
| EHS-Net | Environmental Health Specialists Network |
| OHSU | Oregon Health & Science University |
| PAF | Population Attributable Fraction |
| RTE | Ready to Eat |

## DEFINITIONS

**Restaurant:** An establishment that prepares and serves food to customers; institutions, food carts, mobile food units, temporary food stands, restaurants in supermarkets, and establishments that only cater are not included.

**Cross-Contamination Prevention Practices:** Practices which are observed by data collectors which are intended to prevent cross-contamination of cooked chicken or environment.

**Kill Step:** The cooking of chicken to at least 165 degrees Fahrenheit internal temperature to reduce pathogens to a level unable to cause adverse health.

**Raw Chicken:** Chicken that has not been through a kill step and needs further cooking to reduce pathogens to a level unable to cause adverse health. Chicken that is whole, pre-cut, and processed (e.g., frozen, breaded, seared) will be included in the study, as long as it has not been through a kill step.

**Manager Knowledge:** A course, class, on-the-job training, food safety certification, specific training on how to safely prepare and cook raw chicken.

**Chicken Handling Policies:** A cleaning policy in place regarding food contact surfaces that have been used to prepare raw chicken.

**Training:** Food safety certification of either manager or food worker; specific training on how to safely prepare and cook raw chicken.

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## ABSTRACT

**Background:** Food-borne illness resulting from cross-contamination in a restaurant setting represents a large public health burden. An estimated 76 million cases of food-borne illness occur each year in the United States [3], and contaminated raw chicken is commonly identified as a foodborne illness pathogen vehicle.[11] Restaurants provide opportunities for instances of food-borne illness because large quantities of different foods are handled in the same kitchen. Failure to wash hands, utensils, or countertops can lead to contamination of foods that will not be cooked.[10] Few data are available that describe the likelihood of cross-contamination in the restaurant setting, although such events may not be rare.[5] Further attention to sources of food-handling practices for poultry and meat in restaurants is needed.[5] The purpose of this study was to examine whether establishment characteristics are associated with cross-contamination prevention practices within restaurants.

**Methods:** We performed a secondary analysis on data from the Environmental Health Specialists Network (EHS-Net) 2008 Chicken Handling Study. Using logistic regression, we assessed the potential for cross-contamination in association with specific kitchen manager food safety trainings and associated policies.

**Results:** The unadjusted associations between manager responses to training questions and potential cross-contamination were .76, (CI .40-1.45). The associations became attenuated after adjusting for State and Menu Type to .87 (CI .39-1.96) in the multivariable model. The unadjusted associations between specific raw chicken training and potential cross-contamination were .63 (.40-.99). The associations became attenuated after adjusting for State and Menu Type to .74 (.43-1.25) in the multivariable

model. The trends, while not significant, were found to be in the hypothesized direction for manager food safety training (OR= .87, CI .39-1.96) and specific raw chicken training (OR= .74, CI .43-1.25).

**Conclusion:** While manager food safety training regulations vary by state, it may be beneficial to have similar policies concerning raw chicken preparation and food safety courses. State specific policies should be assessed to ensure safe food preparation practices among raw chicken despite geographical differences.

# CHAPTER 1: INTRODUCTION

Food-borne illness resulting from cross-contamination represents a large public health burden. Vehicles for contamination include meat and poultry where food-borne microbes are present (usually in their intestines), fruits and vegetables which are washed or irrigated with water contaminated by animal manure or human sewage, oysters and other filter feeding shellfish which can concentrate *Vibrio* bacteria, and eggs which can become contaminated with *Salmonella* even before the shell is formed.[3] Pathways that may lead to contamination include unwashed hands of food handlers who are infected, the transfer of microbes between foods by unwashed utensils, and contact between cooked foods and raw foods or drippings.[3]

In the restaurant setting, contaminated chicken has the potential to cause illness such as *Salmonella*, *Campylobacter* jejuni, and *Clostridium* perfringens due to cross-contamination among the environment or ready-to-eat foods.[1] [6] [12] A large-case control study of sporadic *Campylobacter* infections identified 2 major independent food-specific risk factors for *Campylobacter* infection. The most important food-specific risk factor, based on population attributable fraction (PAF), was consumption of chicken prepared at a commercial food establishment.[5]

## Specific Aims

The EHS-Net Chicken Handling Study, from which we conducted a secondary analysis, collected descriptive data on chicken handling and cooking practices in restaurants. This data is useful for examining the factors associated with proper cross contamination prevention practices, as well as for future policy and food safety training recommendations.

The goals of this study were to:

**(1)** Conduct a secondary analysis of 450 EHS-Net Chicken Handling Study questionnaires from a random sample of restaurants for a cross sectional study to examine the associations between restaurant characteristics and cross contamination prevention practices.

**(2)** Test the hypothesis that cross contamination prevention practices differ among those EHS-Net restaurant sites that have greater manager certification, chicken handling policies, and food safety training relative to those who have less knowledge, fewer or no policies and less training.

## Primary Data Collection- EHS-Net Chicken Handling Study

The Environmental Health Specialists Network (EHS-Net) is a collaborative forum of environmental health specialists whose mission is to improve environmental health. The participating states which contribute data to the EHS-Net studies are: California, Connecticut, Georgia, Iowa, Minnesota, New York, Oregon, Rhode Island and Tennessee. The data collection was independent of an inspection and was anonymous.

Participating restaurants that prepared foods from raw chicken were randomly selected through the following recruiting procedure:

(1) Each state was expected to collect data for this study in 50 restaurants.

(2) Each state received a list of randomly selected restaurants from the CDC and used this list to obtain restaurant participants for the study.

(3) The number of restaurants on the list prepared by CDC was over sampled by state refusal and ineligible rates (as determined by previous studies) to ensure that each state was able to meet the target of 50 restaurants. For example, if 25% of restaurants in a state refused or were ineligible (e.g., they were shut down, didn't meet the EHS-Net definition of a restaurant), CDC provided that state with a list of 67 restaurants, expecting that approximately 25% (17) of the 67 would refuse to participate or would be ineligible to participate, and 50 would agree to participate. Inclusion and exclusion criteria are shown in the appendix, as well as the recruiting procedure and interview details (See Appendix 1).

(4) The recruiting script was designed to ensure that only eligible restaurants were included in the study.

## CHAPTER 2: METHODS

### *Overview*

Our secondary analysis of cross-sectional survey data utilized a 2008 food safety study by the Environmental Health Specialists Network (EHS-Net) within the Centers for Disease Control and Prevention (CDC). The study questionnaire was structured with interview questions as well as an observation period by the data collectors. The first part of the interview was conducted with a restaurant manager who had authority over the kitchen. The types of questions that were asked of the manager collected information on such variables as food safety training, specific training on raw chicken, and cleaning policies regarding food contact surfaces. The second part of the data collection was conducted as an observation of the restaurant kitchen. The types of observations included variables such as preparation, thawing, cold-holding, and cooking (Copy of survey included in Appendix 2).

### *Data Management*

The original datasets that we received from the CDC included the Manager Interview and the three Observation sections including Storage, Preparation and Cooking. The Manager Interview included 448 responses, the Storage section included 438 responses, the Preparation section included 829 responses, and the Cooking section included 433 responses. The variation in response totals is due to the structure of the questionnaires, for instance, the preparation section would yield more responses for some questions due to the fact that specific measures were observed for multiple pieces of chicken (i.e. the questions concerning the cooking of raw chicken (Questions 4,5 of Cooking, page 18 of 21) in the kitchen could be observed for up to 4 separate entries.).

For each of the 4 datasets we sorted the cases by the Evaluation ID, which was the unique identifier, and we assessed which restaurants had multiple records. In the case of multiple records for specific variables, we recoded and aggregated the cases according to only the responses which were applicable to our variable (such as, those who observed thawing or cold holding take place in the kitchen, as opposed to other possible responses). The datasets are described in detail below (see 1-4).

***Statistical Methods***

**Descriptive Analysis**

For a preliminary analysis of our chosen variables, we constructed cross tabulations for each of the outcome variables with the four manager variables. We created a new variable called *xcont* which takes into account any cross-contamination within the outcomes across the four manager variables. These are the variables (four manager variables and six outcomes including storage, thawing, cold-holding, utensils/contact surfaces, bare/gloved hand contact, and our new variable *xcont*) that will be used in our regression model to assess whether manager characteristics are associated with cross contamination prevention practices in this EHS-Net restaurant population (See Table 4).

1. **Manager Variables**

The Manager Interview questions which we chose to assess included questions concerning food safety training, food safety certification, specific training or instructions on how to safely prepare raw chicken, and a cleaning policy regarding food contact surfaces that have been used to prepare raw chicken. After performing descriptive analyses and assessing for completeness of the data, our analytic variable included 448 responses.

2. **Observation-Storage Variables**

The Observation-Storage questions which we chose to assess included questions concerning storage conditions that could cause cross-contamination, the number of storage units observed, and the description of the conditions. These questions were answered only if the data collector observed the storage of raw chicken in the kitchen, which referred to raw chicken after it had been received and prior to any preparation. After recoding according to the applicable responses and assessing for completeness of the data, our analytic variable included 432 responses. The descriptions of the observed storage conditions that could cause cross-contamination are detailed in table 10 with the frequency with which it was observed (See Table 10 in Appendix 3).

3. **Observation-Preparation Variables**

The Observation-Preparation questions which we chose to assess included questions concerning thawing (any process short of final cooking in which food goes from a frozen state to an unfrozen state) conditions and cold-holding (any attempt short of freezing to keep food at 41° Fahrenheit or colder) conditions that could cause cross-contamination. In the preceding section of the questionnaire, data collectors were asked whether they observed certain processes involving raw chicken, and if they observed thawing or cold-holding then they proceeded to fill out the section with our preparation variables concerning cross-contamination. After aggregating those who observed thawing of raw chicken in the kitchen, our analytic variable included 122 responses. After aggregating those who observed cold-holding of raw chicken in the kitchen, our analytic variable included 240 responses. The descriptions of the observed thawing conditions that could

cause cross-contamination are detailed in table 11 with the frequency with which it was observed. The descriptions of the observed cold-holding conditions that could cause cross contamination are detailed in table 12 with the frequency with which it was observed (See Tables 11, 12 in Appendix 3).

4. **Observation-Cooking Variables**

The Observation-Cooking questions which we chose to assess included questions concerning utensils & food contact surfaces that were used for both raw and cooked chicken, and the use of bare & gloved hands in ways that could contaminate cooked chicken or the environment. While in the kitchen for the observation section of the questionnaire, the data collectors could report the cooking observations for up to four separate pieces of chicken which lead to multiple observations for each of these variables which we chose. To create an analytical variable for the use of utensils & food contact surfaces with cross-contamination issues, we collapsed all of the answers pertaining to an observation where the potential for cross-contamination was present, and we then summed these responses and recoded them into a new variable. After aggregating those who observed the use of utensils & food contact surfaces with cross-contamination issues, our analytic variable included 346 responses.

The following table includes the key variables which were included in our secondary analysis. We included four questions concerning the kitchen manager interview (explanatory variables) and five questions concerning the kitchen observation period (outcome variables) (See Table 1 below).

## Table 1. Secondary Analysis Key Variables- EHS-Net Chicken Handling Study

| Measure | **Type of Variable** | **Type of Variable** | **Question** | **Possible Responses** | **Additional info** |
|---|---|---|---|---|---|
| Kitchen manager food safety training | Explanatory | Categorical | Have any kitchen managers received food safety training such as a course, class or on-the-job training? | Yes, no, unsure, refused | |
| Food safety certification requirement | Explanatory | Categorical | Does this establishment require kitchen managers to be food safety certified? | Yes, no, unsure, refused | |
| Specific raw chicken training | Explanatory | Categorical | Have you or any other managers received specific training or instructions on how to safely prepare and cook raw chicken? | Yes, no, unsure, refused | |
| Cross-contamination cleaning policy | Explanatory | Categorical | Is there a cleaning policy regarding food contact surfaces that have been used to prepare raw chicken? | Yes, no, unsure, refused, N/A (no raw prep) | |
| Cross-contamination storage conditions | Outcome | Categorical | Did you observe any storage conditions that could cause cross-contamination? | Yes, no, unsure | Answered during kitchen observation |
| Cross-contamination thawing conditions | Outcome | Categorical | Did you observe any thawing conditions that could cause cross-contamination? | Yes, no, unsure, unable to observe | Answered during kitchen observation |
| Cross-contamination cold-holding conditions | Outcome | Categorical | Did you observe any cold-holding conditions that cause cross-contamination? | Yes, no, unsure | Answered during kitchen observation |
| Cross-contamination of utensils/food contact surfaces | Outcome | Categorical | Were any utensils/food contact surfaces used for both raw/partially cooked chicken and cooked chicken? | Yes, no, unsure, unable to observe | Answered during kitchen observation |
| Cross-contamination during cooking | Outcome | Categorical | Were bare hands used in a way leading to cross-contamination of cooked chicken or environment? | Yes, no, unsure, unable to observe | Answered during kitchen observation |

## CHAPTER 3: RESULTS

**Table 2. Descriptive Analysis- Frequencies of Key Variables**

| | **Manager Interview Variables** | | **Frequency** | **Percent** |
|---|---|---|---|---|
| **Manager variable 1** | Have any kitchen manager received food safety training such as a course, class or on-the-job training? | **Yes** | 406 | 91% |
| | | **No** | 41 | 9% |
| | | **Total** | 447 | 100% |
| **Manager variable 2** | Does this establishment require kitchen managers to be food safety certified? | **Yes** | 207 | 47% |
| | | **No** | 231 | 53% |
| | | **Total** | 438 | 100% |
| **Manager variable 3** | Have you or any other managers received specific training or instructions on how to safely prepare raw chicken? | **Yes** | 337 | 77 |
| | | **No** | 99 | 23 |
| | | **Total** | 436 | 100% |
| **Manager variable 4** | Is there a cleaning policy regarding food contact surfaces that have been used to prepare raw chicken? | **Yes** | 374 | 91 |
| | | **No** | 38 | 9 |
| | | **Total** | 412 | 100% |

**(Table 2 continues onto next page)**

**Table 2 continued-Descriptive Analysis- Frequencies of Key Variables**

| | | | | |
|---|---|---|---|---|
| | **Observation-Storage Variables** | | | |
| **Storage Variable 1** | Did you observe any storage conditions that could cause x-contamination? | **Yes** | 51 | 12 |
| | | **No** | 381 | 88 |
| | | **Total** | 432 | 100% |
| **Storage Variable 2** | How many units with x-contamination issues? | **1** | 47 | 92% |
| | | **2** | 3 | 6% |
| | | **3** | 1 | 2% |
| | **Observation-Preparation Variables** | | | |
| **Preparation Variable 1** | Did you observe any thawing conditions that could cause x-contamination? | **Yes** | 20 | 16% |
| | | **No** | 102 | 84% |
| | | **Total** | 122 | 100% |
| **Preparation Variable 2** | Did you observe any cold-holding conditions that could cause x-contamination? | **Yes** | 37 | 15% |
| | | **No** | 203 | 85% |
| | | **Total** | 240 | 100% |
| | **Observation-Cooking Variables** | | | |
| **Cooking Variable 1** | Were any utensils/food contact surfaces used for both raw chicken and cooked chicken? | **Yes** | 72 | 21% |
| | | **No** | 274 | 79% |
| | | **Total** | 346 | 100% |
| **Cooking Variable 2** | Were bare/gloved hands used in a way leading to x-contamination of cooked chicken or environment? | **Yes** | 60 | 33% |
| | | **No** | 122 | 67% |
| | | **Total** | 182 | 100% |

**Overall contamination results from table 2**

From table 2 we observe 1,322 total responses of either yes or no to the questions concerning storage, preparation and cooking which were collected during the kitchen observation period. There were 240 yes responses (18.2%), and there were 1,082 no responses (81.8%). When data was collected for Storage, Thawing, and Cold-Holding, the data collectors were given the option of writing in a description of what they observed if they had answered that they did indeed observe a situation that could potentially cause cross-contamination. These descriptions are listed in tables 10, 11, and 12 in Appendix 3 (See Appendix 3).

**Table 3. Descriptive Analysis- Manager Characteristics by State**

| State | Manager Characteristic | | | Manager Characteristic | | | Manager Characteristic | | | Manager Characteristic | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Have any kitchen managers received food safety training such as a course, class or on-the-job training? | | | Does this establishment require kitchen managers to be food safety certified? | | | Have you or any other managers received specific training or instructions on how to safely prepare raw chicken? | | | Is there a cleaning policy regarding food contact surfaces that have been used to prepare raw chicken? | | |
| California | yes | 46 | 94% | yes | 29 | 62% | yes | 33 | 75% | yes | 48 | 98% |
| | no | 3 | 6% | no | 18 | 38% | no | 11 | 25% | no | 1 | 2% |
| Connecticut | yes | 51 | 100% | yes | 42 | 86% | yes | 35 | 69% | yes | 37 | 79% |
| | no | 0 | 0% | no | 7 | 14% | no | 16 | 31% | no | 10 | 21% |
| Georgia | yes | 48 | 96% | yes | 31 | 66% | yes | 45 | 92% | yes | 43 | 98% |
| | no | 2 | 4% | no | 16 | 34% | no | 4 | 8% | no | 1 | 2% |
| Iowa | yes | 50 | 100% | yes | 5 | 10% | yes | 49 | 98% | yes | 33 | 97% |
| | no | 0 | 0% | no | 44 | 90% | no | 1 | 2% | no | 1 | 3% |
| Minnesota | yes | 46 | 92% | yes | 30 | 61% | yes | 34 | 69% | yes | 33 | 77% |
| | no | 4 | 8% | no | 19 | 39% | no | 15 | 31% | no | 10 | 23% |
| New York | yes | 32 | 65% | yes | 12 | 24% | yes | 35 | 71% | yes | 46 | 92% |
| | no | 17 | 35% | no | 38 | 76% | no | 14 | 29% | no | 4 | 8% |
| Oregon | yes | 42 | 89% | yes | 7 | 15% | yes | 35 | 75% | yes | 41 | 91% |
| | no | 5 | 11% | no | 40 | 85% | no | 12 | 25% | no | 4 | 9% |
| Rhode Island | yes | 50 | 98% | yes | 35 | 70% | yes | 34 | 72% | yes | 46 | 92% |
| | no | 1 | 2% | no | 15 | 30% | no | 13 | 28% | no | 4 | 8% |
| Tennessee | yes | 41 | 82% | yes | 16 | 32% | yes | 37 | 74% | yes | 47 | 94% |
| | no | 9 | 18% | no | 34 | 68% | no | 13 | 26% | no | 3 | 6% |

**Table 4. Descriptive Analysis-**

**Manager Variables by Potential Cross-Contamination Observations**

| **Potential cross-contamination observed in kitchen** | **1** | **Kitchen manager food safety training** | | |
|---|---|---|---|---|
| | | **Y (N) (%)** | **N (N) (%)** | **P-value** |
| Storage (N=438) | | (45) (11.50%) | (6) (14.60%) | 0.559 |
| Cold-holding (N=240) | | (35) (16.40%) | (2) (8%) | 0.274 |
| Thawing (N=123) | | (17) (15.90%) | (3) (21%) | 0.6 |
| Cooking utensils/surfaces (N=346) | | (63) (20.4%) | (9) (25%) | 0.519 |
| Bare/gloved hand (N=182) | | (53) (32.5%) | (7) (37%) | 0.704 |
| Any cross-contamination (N=447) | | (161) (39.8%) | (19) (46%) | 0.413 |
| | | | | |
| | **2** | **Kitchen manager food safety certification requirement** | | |
| | | **Y (N) (%)** | **N (N) (%)** | **P-value** |
| Storage (N=438) | | (24) (11.90%) | (24) (10.80%) | 0.715 |
| Cold-holding (N=240) | | (18) (16.80%) | (18) (14.20%) | 0.576 |
| Thawing (N=123) | | (9) (17%) | (11) (16.40%) | 0.934 |
| Cooking utensils/surfaces (N=346) | | (38) (23.9%) | (34) (18.7%) | 0.239 |
| Bare/gloved hand (N=182) | | (36) (38.3%) | (24) (27.9%) | 0.14 |
| Any cross-contamination (N=447) | | (91) (44%) | (86) (37.2%) | 0.152 |
| | | | | |
| | **3** | **Specific training concerning how to safely prepare & cook raw chicken** | | |
| | | **Y (N) (%)** | **N (N) (%)** | **P-value** |
| Storage (N=438) | | (36) (11%) | (15) (16%) | 0.195 |
| Cold-holding (N=240) | | (33) (17.60%) | (4) (8%) | 0.098 |
| Thawing (N=123) | | (9) (10.10%) | (9) (30%) | 0.009 |
| Cooking utensils/surfaces (N=346) | | (52) (20.1%) | (19) (24.4%) | 0.416 |
| Bare/gloved hand (N=182) | | (38) (28.8%) | (18) (42.9%) | 0.089 |
| Any cross-contamination (N=447) | | (127) (37.7%) | (48) (49%) | 0.045 |
| | | | | |
| | **4** | **Cleaning policy regarding food contact surfaces/raw chicken** | | **P-value** |
| | | **Y (N) (%)** | **N (N) (%)** | |
| Storage (N=438) | | (44) (12.20%) | (6) (16.20%) | 0.486 |
| Cold-holding (N=240) | | (26) (13.50%) | (4) (21.10%) | 0.371 |
| Thawing (N=123) | | (18) (15.90%) | (2) (40%) | 0.16 |
| Cooking utensils/surfaces (N=346) | | (63) (22.5%) | (7) (20.6%) | 0.8 |
| Bare/gloved hand (N=182) | | (51) (32.7%) | (7) (46.7%) | 0.275 |
| Any cross-contamination (N=447) | | (151) (40.5%) | (18) (47.4%) | 0.411 |

## Logistic Regression Modeling

After testing for candidate confounders, we chose to keep State, Menu Type, and the Number of Meals on the Busiest Days in our regression model. After adjusting, the manager variables that were the closest to significance were Training (kitchen managers receiving food safety training) and Raw (manager training specific to safe preparation of raw chicken). Compared to those who did not have food safety training, those who did were only .72 (OR= .72, CI .33-1.53) times as likely to have the potential for cross-contamination. Compared to those who did not have training specific to the safe preparation of raw chicken, those who did were only .75 (OR= .75, CI.45-1.24) times as likely to have the potential for cross-contamination. Therefore, in both of these cases we see a trend towards the hypothesized direction from the food safety training and the raw chicken specific training (see Table 5).

## Multivariable Modeling

For our multivariable model, we decided to keep only Training (kitchen managers receiving food safety training) and Raw (manager training specific to safe preparation of raw chicken) along with State and Menu Type, but we dropped the Number of Meals on Busiest Days due to the lack of significance. Results from the multivariable model for Manager Training showed a marginal increase to .87 (OR= .87, CI .39-1.96) making the association closer to the null value. The odds ratio for Specific Raw Chicken Training did not change much (OR= .74, CI .43-1.25) versus the unadjusted odds ratio (OR= .63, CI .40-.99) (See Table 6).

Results for our covariates showed that, compared to California, each of the other 8 states had a lower risk of the potential for cross-contamination ($p<.0001$) (See Table 6).

Concerning Menu Type, Mexican restaurants had 2.24 times higher odds for the potential for cross-contamination, and Asian restaurants had 1.58 times higher odds for the potential for cross contamination (See Table 12).

**Table 5. Manager Variables Adjusted for State, Menu Type, and Number of Meals on Busiest Day**

| **Manager Variables** | **Unadjusted**<br>OR (95% CI)<br>P-value | **State Adjusted**<br>OR (95% CI)<br>P-value | **State & Menu Adjusted**<br>OR (95% CI)<br>P-value | **State, Menu, & # of meals on busiest day Adjusted**<br>OR (95% CI)<br>P-value |
|---|---|---|---|---|
| **Training**<br>**Have any kitchen managers received food safety training such as a course, class or on-the-job training?** | 0.76 (.40-1.45)<br>(p= .41) | .66 (.32-1.36)<br>(p=.26) | .72 (.34-1.52)<br>(p=.39) | .72 (.33-1.53)<br>(p=.39) |
| | | | | |
| **Certified**<br>**Does this establishment require kitchen managers to be food safety certified?** | 1.32 (.90-1.93)<br>(p= .15) | 1.05 (.66-1.66)<br>(p=.83) | 1.07 (.66-1.72)<br>(p=.78) | 1.03 (.63-1.69)<br>(p=.90) |
| | | | | |
| **Raw**<br>**Have you or any other managers received specific training or instructions on how to safely prepare raw chicken?** | 0.63 (.40-.99)<br>(p= .04) | .68 (.42-1.10)<br>(p=.12) | .73 (.44-1.20)<br>(p=.21) | .75 (.45-1.24)<br>(p=.27) |
| | | | | |
| **Policy**<br>**Is there a cleaning policy regarding food contact surfaces that have been used to prepare raw chicken?** | 0.75 (.38-1.47)<br>(p= .41) | .68 (.34-1.39)<br>(p=.30) | .68 (.33-1.39)<br>(p=.29) | .77 (.36-1.62)<br>(p=.49) |

**Table 6. Unadjusted Odds Ratios and Multivariate Model (continued next page)**

| **Manager Variables** | **Unadjusted Odds Ratio**<br>OR (95% CI)<br>P-value | **Multivariable Model**<br>OR (95% CI)<br>P-value |
|---|---|---|
| **Training**<br>**Have any kitchen managers received food safety training such as a course, class or on-the-job training?** | 0.76 (.40-1.45)<br>(p= .41) | 0.87 (.39-1.96)<br>p=.75 |
| **Certified**<br>**Does this establishment require kitchen managers to be food safety certified?** | 1.32 (.90-1.93)<br>(p= .15) | --- |
| **Raw**<br>**Have you or any other managers received specific training or instructions on how to safely prepare raw chicken?** | 0.63 (.40-.99)<br>(p= .04) | .74 (.43-1.25)<br>p=.26 |
| **Policy**<br>**Is there a cleaning policy regarding food contact surfaces that have been used to prepare raw chicken?** | 0.75 (.38-1.47)<br>(p= .41) | --- |
| | | |
| **Confounders** | | |
| **State** | p<.0001 | p<.0001 |
| California | Referent | Referent |
| Connecticut | .27 (.11-.63)<br>(p=.003) | .35 (.14-.87)<br>p=.02 |
| Georgia | .11 (.04-.28)<br>(p<.0001) | .13 (.05-.35)<br>p<.0001 |
| Iowa | .17 (.07-.40)<br>(p<.0001) | .21 (.08-.54)<br>p=.001 |
| Minnesota | .24 (.10-.56)<br>(p=.001) | .29 (.12-.72)<br>p=.008 |
| New York | .24 (.10-.56)<br>(p=.001) | .32 (.12-.84)<br>p=.02 |
| Oregon | .13 (.05-.34)<br>(p<.0001) | .13 (.05-.33)<br>p<.0001 |
| Rhode Island | .36 (.15-.83)<br>(p=.01) | .54 (.21-1.36)<br>p=.19 |
| Tennessee | .17 (.07-.40)<br>(p<.0001) | .16 (.06-.41)<br>p<.0001 |

**Table 6. (Continued) Unadjusted Odds Ratios and Multivariate Model**

| | | |
|---|---|---|
| **Menu Type** | p=.085 | p=.081 |
| American | Referent | Referent |
| Asian | 1.58 (.84-2.96)<br>(p=.15) | 1.26 (.60-2.64)<br>p=.54 |
| Italian | .91 (.48-1.73)<br>(p=.78) | .72 (.35-1.47)<br>p=.37 |
| Mexican | 2.24 (1.18-4.22)<br>(p=.01) | 2.61 (1.27-5.36)<br>p=.009 |
| Other | 1.33 (.67-2.63)<br>(p=.40) | 1.15 (.54-2.41<br>p=.71 |
| **Number of Meals on Busiest Day** | (p=.65) | --- |
| <75 | Referent | --- |
| 76-200 | 1.0 (.63-1.73)<br>(p=.86) | --- |
| 201-399 | .81 (.45-1.47)<br>(p=.50) | --- |
| >400 | .78 (.46-1.32)<br>(p=.35) | --- |

# CHAPTER 4: DISCUSSION

## *Previous Studies*

A previous EHS-Net study that examined differences between outbreak and non-outbreak restaurants suggested that, since 80% of Americans eat out at least once per week, a better understanding of how and why transmission of food-borne illness occurs in restaurants is needed to develop better prevention measures.[9] Results from an EHS-Net study of food service workers' self-reported food preparation practices indicated that risky food preparation practices were commonly reported; it was also suggested that additional research is needed to better understand the factors that impact food preparation practices.[8] The findings from an EHS-Net study examining factors that impact safe food preparation practices indicated that improvement of restaurant workers' food preparation practice is needed to reduce the incidence of food-borne illness; additionally, they mention that understanding of current practices and factors affecting those practices is necessary before behavior change efforts can be successful.[7] Our examination of the EHS-Net Chicken Handling study provides the opportunity to understand the factors and current practices which affect cross-contamination prevention practices within this randomly selected EHS-Net population.

## *Public Health Implications*

As per the first goal of our study, we performed a secondary, descriptive analysis on the EHS-Net Chicken Handling Study data. We found that approximately half of this EHS-Net population does not require that managers be food safety certified. In a previous EHS-Net study, it was found that certified kitchen managers likely improved the quality of food safety training, since most restaurants appeared to rely on on-the-job food

safety training.[8] Additionally, we found that there were observations of situations in the kitchens where the potential for cross-contamination was present (See Tables 10, 11, 12 in Appendix 3). Although these potential situations were observed, there was no test or confirmation that a cross-contamination threat was indeed present, such as a laboratory test for *Salmonella* or *Campylobacter* jejuni. We suggest that future studies incorporate measures of cross-contamination, such as for food contact surfaces or contamination of other foods, to assess the effects of manager certification on food safety practices in the kitchen.

As per the second goal of our study, we found a trend in the hypothesized direction that cross-contamination prevention practices differ among those restaurants which have manger food safety training and also manger training that is specific to the preparation of raw chicken. In a recent analysis concerning Certified Kitchen Managers, it was found that the presence of certified kitchen managers was protective for most types of critical violations related to routine inspection, and it was suggested that kitchen managers have an important role in communicating to food workers information about recommended practices to reduce the risk of food-borne illnesses.[2] These previous findings, along with our analysis of a specific EHS-Net population suggests that there may be a need for manager training requirements that are congruent across states, especially for the restaurants which prepare and serve raw chicken. Additionally, future analyses of the Chicken Handling Study should include the food worker survey questions to assess the factors associated with cross-contamination prevention practices and the potential for cross-contamination in this sample of EHS-Net restaurants.

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### *Strengths and Limitations*

This study has strength due to the fact that we acquired a complete dataset in which there was thorough data collection through interviews and the associated observation periods. The Chicken Handing Study provided a large amount of data which lends itself to the possibility of multiple analyses of both descriptive and analytic. The variables that we chose for this analysis cover each of the parts of the Chicken Handling Study (Manager Interview and each of the Observation sections) and could prove useful as a starting point for future studies of the Chicken Handling data.

This study has limitations due to the fact that we were unable to assess each of the study variables, which may have added to the study but would have taken considerably more time than we had available. While these data collection sites were randomly selected among the nine states, this may not be representative of the US restaurant population as a whole. The manager interview and the observation period took place once at a random time and therefore may or may not be adequately reflecting the usual occurrences. Additionally, manager variable such as certification or specific training could possibly have different implications in different states, according to state specific regulations or policies. Therefore, it may be beneficial to assess these variables individually and according to state.

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# Appendices

## Appendix 1- EHS-Net Chicken Handling Study Methods

**Table 7. Inclusion and Exclusion Criteria**

| Included Establishments | Excluded Establishments |
|---|---|
| Prepares & serves food to customers | Establishments that only cater |
| Receive and prepare *****raw chicken | Institutions |
| | Food carts |
| | Mobile food units |
| | Temporary food stands |
| | Restaurants in supermarkets |
| | |

*****Raw Chicken is defined as chicken that has not been through a kill step and needs further cooking to reduce pathogens to a level unable to cause adverse health. Chicken that is whole, pre-cut, and processed (e.g., frozen, breaded, seared) was included in the study, as long as it had not been through a kill step (heated to a temperature of above 160° Fahrenheit to reduce pathogens).

The recruiters made a concerted effort to establish contact with any restaurant that they initially tried to contact. This was important because there may be systematic differences between easy-to-contact restaurants and hard-to-contact restaurants. For example, easy-to-contact restaurants may be less busy, better staffed, or better run than hard-to-contact restaurants. As these systematic differences could impact practices in the restaurant, they wanted to be sure that hard-to-contact restaurants were represented in the sample as well as easy-to-contact restaurants. To ensure that every effort was made to contact all restaurants in the sample, the recruiters followed the calling procedures demonstrated in Tables 8 and 9 (See below).

**Table 8. Recruiting Procedure**

| Status of phone call | Attempts to make (different times of day) | Over # of days |
|---|---|---|
| Unanswered | Minimum of 10 | 5 |
| Answered w/ no response | Minimum of 5 | 4 |

**Table 9. Participation Codes for all restaurants attempted to contact**

| | |
|---|---|
| **UNABLE TO CONTACT (U)** | If you followed the protocol above for unanswered calls and do not make contact with a restaurant. Also if you cannot find a working number for a restaurant. |
| **PARTICIPATING (P)** | If you are able to contact a restaurant, it meets the EHS-Net definition, it is not part of an already participating chain, it is eligible to participate, and the restaurant agrees to participate. |
| **REFUSED (R)** | If you followed the protocol above for answered calls and make contact with a restaurant, but do not ever get a definitive response on participation. Also use this code if you do make contact but the manager/owner declines to participate. |
| **CLOSED (CL)** | Use this code if you determine that the restaurant is closed |
| **CHAIN (C)** | If a restaurant on your list is part of chain, and you have already collected data (or you are scheduled to collect data) from a restaurant in that chain. |
| **INELIGIBLE RESTAURANT- NOT EHS-NET (I1)** | If you determine that the restaurant *does not meet the EHS-Net definition of a restaurant*. The following is the EHS-Net definition of a restaurant: An establishment that prepares and serves food to customers; institutions, food carts, mobile food units, temporary food stands, restaurants in supermarkets, and establishments that *only* cater are *not* included. |
| **INELIGIBLE RESTAURANT-CHICKEN (I2)** | If you are able to contact a restaurant, it meets the EHS-Net definition, and it is not part of an already participating chain but it *does not receive and prepare raw chicken*. |
| **INELIGIBLE RESTAURANT-LANGUAGE (I3)** | If you are able to contact a restaurant, it meets the EHS-Net definition, and it is not part of an already participating chain but *there are no managers who speak English.* |
| **OTHER (O)** | Something that does not fall into any of the other categories. |

### *Field Interviewers*

Data collection for the EHS-Net Chicken Handling Study was carried out in the specified sample of restaurants. The EHS-Net data collectors conducted restaurant manager interviews as well as carried out an observation in each restaurant kitchen.

### *Scheduling Visits around Preparation and Cooking*

Ideally, the data collectors would be able to schedule a time to visit the restaurant when both chicken preparation and cooking are occurring. This was strongly encouraged. However, they may not have always been able to do this. If the data collectors were unable to visit the restaurant when both preparation and cooking were occurring, they had two choices: 1) Schedule the visit for when preparation will be occurring. 2) If it is

feasible (i.e., the restaurant is willing and you have the time) to visit the restaurant at two different times (prep time and cooking time), then do so.

### *Time in Establishment*

Data collectors were advised to spend approximately an hour and a half in the establishment. The manager interview was estimated to take about 20 minutes; the rest of the time was spent conducting the storage, preparation, and cooking observations. After the manager interview, the data collector may have wanted to find out from the manager what would be happening in the kitchen and when, so that they could plan accordingly. For example, if a piece of chicken will shortly be cooked for an hour in the oven, they may have wished to observe the beginning cooking process, then observe preparation processes, and then go back and observe the end of the cooking process.

### *Organizing Forms*

The data collected in this study was kept anonymous, meaning that none of the data collected could be linked to the restaurant from which it came. Once the data collection was complete, any identifying information on the restaurant was separated from the restaurant's data.

### *Manager Informed Consent*

Once at the restaurant, the data collectors met with the manager and obtained their informed consent.

## Appendix 2- Data Collection- EHS-Net Chicken Handling Study Questionnaire

## Appendix 3- Descriptions of Observations of Potential Cross-Contamination

### Table 10. Descriptions of Storage Conditions

| Describe the storage conditions leading to potential cross-contamination | Frequency |
|---|---|
| Raw chicken is stored above ready to eat (RTE) or cooked foods | 21 |
| Raw chicken is stored so that it (or its container) is touching raw RTE or cooked foods | 6 |
| Raw chicken is stored above other raw meat | 7 |
| Raw chicken containers are nested with other containers (containing any other type of food item). | 2 |
| Other potential cross-contamination in storage | **15*** |
| ***Other Descriptions** | |
| Accumulated filth and mold, juices on floor | 1 |
| Beef next to chicken improperly stored, not covered | 1 |
| Chicken legs stored in the freezer were open and exposed | 1 |
| Ground beef stored above ready to eat vegetables | 1 |
| Prepared raw chicken stored directly next to a RTE food | 1 |
| Raw carcasses with some skin/meat attached stored in open container in freezer on shelf; and one open container of same stored on the freezer floor with a box stored on top of it | 1 |
| Raw chicken carcass and its dried juice stored directly on bottom of the freezer | 1 |
| Raw chicken containers stored with other types of food containers | 1 |
| Raw chicken inside top of cold sandwich-type unit is placed adjacent to vegetables | 1 |
| Raw chicken meat not covered; could spill | 1 |
| Raw chicken stored next to cooked chicken (not touching, though) | 1 |
| Raw meat cartons stored on floor in beverage only cooler | 1 |
| Raw meat juice throughout the unit | 1 |
| Same level as raw fish | 1 |
| Small amount of chicken juice seen on one shelf inside on reach-in freezer | 1 |

## Table 11. Descriptions of Thawing Conditions

| **Describe the thawing conditions leading to potential cross-contamination** | **Frequency** |
|---|---|
| Raw chicken is thawed above RTE or cooked foods | 3 |
| Raw chicken is thawed so that it (or its container) is touching RTE or cooked foods | 2 |
| Raw chicken is thawed above other raw meat | 1 |
| Thawing containers are nested with other containers (containing any other type of food item) | 1 |
| Splash from running water contaminating other food items | 2 |
| Other potential cross-contamination in thawing | 14 |
| ***Other Descriptions** | 13 * |
| Cook touched raw thawing chicken with bare hands and wiped his apron- no hand washing | 1 |
| Cross contaminated faucet spigot | 1 |
| Didn't wash/rinse/sanitize sink after use and tongs used on raw chicken placed over faucet during process | 1 |
| In sink with other dishes | 1 |
| Potentially chicken juice could leak from bag; sink is not necessarily properly cleaned and sanitized after use | 1 |
| Prep sink used by another food worker during thawing of chicken | 1 |
| Raw chicken juice splashed on preparation table | 1 |
| Raw meat juice throughout meat cooler walk-in | 1 |
| Sink not washed, rinsed, sanitized between uses | 1 |
| Thawing in 2nd & 3rd compartments of 3-bay sink | 1 |
| Thawing in sink that is then not washed and sanitized | 1 |
| This sink is not properly washed/sanitized before or after thawing procedure | 1 |
| This sink was not washed, rinsed, sanitized after thawing | 1 |

## Table 12. Descriptions of Cold-Holding Conditions

| **Describe the cold-holding conditions leading to potential cross-contamination** | **Frequency** |
|---|---|
| Raw chicken is stored above RTE or cooked foods | 27 |
| Raw chicken is stored so that it (or its container) is touching RTE or cooked foods | 4 |
| Raw chicken is stored above other raw meat | 10 |
| Raw chicken containers are nested with other containers (containing any other type of food item) | 2 |
| Other potential cross-contamination in cold-holding | |
| ***Other Descriptions** | 5* |
| Raw chicken skewers stored about cooked foods in fridge; hand assembled bags of raw chicken inside freezer directly on shelves; partially cooked chicken stored in cold sandwich unit | 1 |
| Large containers of prepped chicken with lids that were open or loosely placed on top | 1 |
| Raw chicken breasts marinating in tall “pickle” jar with tongs inside; tong handles touch the inside of the raw jar, worker said they placed the marinating raw chicken jar over RTE foods because there was no room on a lower shelf for the tall jar | 1 |
| Raw chicken containers are held with other containers that contain ready-to-eat foods | 1 |
| Raw chicken stored in top of sandwich-type unit next to vegetables- with no separator in between | 1 |