

Research Note

Frequency of Inadequate Chicken Cross-Contamination Prevention and Cooking Practices in Restaurants[†]

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ABSTRACT

This study was conducted by the Environmental Health Specialists Network (EHS-Net) of the Centers for Disease Control and Prevention. The purpose was to examine restaurant chicken preparation and cooking practices and kitchen managers' food safety knowledge concerning chicken. EHS-Net members interviewed managers about chicken preparation practices in 448 restaurants. The study revealed that many restaurants were not following U.S. Food and Drug Administration Food Code guidance concerning cross-contamination prevention and proper cooking and that managers lacked basic food safety knowledge about chicken. Forty percent of managers said that they never, rarely, or only sometimes designated certain cutting boards for raw meat (including chicken). One-third of managers said that they did not wash and rinse surfaces before sanitizing them. Over half of managers said that thermometers were not used to determine the final cook temperature of chicken. Only 43% of managers knew the temperature to which raw chicken needed to be cooked for it to be safe to eat. These findings indicate that restaurant chicken preparation and cooking practices and manager food safety knowledge need improvement. Findings from this study could be used by food safety programs and the restaurant industry to target training and intervention efforts to improve chicken preparation and cooking practices and knowledge concerning safe chicken preparation.

Poultry is the fourth most common commodity associated with foodborne illness and the number one commodity associated with deaths from foodborne illness in the United States (7). These facts indicate that poultry is a significant food safety problem in the United States.

Surveillance data indicate that during 1998 through 2008, 61% (376) of foodborne illness outbreaks linked with poultry were also linked with restaurants or delicatessens (1). Additional data indicate that eating chicken outside the home (e.g., in a restaurant) is an important risk factor for foodborne illness. Case-control studies have revealed that consumption of chicken outside the home is linked with *Salmonella* Enteritidis (4, 5) and *Campylobacter jejuni* (2, 3) infections. These findings indicate that improvement of restaurant chicken preparation and cooking practices is needed, because proper preparation and cooking can help prevent foodborne illness and outbreaks.

Foodborne illness linked with chicken can be caused through cross-contamination from raw chicken to ready-to-eat (RTE) foods or the environment, such as food contact surfaces and equipment. Cross-contamination often occurs during raw chicken preparation. For example, a restaurant outbreak investigation revealed that cross-contamination from raw chicken to chopped cilantro and a cutting board used for cooked chicken led to an outbreak of *Salmonella* infections among restaurant customers (8). Contaminated chicken can also cause foodborne illness when the chicken is not cooked to a temperature high enough to kill foodborne pathogens on or in the chicken. For example, a restaurant outbreak investigation revealed that undercooked chicken liver pâté caused a *Campylobacter* infection outbreak among restaurant customers (6).

The U.S. Food and Drug Administration (FDA) Food Code provides the basis for state and local food codes that regulate retail food establishments in the United States. This Code contains regulatory guidance aimed at preventing cross-contamination in restaurants. This guidance includes the following prescriptions: properly clean food contact surfaces (includes washing, rinsing, and sanitizing), minimize bare hand contact with food that is not in RTE form (e.g., raw chicken), and separate raw animal foods (e.g., raw chicken) from other foods (e.g., RTE foods) (10). The FDA Food Code also contains guidance aimed at ensuring that

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raw meat and poultry are cooked to a high enough temperature to kill foodborne pathogens. Specifically, the Food Code states that raw chicken should be cooked to 165°F (73.9°C) or above for at least 15 s and that final cook temperatures should be routinely measured with a thermometer to ensure that the correct temperature is reached (10, 11). The Food Code also states that persons in charge (e.g., managers) of retail establishments should be knowledgeable about various food safety topics, including adequate temperatures for safe cooking of potentially hazardous foods such as raw chicken (12).

Information about how chicken is prepared in restaurants and about manager knowledge of safe chicken preparation are essential to the development of effective interventions. However, relatively little information exists on these topics. This study was undertaken to fill the data gap. Specifically, the study was conducted to assess the frequency of chicken preparation practices linked with cross-contamination prevention and proper cooking and to assess manager knowledge of safe chicken preparation. Where appropriate, we discuss results of the study in the context of the FDA Food Code.

MATERIALS AND METHODS

This study was conducted by the Environmental Health Specialists Network (EHS-Net), a network of environmental health specialists and epidemiologists focused on the investigation of environmental factors that contribute to foodborne illness. EHS-Net is a collaborative project of the Centers for Disease Control and Prevention (CDC), the FDA, the U.S. Department of Agriculture (USDA), and state and local health departments. In 2008, when this study was conducted, the state and local EHS-Net sites were in California, Connecticut, Georgia, Iowa, Minnesota, New York, Oregon, Rhode Island, and Tennessee.

The study protocol was cleared by the CDC Institutional Review Board and the appropriate review boards at the EHS-Net sites. All data collectors (EHS-Net environmental health specialists) participated in training designed to increase data collection consistency.

Data collectors obtained data from approximately 50 restaurants at each EHS-Net site. Restaurants were defined as establishments that prepare and serve food or beverages to customers but that are not institutions, food carts, mobile food units, temporary food stands, supermarkets, restaurants in supermarkets, or caterers. Restaurants that did not cook raw chicken (i.e., chicken that has not undergone a kill step and needs further cooking to reduce pathogens to a level unable to cause adverse health outcomes) were excluded from the study.

To request participation in the study, data collectors called restaurants randomly selected from lists of restaurants located in predefined geographical areas of each of the EHS-Net sites. When the manager agreed to participate in the study, the data collector arranged for an on-site interview with a kitchen manager and an observation of chicken preparation. Only one restaurant from any given regional or national chain was included for each EHS-Net site. For example, if chain A had three restaurants at an EHS-Net site, only one of those would be eligible to participate at that site. Only English-speaking managers were interviewed. Data collection was anonymous, i.e., no data that could identify individual restaurants or managers were collected.

Once on site, data collectors interviewed the manager about restaurant characteristics and raw chicken preparation and cooking

TABLE 1. Data on restaurant demographics obtained from interviews with 448 kitchen managers

Interview item	No. of responses	% of total
Restaurant ownership		
Independent	299	66.7
Chain	149	33.3
Menu description		
American	268	59.8
Italian	49	10.9
Mexican	46	10.3
Asian	46	10.3
Other	39	8.7

practices. Preparation questions focused on cross-contamination prevention. Topics included policies and practices concerning cleaning of food contact surfaces used to prepare raw chicken, use of disposable (single use) gloves when preparing raw chicken to minimize bare hand contact, use of cutting boards designated for only raw chicken to separate chicken from other foods, and washing or rinsing raw chicken before preparation. For some questions, managers were asked to rate the frequency with which they engaged in specific practices on a 5-point Likert scale ('never,' 'rarely,' 'sometimes,' 'often,' and 'always').

Cooking questions focused on the use of thermometers to determine final cook temperatures and whether thermometers were calibrated (i.e., checked for accuracy). The interview also included several food safety knowledge questions. Data collectors also collected observational data on chicken preparation and cooking; these data are not presented here.

We conducted univariate analyses to obtain descriptive statistics on the variables of interest. Data from Likert scale questions were collapsed into two categories ('never,' 'rarely,' and 'sometimes' in one and 'often' and 'always' in the other). Analysis was conducted with SPSS 19 statistical software (SPSS Inc., Chicago, IL).

RESULTS

Restaurant characteristics. Kitchen managers in 448 restaurants agreed to participate in the study. Seventy-four percent of contacted managers agreed to participate (this percentage is based on data from eight of the nine EHS-Net sites; participation rate data were unavailable for one site). Most managers said that their restaurant was independently owned and served an American menu (Table 1). The median number of meals served daily in these restaurants was 200 (25th percentile, 100 meals; 75th percentile, 400 meals).

Cross-contamination prevention. More than 90% of managers said that their restaurant had a cleaning policy regarding food contact surfaces used to prepare raw chicken (Table 2). When asked to describe their cleaning policies, more than 80% of managers said that they washed, rinsed, and sanitized food contact surfaces, as recommended by the FDA. However, some managers also described cleaning policies that did not meet FDA recommendations. These managers said that they washed and rinsed surfaces but did not sanitize them (10%), that they used only sanitizer (e.g.,

TABLE 2. Data on restaurant chicken cross-contamination prevention practices obtained from interviews with 448 kitchen managers^a

Interview item	No. of responses	% of N
Is there a cleaning policy regarding food contact surfaces that have been used to prepare raw chicken? (N = 412) ^b		
No	38	9.2
Yes	374	90.8
What is the policy for how food contact surfaces are cleaned and/or sanitized after they have been used for raw chicken? (N = 374) ^c		
Wash, rinse, sanitize	312	83.4
Wash, rinse, do not sanitize	38	10.2
Only sanitize	17	3.8
Wipe surfaces with towel stored in sanitizer solution	107	28.6
Wipe surfaces with towel not stored in sanitizer solution	15	4.0
Other ^d	45	12.0
How often are single-use (disposable) gloves used during the preparation of raw chicken? (N = 446)		
Never, rarely, sometimes	126	25.3
Often, always	320	71.7
How often do you designate certain cutting boards for raw meat only? (N = 424)		
Never, rarely, sometimes	171	40.3
Often, always	253	59.7
How often is chicken washed or rinsed before preparation? (N = 444)		
Never, rarely, sometimes	258	58.1
Often, always	186	41.9

^a Number of total responses differs for each question because of missing data or skip patterns in the interview.

^b This question was answered only by managers of restaurants in which raw chicken was prepared in some way before cooking.

^c Participants were able to provide multiple responses to the question; thus, the number of responses add to more than 374 and the percentages add to more than 100.

^d Examples of this response are “bleach, wash, rinse” and “rinse and sanitize.”

sanitizer spray bottle) (4%), and that they only wiped surfaces using a towel that was (29%) or was not (4%) stored in sanitizer solution. One-quarter of managers said that disposable gloves were never, rarely, or only sometimes used during the preparation of raw chicken. Forty percent said that they never, rarely, or only sometimes designated certain cutting boards for raw meat only (including chicken). Forty-two percent said that raw chicken was often or always washed or rinsed before preparation.

Cooking. Forty-six percent of managers said that food workers used the FDA-recommended method of taking temperatures with a thermometer to determine when chicken had reached its final cook temperature (Table 3). However,

TABLE 3. Data on restaurant chicken cooking practices obtained from interviews with 448 kitchen managers^a

Interview item	No. of responses	% of N
How do food workers determine when chicken has reached its final cook temperature? (N = 448) ^b		
Chicken's appearance	211	47.1
Chicken's feel or touch	124	27.7
Timer	128	28.6
Experience, skill	70	15.6
Thermometer	205	45.8
Other ^c	53	11.8
How often are thermometers calibrated? (N = 202)		
At least once per day	56	27.7
At least once per week	44	21.8
At least once per month	30	14.9
Less than once per month	3	1.5
Never	23	11.4
Other ^d	12	5.9
Unsure	34	16.8

^a Number of total responses differs for each question because of missing data or skip patterns in the interview.

^b Participants were able to provide multiple responses to the question; thus, the number of responses add to more than 448 and the percentages add to more than 100.

^c Examples of this response are “cook till the chicken floats in the fryer” and “sauce gets thick.”

^d Examples of this response are “sometimes” and “when needed.”

54% of managers also reported other methods to determine final cook temperature. These methods included chicken's appearance (47%), chicken's feel or touch (28%), a timer (29%), and experience and skill (46%). Of the managers who reported using a thermometer, 28% said thermometers were never calibrated or were calibrated less often than once per week. Seventeen percent of managers did not know how often their thermometers were calibrated.

Manager knowledge. When asked to what temperature raw chicken needed to be cooked for it to be safe to eat, 43.3% (194) of managers correctly reported the temperature recommended by the FDA (165°F [73.9°C]). One-quarter (24.6%, 110) of managers provided a temperature that was below 165°F (median, 155°F [68.3°C]; minimum, 90°F [32.2°C]; maximum, 160°F [71.1°C]), and 24.8% (111) provided a temperature that was above 165°F (median, 180°F [82.2°C]; minimum, 168°F [75.6°C]; maximum, 500°F [260°C]). Only 7.4% (33) of managers said that they did not know the answer to this question. Managers were also asked which two pathogens among *Salmonella*, *Campylobacter*, *Staphylococcus aureus*, and *Escherichia coli* O157:H7 were most likely to contaminate their kitchens during raw chicken preparation. One correct response, *Salmonella*, was given by 86.4% (387) of managers, and the other correct response, *Campylobacter*, was given by 15.2% (68). Only 13.6% (61) correctly reported that

both *Salmonella* and *Campylobacter* were likely to cause contamination. Almost 17% (16.5%, 74) chose *S. aureus*, and 56.9% (255) chose *E. coli* O157:H7; these pathogens are not typically associated with chicken. Almost 10% (9.6%, 43) of managers said that they did not know the answer to the question.

DISCUSSION

These results suggest that some restaurants are not engaging in practices that could reduce the potential for pathogen cross-contamination from raw chicken to the environment or food. Although most managers said that their restaurants followed FDA-recommended policies for cleaning surfaces used to prepare raw chicken, which require washing, rinsing, and sanitizing, some managers also described policies that did not follow this FDA guidance, such as only wiping surfaces with a towel. These findings are concerning, because it is difficult to prevent cross-contamination when food contact surfaces are not adequately washed, rinsed, and sanitized.

Some managers said that they did not often use disposable gloves during preparation of raw chicken or that they did not designate specific cutting boards for use only with raw meat. Although cross-contamination from raw chicken can be prevented without the use of disposable gloves or designated cutting boards, implementing these preventive practices can make it easier to prevent cross-contamination and consequently reduce foodborne illness risk.

Over half of the managers said that they rinsed or washed raw chicken. This process may reduce pathogens on the chicken but can also create cross-contamination (e.g., through rinse water splashing onto other food or the environment). USDA regulations allow poultry processing facilities to rinse poultry as long as the process does not create cross-contamination (9). Currently, no regulations or guidelines have been published for retail food establishments regarding rinsing raw chicken. Rinsing of raw chicken may be appropriate for restaurants if they adequately address the cross-contamination risk associated with this practice. In this study, we did not assess restaurant practices concerning cross-contamination prevention during rinsing of raw chicken. Because our results suggest that this practice is widespread, future food safety research and intervention efforts should address this topic.

The findings from this study also suggest that some restaurants are not engaging in practices that could help ensure adequate cooking of chicken. The use of thermometers to determine the final cook temperature of chicken is a crucial step for ensuring that chicken is safe to eat. The fact that some managers reported using methods other than thermometers (e.g., chicken's appearance) to determine adequate cooking is a matter of concern. However, taking the temperature of every piece of chicken cooked is not always necessary. When a restaurant has established standard operating procedures that have been tested and verified to ensure that they consistently address food safety hazards, the restaurant can rely on those procedures (13).

Some of the restaurants in our study may have had such procedures in place related to cooking chicken; we did not collect data on this topic. A relatively small percentage of managers said that the thermometers they used to determine the final cook temperature of chicken were not often or never calibrated. However, even this small percentage is concerning because uncalibrated thermometers may give inaccurate temperature readings, leading to undercooked chicken.

Findings from this study suggest that manager knowledge concerning the temperature to which raw chicken needed to be cooked for it to be safe to eat is lacking. One-quarter of managers thought that the temperature to which raw chicken needed to be cooked was lower than the FDA-recommended minimum temperature. When managers do not know this minimum temperature, it seems unlikely that this standard will be met. Another one-quarter of managers thought that the temperature to which raw chicken needed to be cooked was higher than the FDA-recommended temperature. Although cooking chicken to a temperature higher than the recommended minimum temperature is safe, the fact that many managers believed that chicken needed to be cooked to these higher temperatures demonstrates these managers' lack of current food safety knowledge about chicken.

Most managers knew that *Salmonella* was commonly associated with raw chicken. However, few knew that *Campylobacter* was also commonly associated with raw chicken. Chicken contamination prevention practices do not generally vary by pathogen; basic steps to address the risk of pathogen contamination would be effective for both *Campylobacter* and *Salmonella*. However, simple knowledge of pathogens associated with food is not enough to ensure safe food; steps must be taken to prevent exposure to these pathogens. Our data suggest that manager knowledge of pathogens associated with food is not necessarily associated with effective prevention practices.

A limitation of our study is that the data were collected through self-report methods and thus may be susceptible to a bias toward overreporting socially desirable behaviors, such as preparing chicken properly. Data were collected from English-speaking managers only; thus, our data may not represent the proportion of kitchen managers who are not English speakers.

The data reported here indicate that knowledge and practices associated with restaurant chicken preparation and cooking need improvement. Findings from this study could be used by food safety programs and the restaurant industry to target training and intervention efforts to improve chicken preparation and cooking practices. Training and intervention efforts could focus on the more worrisome findings from this study, such as inadequate cleaning and sanitizing practices and lack of knowledge concerning the recommended final cook temperature of chicken. Intervention efforts could also focus on identifying and addressing the barriers to safe chicken preparation and cooking practices.

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