Final Report

RTI Project No. 0215472
FSIS Contract No. AG-3A94-D-16-0130

August 20, 2019

Food Safety Consumer Research Project: Meal Preparation Experiment Related to Poultry Washing

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Executive Summary

The Food Safety and Inspection Service (FSIS) of the U.S. Department of Agriculture (USDA) contracted with RTI International and its subcontractor North Carolina State University (NCSU) to conduct meal preparation experiments to evaluate consumer food handling behaviors in a test kitchen. The research team is conducting five separate iterations of the study to address a specific consumer behavior and to determine the effectiveness of a behavior change intervention. The meal preparation experiments are part of a larger 5-year annual study that also includes focus groups (two iterations) and web surveys (two iterations). This report describes the results of the second iteration of the meal preparation experiment that examined consumers' washing of poultry when preparing a meal of chicken thighs.

RTI and NCSU conducted the study in eight test kitchen facilities located in the metro Raleigh-Durham area of North Carolina and Lillington, North Carolina, a rural location, with individuals who self-reported washing or rinsing raw poultry when cooking at home. Three existing Office of Public Affairs and Consumer Education (OPACE) food safety messages were delivered to intervention participants via email before their appointment; each message was sent twice as part of the signature line of the NCSU scheduling team. One message focused on not washing poultry before cooking to avoid cross-contamination and included a link to an OPACE YouTube video (with screenshot of video), one message recommended using separate cutting boards for raw and ready-to-eat foods (with graphic), and one message featured an OPACE "Clean" infographic with information on not washing poultry and the messages to wash hands for 20 seconds with soap and warm water and to wash kitchen surfaces and equipment (e.g., utensils).

In each test kitchen, six cameras recorded participants' actions at various locations throughout the kitchen and recorded the meal preparation from beginning to end. Participants in the control and treatment groups were observed while cooking chicken thighs (spiked with harmless traceable nonpathogenic *E. coli* strain DH-5 alpha) and preparing a mixed green salad recipe to determine whether they washed their poultry, the extent of cross-contamination throughout the kitchen, and whether they adhered to other food safety behaviors throughout meal preparation. Following meal preparation and participants' cleaning and/or sanitizing of the kitchen, the study team collected microbiological samples from surfaces and lettuce and analyzed the samples for prevalence and level of DH-5 alpha.

Participants participated in a post-observation interview to collect information on their usual food preparation practices and possible predictors of behavior change. A total of 300 people participated in the study (158 control, 142 treatment).

ES.1 Key Findings

The key findings from the study are summarized below:

Poultry Washing

- The food safety messages in the emails effectively encouraged participants not to wash raw chicken thighs before cooking: 93% of treatment group participants did not wash the chicken compared with 39% for the control group.
- When washing the chicken, most participants rinsed it in the sink rather than submerging it in the sink or container. Participants who wash chicken when preparing it at home reported that they did so to remove blood/slime (30%) or because that is how a family member does it (19%).
- In the post-observation interviews, 66% of participants stated that reading the email messages influenced their cooking behavior in the kitchen; of these participants, 40% reported that their actions were influenced by learning new information about preparing poultry.

Handwashing

- Proper handwashing was addressed in one of the email messages but did not influence participants' handwashing practices. Among all handwashing events required before or during meal preparation, only 2% included all steps necessary to be considered an adequate handwashing event (defined by the Centers for Disease Control and Prevention's recommended steps).
- Comparing the results for Years 1 and 2, there were no significant differences in terms of handwashing events attempted and successful and unsuccessful handwashing attempts. As in Year 1, the most documented reason for not successfully washing hands was failing to rub hands with soap for at least 20 seconds.

Cleaning and Sanitizing Surfaces and Equipment

- The intervention did not appear to affect whether participants attempted cleaning and sanitizing when required or whether it was successful for the kitchen counter, the sink among poultry washers, and knives or cutting boards used to prepare chicken. There was not a significant difference in successful cleaning and sanitizing events between the control and treatment groups.
- The use of the same cutting board for preparing the chicken and the salad was lower among treatment group participants compared with the control group, suggesting an intervention effect—one of the email messages advised using separate cutting boards for raw meat/poultry and RTE foods.

Cross-contamination and Microbiological Analysis

- The lettuce from the prepared salad was found to be contaminated at a frequency of 26% and 20% for poultry washers and nonwashers, respectively. Hand-facilitated cross-contamination is suspected to be an important factor in explaining this level of cross-contamination.

- High levels of the tracer *E. coli* strain DH-5 alpha detected in the sink and on the salad lettuce suggest that microbes harbored in the sink from chicken, packaging, or contaminated hands are a larger cause for concern than splashing contaminated chicken fluids onto the counter.
- As previously noted, there was no impact on cleaning and sanitizing or handwashing behaviors when comparing the control and treatment groups, but for nonpoultry washers, participants in the control group were more likely to contaminate the salad than those in the treatment group, suggesting an intervention effect.

Thermometer Use

- Forty-seven percent of all participants used a food thermometer on at least one chicken thigh. There were no significant differences between the control and treatment groups.
- In the Year 1 study, 34% of participants in the control group used a thermometer on at least one turkey patty, while in Year 2, 44% of the control group used a thermometer on at least one chicken thigh.

ES.2 Implications for OPACE Outreach Efforts

Exposure to the email messages on risks of poultry washing encouraged participants not to wash raw poultry; however, more needs to be done to increase adherence to more nuanced recommended practices such as proper cleaning and sanitizing of kitchen surfaces and equipment and proper handwashing. Based on the study findings and previous work in the literature related to risk communication, we recommend that OPACE consider designing food safety messaging that:

- changes the frame of "don't wash your poultry" messaging to focus on preventing contamination of sinks, where fruits and vegetables are often washed;
- clarifies that recommendations to not wash poultry include not rinsing as well;
- emphasizes the importance of both cleaning *and* sanitizing;
- continues to emphasize handwashing and cross-contamination because improvements are needed in these areas;
- uses social media to reach a broad audience quickly; and
- emphasizes USDA's role as a credible source of information.

There is a great deal more to learn about consumer attitudes and behaviors as they relate to food safety, in particular related to actions consumers take to prevent cross-contamination in the kitchen. Understanding these factors will help OPACE create more targeted messaging and incorporate everyday contexts into food safety communications.

1. Introduction

This report describes the study methods and presents the results from a meal preparation study related to poultry washing, conducted as part of the Food Safety Consumer Research Project. The study, conducted in test kitchens, used an experimental design to measure consumers' adherence to the "clean" message by measuring the rate of not washing poultry (the recommended practice to avoid cross-contamination) and adherence to following recommended cleaning and sanitation practices to compare behaviors between participants who received an educational intervention and those who did not. The poultry washing study is the second of five iterations of a meal preparation experiment in which consumers are observed while preparing meat and poultry products regulated by the U.S. Department of Agriculture's (USDA's) Food Safety and Inspection Service (FSIS). This report details the study design, data collection procedures, and data analysis approach and presents the results of the study for poultry washing, cleaning and sanitation practices, handwashing compliance, thermometer use, and cross-contamination. FSIS can use the results of this study to enhance consumer messaging on avoiding cross-contamination through cleaning and sanitizing and not washing poultry. Additionally, the report compares key behavioral outcomes for Year 1 and 2 of the study. The rest of this section provides an overview of the Food Safety Consumer Research Project, describes the purpose of the second iteration of the meal preparation experiment, and details the organization of the report.

1.1 Background and Project Overview

USDA FSIS' Office of Public Affairs and Consumer Education (OPACE) ensures that all segments of the farm-to-table chain receive valuable food safety information. The consumer education programs developed by OPACE's Food Safety Education Staff inform the public on how to safely handle, prepare, and store meat, poultry, and egg products to minimize incidence of foodborne illness.

OPACE strives to continuously increase consumer awareness of recommended food safety practices with the intent to improve food handling behaviors at home. OPACE shares its messages through the *Food Safe Families* campaign, social media, Ask Karen (an online database of frequently asked food safety questions), the FSIS web site, FoodSafety.gov, the Meat and Poultry Hotline, publications, and events. These messages are focused on the four core food safety behaviors: clean, separate, cook, and chill. Additionally, OPACE's public education and outreach initiatives reach vulnerable and underserved populations.

By testing new consumer messaging and tailoring existing messaging, FSIS can help ensure that it is effectively communicating with the public and promoting behavior change with a goal of improving consumer food safety practices. FSIS contracted with RTI International to conduct consumer research over a 5-year period, fiscal year 2017 through fiscal year 2022.

RTI is teaming with researchers at North Carolina State University (NCSU) to conduct the project. This behavioral research will include observation studies of food preparation in test kitchens using an experimental design (five iterations), focus group studies (two iterations), and web surveys (two iterations). Each iteration of each data collection activity will address different research questions and use a different sample of consumers. This research will provide insight into the effect FSIS consumer outreach campaigns have on consumers' food safety behaviors. FSIS will use the results of this research to enhance messaging and accompanying materials to improve food safety behaviors of consumers.

1.2 Objectives of Meal Preparation Experiment Related to Poultry Washing

Previous research suggests that self-reported data collected through surveys on consumers' food safety practices are unreliable because consumers tend to overreport their behavior (e.g., simply rinsing their hands instead of washing with soap and water for 20 seconds as recommended) (Redmond & Griffith, 2003). Because of this limitation, observation is a preferred approach for collecting information on consumers' actual food safety practices. Studies that have used direct observation of consumer food handling have reported that many consumers commit errors during preparation and self-report different actions (Anderson et al., 2004; DeDonder et al., 2009; Jay, Comar, & Govenlock, 1999; Kendall et al., 2004; Redmond, Griffith, Slader, & Humphrey, 2004). The results of the meal preparation experiments will help FSIS assess adherence to the four recommended food safety behaviors of clean, separate, cook, and chill; determine whether food safety messaging focused on those behaviors affects consumers' safe food handling behaviors; and determine whether consumers introduce cross-contamination during food preparation.

Each iteration of the meal preparation experiment addresses a specific consumer behavior. The second iteration examined consumer poultry washing and cleaning and sanitizing practices in the kitchen. Washing or rinsing of raw poultry is not recommended because bacteria in poultry juices can cross-contaminate other foods, utensils, and surfaces. Droplets have been shown to be dispersed up to 50 cm in front of a sink and 60 to 70 cm to either side of a sink where chicken was washed (Everis & Betts, 2003). For this study, participants randomized to the control or treatment group (exposed to intervention on poultry washing/avoiding cross-contamination) were asked to cook chicken thighs and prepare a mixed green salad with lettuce, carrots, and celery as they would at home. We observed participants throughout meal preparation to determine whether they washed their poultry and whether they adhered to other food safety practices such as handwashing and cleaning and sanitizing of surfaces and utensils. The study also assessed pathogen transfer during meal preparation and included the collection of microbiological samples from lettuce (from the ready-to-eat [RTE] salad) and kitchen surfaces. Post-observation interviews collected information on participants' reasons for following or not following recommended food safety practices during meal preparation.

Table 1-1 lists the study's research questions, data sources, and the corresponding section of this report with the results of the analysis conducted to address each research question.

Table 1–1. Research Questions, Data Sources, and Location of Results in Report

Research Question	Data Source	Location in Report
Is the rate of poultry washing lower for the treatment group compared with the control group?	Observations	Section 3.2, Table 3-3
What is the rate of successful cleaning and sanitizing attempts for kitchen surfaces, the sink, knives, and cutting boards? Are the rates different for the control and treatment groups? What are the reasons for unsuccessful cleaning and sanitizing attempts?	Observations	Section 3.4, Tables 3-7, 3-8, 3-9, 3-10, 3-11
What is the rate of thermometer use for the control and treatment groups?	Observations	Section 3.5, Table 3-13
What methods are used to determine doneness in lieu of a food thermometer for the control and treatment groups?	Observations, post-observation interviews	Section 3.5, Table 3-14
What is the rate of successful handwashing attempts for the control and treatment groups? What are the reasons for unsuccessful handwashing attempts?	Observations	Section 3.3, Tables 3-5, 3-6, Figures 3-1, 3-2
What are the prevalence and the levels of contamination of kitchen surfaces and salad lettuce for the control and treatment groups?	Microbiological sampling data	Section 3.6, Tables 3-15, 3-16
What elements of the intervention emails are effective at encouraging participants to follow recommended practices? (treatment group only)	Post-observation interviews	Section 3.7, Table 3-17
What differences are there between key behavioral outcomes for Year 1 and 2 of the study?	Observations and microbiological sampling data	Section 3.8, Table 3-18

1.3 Organization of Report

This report is organized as follows:

- Section 2 describes the research design, data collection procedures, and analysis approach.
- Section 3 presents and discusses the results of the study for poultry washing, handwashing compliance, cleaning and sanitizing practices, thermometer use, cross-contamination, and other behaviors, as well as participants' response to the intervention.

- Section 4 concludes the report by discussing the implications of the study results for OPACE's consumer food safety education and outreach efforts.

The appendices are organized as follows:

- Appendix A: Description of intervention
- Appendix B: Power analysis to determine sample size for study
- Appendix C: List of equipment provided in each test kitchen
- Appendix D: Observation script and recipes
- Appendix E: Microbiological methods (provides complete description of the selection of the surrogate and the microbiology methodology)
- Appendix F: Post-observation interview guide
- Appendix G: Screening questionnaire for participation in study
- Appendix H: Observation rubric for coding participant actions in the kitchen

2. Study Methods

This section describes the methodology for the meal preparation experiment, the recruitment procedures, the approach for coding and analyzing the observations and post-interview data, and the procedures for collecting and analyzing the microbiological samples. The Office of Management and Budget (OMB control number 0583-0169, expiration date 6/30/2019) and NCSU's Institutional Review Board (IRB) approved the study protocol and materials.

2.1 Meal Preparation Experiment Methodology

2.1.1 Research Design

The second meal preparation experiment focused on the food safety behavior of "clean," specifically whether participants did not wash poultry (as recommended) following exposure to food safety messaging USDA FSIS OPACE routinely uses and to assess the extent of cross-contamination in the kitchen due to failure to follow recommended cleaning and sanitation practices.

We recruited individuals who self-reported washing/rinsing chicken when preparing raw chicken at home and randomly assigned participants to a control group (no exposure) or a treatment (intervention) group. For the purposes of this studying, "washing" was defined as rinsing or submerging the chicken into a container or the sink. The treatment group received USDA FSIS OPACE's "clean" messages by including these messages as part of the email scheduling process (see Appendix A).

We calculated the sample size to determine the minimum number of participants needed to provide a level of confidence that the meal preparation experiment was sufficiently powered, meaning that a change of the anticipated size or greater would be interpreted as occurring beyond chance (i.e., statistically significant). Based on the power analysis (see Appendix B), the desired sample size was 306 (153 per group) to provide 80% statistical power and a 95% level of confidence. The sample size calculation took into consideration the anticipated base rate for poultry washing and the anticipated distributional characteristics of a dichotomous outcome and the research design that is feasible given the logistical constraints of conducting test kitchen observations in one state.

2.1.2 Study Procedures

Figure 2-1 summarizes the study procedures. We conducted the study in eight test kitchen facilities located in the Raleigh-Durham area of North Carolina (Wake, Durham, and Orange Counties) and Lillington, North Carolina, a rural location (Harnett County). The test kitchens were similar in layout—each had two compartment sinks, refrigerators, and stove/ovens—and were stocked with the same meal preparation equipment (dishes, knives, utensils,

cutting boards, thermometer). In each test kitchen, six cameras recorded participants' actions at various locations throughout the kitchen and recorded the meal preparation from beginning to end. Researchers monitored the cameras to identify any trigger behaviors for follow-up discussion in the post-observation interviews (see Table 2-1).

Figure 2-1. Study Procedures for Meal Preparation Experiment on Poultry Washing

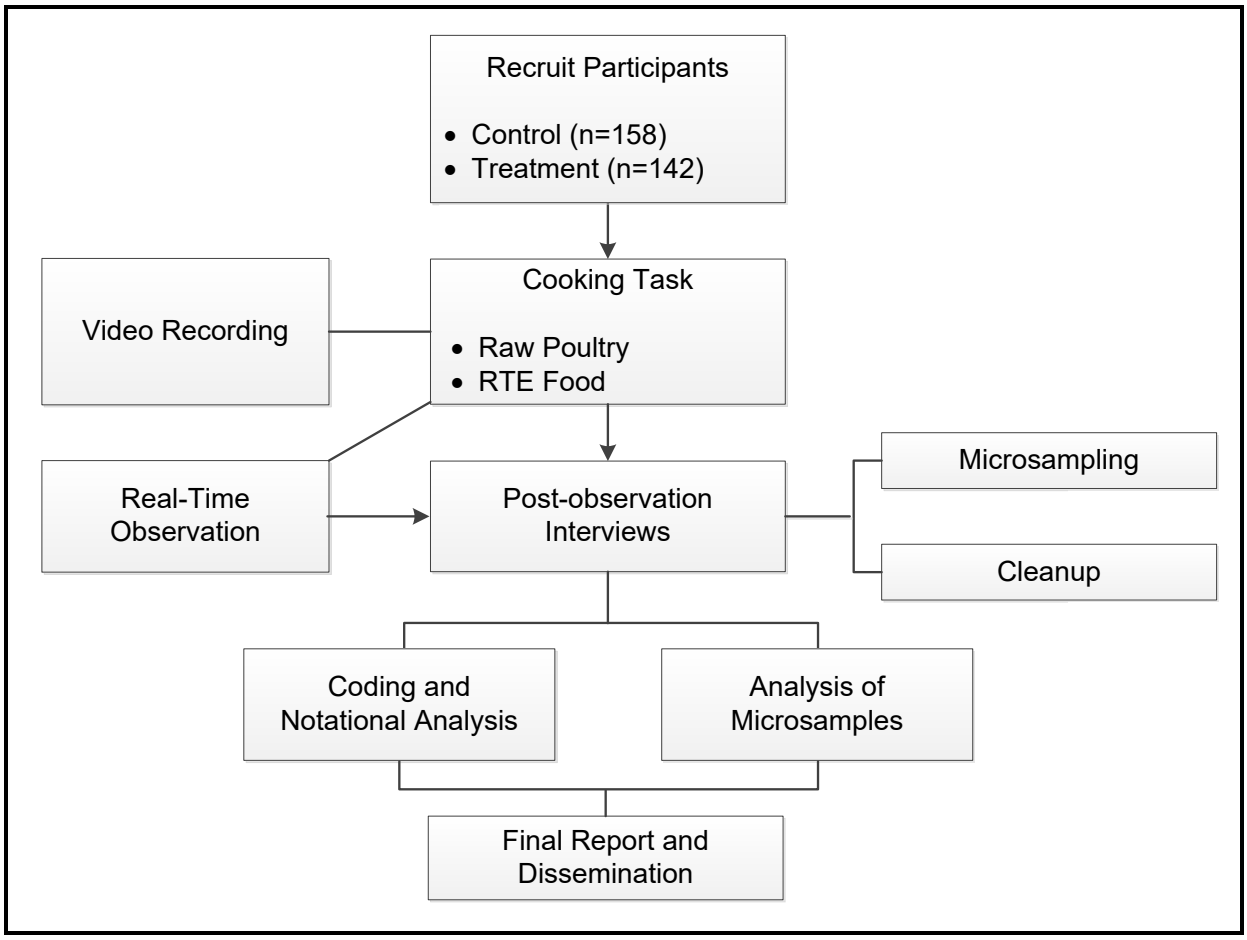


Table 2-1. Trigger Behaviors

Trigger	Options
Handwashing – start of meal preparation	▪ Washed hands according to Centers for Disease Control and Prevention (CDC) guidelines ▪ Did not wash hands according to CDC guidelines
Hand drying	▪ Dried hands after washing using paper towels ▪ Did not use paper towels to dry hands
Packaging	▪ Did not move packaging for raw chicken thighs around in food preparation area ▪ Moved packaging for raw chicken thighs around in food preparation area
Handwashing – raw product	▪ Washed hands according to CDC guidelines after handling raw chicken thighs ▪ Did not wash hands according to CDC guidelines after handling raw chicken thighs
Poultry washing/rinsing	▪ Did not wash or rinse chicken thighs ▪ Washed/rinsed chicken thighs
Thermometer use	▪ Used thermometer on chicken thighs ▪ Did not use thermometer on chicken thighs
Produce washing	▪ Washed produce ▪ Did not wash produce
Cutting board use	▪ Did not use the same cutting board/plates for produce and raw chicken thighs ▪ Used same cutting board/plates for produce and raw chicken thighs
Knife use	▪ Did not use same knife for produce and raw chicken thighs ▪ Used same knife for produce and raw chicken thighs
Cutting board/utensils wash step	▪ Washed and then sanitized cutting board and utensils with soap and water ▪ Did not wash and then sanitize cutting board and utensils with soap and water
Drying equipment	▪ Dried kitchen equipment (cutting boards, knives) with paper towels ▪ Did not dry kitchen equipment with paper towels
Kitchen surfaces	▪ Washed and then sanitized kitchen surfaces that raw chicken thighs contacted ▪ Did not wash and then sanitize kitchen surfaces that raw chicken thighs contacted
Sink	▪ Washed and then sanitized sink after contact with raw chicken thighs ▪ Did not wash and then sanitize kitchen surfaces that raw chicken thighs contacted

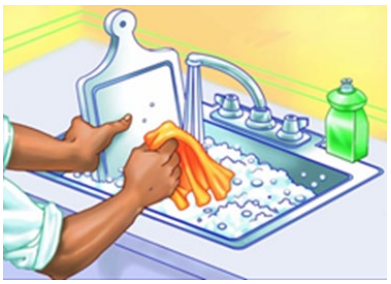
Note: The recommended (safe) practice is listed as the first option.

We used convenience sampling to recruit participants using a variety of approaches. Section 2.2 describes the participant screening criteria and recruitment procedures. Participants were told they would receive a $75 gift card and gift (food thermometer) for taking part in the 2-hour study. Participant recruitment began May 10, 2018. We conducted observations starting May 18, 2018, and ending December 11, 2018.

Six cameras in each test kitchen recorded participant behaviors during meal preparation.

We randomly assigned participants to the treatment or control group when the appointment was scheduled with the goal of 153 participants in each group. Three OPACE food safety messages were delivered to intervention participants via three separate emails before their appointment. Each message was sent twice as part of the signature line of the NCSU scheduling team (see Appendix A):

Message 1 (in Emails 1 and 3): Prepping dinner? Avoid cross-contamination! Use 2 separate cutting boards: 1 for produce & bread and 1 for raw meat, poultry, & seafood.



Message 2 (in Emails 1 and 2): Why do we recommend NOT washing your meat & poultry? The answer is simple, it doesn't destroy bacteria, it spreads it! Click here to learn more https://www.youtube.com/watch?v=SBeMcOvDoi8&app=desktop)

Message 3: (in Emails 2 and 3): DON'T WASH YOUR CHICKEN! Washing will spread bacteria & won't even clean your bird! The only way to be safe is to cook your chicken to 165°F! #FoodSafety

We sent Email #1 to intervention participants on the day on which their appointment was scheduled. We sent Email #2 5 days before participants' scheduled appointment, and we sent Email #3 2 days before participants' scheduled appointment. The control group received appointment reminders without the messaging.

We scheduled appointments at one of the test kitchen locations based on kitchen availability. Once participants arrived at the test kitchen, a study team member greeted them and instructed them to read and sign an informed consent form. Using a script to ensure consistency in delivery, the study team member described what participants could expect during the study. Initially, we told participants the purpose of the study was testing a new spice blend. Consistent with the approach used in other observation studies, we informed participants of the real purpose of the study following the meal preparation and why it was important from a scientific perspective to inform them after the study was complete[1] (Chapman, Eversley, Fillion, MacLaurin, & Powell, 2010; DeDonder et al., 2009).

A study team member gave participants a laminated recipe card—one side had a mixed green salad recipe and one side had a chicken thighs recipe. A study team member pointed out that cabinets contained utensils, dishes, pans, and cleaning supplies and were labeled accordingly (see Appendix C for a complete list of equipment provided in each test kitchen and a picture of one of the test kitchens). Participants were instructed to prepare the chicken thighs as they would at home (see Appendix D for a copy of the script and recipe) and to tell project staff when the chicken was ready to be baked so that project staff could get a picture of the spice blend on the chicken. When the participant indicated the chicken was ready to be baked, one study team member asked the participant questions about the spice blend in an area outside of the kitchen, while other team members collected samples for microbiological analysis and placed the chicken in the preheated oven. Participants were

[1] After being informed of the study's purpose, participants could opt out of the study; if they did opt out, we did not use their data. Only one participant opted out of the study; thus, his data were not used in the analysis.

then brought back into the kitchen and instructed to prepare the salad while the chicken was baking and to take the chicken out of the oven when they thought it was done. Additional samples for microbiological analysis were taken following meal preparation and participants' cleaning and/or sanitizing of the kitchen.

We used a nonpathogenic strain of *E. coli* (DH-5 alpha) to track any potential cross-contamination from chicken thighs to various locations around the kitchen and to the salad during meal preparation. The chicken thighs were inoculated with the traceable *E. coli* strain, which behaves like *Salmonella*, and tagged with green fluorescent protein (GFP) (Niebuhr et al., 2008). This surrogate and microbiological approach was cleared by FSIS' Office of Public Health Science. *E. coli* is a Gram-negative organism (as is *Salmonella*), behaves similarly to *Salmonella* on raw meat/poultry when exposed to inactivation methods such as heat, has the ability to be differentiated from background microflora, and has been used widely as a surrogate for *Salmonella* in the literature. *E. coli* and *Salmonella* survive longer on surfaces than *Campylobacter* (De Cesare, Sheldon, Smith, & Jaykus, 2003), however, in the context of this study where it could be assumed the RTE salad would be consumed in the home environment almost immediately after preparation, it would be expected that levels of *E. coli* found on surfaces and in the RTE salad would be representative of infectious *Campylobacter* as well.

The inoculated thighs were packaged in a Styrofoam tray with a piece of food grade plastic beneath them and wrapped in clear film. The product included a mock label and the USDA Safe Handling Instructions to resemble chicken thighs purchased at a grocery store. The packaged chicken thighs (two per package) were transported in freezer bags and kept at refrigeration temperatures until the observations occurred.

We cleaned and sanitized all accessible kitchen surfaces (e.g., counters, drawer pulls, stove top), appliances, and other sites after each participant to ensure that any potentially remaining *E. coli* DH-5 alpha contamination was removed before the next participant entered the kitchen. To confirm effective decontamination of the kitchen between participants, one cleaning validation surface swab was taken before a participant began preparing the meal. A total of seven surface samples and one lettuce sample were taken for each observation, resulting in eight total samples per meal preparation event excluding the first 28 observations for which a larger area of the counter was sampled. An NCSU lab processed the swabs to determine the presence and concentration of the *E. coli* DH-5 alpha. Appendix E provides a complete description of the selection of the surrogate and the microbiology methodology.

Supplementing the observations, we conducted semi-structured post-observation interviews to provide insight into participants' views, opinions, and experiences during the meal preparation experiment and asked questions based on the trigger behaviors that were observed during food preparation. The interviews also collected information on antecedents

such as concerns about food safety and previous experience with foodborne illness. Interviews lasted approximately 20 minutes (see Appendix F for the post-observation interview guide).

2.1.3 Pilot Testing

Before initiating the full-scale data collection, we conducted pilot studies to test the study materials, procedures, and the time allotted for data collection. We conducted the pilot with one NCSU food science student and one member of the public related to the student. Based on the pilot observations, we modified the recipes and script to provide clearer information to participants, added behaviors to the list of triggers, and updated the list of needed ingredients and kitchen equipment. Before data collection began, we revised the materials and updated the study's standard operating procedures document. Pilot studies were also conducted to determine the potential spread of pathogens to kitchen surfaces following a chicken washing event to help inform the selection of sampling locations and sampling frequency.

2.2 Recruitment Procedures

The study team used convenience sampling with quotas to help ensure that study participants reflected the demographic characteristics of the U.S. population based on the most recent Census data. We recruited participants using social media outlets, (e.g., Facebook, Twitter) and online advertising platforms (e.g., Craigslist) and by sending emails to Expanded Food and Nutrition Education Program participants (to reach low-income consumers), parents and guardians of the Juntos program (which helps Latinos have more success in middle and high school), and other Latino community groups who work with cooperative extension programs within North Carolina.

Participants had to meet specific inclusion and exclusion criteria. The inclusion criteria were as follows:

- age 18 or older
- primarily speak English or Spanish[2]
- prepare meals at home four or more times a week
- have prepared raw poultry at home within the past 3 months
- rinsed/washed raw poultry the last time a meal was prepared at home using raw poultry
- have a working email address

The exclusion criteria were as follows:

[2] Although the recruiting materials were made available in Spanish, none of the participants requested that the data collection be conducted in Spanish.

- have cooked or worked professionally in a food preparation setting in the past 2 years
- have received any type of food safety training, such as ServSafe
- participated in a study about cooking within the past 12 months

The Year 1 exclusion criteria were updated for Year 2 to exclude those who cooked or worked professionally in a food preparation setting only if they had done so within the past 2 years. In Year 1, respondents were excluded if they had *ever* cooked or worked in a food preparation setting, which led to challenges in recruiting enough respondents to meet the target demographics. An additional exclusion criterion was added in Year 2 to exclude anyone who may have taken part in the Year 1 study (participated in a study about cooking within the past 12 months).

Recruitment materials directed prospective participants to call or email the study team to be screened for eligibility or to a web link that hosted the screening questionnaire (see Appendix G). For participants screened by phone, we invited eligible participants to participate in the study and scheduled an appointment during the screening call. For participants who completed the web-based screener, we contacted eligible participants by phone, invited them to participate in the study, and scheduled an appointment. Appointments were scheduled during work hours, evenings, and weekends to allow for a broader participant pool. After an appointment was scheduled, we sent three confirmation emails leading up to the scheduled appointment. As previously described, food safety messaging was included in the confirmation emails for the treatment group participants.

A total of 300 people participated in the study: 158 in the control group and 142 in the treatment group. Section 3 provides information on the demographic characteristics of participants. The overall eligibility rate (percentage of cases that completed the web-based or phone screening and met the eligibility criteria) was 25%. For prospective participants completing the web-based survey, we screened out approximately 18% because of prior food safety training (e.g., ServSafe) and then 6% of this potential sample because of work experience in the food industry. From this potential sample, we screened out 30% because they prepared meals at home three or fewer times a week. Of the potential participant pool at this point, only 11% self-reported rinsing or washing raw poultry. Among the 300 study participants, we recruited 55% using social media (Facebook and Twitter), 36% using Craigslist, and 9% using other recruiting efforts such as postcards and advertising in Spanish-language newspapers.

The expected show rate for the kitchen preparation study was 80% based on Year 1 experiences; the actual show rate averaged 91%. The higher show rate for Year 2 may be attributable to sending three reminder emails instead of one; thus, we plan to send three reminder emails for the remainder of this project.

2.3 Coding of Observation Data and Analysis

We used notational analysis to assess recorded actions and their frequencies. Notational analysis is a generic tool used to collect observed events and place them in an ordered sequence (Hughes & Franks, 1997); it has been used to track food safety behaviors, because it enables the recording of specific details about events in the order in which they occur by associating a time stamp with actions (Clayton & Griffith, 2004). Using a time stamp is especially useful when looking at sanitation steps limiting cross-contamination or the use of common food contact surfaces and equipment. Notational analysis has been used in both nonparticipant and participant consumer food safety behavior observation studies, as well as participant foodservice observation (Chapman et al., 2010; Clayton & Griffith, 2004; Green et al., 2006; Redmond et al., 2004).

Poultry washing was characterized by whether participants washed or rinsed the chicken (Table 2-2). "Washing" is defined as rinsing or submerging the product into a container or the sink. "Rinsing" is defined as using the sink tap or faucet to run water over the chicken without placing the chicken into any container. "Other" includes participants who rinsed the chicken while it was still inside the packaging or rinsed the chicken under water but used a strainer or colander while doing so. For the purposes of this report, these behaviors are referred to throughout as "washing."

Table 2-2. Observed Washing Behaviors for Handling Raw Chicken

Behavior	Definition
Washing	Submerging product into a container or the sink
Rinsing	Using the sink tap or faucet to run water over the chicken without placing the chicken into any container
Other	Rinsing the chicken while still inside the packaging; rinsing under water but using a strainer or colander

We developed coding rubrics to characterize the following behaviors:

- handwashing
- indirect cross-contamination (failure to properly clean and sanitize surfaces, utensils, and cutting boards)
- thermometer usage

We also observed behaviors related to direct cross-contamination, methods used to determine doneness, and vegetable washing.

A trained coder viewed each video and followed the rubric to indicate level of adherence to recommended behaviors while observing participants. Coders were trained by reviewing the coding rubric and using practice food safety handling scenarios to compare inter- and intra-coding reliability. Incorrect and inconsistent coding situations were discussed with coders to

ensure that proper and consistent training occurred. Appendix H provides the coding rubrics.

For each behavior of interest, we tabulated the responses for the control and treatment groups and conducted statistical testing to test for differences in proportions between the two groups. We used a *p* value of ≤.05 to indicate statistical significance.

2.4 Microbiological Data and Analysis

As previously noted, a nonpathogenic strain of *E. coli* DH5-alpha that fluoresces under UV light was selected as the surrogate for this year because of its safety, similar behavior to foodborne pathogens associated with poultry, and ability to be differentiated from background microflora. We determined the concentration of DH5-alpha on swab samples by enumerating the bacteria on selective media and visualizing colonies under UV light. To confirm effective decontamination of the kitchen between participants, one cleaning validation surface swab was taken before a participant began preparing the meal. A total of seven surface samples, one of which was taken before a participant entered the kitchen and used as a control, and one lettuce sample were taken for each observation, resulting in eight total samples per meal preparation event, excluding early events for which a larger area of the counter was sampled. Appendix E provides additional information on the microbiological inoculation and sampling.

For each surface and lettuce samples, we calculated prevalence and level of contamination for two subpopulations: (1) participants who washed the chicken thighs and (2) participants who did wash the chicken thighs. Within each subpopulation, we conducted statistical testing to test for differences between the treatment and control groups. We used a *p* value of ≤.05 to indicate statistical significance.

2.5 Post-observation Interviews and Analysis

The post-observation interviews collected information on participants' behaviors while cooking the meal and information about their food handling behaviors that were not observed (Appendix F provides the interview guide). We audio recorded the interviews and had typed transcripts prepared using the service TranscribeMe. We coded the transcripts and analyzed the data using QSR International NVivo, Version 12 software.

Participants in the treatment group answered questions about the intervention messages they received via email, including whether they read the emails, what they remembered about the emails if they read them, and whether they watched the YouTube video linked in the email. If participants remembered seeing at least some of the messages, graphics, or video, they were asked if the information influenced their actions in the kitchen during the study and whether they believe the information will influence how they cook at home in the future.

Questions posed to all participants during the interview were informed by the trigger behaviors that were observed during meal preparation (see Table 2-1) and related to:

- washing hands before meal preparation;
- washing or rinsing raw chicken;
- using a food thermometer;
- washing hands after touching raw chicken or packaging;
- using paper versus reusable towels during meal preparation;
- cleaning and/or sanitizing cutting boards, utensils, and other kitchen items; and
- cleaning and/or sanitizing the sink and counters.

For each behavior, the interviewer prompted the participant based on the actions observed and asked why he or she did the behavior and whether that is a behavior he or she typically does at home.

Following data collection and transcription, analysts uploaded the transcripts from all recorded interviews into NVivo for coding and analysis. We assigned a unique case number to each participant to link the screener data and post-observation data. We coded the following variables presented in this report:

- food poisoning:
  - participant ever experienced food poisoning
  - family member of participant ever experienced food poisoning
- level of concern about food safety
- perception of how common it is for people to get food poisoning because of the way food is prepared at home

In addition, we coded the following variables for the treatment group to describe their responses to the poultry washing messaging (yes/no) and the reasons for their responses (coding categories developed):

- Did the messaging influence your actions in the kitchen today?
- Do you think the messaging will influence how you cook at home in the future?

We tabulated the responses for the control and treatment groups and conducted statistical testing to test for differences between the two groups. We used a p value of $\leq .05$ to indicate statistical significance.

3. Results

This section describes the characteristics of the study sample and presents the results of the meal preparation experiment for poultry washing, handwashing compliance, cleaning and sanitizing, cross-contamination, and thermometer use. When available, the results from the current study are compared with results from national surveys and the published literature.

3.1 Sample Characteristics

Of the 300 participants in the study sample, 66% were White and 87% were non-Hispanic. Participants represented a variety of ages with 32% in the 18 to 34 age category, 41% in the 35 to 54 age category, and 26% in the 55 or older age category. Forty-two percent of participants had at least a 4-year college degree, and 46% had at least one child living in the household (≤17 years). About 51% of participants had at least one individual in the household at risk for foodborne illness (i.e., adult aged 60 years or older; pregnant woman; child aged 5 years or younger; or individual diagnosed with diabetes, kidney disease, or another condition that weakens the immune system) (see Table 3-1). There were no statistically significant differences between the control and treatment groups for these demographic characteristics.

Table 3-2 compares the demographic characteristics of the study sample to the most recent Census data and the recruiting targets that were set for the study. Except for education, the study generally met the recruiting targets; the target for the lowest education level (high school or less/vocational school) was 26% vs. 19% for the study sample. This reflects the challenge of recruiting high school–educated individuals for the study. Although there are some differences in the distribution of the demographic characteristics for the study sample compared with the U.S. population, the study sample is still diverse regarding the demographic characteristics of interest.

Table 3-1 also provides information on participants' experience with and perceptions regarding foodborne illness, as reported in the post-observation interviews. These factors may influence participants' food safety behaviors. We saw no significant differences between responses to these questions for the control and treatment group participants.

Many participants in the study sample had experience with food poisoning; 59% reported they have personally had food poisoning, and 58% reported a family member has had food poisoning.[3] On a scale of 1 to 7, with "1" being not at all concerned, "4" being neutral, and "7" being extremely concerned, 73% of participants had concerns (response of 5, 6, or 7) "about bacteria or viruses on or inside the food [they] cook." About 67% of participants

[3] Participants were asked the following questions: "Have you ever had food poisoning?" and "Has a family member ever had food poisoning?" Information was not collected on whether the person was diagnosed with food poisoning by a health care professional.

reported that it is "very" or "somewhat common" for people in the United States to get food poisoning because of the way food is prepared in the home, and 33% reported that it is "not very common." Comparing these results with those from the 2016 Food Safety Survey, 45% of respondents to the national survey believed that it is "very" or "somewhat" common and 53% believed it is "not very common" (Lando et al., 2016);[4] thus, a larger percentage of participants in the meal preparation experiment perceived food poisoning to be more common than respondents to the national survey.

Table 3-1. Sample Characteristics

Characteristic	All Participants (*n* = 300)	Control (*n* = 158)	Treatment (*n* = 142)	*p* value[a]
Race				
Caucasian or White	66% (198)	66% (104)	66% (94)	.9682
Black or African American	28% (85)	29% (46)	27% (39)	.7888
Other race[b]	6% (17)	5% (8)	6% (9)	.6433
Ethnicity				
Not Hispanic or Latino	87% (261)	85% (135)	89% (126)	.4301
Hispanic or Latino	13% (39)	15% (23)	11% (16)	.7604
Age				
18–34	32% (96)	32% (50)	32% (46)	.9089
35–54	41% (124)	41% (65)	42% (59)	.9560
55–65	22% (67)	22% (34)	23% (33)	.7529
66 or older	4% (13)	6% (9)	3% (4)	.2316
Education				
Less than high school, high school diploma/GED, or technical or vocational school	19% (58)	20% (31)	19% (27)	.9051
Some college	39% (118)	39% (62)	39% (56)	.9784
Bachelor's degree	23% (68)	23% (36)	23% (32)	.9638
Graduate or professional degree	19% (56)	18% (29)	19% (27)	.8949
Have child 17 or younger living in household	46% (137)	52% (71)	48% (66)	.7889
Have at-risk individual living in household[c]	51% (154)	53% (82)	47% (72)	.8326
Participant has had foodborne illness (self-reported)	59% (178)	68% (107)	50% (71)	.0896

(continued)

[4] The 2016 Food and Drug Administration (FDA) Food Safety Survey was a national telephone survey of 4,169 adults (18 years or older).

Table 3-1. Sample Characteristics (continued)

Characteristic	All Participants (*n* = 300)	Control (*n* = 158)	Treatment (*n* = 142)	*p* value[a]
Participant's family member has had foodborne illness (self-reported)	58% (175)	60% (95)	56% (80)	.7865
Participant's level of concern about food safety[d]				
Depends on the food	1% (3)	1% (1)	1% (2)	—
1–3 (Not concerned)	12% (36)	16% (24)	9% (12)	.0592
4 (Neutral)	14% (42)	13% (19)	16% (23)	.4140
5–7 (concerned)	70% (210)	71% (106)	74% (104)	.6491
Participant's perception of how common it is for people to get food poisoning because of the way food is prepared at home[e]				
Very common	20% (58)	23% (36)	16% (22)	.2343
Somewhat common	47% (136)	49% (76)	45% (60)	.5943
Not very common	33% (96)	28% (44)	39% (52)	.1189

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for each characteristic. Differences are statistically significant if the *p* value is ≤.05.

[b] Other race includes American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, and two or more races.

[c] At-risk populations are people who are 60 years of age or older, children 5 years of age or younger, pregnant women, people diagnosed with diabetes or kidney disease, and people diagnosed with a condition that weakens the immune system.

[d] Participants were asked the following question in the post-observation interview: "How concerned are you about bacteria or viruses on or inside the food you cook?" Nine responses were not clear/available.

[e] Participants were asked the following question in the post-observation interview: "How common do you think it is for people in the United States to get food poisoning because of the way food is prepared in their home?" Ten responses were not clear/available.

Sources: 2018 meal preparation experiment—data are from the screening questionnaire or post-observation interview (as noted in footnotes). Note: *N* = 297 for post-observation interview data. Differences in reported number and totals for each response are due to participant responses that were not available.

Table 3-2. Comparison of the Study Sample with Recruiting Targets and the Demographic Characteristics of the U.S. Population (2016)

Characteristic	Number (Percentage) of Participants in Study Sample (*n* = 300)	Target Percentage for Recruiting of Participants	Percentage from Census Data[a]
Race			
White	198 (66%)	68%	73%
Non-White[b]	102 (34%)	32%	27%
Ethnicity			
Not Hispanic or Latino	261 (87%)	84%	83%
Hispanic or Latino	39 (13%)	16%	17%
Age			
18–34[c]	96 (32%)	35%	28%
35–54	124 (41%)	39%	36%
55+	80 (27%)	26%	36%
Education			
Less than high school, high school diploma/GED, or technical or vocational school	58 (19%)	26%	40%
Some college	118 (39%)	40%	29%
Bachelor's degree	68 (23%)	19%	19%
Graduate or professional degree	56 (19%)	15%	12%
Household status[d]			
Family household (children)	137 (46%)	48%	66%
Nonfamily household (no children)	163 (54%)	52%	34%

[a] Source: U.S. Census Bureau. (n.d.). 2012-2016 American Community Survey 5-year data profiles. Retrieved from https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2016/

[b] Non-White includes Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, other races, or 2 or more races.

[c] For the Census data, the first age category was 20–34 years, instead of 18–34 years.

[d] For the Census data, family household includes households with children 18 years or younger; married-couple families; male householder, no wife; and female householder, no husband. Nonfamily household includes people living alone and people 65 years or older. For the current study, we classified a participant as a family household if the participant had a child less than 18 years of age living at home.

3.2 Poultry Washing

The second iteration of the meal preparation experiment focused on poultry washing by participants who self-reported during recruitment that the last time they prepared a meal at home using raw turkey or chicken they washed or rinsed it before cooking. Among all participants, 104 (35%) washed or rinsed the chicken thighs during preparation. The control

group washed the chicken thighs 61% of the time, while participants who were exposed to the email messages washed the chicken thighs 7% of the time (p <.0001) (see Table 3-3). The control group's chicken washing of 61% was similar compared with the 67% of respondents to FDA's 2016 Food Safety Survey (Lando et al., 2016) and in line with other food safety surveys (Kosa et al., 2015).

Table 3-3. Rate of Poultry Washing[a]

	Control (n = 154)	Treatment (n = 140)	p value[b]
Did not wash	39% (60)	93% (130)	<.0001
Washed	61% (94)	7% (10)	<.0001
Rinsed in sink[c]	85% (80)	90% (9)	.8736
Submerged in container/sink	4% (4)	10% (1)	.4301
Other[d]	11% (10)	0% (0)	.3023

[a] "Washing" is defined as rinsing or submerging of the chicken into a container or the sink.

[b] We calculated p value significance testing using a chi-squared test for the difference between the control and treatment groups for each outcome. Differences are statistically significant if the p value is ≤.05.

[c] "Rinsing" is defined as using the sink tap or faucet to run water over the chicken without placing the chicken into any other container.

[d] "Other" includes participants who rinsed the chicken while it was still inside the packaging or rinsed the chicken under water but used a strainer or colander while doing so.

Source: 2018 meal preparation experiment—coding of food preparation.

We examined whether poultry washing differed by demographic characteristics (race, ethnicity, age, and education level). The only difference that was statistically significant was for race. Among washers, 41% were African American and among nonwashers, 8% were African American (p =.0002) (results not shown). This finding suggests that African Americans are more likely to wash poultry compared with Caucasians. This finding is consistent with a study that surveyed consumers about their food handling practices and found that Caucasians were less likely to wash raw poultry and pork than other races (Henley et al., 2015).

Participants were asked to explain why they wash poultry and whether they used the same method of washing in the test kitchen as they typically do at home (Table 3-4). Approximately, 30% of participants answered that they washed their chicken to remove slime/blood:

> *"I usually trim the fat off the best I can. If it's still slimy—I'm not sure what that is. It just feels good to wash it."*

> *"When it comes out it's all juicy and stuff. You want to get it off."*

"When it's pre-packaged like that, you don't know how long it's been sitting in the pack and it may have drained blood or whatever."

Table 3-4. Responses to Questions on Washing Raw Poultry at Home among Participants Who Washed Poultry (Control and Treatment Groups)

Question	Response % (n) (n = 104)
Reasons for washing raw poultry[a]	
Family member has always washed/rinsed poultry	19% (20)
To remove slime/skin, fat, blood	30% (31)
To remove germs or bacteria	19% (20)
To remove chemicals/impurities	11% (12)
Habit	28% (29)
Other	2% (2)
No answer/not clear/answer not relevant	2% (2)
Method used to wash poultry at home[b]	
Rinse under faucet	62% (65)
Submerge in a bowl of water	5% (5)
Use salt, lemon, or vinegar	17% (18)
Running water with a strainer	9% (9)
No answer/not clear/answer not relevant	7% (7)
If sink sprayer available at home, use it to wash/rinse chicken?[b]	
Sink sprayer not available	13% (14)
Yes, use sink sprayer	10% (10)
Yes, use sink sprayer, but only on whole chicken/turkey	8% (8)
No, do not use sink sprayer	62% (64)
No answer/not clear/answer not relevant	8% (8)

[a] Multiple responses allowed, so total may sum to more than 100%.

[b] Percentages do not add to 100% because of rounding.

Source: 2018 meal preparation experiment—post-observation interviews.

Nearly 20% of participants reported washing chicken at home because that is how a family member prepares it:

"And that's just how my mama did it."

"And then because it never hurts to wash things. So that's how my mom always taught me to cook chicken."

"It is, because my grandmother taught me that. She just said to wash all your food, because there's no telling where it's been before it got in the pack, or whatever."

When cooking at home, 62% of respondents reported that they rinse the chicken by holding it under a running faucet without placing the chicken into any other container; this was also the most common observed method (86%) of chicken washing in the test kitchen. Additionally, 17% of participants mentioned using salt, lemon, or vinegar when washing chicken at home. In some of these cases, participants mentioned soaking the poultry in these substances inside a bowl.

Participants were also asked about using a kitchen sink sprayer when washing chicken at home: 62% do not use a sprayer when available, 10% use a sprayer at home, and 8% reported using a sprayer but only with whole chicken or turkey.

3.3 Handwashing Compliance

Inadequate handwashing has been identified as a contributing factor to foodborne illness, especially when preparing raw meat and poultry. Hands can become vectors that move pathogens around sites for foodborne pathogens found in raw meat and poultry and that contribute to home-acquired foodborne illnesses. Frequency and level of contamination of hands have not been well studied. The one email message noted the need to wash hands for 20 seconds with soap and warm water (in the clean infographic) but was not mentioned in the other two messages.

The total handwashing events required per observation were determined during the coding for each observation. A handwashing event was required for each of the following instances:

- before onset of food preparation
- anytime between touching raw poultry or packaging and then touching a nonpoultry item
- after touching another person or self
- after touching cell phone
- after multitasking (chores)
- after touching contaminated (post-meal) trash or trash can

The total number of attempts per observation was the number of times a participant washed their hands. Each handwashing event was coded as successful or unsuccessful based on CDC's criteria: wet hands with water; rub hands with soap for at least 20 seconds; rinse hands with water; and dry hands using a clean, one-use towel. For example, participant 001T was required to wash her hands nine times but attempted only two times. Of these two times, neither was coded as successful because she did not rub her hands with soap for a total of 20 seconds.

A total of 209 participants attempted to wash hands before beginning meal preparation (see Table 3-5). A total of 4% of attempts contained all steps of a correct handwashing event.

There was a significant difference in successful events between the control and treatment groups before the start of meal preparation. As mentioned above, the need to wash hands for 20 seconds with soap and water was mentioned in the clean messages as part of the intervention; however, this difference in successful attempts was not seen during meal preparation (see Table 3-6) and could be a result of the small number of successful attempts overall.

Table 3-5. Handwashing Compliance before the Start of Meal Preparation

	Control (*n* = 154)	Treatment (*n* = 140)	*p* value[a]
Did not attempt	26% (40)	32% (45)	.3259
Attempts[b]	74% (114)	68% (95)	.5309
Successful attempts[c]	1% (1)	7% (7)	.0168
Unsuccessful attempts	98% (112)	92% (87)	.6316
Undetermined[d]	1% (1)	1% (1)	—
Reasons for unsuccessful attempt[e]			
Did not wet hands with water	63% (71)	63% (55)	.9573
Did not use soap	2% (2)	2% (2)	.8054
Did not rub hands with soap for at least 20 seconds	93% (104)	90% (78)	.7794
Did not rinse hands with water	0% (0)	0% (0)	.9999
Did not dry hands	0% (0)	1% (1)	.2581
Dried hands with surface other than clean, one-use towel (e.g., wiped hands on clothing or used previously used towel)	2% (2)	5% (4)	.2608

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for handwashing compliance. Differences are statistically significant if the *p* value is ≤.05.

[b] "Attempt" was defined as any time that a participant appeared to wash their hands; the attempt could be successful or unsuccessful.

[c] A successful attempt was defined as a participant meeting all of the CDC criteria for handwashing: wet hands with water; rub hands with soap for at least 20 seconds; rinse hands with water; and dry hands using a clean, one-use towel.

[d] There were two instances where a handwashing attempt could not be determined as successful or not. These were classified as undetermined due to a delay in camera recording and the first part of the handwashing event was not clear.

[e] There may be multiple reasons for unsuccessful attempts, so the total may sum to more than 100%.

Source: 2018 meal preparation experiment—coding of food preparation. *N* = 294 observations coded.

We observed 2,063 cases in which a handwashing event was required to prevent cross-contamination during meal preparation; of these, handwashing was attempted 25% of the time (see Table 3-6). Among handwashing events attempted, 1% of attempts contained all steps of a correct handwashing event. The most common reason for unsuccessful

handwashing was not rubbing hands with soap for at least 20 seconds (77% in the control group and 70% in the treatment group), followed by not wetting hands with water (23% in the control group and 21% in the treatment group). Twenty-two attempts did not include proper drying with a one-use towel. Both dish/hand towels and paper towels were provided. Drying hands using a clean, one-use towel is an important step in handwashing because it can physically remove microbes and contaminants from hands, resulting in up to a 1 log reduction (Huang, Ma, & Stack, 2012). There were no significant differences between the two groups in number of handwashing attempts or successful attempts.

Table 3-6. Handwashing Compliance for Required Events during Meal Preparation

	Control (*n* = 154)	Treatment (*n* = 140)	*p* value[a]
Handwashing event required	1,145	918	.7222
Did not attempt	74% (849)	75% (693)	.6597
Attempts[b]	26% (296)	25% (225)	.4488
Successful attempts[c]	1% (2)	2% (5)	.0881
Unsuccessful attempts	99% (292)	98% (218)	.8594
Reasons for unsuccessful attempt[d]			
Did not wet hands with water	23% (67)	21% (46)	.8080
Did not use soap	16% (47)	11% (23)	.1626
Did not rub hands with soap for at least 20 seconds	77% (225)	70% (153)	.7247
Did not rinse hands with water	1% (2)	0% (1)	.8246
Did not dry hands	2% (6)	2% (5)	.6908
Dried hands with surface other than clean, one-use towel (e.g., wiped hands on clothing or used previously used towel)	2% (6)	2% (5)	.6908
Undetermined	1% (2)	1% (2)	—

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for handwashing compliance. Differences are statistically significant if the *p* value is ≤.05.

[b] "Attempt" was defined as any time that a participant appeared to wash their hands; the attempt could be successful or unsuccessful.

[c] A successful attempt was defined as a participant meeting all CDC criteria for handwashing: wet hands with water; rub hands with soap for at least 20 seconds; rinse hands with water; and dry hands using a clean, one-use towel.

[d] There may be multiple reasons for unsuccessful attempts, so the total may sum to more than 100%.

Source: 2018 meal preparation experiment—coding of food preparation. *N* = 294.

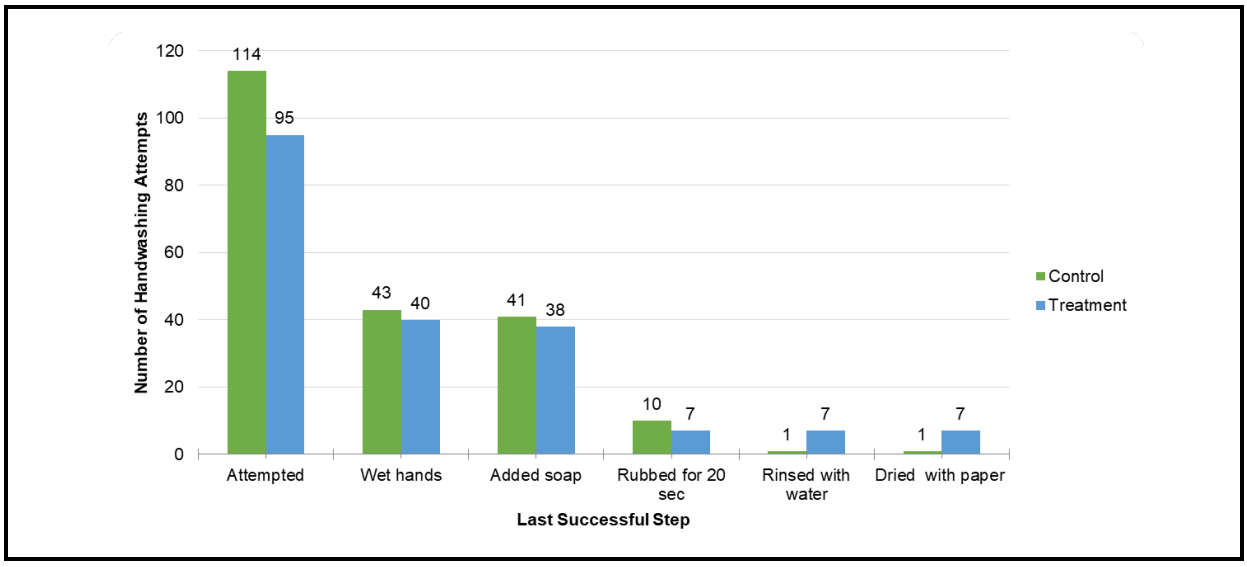
Handwashing compliance is also illustrated in Figures 3-1 through 3-3. Figure 3-1 shows the point at which participants fell out of compliance with the CDC definition of a successful

handwashing attempt before meal preparation by giving counts associated with the last successful step of handwashing performed (the steps are mutually exclusive). In only 43 of the control events and 40 of the treatment events did participants wet hands, and in only 41 of the control events and 38 of the treatment events was soap used. The majority of the remaining events failed at the step of rubbing hands for 20 seconds (ten successful completions of that step in the control group and seven successful completions in the treatment group). Overall, there was a total of one successful attempt for the control group and seven successful attempts for the treatment group for completing all steps required for handwashing successfully.

Handwashing during meal preparation (Figure 3-2) shows similar results. The largest deviation from compliance occurred for participants rubbing hands for 20 seconds (only two events from the control group and five from the treatment group were successful). As with handwashing compliance before meal preparation, for handwashing compliance during meal preparation, once a participant rubbed their hands for 20 seconds, they then rinsed with water and dried with a paper towel as required, thus successfully completing the handwashing attempt. Failing to wet hands and failing to use soap at any time, prior to and during the handwashing event was also a large contributor to not successfully washing hands during meal preparation.

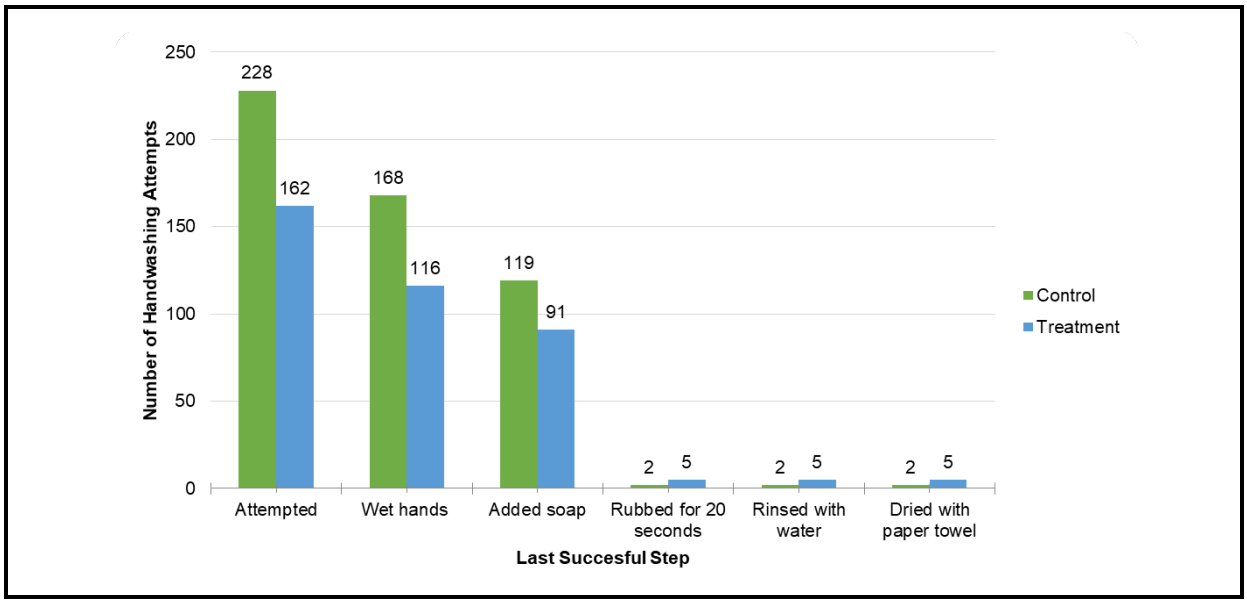
Figure 3-3 illustrates the number of handwashing attempts per participant observation, which includes both before and during meal preparation. The largest number of observations (46) involved participants who had 11 or more handwashing attempts, followed by 44 observations who had 6 attempts and 42 observations who had 5 attempts. No observations had fewer than 2 handwashing attempts.

Figure 3-1. Handwashing Compliance before Meal Preparation



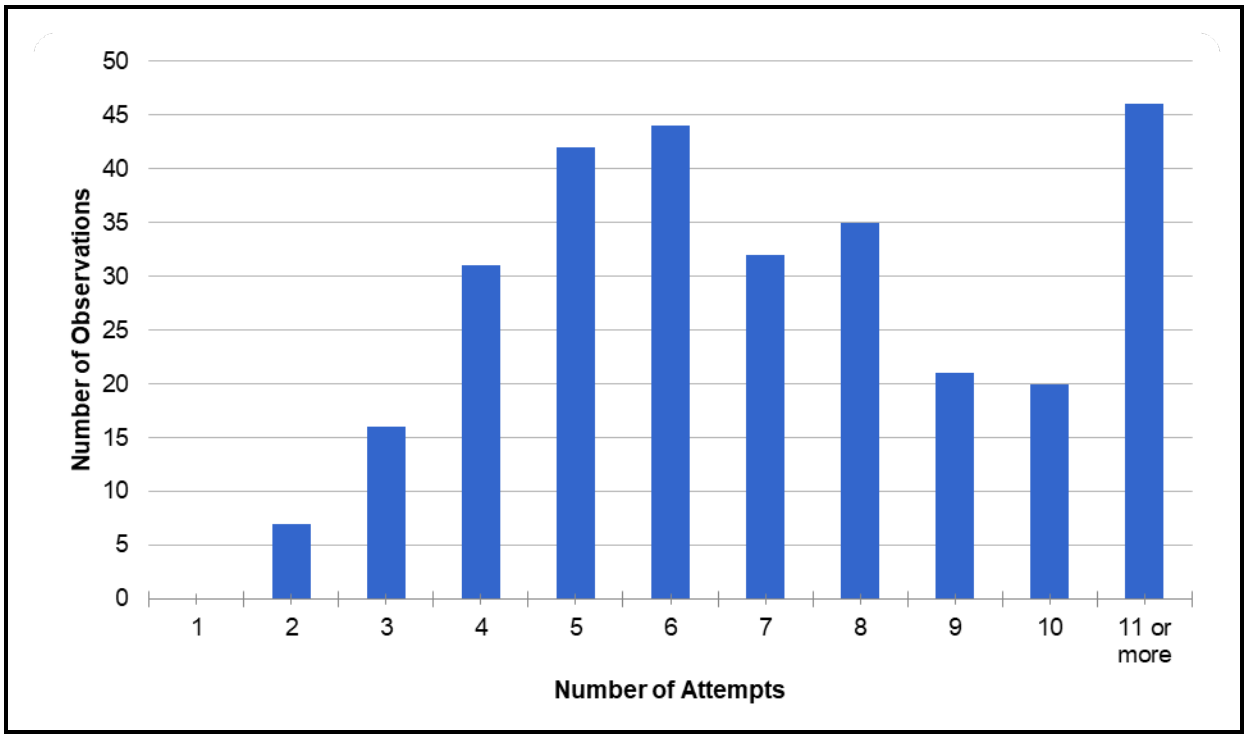
Notes: Illustrates point at which participants fell out of compliance with the CDC definition of a successful handwashing attempt when washing their hands before meal preparation by giving counts associated with the last successful step of handwashing performed (the steps are mutually exclusive).
Total control handwashing events = 114
Total treatment handwashing events = 95
Source: 2018 meal preparation experiment—coding of food preparation. *N* = 294

Figure 3-2. Handwashing Compliance during Meal Preparation



Notes: Illustrates point at which participants fell out of compliance with the CDC definition of a successful handwashing attempt when washing their hands during meal preparation by giving counts associated with the last successful step of handwashing performed (the steps are mutually exclusive).
Total control handwashing events = 228
Total treatment handwashing events = 162
Source: 2018 meal preparation experiment—coding of food preparation. *N* = 294

Figure 3-3. Number of Handwashing Attempts per Participant Observation before and during Meal Preparation



Notes: Illustrates number of handwashing attempts per participant observation. No observations had fewer than two handwashing attempts.

Source: 2018 meal preparation experiment—coding of food preparation. *N* = 294

3.4 Cleaning and then Sanitizing Kitchen Surfaces and Equipment

Cleaning and then sanitizing kitchen surfaces and equipment can help prevent cross-contamination. Cleaning is defined by CDC as washing a surface with soap and warm water to remove dirt and debris. Sanitizing reduces the number of bacteria present on a surface by using a specific sanitizing compound such as a solution of chlorine bleach, quaternary ammonia, or alcohol-based solution to spray the surface with a specified contact time and either letting it dry or wiping it dry with a clean, one-use towel so that bacterial loads, including pathogens, can be reduced.

Tables 3-8 through 3-12 list the number of potential cleaning events, attempts, successful attempts (cleaning and then sanitizing), and unsuccessful attempts (e.g., cleaning only or sanitizing only) for the control and treatment groups specific to cleaning kitchen counters, the sink, knives, and cutting boards. The intervention did not appear to affect whether cleaning was attempted or if the cleaning attempt was successful. The results are summarized below.

Key Takeaways for Kitchen Equipment

Knives:

- 39% of all participants used knives to prepare chicken (*n* = 116)
- 26% of knife users used same knife for chicken and salad
- Among participants who used same knife, 80% attempted clean step between prepping chicken and salad
- Among those who attempted clean step (*n* = 24), 17% only rinsed with water, 83% only cleaned the knife, and no participants sanitized the knife
- No statistically significant differences between treatment and control groups for those who used same knife

Cutting boards:

- 29% of all participants used cutting boards to prepare chicken (*n* = 88)
- The use of the same cutting board for preparing the chicken and the salad was lower among the treatment group (15%) compared with the control group (40%) (p = .0416) suggesting an intervention effect (the message to use separate cutting boards was included in one of the email messages)
- Among participants who used same cutting board, 93% attempted clean step between prepping chicken and salad
- Among those who attempted clean step (*n* = 25), 8% only rinsed with water, 92% only cleaned, and no participants sanitized
- No statistically significant differences between treatment and control groups related to attempted cleaning

For the kitchen counter, there were two potential cleaning/sanitizing events: one at the start of meal preparation and one after meal preparation at the end of the observation. The start of meal preparation was counted because participants are in an unfamiliar kitchen, and best practice would be to clean and sanitize the counter before cooking. The control group had 308 attempted cleaning and/or sanitizing events and the treatment group 280 events; no significant difference was observed between the control and treatment groups in the number of cleaning events required and attempts, both successful and unsuccessful. The percentage of successful attempts (cleaning and then sanitizing) for both type of events was low—3% for the control group and 6% for the treatment group (see Table 3-7).

Washing of the sink was assessed if the participant washed the chicken before cooking it. As previously noted, 104 participants washed the chicken. Among these participants, a total of 208 cleaning events were required by each of these participants: one immediately following chicken washing and one at the end of the observation. There was no significant difference between the control and treatment groups in the number of attempts and successful attempts. Again, the number of successful attempts (cleaning and then sanitizing) was very low (see Table 3-8).

Table 3-7. Cleaning and Sanitizing of Kitchen Counter among All Participants

	Control (*n* = 154)	Treatment (*n* = 140)	*p* value[a]
Event—Before Meal Preparation			
Attempt[b]	29% (45)	30% (42)	.9023
Successful attempts[c] (cleaned and then sanitized)	0% (0)	2% (1)	.3006
Unsuccessful attempts			
Water only[d]	42% (19)	31% (13)	.3864
Clean only	27% (12)	38% (16)	.3478
Sanitize only	31% (14)	29% (12)	.8286
Did not attempt	71% (109)	70% (98)	.9366
Event—After Meal Preparation			
Attempt[b]	81% (125)	76% (107)	.6479
Successful attempt[c] (cleaned and then sanitized)	4% (5)	7% (8)	.2647
Unsuccessful attempts			
Water only[d]	39% (49)	28% (30)	.1463
Clean only	34% (42)	32% (34)	.8087
Sanitize only	23% (29)	33% (35)	.1691
Did not attempt	19% (29)	24% (33)	.3767

Note: Each participant had opportunities to clean the counter once before meal preparation and once at the end of the observation. Within each type of event, the percentage of attempts and did not attempts sums to 100% and within attempts, the percentages for types of attempts (successful vs. reason for unsuccessful) sum to 100%.

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for each outcome. Differences are statistically significant if the *p* value is ≤.05.

[b] "Attempt" was defined as any time that a participant appeared to clean the surface; the attempt could be successful or unsuccessful.

[c] The counter was considered cleaned if the participant used soap and water to scrub the surface and wiped it dry with a clean, one-use towel. The counter was considered sanitized if the participant used one of the provided sanitizers (containing chlorine bleach, quaternary ammonia, or alcohol-based) to spray the surface and wiped it dry with a clean, one-use towel. For an attempt to be considered successful, the counter had to first be cleaned and then sanitized.

[d] Cleaning attempts with water only were considered attempts; however, it is not clear if this type of attempt reduces potential contamination or merely spreads around possible pathogens.

Source: 2018 meal preparation experiment—coding of food preparation. *N* = 294.

Table 3-8. Cleaning and Sanitizing of Sink among Participants Who Washed Poultry

	Control (*n* = 94)	Treatment (*n* = 10)	*p* value[a]
Event—Immediately Following Chicken Washing			
Attempt[b]	24% (23)	20% (2)	.7841
Successful attempts[c] (cleaned and then sanitized)	4% (1)	0% (0)	.7680
Reasons for unsuccessful attempts			
Water only[d]	30% (7)	50% (1)	.6698
Cleaned only	39% (9)	0% (0)	.3657
Sanitized only	26% (6)	50% (1)	.5688
Did not attempt	76% (71)	80% (8)	.8875
Event—End of Observation			
Attempt[b]	71% (67)	30% (3)	.1303
Successful attempts[c] (cleaned and then sanitized)	4% (3)	0% (0)	.7139
Reasons for unsuccessful attempts			
Water only[d]	27% (18)	33% (1)	.8334
Cleaned only	46% (31)	67% (2)	.6147
Sanitized only	22% (15)	0% (0)	.4125
Did not attempt	29% (27)	70% (7)	.8775

Note: Each participant had the opportunity to clean the sink once during meal preparation (following washing) and once at the end of the observation. Within each type of event, the percentage of attempts and did not attempts sums to 100% and within attempts, the percentages for types of attempts (successful vs. reason for unsuccessful) sum to 100%.

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for each outcome. Differences are statistically significant if the *p* value is ≤.05.

[b] "Attempt" was defined as any time that a participant appeared to clean the sink; the attempt could be successful or unsuccessful.

[c] The sink was considered cleaned if the participant used soap and water to scrub the surface and wiped it dry with a clean, one-use towel. The sink was considered sanitized if the participant used one of the provided sanitizers (containing chlorine bleach, quaternary ammonia, or alcohol-based) to spray the surface and wiped it dry with a clean, one-use towel. For an attempt to be considered successful, the sink had to first be cleaned and then sanitized.

[d] Cleaning attempts with water only were considered attempts; however, it is not clear if this type of attempt reduces potential contamination or merely spreads around possible pathogens.

Source: 2018 meal preparation experiment—coding of food preparation. *N* = 104 washed poultry.

Washing of the kitchen counter was also assessed among only those 104 participants who washed the chicken. Among these participants, there were 208 opportunities for cleaning events—one immediately following chicken washing and one at the end of the observation. There were no significant differences between the control and treatment groups. Again, the number of successful attempts (cleaning and sanitizing) was very low (see Table 3-9).

Table 3-9. Cleaning and Sanitizing of Kitchen Counter among Participants Who Washed Poultry

	Control (*n* = 94)	Treatment (*n* = 10)	*p* value[a]
Event—Immediately Following Chicken Washing			
Attempt[b]	33% (31)	50% (5)	.5270
Successful attempts[c] (cleaned and then sanitized)	0% (0)	0% (0)	—
Reasons for unsuccessful attempts			
Water only[d]	35% (11)	60% (3)	.4146
Cleaned only	26% (8)	40% (2)	.5760
Sanitized only	39% (12)	0% (0)	.1641
Did not attempt	67% (63)	50% (5)	.6182
Event—End of Observation			
Attempt[b]	84% (79)	90% (9)	.8456
Successful attempts[c] (cleaned and then sanitized)	5% (4)	0% (0)	.4996
Reasons for unsuccessful attempts			
Water only[d]	39% (31)	56% (5)	.4684
Cleaned only	33% (26)	22% (2)	.5901
Sanitized only	23% (18)	22% (2)	.9732
Did not attempt	16% (15)	10% (1)	.6479

Note: Each participant had the opportunity to clean the counter once during meal preparation (following washing) and once at the end of the observation. Within each type of event, the percentage of attempts and did not attempts sums to 100% and within attempts, the percentages for types of attempts (successful vs. reason for unsuccessful) sum to 100%.

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for each outcome. Differences are statistically significant if the *p* value is ≤.05.

[b] "Attempt" was defined as any time that a participant appeared to clean the counter; the attempt could be successful or unsuccessful.

[c] The counter was considered cleaned if the participant used soap and water to scrub the surface and wiped it dry with a clean, one-use towel. The counter was considered sanitized if the participant used one of the provided sanitizers (containing chlorine bleach, quaternary ammonia, or alcohol-based) to spray the surface and wiped it dry with a clean, one-use towel. For an attempt to be considered successful, the counter had to first be cleaned and then sanitized.

[d] Cleaning attempts with water only were considered attempts; however, it is not clear if this type of attempt reduces potential contamination or merely spreads around possible pathogens.

Source: 2018 meal preparation experiment—coding of food preparation. *N* = 104 washed poultry.

Table 3-10 lists cleaning and sanitation of knife attempts (116 participants total) grouped by participants who used a knife only to prepare chicken (*n* = 86) and those who used the same knife to prepare both the chicken and the salad (*n* = 30). Each participant had the opportunity to clean knives twice: once immediately after use and once at the end of the observation. There was a significant difference between the control and treatment groups

for those who rinsed knives with water immediately following chicken preparation (unsuccessful attempt); however, given the small sample size, no conclusions should be drawn based on this result.

Table 3-10. Cleaning and Sanitizing of Knives Used to Prepare Chicken

	Control (*n* = 75)	Treatment (*n* = 41)	*p* value[a]
Cleaning Event Required—Knife Used Only to Prepare Chicken	**72% (54)**	**78% (32)**	**.7175**
Event—Immediately After Use			
Attempted immediately[b]	54% (29)	53% (17)	.8149
Successful attempts (used dishwasher[c])	21% (6)	24% (4)	.8420
Reasons for unsuccessful attempts			
Water only	3% (1)	24% (4)	.0462
Cleaned only	72% (21)	53% (9)	.4298
Sanitize only	3% (1)	0% (0)	.4438
Did not clean immediately	46% (25)	47% (15)	.8065
Event—End of Observation			
Attempted[b]	100% (25)	100% (15)	.9999
Successful attempts (used dishwasher[c])	40% (10)	40% (6)	.9999
Reasons for unsuccessful attempts			
Water only	0% (0)	0% (0)	—
Cleaned only	60% (15)	60% (9)	.9999
Sanitize only	0% (0)	0% (0)	—
Did not clean final	0 (0)	0 (0)	—
Cleaning Event Required—Same Knife Used to Prepare Both Chicken and Salad	**28% (21)**	**22% (9)**	**.5402**
Event—Immediately after Use			
Attempted immediately[b]	81% (17)	78% (7)	.9290
Successful attempts (used dishwasher[c])	0% (0)	0% (0)	—
Reasons for unsuccessful attempts			
Water only	24% (4)	0% (0)	.1994
Cleaned only	76% (13)	100% (7)	.5660
Sanitize only	0% (0)	0% (0)	—
Did not clean immediately	19% (4)	22% (2)	.8585

(continued)

Table 3-10. Cleaning and Sanitizing of Knives Used to Prepare Chicken (continued)

	Control (*n* = 75)	Treatment (*n* = 41)	*p* value[a]
Event—End of Observation			
Attempted[b]	100% (4)	100% (2)	.9999
Successful attempts (used dishwasher[c])	0% (0)	50% (1)	.1572
Reasons for unsuccessful attempts			
Water only	0% (0)	0% (0)	—
Cleaned only	100% (4)	50% (1)	.5270
Sanitize only	0% (0)	0% (0)	—
Did not clean	0% (0)	0% (0)	—

Notes: Each participant had the opportunity to clean knives once immediately after use and once at the end of the observation. Within each type of event, the percentage of attempts and did not attempts sums to 100% and within attempts, the percentages for types of attempts (successful vs. reason for unsuccessful) sum to 100%.

For participants who only used the knife for chicken and did not "immediately clean," the knife was either left in the sink or on the counter and was not used again.

For participants who used the same knife for the chicken and the salad, the knife should have been cleaned and then sanitized immediately following use to prevent potential cross contamination.

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for each outcome. Differences are statistically significant if the *p* value is ≤.05.

[b] "Attempt" was defined as any time that a participant appeared to clean the knife; the attempt could be successful or unsuccessful.

[c] Assumed that dishwasher action, regardless of setting, results in a pathogen-free untense.

Source: 2018 meal preparation experiment—coding of food preparation. *N* = 116 participants used knives to prepare chicken.

The only successful attempts for cleaning and then sanitizing came from participants who used the dishwasher. We assumed, based on our coding definitions, that the dishwasher action, regardless of setting, results in a pathogen-free utensil. Dishwasher manufacturers state that while water temperatures can vary between 110 and 170°F, the sustained wet heat time–temperature combinations would result in a 5-log reduction of bacterial pathogens and that dishwashing is an integral step to risk reduction (Cogan, Slader, Bloomfield, & Humphrey, 2002).

Among all participants, 88 participants used a cutting board to prepare the chicken. There were no significant differences between the control and treatment groups for cleaning and sanitizing of cutting boards for those participants who used a cutting board with chicken only (*n* = 61). There was a significant difference between the control and treatment groups for participants who used the same cutting board for preparing the chicken and the salad; however, given the small sample size (*n* = 27), no conclusions should be drawn based on

this result. As with the knives, the only successful attempts for both cleaning and sanitizing came from participants who placed the cutting board in the dishwasher (see Table 3-11).

Table 3-11. Cleaning and Sanitizing of Cutting Boards Used to Prepare Chicken

	Control (*n* = 55)	Treatment (*n* = 33)	*p* value[a]
Cleaning Event Required—Cutting Board Used for Chicken Only	**60% (33)**	**85% (28)**	**.1752**
Event—Immediately after Use			
Attempted[b]	36% (12)	46% (13)	.6101
Successful attempt (used dishwasher[c])	42% (5)	15% (2)	.2147
Reasons for unsuccessful attempts			
Water only	17% (2)	31% (4)	.4721
Clean only	42% (5)	54% (7)	.6606
Sanitize only	0% (0)	0% (0)	—
Did not attempt	64% (21)	54% (15)	.5406
Event—End of Observation			
Attempted	100% (21)	100% (15)	.9999
Successful attempt (used dishwasher[c])	33% (7)	27% (4)	.6634
Reasons for unsuccessful attempts			
Water only	0% (0)	0% (0)	—
Clean only	62% (13)	73% (11)	.7683
Sanitize only	0% (0)	0% (0)	—
Attempt undetermined[d]	5% (1)	0% (0)	—
Did not attempt	0% (0)	0% (0)	—
Cleaning Event Required—Same Cutting Board Used to Prepare Both Chicken and Salad	**40% (22)**	**15% (5)**	**.0416**
Event—Immediately after Use			
Attempted	91% (20)	100% (5)	.5002
Successful attempt (used dishwasher[c])	0% (0)	0% (0)	—
Reasons for unsuccessful attempts			
Water only	10% (2)	0% (0)	.4795
Clean only	90% (18)	100% (5)	.8348
Sanitize only	0% (0)	0% (0)	—
Did not attempt	9% (2)	0% (0)	.8488

(continued)

Table 3-11. Cleaning and Sanitizing of Cutting Boards Used to Prepare Chicken (continued)

	Control (*n* = 55)	Treatment (*n* = 33)	*p* value[a]
Event—End of Observation			
Attempted	100% (2)	0% (0)	.9999
Successful attempt (used dishwasher[c])	50% (1)	0% (0)	—
Reasons for unsuccessful attempts			
Water only	0% (0)	0% (0)	—
Clean only	50% (1)	0% (0)	—
Sanitize only	0% (0)	0% (0)	—
Did not attempt	0% (0)	0% (0)	—

Note: Each participant had the opportunity to clean cutting boards once during meal preparation and once at the end of the observation. Within each type of event, the percentage of attempts and did not attempts sums to 100% and within attempts, the percentages for types of attempts (successful vs. reason for unsuccessful) sum to 100%.

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for each outcome. Differences are statistically significant if the *p* value is ≤.05.

[b] "Attempt" was defined as any time that a participant appeared to clean the cutting board; the attempt could be successful or unsuccessful.

[c] Assumed that dishwasher action, regardless of setting, results in a pathogen-free utensil.

[d] Undetermined attempt was due to a corrupt video file.

Source: 2018 meal preparation experiment—coding of food preparation. *N* = 88 used cutting boards to prepare chicken.

Just over 50% of all the participants in the study washed all the salad ingredients (lettuce provided in a Ziploc bag, celery, and carrots), and 11% did not wash any of the ingredients. There were no significant differences between the control and treatment groups in vegetable washing (see Table 3-12).

Table 3-12. Washing Vegetables before Preparing Salad

	Control (*n* = 156)	Treatment (*n* = 143)	*p* value[a]
Did not wash any lettuce/produce	11% (17)	11% (16)	.3176
Washed some lettuce/produce	34% (53)	42% (60)	.9329
Washed all lettuce/produce	55% (86)	47% (67)	.2619

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for each outcome. Differences are statistically significant if the *p* value is ≤.05.

Source: 2018 meal preparation experiment—coding of food preparation as recorded on trigger sheet and video observations. *N* = 299.

3.5 Thermometer Use

Overall, 47% of all participants used a food thermometer on at least one chicken thigh (see Table 3-13). Among participants who used a thermometer, 24% of participants checked only one thigh and 76% checked both thighs. There were no significant differences between the control and treatment groups. Unlike the first year's observational research, data are not available on the final endpoint temperature when a thermometer was used to check doneness in this year's research, but this issue will be revisited in future years by viewing the video from the overhead cameras.

Table 3-13. Rate of Thermometer Use

	Control (*n* = 154)	Treatment (*n* = 140)	*p* value[a]
Participant used thermometer to check doneness of one or both chicken thighs	44% (67)	51% (72)	.3238
Among participants who used thermometer, number of chicken thighs checked			
One thigh	30% (20)	19% (14)	.3046
Two thighs	70% (47)	81% (58)	.3220

[a] We calculated *p* value significance testing using a chi-squared test for dichotomous variables and repeated measures of analysis of variance (i.e., ANOVA) for continuous variables for the difference between the control and treatment groups for each outcome. Differences are statistically significant if the *p* value is ≤.05.

Source: 2018 meal preparation experiment—coding of food preparation. *N* = 294.

Some participants attempted to determine doneness using other indicators. Nearly 18% of participants relied solely on a visual cue (e.g., cutting into a thigh), and 8% relied solely on firmness (e.g., touch); however, 14% of participants used more than one method (excluding thermometer) to determine doneness (see Table 3-14). There were no significant differences between the control and treatment groups in thermometer use and other methods used to determine doneness.

Table 3-14. Methods Used to Determine Doneness

Method	Control (*n* = 154)	Treatment (*n* = 140)	*p* value[a]
Only used thermometer	32% (49)	33% (46)	.3474
Only used visual cue (inside or outside color)	20% (31)	15% (21)	.6026
Only used touch (e.g., firmness)	9% (14)	6% (9)	.6510
Only used time	11% (17)	14% (19)	.5354

(continued)

Table 3-14. Methods Used to Determine Doneness (continued)

Method	Control (*n* = 154)	Treatment (*n* = 140)	*p* value[a]
Used more than one method, including thermometer	12% (19)	19% (27)	.3819
Used more than one method, not including thermometer	16% (24)	13% (18)	.9770

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for each method. Differences are statistically significant if the *p* value is ≤.05.

Sources: 2018 meal preparation experiment—coding of food preparation. *N* = 294.

3.6 Cross-Contamination and Microbiological Analysis

To assess cross-contamination in the kitchen, we analyzed the spread of the surrogate from the inoculated chicken thighs to various surfaces and the salad lettuce. Lack of or failed handwashing attempts can spread pathogens to high-touch surfaces through contact of contaminated hands to surfaces and foods. *Campylobacter* and *Salmonella*, pathogens found in poultry products, have been shown to be viable on food contact surfaces for 4 to 32 hours, respectively (De Cesare, Sheldon, Smith, & Jaykus, 2003), posing a potential health risk in the home if contaminated surfaces are not adequately cleaned and sanitized.

We used the microbiological data to identify both the direct and indirect cross-contamination events that occurred during the meal preparation experiment. Direct cross-contamination is defined as when raw meat or raw meat packaging (in this case chicken thighs) comes into direct contact with an RTE food (in this case, salad lettuce) or a food handling surface or utensil and the area is not cleaned and sanitized after contact. Indirect cross-contamination is when utensils, surfaces, and/or hands contact a contaminant and then are not cleaned and/or sanitized adequately before the next use, any time between touching raw meat or packaging and then touching a nonmeat item, touching a mobile device, or touching trash. We analyzed the data before and after cleaning for the chicken preparation area (if poultry was not washed), the sink, and the area around the sink (if poultry was washed). Tables 3-15 and 3-16 show the prevalence and level of contamination for these sites, as well as the prevalence and level of contamination in the salad lettuce. Positive validation samples (n = 12 for control and n = 1 for treatment) required exclusion of the entire participant sample from the microbial analysis, which accounts for the lower number of microbiological samples.

When the chicken was not washed by the participant, we sampled the "chicken preparation area" (CPA), the area where the participant prepared the chicken to be cooked, in lieu of the counter area next to the sink. Among participants who washed the chicken, the area of counter sampled ranged from 0 to 6 inches to 0 to 32 inches. The variation in distance was due to preliminary laboratory testing. Preliminary laboratory work where chicken washing

was simulated showed that the surrogate was rarely detected more than 18 inches away from the sink and was most frequently found within 6 inches of the sink. However, we included up to 32 inches of counter space through the first 28 observations to see if the microbiological results from the meal preparation experiment mirrored those preliminary studies. As shown in Table 3-15, the surrogate was never detected farther than 18 inches from the sink and was primarily localized within 0 to 6 inches from the sink, confirming our preliminary lab work. After the first 28 observations, additional sampling areas were included because the surrogate was also detected in the lettuce of the nonpoultry washer participants. At this point, we included the sink and tap (faucet) handle to form a more complete model for how cross-contamination was occurring during meal preparation.

The inner sink post-wash/pre-clean was positive 60% and 36% of the time for washers and nonwashers, respectively, which was the most frequently positive surface among both groups (see Tables 3-15 and 3-16). It is likely that the packaging, chicken, or hands contaminated with the surrogate from the chicken or packaging were in contact with the sink, resulting in the high frequency of contamination. This was especially true in the washer group, where direct cross-contamination of the sink was likely to have occurred because the chicken was more likely to be in direct contact with the sink. The likelihood of direct cross-contamination occurring on this surface for washers probably also contributed to the level of surrogate present (4.49 log CFU/surface), which was the highest among the locations sampled for washers.

The tap handle was rarely found to be positive, and even when contamination was found, a low level of the surrogate was detected (around 1 to 2 log CFU/surface on average) for both the washers and nonwashers. The same was true for the post-clean CPA, which also had a level of surrogate ranging from 1 to 2 log CFU/surface. Furthermore, these areas had the lowest frequency of surrogate for both washers—the tap handle was positive 1.59% of the time—and nonwashers—the CPA was positive 1.63% of the time. Surrogate was also not detected on the spice containers frequently or at a comparable level to the sink surface: it was positive 6% of the time (2.23 log CFU/surface) and 5% of the time (2.49 log CFU/surface) for washers and nonwashers, respectively. This finding was interesting because the Year 1 study showed spice containers with the highest detected level of surrogate and positive around 50% of the time. However, the lower level and prevalence were not surprising because for the Year 1 study a viral surrogate was used that persisted much longer than the bacterial surrogate on kitchen surfaces, a different raw product was used (ground turkey vs. chicken thighs), and the Year 1 instructions regarding spice containers were different in that they instructed participants to season turkey patties on both sides of the raw patties, likely increasing the rate of cross-contamination to the spice containers. The intervention did not significantly affect the frequency or level of surrogate detected on any surface regardless of whether participants washed the chicken.

Table 3-15. Prevalence of Surrogate Contamination and Level of Contamination for Locations in the Kitchen and Salad Lettuce When Chicken Was Washed

Location		All Participants	Control	Treatment	*p* value[a]
Post-wash inner sink**	Prevalence contaminated % (*n*)	60.32 (63)	59.65 (57)	66.67 (6)	.7401
	Level of contamination ± SD, log CFU/g (*n*)	4.49 ± 4.84 (38)	4.49 ± 4.86 (34)	4.47 ± 4.72 (4)	.9938
Post-wash 0–6 inches from sink	Prevalence contaminated % (*n*)	22.58 (93)	21.69 (83)	30.00 (10)	.5548
	Level of contamination ± SD, log CFU/g (*n*)	4.06 ± 4.25 (21)	4.09 ± 4.28 (18)	3.80 ± 3.77 (3)	.9136
Post-wash 6–12 inches from sink*	Prevalence contaminated % (*n*)	14.29 (28)	12.00 (25)	33.33 (3)	.3273
	Level of contamination ± SD, log CFU/g (*n*)	2.58 ± 2.43 (4)	2.46 ± 2.41 (3)	2.80 ± NA (1)	NA
Post-wash 12–18 inches from sink*	Prevalence contaminated % (*n*)	8.33 (24)	4.77 (21)	33.33 (3)	.1013
	Level of contamination ± SD, log CFU/g (*n*)	1.30 ± 0.55 (2)	1.35 ± NA (1)	1.24 ± NA (1)	NA
Post-wash 18–24 inches from sink*	Prevalence contaminated % (*n*)	0 (16)	0 (14)	0 (2)	NA
	Level of contamination ± SD, log CFU/g (*n*)	—	—	—	—
Post-wash 24–32 inches from sink	Prevalence contaminated % (*n*)	0 (12)	0 (11)	0 (1)	NA
	Level of contamination ± SD, log CFU/g (*n*)	—	—	—	—
Tap handle**	Prevalence contaminated, % (*n*)	1.59 (63)	1.75 (57)	0 (6)	.7474
	Level of contamination ± SD, log CFU/handle (*n*)	2.43 ± NA (1)	2.43 ± NA (1)	—	—
Post-clean inner sink**	Prevalence contaminated, % (*n*)	14.29 (63)	14.04 (57)	16.67 (6)	.8621
	Level of contamination ± SD, log CFU/g (*n*)	4.11 ± 4.55 (9)	4.16 ± 4.58 (8)	1.65 ± NA (1)	NA
Post-clean 0–6 inches from sink	Prevalence contaminated, % (*n*)	2.15 (93)	2.41 (83)	0 (10)	.6231
	Level of contamination ± SD, log CFU/g (*n*)	1.77 ± 1.09 (2)	1.77 ± 1.09 (2)	—	—
Post-clean 6–12 inches from sink*	Prevalence contaminated, % (*n*)	0 (28)	0 (25)	0 (3)	NA
	Level of contamination ± SD, log CFU/g (*n*)	—	—	—	—

(continued)

Table 3-15. Prevalence of Surrogate Contamination and Level of Contamination for Locations in the Kitchen and Salad Lettuce When Chicken Was Washed (continued)

Location		All Participants	Control	Treatment	*p* value[a]
Post-clean 12–18 inches from sink*	Prevalence contaminated, % (*n*)	3.85 (26)	4.00 (25)	0 (3)	.7927
	Level of contamination ± SD, log CFU/g (*n*)	1.65 ± NA (1)	1.65 ± NA (1)	—	—
Spice container	Prevalence contaminated % (*n*)	6.25 (96)	4.65 (86)	20.00 (10)	.0590
	Level of contamination (SD), log CFU/g (*n*)	2.23 ± 2.12 (6)	2.07 ± 1.99 (4)	2.45 ± 2.41 (2)	.8449
Salad lettuce	Prevalence contaminated % (*n*)	25.77 (97)	26.44 (87)	30.00 (10)	.8108
	Level of contamination (SD), log CFU/g (*n*)	3.09 ± 3.35 (25)	3.05 ± 3.34 (23)	3.39 ± 3.52 (3)	.8703

Notes:

A positive result was any colony that fluoresced under UV when grown on selective media.

(*n*) = number of samples used in the analysis; SD = standard deviation; NA = unable to calculate *p* value because of small number of observations

[a] We calculated *p* value significance testing using a chi-squared test for prevalence and repeated measures of analysis of variance (i.e., ANOVA) for level of contamination for the difference between the control and treatment groups. Differences are statistically significant if the *p* value is ≤.05.

* Denotes original counter sampling scheme.

** Denotes surfaces added in new sampling scheme.

Source: 2018 meal preparation experiment—microbiological samples.

Table 3-16. Prevalence of Surrogate Contamination and Level of Contamination for Locations in the Kitchen and Salad Lettuce When Chicken Was Not Washed

Location		All Participants	Control	Treatment	*p* value[a]
Pre-clean inner sink**	Prevalence contaminated % (*n*)	35.56 (135)	47.62 (42)	30.11 (93)	.1013
	Level of contamination ± SD, log CFU/g (*n*)	4.27 ± 4.83 (48)	3.85 ± 4.38 (20)	4.43 ± 4.93 (28)	.6760
Pre-clean chicken prep area	Prevalence contaminated % (*n*)	9.24 (184)	7.27 (55)	10.01 (129)	.5570
	Level of contamination ± SD, log CFU/g (*n*)	4.45 ± 4.71 (17)	4.64 ± 4.94 (4)	4.37 ± 4.58 (13)	.9205

(continued)

Table 3-16. Prevalence of Surrogate Contamination and Level of Contamination for Locations in the Kitchen and Salad Lettuce When Chicken Was Not Washed (continued)

Location		All Participants	Control	Treatment	*p* value[a]
Tap handle**	Prevalence contaminated % (*n*)	2.90 (138)	2.33 (43)	3.16 (95)	.7886
	Level of contamination ± SD, log CFU/handle (*n*)	1.71 ± 1.85 (4)	0.54 ± NA (1)	1.83 ± 1.89 (3)	NA
Post-clean inner sink**	Prevalence contaminated % (*n*)	5.11 (137)	6.98 (43)	4.26 (94)	.5040
	Level of contamination ± SD, log CFU/g (*n*)	3.09 ± 3.48 (7)	3.43 ± 3.66 (3)	2.11 ± 2.23 (4)	.5757
Post-clean chicken prep area	Prevalence contaminated % (*n*)	1.63 (184)	0 (55)	2.33 (129)	.2575
	Level of contamination ± SD, log CFU/g (*n*)	1.95 ± 1.99 (3)	—	1.95 ± 1.99 (3)	—
Spice container	Prevalence contaminated % (*n*)	4.89 (184)	7.27 (55)	3.88 (129)	.3305
	Level of contamination ± SD, log CFU/g (*n*)	2.49 ± 2.57 (9)	1.93 ± 1.84 (4)	2.68 ± 2.63 (5)	.6452
Salad lettuce	Prevalence contaminated % (*n*)	19.57 (184)	30.91 (55)	14.73 (129)	.0115
	Level of contamination ± SD, log CFU/g (*n*)	4.86 ± 5.54 (36)	4.48 ± 5.03 (17)	5.04 ± 5.67 (19)	.7570

Notes:

A positive result was any colony that fluoresced under UV when grown on selective media.

(*n*) = number of samples used in the analysis; SD = standard deviation; NA = unable to calculate *p* value because of small number of observations

[a] We calculated *p* value significance testing using a chi-squared test for prevalence and repeated measures of analysis of variance (i.e., ANOVA) for level of contamination for the difference between the control and treatment groups. Differences are statistically significant if the *p* value is ≤.05.

* Denotes original counter sampling scheme

**Denotes surfaces added in new sampling scheme

Source: 2018 meal preparation experiment—microbiological samples.

The lettuce in the RTE salad was tested for the surrogate to determine if cross-contamination from the chicken thighs to an RTE product occurred. The lettuce was found to be contaminated at a frequency of 26% and 20%, for the washers and nonwashers, respectively. The average level of surrogate detected within the salads of participants who did not wash their chicken, 4.9 log CFU on average, was the highest in the entire study.

While it was expected to see some level of contamination when chicken was washed, we did not expect to see much contamination of the salad among nonwashers. However, the most frequently positive surface for nonwashers was the sink, which could explain where cross-contamination may have occurred especially if produce (i.e., the salad ingredients) was washed in the sink. Hand-facilitated cross-contamination is also suspected to be an important factor in explaining the cross-contamination that occurred in both groups. The lack of proper handwashing as denoted previously means that participants may have been preparing the meal with contaminated hands and spreading the surrogate to other surfaces around the kitchen. For nonwashers, those in the control group were more likely to contaminate the salad than those in the treatment group ($p = .0115$), suggesting an intervention effect. However, this effect was not seen for the washer group.

The high level and the high frequency of surrogate detection in the sink suggest that splashing contaminated chicken fluids onto the counter is not a major route of cross-contamination during chicken washing. The frequency of contamination suggests the microbes harbored in the sink from the chicken, packaging, or contaminated hands could be the larger issue, especially because produce is often washed in the sink. This hypothesis is further supported by the high level of surrogate found on the salad lettuce of nonwashers.

The sink and the counter or CPA were sampled before and after cleaning occurred to determine whether the cleaning and sanitation steps taken by the participants were effective. While the level of contamination was not significantly different for either the sink or counter/CPA of the washer and nonwasher groups, the frequency of contamination was significantly lower ($p < .0001$) for both the sink and counter/CPA after cleaning and/or sanitizing from washers and nonwashers (results not shown). This finding suggests that overall the cleaning and sanitizing steps participants took after they finished cooking lowered the microbial presence from chicken on the sink and counter. However, the surrogate was detected in lettuce samples from both groups, which means that until these areas are sanitized there is still opportunity for cross-contamination of these surfaces and to RTE products like salad. Without proper cleaning and then sanitizing between chicken preparation and salad preparation, consumers can still potentially cross-contaminate an RTE product like salad. If consumers were to clean and/or sanitize their sink in between, the results suggest they would be far less likely to cross-contaminate the salad.

3.7 Participant Response to Email Intervention (Treatment Group Only)

During the post-observation interviews, we collected information about the participants' responses to the email messages with information on poultry washing and cleaning/sanitizing (see Table 3-17).

Table 3-17. Participants' Responses to Email Messages with Information on Not Washing Poultry and Preventing Cross-Contamination

Question	Response % (*n*) (*n* = 142)
Read emails	
All of the emails	59% (84)
Some of the emails	39% (55)
None of the emails (did not answer remaining questions)	2% (3)
Before getting the emails, participant had heard the recommendation to not wash raw poultry before cooking it (% yes)	50% (71)
Device used to view the emails	
Desktop	15% (21)
Laptop	14% (20)
Tablet	2% (3)
Smartphone	43% (61)
More than one device	24% (34)
Don't recall	2% (3)
Recall seeing message at the bottom of each email (% yes)	67% (95)
Recall seeing graphic at the bottom of any of the emails (% yes)	82% (117)
Recall seeing link to YouTube video at the bottom of one of the emails (% yes)	49% (69)
If recalled seeing link to video, watched the video (% yes)	59% (41)
If recalled the emails, did the information influence participants' actions in the kitchen today? (*n* = 128)	
Yes, emails influenced actions	66% (84)
New information about preparing poultry	40% (34)
Reinforced normal poultry preparation practices	25% (21)
Other reason: cleaning, cross-contamination	10% (8)
Other reason: time, "awareness," thermometer use	11% (9)
Other: recalled emails/messages but provided no information about actions	8% (7)
Not answered/answer not clear/answer not relevant	6% (5)
No, emails did not influence actions	22% (28)
Reinforced normal poultry preparation practices	43% (12)
Other	18% (5)
Not answered/answer not clear/answer not relevant	39% (11)
Question not asked[a]	13% (16)
If recalled the emails, will the information influence how participant cooks at home in the future? (*n* = 128)	
Yes, will influence	66% (85)
New information about preparing poultry	68% (58)
Reinforced normal poultry preparation practices	9% (8)
Other	16% (14)
Not answered/answer not clear/answer not relevant	6% (5)

(continued)

Table 3-17. Participants' Responses to Email Messages with Information on Not Washing Poultry and Preventing Cross-Contamination (continued)

Question	Response % (*n*) (*n* = 142)
No, will not influence	21% (27)
Reinforced normal poultry preparation practices	63% (17)
Other	30% (8)
Not answered/answer not clear/answer not relevant	7% (2)
Question not asked[a]	13% (16)

[a] Question not asked. Participants reported recalling the message; however, the questions on whether the messages influenced their behaviors were not asked for two reasons: (1) participant did not readily recall applicable content (e.g., "There was a number to call for rescheduling and a map.") or (2) interviewer did not ask the questions.

Source: 2018 meal preparation experiment—post-observation interviews.

Nearly 60% of participants reported that they read all three emails, and 39% read some of the emails. The most common device for reading the emails was a smartphone (43%) and 24% of participants responded that they read the emails on more than one type of device. With respect to the content of the three emails, about 67% recalled seeing a message at the bottom of the email, 82% recalled seeing a graphic at the end of the email messages; and 49% recalled seeing a link to a YouTube video. Among these participants, 59% reported watching the video. Half of the participants mentioned that they had heard the recommendation to not wash poultry before, and the sources of this information included the news, school, and "somewhere on Facebook."

Approximately 66% of the participants reported that the information contained in the emails will likely influence future cooking behaviors, and 40% of these participants mentioned learning new information about chicken washing as the primary reason for behavior change.

"I don't know. It's just [inaudible]—it's prevalent in my head that that actually spreads it and not prevents it. So that alone would stop me from doing it."

"Yes. I learned about the right way to prep poultry in 20 seconds."

"Yes because, from now on—because I did [inaudible] more research after that email, I found out how it can spread bacteria, and it does do that. I'm not going to do it at home."

3.8 Comparison between Years 1 and 2 for Control Group Participants

Table 3-18 compares the results for year 1 and 2 for handwashing, thermometer use, and cross-contamination of the salad lettuce. In Year 1, participants prepared turkey burgers with a garnish and a chef salad. The primary focus was to examine thermometer use when

cooking turkey patties, but data were also collected on handwashing behaviors and potential cross-contamination of kitchen surfaces and the lettuce.

There were no significant differences between Years 1 and 2 in terms of handwashing events required and successful and unsuccessful handwashing attempts among control group participants. Consistent with the results for Year 1, the most common reason for unsuccessful handwashing attempts was not rubbing hands with soap for 20 seconds (Cates et al., 2018).

Regarding thermometer use, in Year 1, 34% of participants in the control group used a thermometer on at least one turkey patty, and in Year 2, 44% of the control group used a thermometer on at least one thigh. There was not a significant difference in thermometer use between the two years (Table 3-18).

In Year 1, 9% of the salad lettuce in the control group was contaminated, while in Year 2, 28% of the salad lettuce in the control group was contaminated (Table 3-18). However, conclusions should not be drawn solely based on these values given the differences between the two years in the surrogates used, the varying inoculation levels, and the order that the food was prepared (in Year 1, participants had the choice of which dish to prepare first, while in Year 2 participants had to prepare the salad after the raw product).

Table 3-18. Comparison of Key Outcomes for Year 1 and Year 2 Meal Preparation Experiments for Control Group Participants

	Year 1	Year 2	*p* value[a]
Handwashing			
Handwashing event required (before or during meal preparation)	1,195	1,299	.2783
% did not attempt	69% (830)	68% (889)	.1228
% unsuccessful attempt	31% (365)	32% (410)	.1387
% successful attempt[b]	3% (10)	0.7% (3)	.2852
Thermometer Use			
% used thermometer on at least one item	34% (69)	44% (67)	.1661
Cross Contamination of Salad Lettuce			
% observations contaminated	9% (10)	28% (40)	NA

[a] We calculated *p* value significance testing using a chi-squared test for the difference between the control and treatment groups for each outcome. Differences are statistically significant if the *p* value is ≤ .05. The *p* value is not presented for the salad contamination given the major differences between year 1 and 2 (different surrogates were used [bacteriophage vs. bacteria], varying inoculation levels, and order of food preparation. For these reasons, a *p* value would not be meaningful.

[b] Successful attempt represents successful handwashing attempts out of all attempts.

Sources: 2018 and 2017 2018 meal preparation experiment—coding of food preparation; 2018 and 2017 meal preparation experiment—microbiological samples. *N* = 201 control group observations for Year 1 and 154 control group observations for Year 2. *N* = 109 salad samples for Year 1 and 142 salad samples for Year 2.

4. Discussion and Implications

This section concludes the report by discussing implications for message development that FSIS OPACE may want to consider as it refines 1) the messages and delivery mechanisms used to inform consumers on the importance of not washing raw poultry and proper cleaning and sanitizing of surfaces and utensils when preparing raw meat and poultry and 2) communications about other recommended food safety practices. These recommendations are based on the literature in combination with the results of this study.

CDC has identified contributing factors to foodborne illness, including food from unsafe sources, improper holding/time and temperatures, inadequate cooking, poor personal hygiene, and contaminated equipment/prevention of contamination; four of these factors are linked directly to food handler behaviors (Bean et al., 1996; CDC, n.d.). Five of the top 10 food–pathogen combinations with the highest estimated annual disease burden are directly related to consumer handling (either controlled by cooking or reducing cross-contamination), and some of these combinations contain food groups that are regulated by USDA: poultry, pork, and beef (Batz, Hoffmann, & Morris, 2012). Pathogens such as *Campylobacter* and *Salmonella* can be fully controlled in consumer homes by cooking foods to safe internal temperatures and preventing cross-contamination. Risky preparation and handling of food have been linked to multiple outbreaks of foodborne illness and identified as a factor in public health burden (Nesbitt et al., 2009; Redmond & Griffith, 2003).

4.1 Updated Messaging on Poultry Washing Needed

The current message of not washing poultry or other raw meats because of the increased risk of spreading pathogens from the washing site (i.e., sink) to the rest of the food preparation setting is based on what is often referred to as the Campden BRI study, which was not subject to peer review. The study simulated chicken washing in a laboratory setting by one individual on fewer than 10 chicken pieces and found pathogens 3 feet from the washing site. Historically, risk messages related to meat and poultry washing have referred to this study; thus, it is important to highlight it as a starting point for studies related to contamination through poultry washing. The current study shows that the risk of cross-contamination from the sink itself may be more of a concern and warrants a broader message than simply the message to not wash poultry because of the risk of spreading pathogens.

The results of the current study, which used a more robust study design and actual meal preparers in simulated home kitchen sites, demonstrate that the wash basin of a sink is used for many actions in the meal preparation path. The wash basin of a sink can be used as a holding location for packaged meat; where handwashing happens; as the place where poultry is washed most of the time; and as the place where RTE foods (in this case salad ingredients) are staged, held, and even prepared.

Based on these results, we recommend updating the poultry washing message with the new science and focus on reasons for not washing in a more targeted way. We suggest dissemination of a more complete message: **avoid washing raw meat and poultry because potentially harmful bacteria on the surface of the raw product can accumulate in high concentrations within the sink and cross-contaminate ready-to-eat foods**.

Just as the wash basin of the sink was used for a variety of food preparation actions, the participants in the test kitchen demonstrated several methods of washing chicken that were not considered at the beginning of this study. We hypothesized that chicken washing would be a simple action of holding the piece of chicken under a running faucet. This technique was by far the most common; however, nearly 15% of the participants employed different techniques including submerging the pieces of chicken in a bowl of water and using the opened chicken packaging as a container and placing it under a running faucet. The post-observation interviews provided additional insight into other chicken washing methods when cooking at home such as rinsing with water, lemon, and vinegar. Participants also mentioned using a kitchen sink sprayer to occasionally wash chicken at home. Although a sprayer was not a common method of washing for smaller cuts of poultry, participants were more likely to use a sprayer on a whole chicken or turkey (e.g., to help flush out the cavity). The interviews also provided insight into the reasons behind washing chicken. The most common reason cited for washing was to remove the "slime," blood, and "juices" rather than to remove potential pathogens. Additionally, a significant number of participants explained that washing chicken is just a habit—something they learned from watching a family member do it.

4.2 Cleaning and Sanitizing Insights

In general, we observed no significant difference between the control and treatment groups in the number of cleaning events required and attempts, both successful and unsuccessful. It should be noted here that CDC recommends a two-step process of cleaning and sanitizing during which debris is removed using a soap or detergent followed by a sanitizing step with a chemical sanitizer compound (such as chlorine) or a heat step. For kitchen surfaces and sinks, the percentage of successful attempts was very low. When looking at utensils specifically (knives and cutting boards), the only successful attempts for both cleaning and sanitizing came from participants who used the dishwasher. These results suggest that messages on cleaning and sanitizing should be revisited to emphasize the importance of the scientifically grounded two-step process, especially when focusing on the kitchen environment following handling of raw meat and poultry.

The use of the same cutting board for preparing the chicken and the salad was lower among the treatment group (15%) compared with the control group (40%) suggesting an intervention effect—one of the email messages advised using separate cutting boards for

raw meat/poultry and RTE foods. Using separate cutting boards can help prevent cross-contamination.

4.3 Impact of Directed Communications

Among all participants, 104 (35%) washed or rinsed the chicken thighs during preparation. The control group washed the chicken thighs 61% of the time, while participants who were exposed to the email messages washed the chicken thighs just 7% of the time, or a tenth of the control, indicating the impact of the intervention. This finding is similar to Year 1's finding where participants who watched a video on thermometer use directly before completing the observation task were 3 times more likely to use a food thermometer correctly. The email messages did not appear to have an effect on handwashing or cleaning and sanitizing of kitchen surfaces, sinks, and equipment. Based on the results of the microbiological analysis, among nonwashers, those in the control group were more likely to contaminate the salad than those in the treatment group, suggesting an intervention effect.

In short, message delivery methods or targeting is important to change consumer behavior. Through the use of social media, FSIS has the ability to influence many consumers at multiple times and target consumers directly through boosted or sponsored ads (or information nodes). Ultimately, public health communications should support or foster healthy behaviors by the target audience. Heldman et al. (2013) posit that the potential for behavior change with social media engagement exists, but that more inquiry is needed.

In a 2013 survey of 1,800 Americans, U.S. communications firm Ketchum (2013) investigated the changing landscape of online discussions related to food quality, nutrition, and safety and identified a subset of the Internet public as food evangelists. According to Ketchum, this population generates up to 1.7 billion conversations about food weekly and does not see itself as activists with entrenched beliefs on these issues; rather, they are an interested public. They expect the food system, including federal agencies, to work interactively to engage the eating public in dialogue and to share information proactively and transparently.

Social media can be an asset to food safety risk communicators and a hindrance as well. Benefits can be speed, accessibility, and interactive capacity when raising awareness about an issue or during crisis communications, but these benefits may be countered by a lack of control on accurate information, low trust in the information source, the risk of information overload, and a preference for traditional media.

Online discussion of risk may be susceptible to social amplification of risk, wherein risks assessed by technical experts as relatively minor elicit strong public concerns that result in substantial impacts on society and economy. Misinformation and false assertions may be easily disseminated via social media with or without malicious intent and be widely believed.

With the ubiquitous nature of social media in current society, health and food safety risk communicators should be taking advantage of these platforms to provide information and engage the public. The characteristics of social media allow it to be used in a variety of ways, but care must be taken to tailor messages and engage audiences to take advantage of the interactive, multidirectional nature of social media.

4.4 Actionable Skills and Compelling Reasons Are More Important than Knowledge

Verbeke, Frewer, Scholderer, and De Brabander (2007) reported that experts in food risk management tend to view the general public as deficient in understanding food hazards and associated risks; the general public displays behavioral patterns and makes choices that seem irrational or illogical or at least inconsistent with expert opinions and scientific knowledge. As noted by Bob Lalasz, the director of science communication for the Nature Conservancy, regarding the public's response to scientific innovations and influences on behavior, there is the assumption by experts that "the public isn't getting the gravity of the problem—because if they did, how could they fail to act?" (Contractor & DeChurch, 2014).

Even with careful attention to message framing and language, consumers may find it difficult to apply risk control measures in their daily practices. Wills, Meah, Dickinson, and Short (2015) studied home food preparation practices to gain insight on how food stored, prepared, and eaten in the home may contribute to foodborne disease. They observed that kitchen practices were entangled in people's habits and cultural practices and were embedded within sequences comprising many small events that also included nonfood-related activities. Their study found that food preparation, laundry, childcare, pet care, social life, school and office work, arts and crafts activities, music practice, reading, gardening, and bicycle repairs also took place in people's kitchen spaces. Cleaning was one action carried out within these sequences of events, but its purpose was to make the area tidy and nice, or cleaning was part of a habitual routine rather than to prevent foodborne illness. The youngest children, oldest adults, and family pets were all engaged in the kitchen, which has implications for preventing foodborne diseases as well.

Meah (2014) also collected qualitative and ethnographic data to examine how concerns about food safety were negotiated into everyday domestic kitchen practices in the United Kingdom and found that common sense logic was used to balance food safety against experiential knowledge and sustainability concerns (e.g., reducing food waste). These findings conflict with the widely held assumption that consumers' failures to follow safe food handling instructions are often due simply to a lack of knowledge (Verbeke et al., 2007). Meah proposed that authorities' advice would have more impact if it took more account of consumers' practical knowledge and routine practices and incorporated current levels of public understanding and knowledge base rather than assuming a deficit of knowledge.

Emphasizing the human rather than statistical aspects can increase the interest and relevance of the information to an audience (Food and Agriculture Organization, 1999), and identifying individual victims enhances the perception of personal risk (Covello, Peters, Wojtecki, & Hyde, 2001). Recapping a persuasive narrative with a nonnarrative summary may help reinforce the takeaway messages (Slater & Rouner, 2002).

General information about risk is not enough; consumers will practice safe food behaviors only when they perceive a direct risk to themselves. Consumer knowledge and awareness of foodborne illness and pathogens do not always result in a positive change in food handling behavior. It is thus important to learn more about consumer attitudes and behaviors to create awareness of safe food handling practices, to promote public trust and credible information sources, to encourage food safety education, to create familiarity, and to incorporate everyday context into food safety communications. Foodborne illness prevention messages should stimulate perceptions of risk and bolster self-efficacy to increase the adoption of safe food handling behaviors. Food safety messages for consumers should address the behaviors that lead to the highest incidence of foodborne illness and cause the most serious consequences. Risk messages directed to specific concerns are more relevant to the public than general messages.

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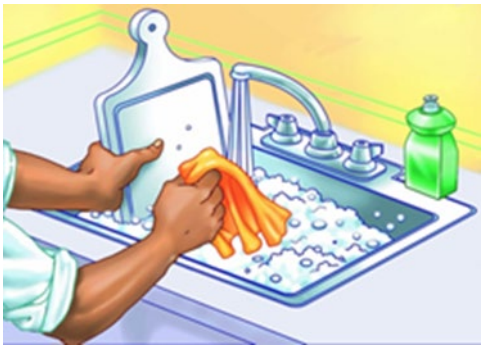
Appendix A:
Description of Intervention

Message 1 (in Emails 1 and 3): Prepping dinner? Avoid cross-contamination! Use 2 separate cutting boards: 1 for produce & bread and 1 for raw meat, poultry, & seafood.



Message 2 (in Emails 1 and 2): Why do we recommend NOT washing your meat & poultry? The answer is simple, it doesn't destroy bacteria, it spreads it! Click here to learn more https://www.youtube.com/watch?v=SBeMcOvDoi8&app=desktop.

Message 3: (in Emails 2 and 3): DON'T WASH YOUR CHICKEN! Washing will spread bacteria & won't even clean your bird! The only way to be safe is to cook your chicken to 165°F! #FoodSafety

We sent Email #1 to intervention participants on the same day his or her appointment was scheduled. We sent Email #2 five days before participant's scheduled appointment, and we sent Email #3 two days before participant's scheduled appointment. The control group received appointment reminders without the messaging.

Appendix B:
Power Analysis to Determine Sample Size for the Study

We calculated sample sizes to determine the minimum sufficient number of participants needed to provide a level of confidence that the observational experimental study on poultry washing is not underpowered, meaning that a change in behavior of the anticipated size or greater will be interpreted as occurring beyond chance (i.e., statistically significant). The measure of confidence is statistical power, and by convention we aim for 80%, meaning that we accept a 1-in-5 likelihood that a nontrivial program effect will not reach a level of statistical significance. We also, by convention, aim for a 95% level of confidence that we will not misinterpret a trivial difference as statistically significant. These factors are included in our sample size calculations.

The primary outcome of interest for the Year 2 observation study is proper handling of chicken before cooking, defined as not washing or rinsing chicken. We assumed that proper chicken handling will be assessed as a dichotomous variable with participants scored as successful if they do not wash chicken and unsuccessful if they wash chicken. Our effect size estimates are based on Henley and colleagues' (2016) recent study examining poultry washing in a general population sample. Their intervention included indirect education in a public space with post-intervention questionnaires among individuals potentially exposed to (treatment) and not exposed to (control) educational materials. Their results indicate a 10.3 percentage point difference between control and treatment (9.8 vs. 20.1) in the number of participants who acknowledged that they did not wash small cuts of chicken (e.g., thighs, wings, breasts) based on analysis of the post-intervention data; this equates to an intervention effect of $h = 0.29$.

The intervention for the Year 2 observation study has two advantages over the study conducted by Henley et al. First, it employs targeted social media outreach to participants in the treatment group; thus, we have greater confidence in message receipt and anticipated stronger effects. Second, the study observes behavior in a controlled kitchen setting rather than collecting self-reported behavior by survey methods; recent safe food handling studies in this environment (i.e., thermometer use) have produced substantially larger intervention effects. Accordingly, for planning purposes we anticipated a modestly stronger intervention effect than the one reported by Henley et al.

Study participation is limited to those who self-identify as individuals who wash chicken parts. We assumed a small proportion of participants in the control condition may not wash chicken because they are in a laboratory setting (i.e., Hawthorne effect). Accordingly, we assumed 98% of our study sample will wash chicken without any form of intervention. With an assumed starting rate of 98%, we provide in Table B-1 sample size and effect size estimates based on the anticipated percentage point difference between the treatment and

control groups. With a sample size of 306, we can identify statistically significant differences of 8 percentage points or greater (effect size estimate of $h = 0.36$).

Table B-1. Sample Size Estimates for an Observational Study of Safe Food Handling Practices: Chicken Washing

Poultry Handling (Washing): Base Rate	Expected Change in the Exposed Group	Poultry Handling (Washing) in the Exposed Group: Observed	Effect Size Estimate (*h*)	Total Sample Size (*N*)
98%	−10.3%	87.7%	0.43	216
98%	***−8%***	***90%***	***0.36***	***306***
98%	−6%	92%	0.29	460

Appendix C:
List of Equipment Provided in Each Test Kitchen

The picture below shows one of the test kitchens used for the meal preparation experiment. The equipment provided in each test kitchen is listed below.

Kitchenware

Grill

- ❑ George Foreman grill

Skillet

- ❑ Medium-sized skillet (9–12 inches)

Frying pans

- ❑ Small (8-inch) nonstick
- ❑ Medium or large (10–12 inches)

Sauce pans

- ❑ Small (2–3 quarts)
- ❑ Medium or large (4–5 quarts)

Knives
- ❑ Chef's knife
- ❑ Paring knife/fruit knife

Baking dishes
- ❑ 9x13 baking dish (rectangular)
- ❑ Smaller square, rectangular, or oval baking dish

Utensils
- ❑ Wooden or plastic stirring spoons (1–2)
- ❑ Heat-resistant plastic or silicone spatula
- ❑ Slotted spoon
- ❑ Ladle
- ❑ Flat spatula
- ❑ Cooking tongs
- ❑ Digital tip-sensitive instant read thermometer
- ❑ Dry measuring cups
- ❑ Liquid measuring cup (1 cup)
- ❑ Measuring spoons
- ❑ Can opener
- ❑ Liquid measuring cup (2 cups)
- ❑ Whisk
- ❑ Rolling pin
- ❑ Peeler
- ❑ Zester/grater
- ❑ Large cutting boards
- ❑ Splatter guard
- ❑ Serving bowl
- ❑ Serving utensils (serving fork, spoon, and tongs)
- ❑ Salt and pepper shaker (must be glass)
- ❑ Garlic and onion powder
- ❑ Utensil holder

Other essential tools
- ❑ Small, medium, and large mixing bowls
- ❑ Colander
- ❑ Salad spinner

Silverware/dinnerware
- ❑ Set of spoons, knives, and forks
- ❑ Dinner plates
- ❑ Salad plates
- ❑ Bowls

Cleaning/dishwashing supplies

- ❑ Kitchen towels
- ❑ Dish cloths
- ❑ Hand soap
- ❑ Dish drain board/dish rack
- ❑ Paper towels
- ❑ Sponge
- ❑ Sponge caddy
- ❑ Paper towel holder
- ❑ Apron
- ❑ Oven mitts
- ❑ Pot holders
- ❑ Dishwashing detergent

Cleaning stuff for under sink

- ❑ Bucket
- ❑ Windex
- ❑ Simple green cleaner
- ❑ Clorox bleach
- ❑ Formula 409 spray
- ❑ Lysol spray

Leftover kit supplies

- ❑ Ziploc bags (gallon and quart sizes)
- ❑ Plastic wrap
- ❑ Plastic containers with lids

Note: Containers must be sanitized between observation events. Ziploc bags and plastic wrap must be taken out of retail packaging and placed in kitchen drawers.

Housekeeping items

- ❑ Trash can for kitchen (13 gallons with a cover but no step-to-open feature). Note: position the trash can near the cooking area.
- ❑ Trash bags (13 gallons)
- ❑ First aid kit

Appendix D:
Observation Script and Recipes

Check-in Script - English

Welcome! My name is _____ and I'll be walking you through what you'll be doing as part of our study today.

Today you will be preparing chicken thighs baked with a spice blend and a mixed green salad with a spiced olive oil dressing and we will interview you after you finish cooking. The cooking and interview will last no more than two hours total.

Before we start, I need you to **read and sign the consent form.** Please let me know if you have any questions or concerns. You will receive a copy of the form to take home.

Pre-cooking Script (after consent form signed)

Today you will be preparing two simple recipes to test a new spice product formulation. We would like you to take this spice blend and apply it to the chicken thighs that are found in the refrigerator. Please prepare the chicken thighs exactly as you would in your own kitchen. After preparing the chicken, you will prepare a salad with mixed greens and an olive oil dressing with the same spice blend. Please do not eat the chicken or salad.

When you are ready to begin, please preheat the oven to 475 ◦F and set, *but do not start,* the timer for 25 minutes. Remove the chicken from the packaging and place the thighs in a baking dish or baking pan and drizzle with olive oil.

Apply the spice blend to the chicken thighs, based on how you have applied spices in the past, use as little or as much as you want.

Inform us as soon as you are ready to place the thighs in the oven so we can take a picture of the chicken for our research.

We will place the chicken in the oven for you and start the timer. While the chicken is cooking, please prepare the salad and dressing. After the salad is prepared, and if the chicken is still cooking, you can clean up as you normally would do so at home. When the timer goes off, please check to see if the chicken is done as you would at home. If the chicken is done, please remove it from the oven and place it on a plate. If the chicken is not done yet, please return it to the oven and take it out when you think it's done and place on a plate. Again, please do not eat the chicken. We will interview you after you are finished cooking. The cooking and interview will last no more than 2 hours total.

This is the area where you will be cooking. All the available utensils and dishes are in these drawers/cabinets. [Note: open a few cabinet and drawers and be sure to open the drawer with the thermometer].

Feel free to use whatever you need. Please make yourself at home, you are welcome to use your phone to listen to music, or whatever you usually do when cooking at home. If the temperature of the kitchen is not okay, let me know and I can adjust it.

Restrooms are located _____, and in case of an emergency, the exits are _____. The fire extinguisher is located _____ and the first aid kit is located _____.

Before you begin, do you have any questions?

If you have any questions or concerns while you're cooking, I will be in the _____ room.

Remember, please let us know after you have put the spice rub on the chicken and are ready for the photo by pushing this button/waving hand/stepping out. We want to take a photo very soon after the spice is applied, so please do not prepare the salad until after we have taken the photos.

[After Putting Spice Rub on Chicken]

Thank you. We'll go out into this waiting area while my colleague takes a few pictures.

[Wait with the participant and ask the following questions]

While we are waiting, I would like to ask a few questions about the spice blend you were using.

1. On a scale of 1-10, with 10 being very strong and 1 virtually undetectable, how would you rate the strength of the aroma?
2. Could you identify any one specific spice in the blend? In other words, did one spice really stand out?
3. If you applied the blend with your hands, how would you describe the texture? Was it fine or coarse? Did it rub on smoothly or clump up?
4. Thinking about aroma and texture, how would you rate this particular blend with 1 being not appealing at all to 5 being very appealing and you would actually use it?
    a. Can you provide us a little more information behind your rating?
5. What spices do you typically use on your chicken?
6. Do you typically apply one spice or create your own spice blend at home? If you do create a blend, what are you looking for?
7. How do you normally apply spices to your chicken?

Note: You do not need to ask all of these questions if the swabbing is complete.

[After Going Back into Kitchen]

While the chicken bakes, please prepare the salad and dressing. Once the salad is finished, please clean up the kitchen as you would at home. ***However, you do not need to put any dishes or utensils back into the cabinets/drawers. Also, if you normally use a dishwasher, feel free to use the one provided in the room, but please do not turn it on.*** If you finish cleaning and the chicken is still baking, please feel free to read magazines, watch TV, or use your phone to make yourself feel at home.

When the chicken is done, please remove from the oven and let us know by pushing this button/waving hand/stepping out.

[After cooking]

Now that you have finished the cooking portion of the study, we are ready to begin the interview. It should take no more than 20 minutes to complete. Do you need a break before we begin that portion?

Chicken Thighs Recipe

[Note: The recipe was printed front and back on a laminated card.]

Ingredients

2 chicken thighs

Olive oil

Spice blend

Directions

1. Preheat oven to 475 ◦F and set timer (but do not start it) for 25 minutes.
2. Drizzle chicken thighs with olive oil.
3. Apply spice blend.
4. Inform us when you are ready to place the chicken in the oven.
5. When the timer goes off, check the doneness of the chicken as you do at home. If the chicken is done, please remove from the oven and place on a plate. If the chicken is not done yet, please return it to the oven and take it out when you think it's done.

Summer Mixed Green Salad

Ingredients:

Fresh mixed greens

Carrots

Celery

Dressing Ingredients:

Olive oil

Spice blend

Directions:

1. Chop carrots and celery into bite-sized pieces. Combine in bowl with fresh mixed greens and set aside.
2. For the dressing measure ½ cup olive oil and ½ tablespoon of the spice blend into the salad dressing mixer, shake well, and set aside.

Appendix E:
Microbiological Methods

E.1 DH5-alpha Stock Selection and Preparation

The surrogate was selected in an attempt to model an organism that would react similarly to foodborne pathogens of concern that are associated with poultry products like *Salmonella* and *Campylobacter*. The safety of the consumer was the paramount concern, and the surrogate DH5-alpha, a nonpathogenic *E. coli* derived from K-12, with the pBIT plasmid was chosen for the study and IRB approval was obtained. A green fluorescent protein (GFP) and kanamycin resistance gene were contained in the pBIT plasmid that would allow the differentiation of bacterial contamination from improper handling of the chicken thighs and any other naturally present *E. coli* or kanamycin-resistant bacteria. A DH5-alpha colony with pBIT will fluoresce green under ultraviolet light (UV) and be easily identifiable compared with a colony from a bacteria that is naturally occurring and not indicating cross-contamination.

The DH5-alpha was obtained and frozen in an 80/20 trypticase soy broth kanamycin (30 ug/mL)/glycerol stock at −80 C. When used for inoculation one loopful of the frozen stock was placed in the appropriate amount of trypticase soy broth with 30 ug/mL of kanamycin and mixed. The bacteria was then incubated, shaking overnight at 37°C aerobically. The culture was also streaked directly onto trypticase soy agar with kanamycin (TSA Kan30), incubated upside down aerobically at 37°C, and visualized under UV light to validate that the stock still had an active pBIT plasmid.

E.2 Chicken Thigh Inoculation

Inoculation was performed according to Niebur, Laury, Acuff, and Dickson (2008) with modifications for dip inoculation, which proved more consistent when piloted in the lab (data not provided). Two chicken thighs were used for each meal preparation event, and chicken thighs were inoculated with the surrogate three times a week to keep the bacterial concentration high and keep the chicken within its shelf life. The surrogate was grown up overnight, shaking at 37°C in a trypticase soy broth with kanamycin. It was then spun down at 3000 x g for 15 minutes at 4°C. The supernatant was then poured off and the pelleted surrogate was resuspended in 0.1% buffered peptone water (BPW). Two thighs bought within 24 hours were then placed in Ziplock bags with 100 mLs of resuspended surrogate and massaged for 2 minutes. Thighs were then placed on racks and dried for 20 minutes in a bacteriological hood to facilitate attachment of the surrogate to the chicken thighs. After drying, the thighs were packaged and transported to the test kitchens where they were used within 3 to 4 days.

E.3 Inoculation Validation

There were two extra chicken thighs placed into two separate bags at random during every inoculation. These thighs were not packaged but instead placed in separate filtered WhirlBags to validate the inoculation procedure. Thighs were stomached with 50 mL of 0.1% BPW for 1 minute at 260 rpm. The liquid was serially diluted and plated on TSA Kan30 in incubated upside down overnight at 37°C aerobically. Colonies were counted and visualized under UV light, and an average of the surrogate for each thigh was used to represent the amount of surrogate present on all thighs inoculated that day (usually between log 7 and log 10).

E.4 Environmental Sampling and Lettuce Collection

Environmental sampling was performed to assess cross-contamination that occurred during meal preparation. Enviro Swabs (3M) were used to sample the kitchen surfaces, and an aliquot of 25 g of the lettuce was collected in a Ziplock bag for each meal preparation event. Irregular surfaces were swabbed entirely, while flat surfaces were swabbed using a 100 cm^2 template.

E.5 Detection and Quantification of DH5-alpha on Environmental Samples and Lettuce

The environmental samples and lettuce samples were analyzed at an NCSU lab within 24 hours. The samples were kept at 4°C until they were processed. A processing method was adapted from the 3M Enviro Swab instructions (3M, 2016) for the processing of samples (data not shown). The outside of the swabs was wiped down with ethanol to remove any kitchen surface contamination and then 4.5 mLs of 0.1% BPW. The swabs were vortexed for 15 seconds, and then a tenfold dilution was made for each swab using 9 mLs of 0.1% BPW. These samples were briefly vortexed to mix, and then 100 uL was plated in duplicate for each swab and dilution onto TSA Kan30 plates. These were incubated aerobically upside down at 37°C for 24 hours. They were examined under UV light and glowing colonies were counted as a positive result. The counts were adjusted for total volume and dilution and recorded.

For the lettuce sample, 25 grams were weighed into a filtered WhirlBag and stomached at 260 rpm for 1 minute with 50 mLs 0.1% BPW. A tenfold dilution was prepared in 9 mL of 0.1% BPW and vortexed briefly to mix. 100 uL of the salad and dilution were plated on TSA Kan30 plates and incubated aerobically upside down at 37C for 24 hours. They were examined under UV light, and glowing colonies were counted as a positive result. The counts were adjusted for total volume and dilution and recorded.

E.6 Sanitation After Meal Preparation Event

We sanitized the kitchens following meal preparation in accordance with NCSU's guidelines for sanitizing laboratory work surfaces, a requirement of the University. We applied household bleach diluted to a 10% concentration to hard surfaces with a contact time of 60 seconds before wiping them clean with a disposable paper towel. We repeated this step twice for a total of three sanitation steps. The efficacy of this sanitation procedure was confirmed during in-lab optimization studies and the pilot conducted in the test kitchen. All utensils, including knives, cutting boards, and bowls, for example, were cleaned in dishwashers.

References

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Appendix F:
Post-observation Interview Guide

OMB Control Number: 0583-0169
Expiration date: 06/30/2018

1. TREATMENT GROUP INTERVIEW GUIDE[1]

Introduction Script

Thank you so much for your time today and allowing us to record your actions while you prepared a meal just like you would in your home. If it is okay with you, I'm going to ask you a few follow-up questions that will focus on some of the activities you participated in while in the model kitchen.

Is it okay with you if I record your answers? The recording is confidential and will only be used to accurately capture our conversation (allowed recording y/n).

If it is okay with you, I'd like to begin this interview, which will take about 20 minutes. If **no**: Terminate interview.

If **yes**: Proceed.

Observation Follow-Up (use trigger form for context)

1.1 Handwashing

[Provide context] I saw that you **washed your hands before you started cooking** today, can you tell me why you did that? Is that something you typically do when cooking at home? Why?

OR

[Provide context] I saw that you **did not wash your hands for a full 20 seconds before cooking** today, can you tell me why not? When you cook at home, do you usually not wash your hands before cooking? Why not?

[1] The control group interview guide was the same as the treatment group guide with the exception of Section 1.12, in which participants were asked about food safety messaging they would like to see and how they normally obtain information on food safety.

1.2 Washed Raw Chicken

How often do you cook bone-in, skin-on chicken thighs? [Probe: is this typical of the types of chicken you cook at home? If not, what other types of chicken do you normally cook?]

[Provide context] I saw that you washed the raw chicken today, can you tell me why you did that? Is that something you typically do when cooking at home? Why?

How do you wash or rinse raw chicken at home? Is there something you would do differently at home, that you didn't do today?

If you are cooking a whole chicken, would you wash it the same way as you did today with the chicken thighs?

Do you have a kitchen sink sprayer at home? [Probe: do you use it to wash/rinse chicken?]

At what point do you wash or rinse chicken at home? [Probe: if you purchase in bulk, do you wash/rinse before repackaging? Right before cooking?]

Why do you wash or rinse raw chicken at home? [Probe: to get rid of slime, skin, fat, blood, bacteria or germs? Habit? My family has always washed or rinsed raw chicken.]

[Ask if wash or rinse to rid of bacteria or germs] How important is it to you to wash or rinse raw chicken to get rid of bacteria or germs?

- Very important
- Somewhat important
- Not important at all
- [Don't Know]

OR

[Provide context] When we recruited you for the study, you said you usually wash raw chicken before cooking it. I saw that you <u>did not</u> wash or rinse the raw chicken today, can you tell me why?

[If "social media" emails mentioned, ask] Can you tell me exactly what you saw that made you decide to not wash raw chicken today?

What about the next time you cook raw chicken at home, do you think you will wash it? If yes, why? If no, why not?

1.3 Washing Hands after Handling Raw Chicken

[Provide context] I saw that you **washed your hands after handling raw chicken** today, can you tell me why you did that? Is that something you typically do when cooking at home? Why?

OR

[Provide context] I saw that you **did not wash your hands after handling raw chicken** today, can you tell me why not? When you cook at home, do you usually not wash your hands after handling raw chicken? Why not?

1.4 Food Thermometer

[Provide context] I saw that you **used a food thermometer** today, can you tell me why you did that? What information were you looking for? Is there a specific temperature?

Do you have a food thermometer at home?

Do you typically use a food thermometer when cooking chicken thighs at home? Why?

How important do you think it is to use a food thermometer when cooking? Would you say …

- Very important
- Somewhat important
- Not important at all

[Don't know]

OR

[Provide context] I saw that you **did not use a food thermometer today**, can you tell me why not?

Do you usually not use a thermometer when cooking at home? Why not?

Do you have a food thermometer at home? If yes, do you ever use it when cooking chicken thighs? What about for other types of meat or poultry?

How do you usually determine doneness?

How important do you think it is to use a food thermometer when cooking? Would you say …

- Very important
- Somewhat important
- Not important at all

[Don't know]

1.5 Towels

[Provide context] I saw that you **used a reusable/cloth kitchen towe**l during cooking today. Is that something you typically do when cooking at home? Why?

OR

[Provide context] I saw that you **used disposable paper towels** while cooking today. When you cook at home, is something you typically do? Why?

1.6 Cleaning Kitchen Items

[Provide context] I saw that you **washed the cutting board and utensils** today with soap and water, can you tell me why you did that? Is that something you typically do when cooking at home? Why?

OR

[Provide context] I saw that you **did not wash the cutting board and utensils today** with soap and water, can you tell me why not? When you cook at home, do you usually not wash the cutting board with soap and water? Why not?

1.7 Cleaning/Disinfecting Sink

[Provide context] I saw that you simply **rinsed the sink today without using soap or sanitizer**, can you tell me why? Is that how you typically do it when cooking at home? Why?

OR

[Provide context] I saw that you **washed the sink** today with **soap and water**, can you tell me why you did that? Is that something you typically do when cooking at home? Why?

OR

[Provide context] I saw that you **disinfected the sink** today with **sanitizer**, can you tell me why you did that? Is that something you typically do when cooking at home? Why?

1.8 Cleaning/Disinfecting Counter

[Provide context] I saw that you simply **wiped the counter today without using soap or sanitizer**, can you tell me why? Is that how you typically do it when cooking at home? Why?

OR

[Provide context] I saw that you **washed the counter** today with **soap and water**, can you tell me why you did that? Is that something you typically do when cooking at home? Why?

OR

[Provide context] I saw that you **disinfected the counter** today with **sanitizer**, can you tell me why you did that? Is that something you typically do when cooking at home? Why?

1.9 Leftovers

Imagine you just cooked a large pot of soup or chili so that you would have enough to eat the next day. What do you do with the **leftovers**?

> Probe: Do you place the leftovers in one container or multiple containers? How big are the containers?
>
> Probe: Do you refrigerate the leftovers within two hours? Or do you typically wait longer? If so, how long? Why do you wait longer?

How long do you store the leftovers in the refrigerator before someone eats them or you throw them away?

1.10 Thawing

Imagine you have chicken in the freezer, and you plan to cook it for dinner later in the week. How would you **thaw it**?

> Probe: Do you thaw it the day you're cooking it or a couple days before?
>
> Probe: What method of thawing do you use: in the microwave, in the refrigerator, in water in the sink, or on the countertop?
>
> If water in sink, do you use hot or cold water? Running or standing water? Do you change the water at some point? When do you cook it?
>
> If in refrigerator, where do you place the frozen chicken? On the top, bottom, or middle shelf? What, if anything, do you place it on? When do you cook it?
>
> If in the microwave, do you cook it immediately or wait awhile before cooking it? How long do you wait?

Let's say you thawed the chicken for dinner tonight, but something came up and you were not able to cook it. How many days would you leave it in the refrigerator before cooking it or throwing it away?

1.11 Antecedent Questions

1. How concerned are you about bacteria or viruses on or inside the food you cook? On a scale of 1-7, with 1 being not at all concerned, 4 being neutral, and 7 being extremely concerned, how concerned are you?
2. When thinking about the food you prepare and cook, do you feel you are able to impact the safety of a meal. For example, does the action of cooking foods matter?
3. Have you ever had food poisoning? Y/N

4. Follow-up: Can you tell me about your experience? What were the symptoms, what food do you think made you sick? Do you believe your illness was contracted from cooking at home, or eating prepared food away from home?

5. How common do you think it is for people in the United States to get food poisoning because of the way food is prepared in their home? Would you say that it is…

    - Very common
    - Somewhat common
    - Not very common

6. Has a family member ever had food poisoning? Y/N
7. Follow-up: Can you tell me about his/her experience? What were his/her symptoms, what food do you think made him/her sick? Do you believe their illness was contracted from eating at home, or eating prepared food away from home?

1.12 Intervention Questions

1. After you signed up for the study, we sent you 3 emails. Did you read the emails?

    a. If yes, did you read all the emails or some of the emails?

    b. IF YES: Before getting the emails, had you heard that you should NOT wash raw poultry before cooking it?

        - If had heard before: Can you recall where you heard this information? In your own words, tell me why you shouldn't wash raw poultry before cooking it.

    c. If no, why didn't you read the emails? **[Go to Conclusion]**

2. Do you recall if you viewed the emails on a desktop, laptop, tablet or smartphone?

3. Tell me what you remember about the emails.

    a. *[If necessary]* Do you remember seeing a message at the bottom of each email?

        - If yes, can you tell me what the messages said?

    b. *[If necessary]* Do you remember seeing a graphic at the bottom of any of the emails?

        - If yes, can you tell me what the graphic or graphics looked like?

    c. *[If necessary]* Do you remember seeing a link to a YouTube video at the bottom of one of the emails?

        - If yes, did you click on the link?

            - If yes, did you watch the video?

- If yes, do you recall what it was about?

[If respondent does not remember seeing any of the messages, graphics, or video, Go to Conclusion.]

4. Did the information in the email(s) or the video influence your actions in the kitchen today or not? If yes, in what way?

5. Do you think the information in the email(s) or the video will influence how you cook at home in the future or not? Why?

1.13 Conclusion

We mentioned in our recruiting materials that we were interested in cooking practices and how to evaluate recipes. However, the specific focus of our study is on food safety and how to prevent food poisoning. The aim of this study is to measure handling and preparation practices and investigate the movement of bacteria from raw foods, so we can better understand exactly how contamination can spread. In addition, a biological tracking agent was in the food to help us track where contamination might occur. This biological tracking agent does not pose any health hazard to you. We purposely did not tell you exactly what our specific research objectives were in advance in order to capture your behaviors in a natural way. You can request to be removed from the study at any time, and if you decide to exit the study at this point, we will destroy the recordings of your actions, and you will not be included in the data set.

We want to confirm with you now that you understand the focus of our study and that you wish to remain as a participant.

If **no**: Thank you so much for your time, your participation in our study is now complete, and we will remove your data from our dataset and destroy any records.

If **yes**: Thank you for your consent.

Thank you again for your time and for your participation in our study today. Are there any questions that you have for me?

Please see the greeter on your way out to receive the $75 gift card and gift.

Appendix G:
Screening Questionnaire

1. Web-Based Screening Questionnaire—English[1]

Screen 1

Thank you for your interest in our research study, which is funded by the U.S. Department of Agriculture and conducted by researchers from North Carolina State University and RTI International.

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0583-0169 and the expiration date is 06/30/2018. The time required to complete this information collection is estimated to average 8 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Screen 2

If you are eligible for the study, you will be asked to prepare two recipes while being videotaped and participate in an interview at a day and time convenient for you. The study will last no more than 2 hours, and you will receive $75 and a small gift for taking part in the study. To determine whether you are eligible, you will need to answer a few questions. These questions will take less than 10 minutes to complete. Your participation in this study is completely voluntary. All of your answers and your contact information will be kept private. Please click the ">>" arrows below if you would like to continue.

Question Screens

1. If you are eligible to take part in this study, we will send you up to three emails. Do you have a working email address?
   - ☐ Yes
   - ☐ No →***Ineligible. Terminate***

2. Have you ever received any type of food safety training, such as ServSafe?
   - ☐ Yes →***Ineligible. Terminate.***
   - ☐ No

3. Have you cooked or worked professionally in a food preparation setting in the past two years?
   - ☐ Yes →***Ineligible. Terminate.***
   - ☐ No

[1] A telephone version of the screening questionnaire was available for people who contacted NCSU by phone to participate in the study.

4. How many times per week do you prepare a meal at home?
   - ☐ Never →***Ineligible. Terminate.***
   - ☐ 1 to 3 times →***Ineligible. Terminate.***
   - ☐ 4 or more times

5. In the past three months, have you, yourself, prepared and cooked a meal using any of the following foods? *(Select all that apply.)*
   - ☐ Raw turkey or chicken breasts
   - ☐ Raw, whole turkey or chicken
   - ☐ Raw, ground turkey or chicken
   - ☐ Raw chicken thighs, wings, or legs
   - ☐ None of the above →***Ineligible. Terminate.***

6. When following a recipe for the first time, do you…? *(Select one.)*
   - ☐ Read the whole recipe before you start cooking
   - ☐ Read the recipe while you are cooking

7. Think about the last time you are prepared a meal at home using raw turkey or chicken. Which of the following things did you do before cooking the turkey or chicken? *(Select all that apply.)*
   - ☐ Thawed raw turkey or chicken
   - ☐ Rinsed, washed, or soaked raw turkey or chicken with water →***Ineligible if NOT selected. Terminate.***
   - ☐ Patted raw turkey or chicken dry with paper towel
   - ☐ Marinated it in a shallow dish or sealable plastic bag.
   - ☐ Rubbed it with butter and/or oil.
   - ☐ Seasoned it with salt and/or pepper.
   - ☐ Seasoned it with dry rub, spices, or herbs.
   - ☐ Dredged it in flour, breadcrumbs, cornmeal or other dry ingredient.

8. After preparing the turkey or chicken, how did you cook it? *(Select all that apply.)*
   - ☐ On the stovetop
   - ☐ On the grill
   - ☐ In the oven
   - ☐ In the microwave
   - ☐ In a crockpot, slow cooker, or pressure cooker
   - ☐ Other

9. Which of the following categories best describes your age?
   - ☐ Under 18 →***Ineligible. Terminate.***
   - ☐ 18 to 34
   - ☐ 35 to 54
   - ☐ 55 to 65
   - ☐ 66 to 75
   - ☐ 76 or older

10. Are you…?
    - ☐ Hispanic or Latino
    - ☐ Not Hispanic or Latino

11. What is your race? Please select one or more.
    - ☐ American Indian or Alaska Native
    - ☐ Asian
    - ☐ Black or African American
    - ☐ Native Hawaiian or Other Pacific Islander
    - ☐ White

12. What is the highest level of education that you have completed?
    - ☐ Less than high school
    - ☐ High school graduate or GED
    - ☐ Technical or vocational school
    - ☐ Some college, but do not have a degree
    - ☐ Associate or 2-year degree
    - ☐ College or 4-year degree
    - ☐ Post-graduate degree

13. Do you have any children living in your household who are less than 18 years of age?
    - ☐ Yes
    - ☐ No

14. Are you or any members of your household …? *(Select all that apply.)*
    - ☐ 60 years of age or older
    - ☐ 5 years of age or younger
    - ☐ Pregnant
    - ☐ Breastfeeding
    - ☐ Diagnosed with an allergy to any food or food ingredient
    - ☐ Diagnosed with diabetes or kidney disease
    - ☐ Diagnosed with a condition that weakens the immune system, such as cancer, HIV, or AIDS; a recipient of a transplant; or receiving treatments, such as chemotherapy, radiation, or special drugs or medications to treat these conditions
    - ☐ None of the above

15. Have you participated in a study about cooking in the past 12 months? *(Select one.)*
    - ☐ Yes →***Terminate.***
    - ☐ No

16. Where did you hear about this study?
    - ☐ Facebook
    - ☐ Twitter
    - ☐ Craigslist
    - ☐ Email from the Expanded Food and Nutrition Education Program
    - ☐ Sign
      Specify location: _____
    - ☐ Other
      Specify location: _____
    - ☐ Don't know

17. Great! You qualify for the study. Would you like to participate in the study?
    - ☐ Yes
    - ☐ No →***Terminate.***

Contact Screen 1

Great! Please enter your name and telephone number so that a study team member can call you and schedule an appointment at a day and time convenient for you. The study will last no more than 2 hours, and you will receive $75 and a small gift for taking part in the study.

[ENTER NAME]

[ENTER TELEPHONE NUMBER]

Contact Screen 2

Please enter your email address so we can send you a confirmation email with directions. In addition to the confirmation email, we will also send you up to three emails about the study. [ENTER EMAIL ADDRESS; REQUIRE DOUBLE ENTRY FOR VERIFICATION].

Thank you for your time. A study team member will call you in one or two days to schedule an appointment with you.

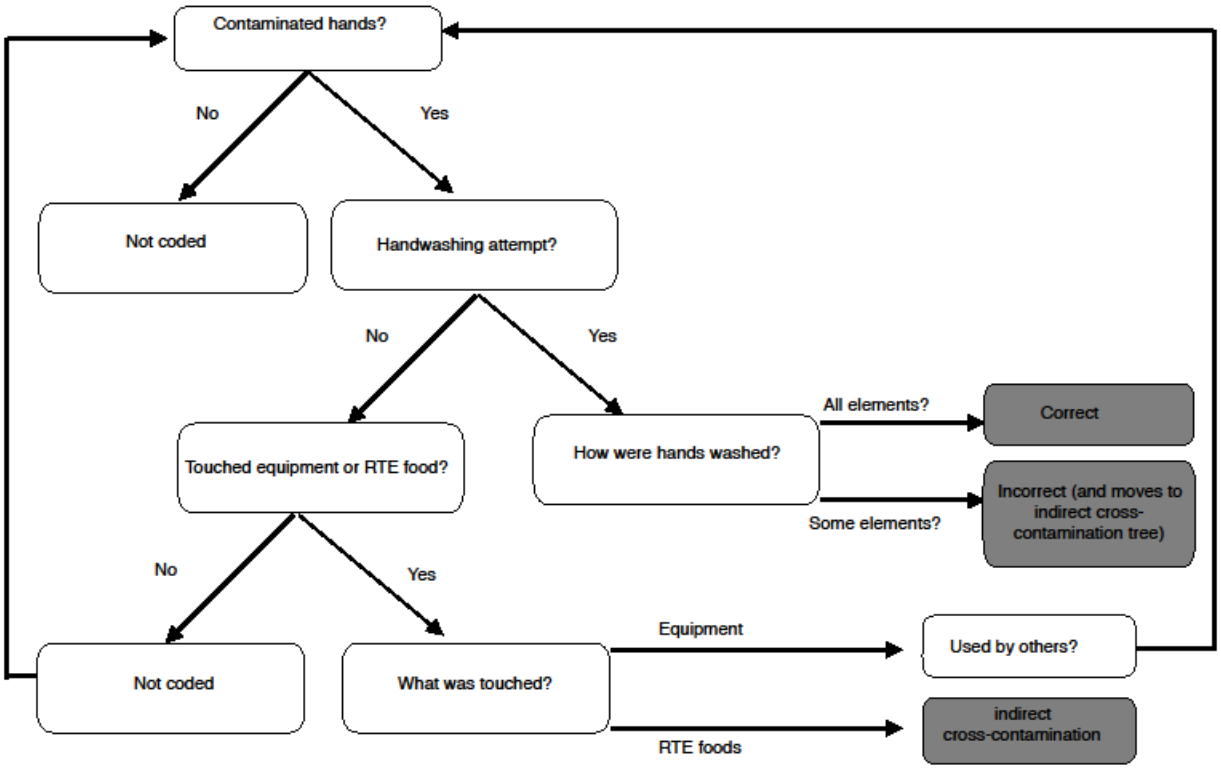
If you have any questions about the study, you may contact Lisa Shelley at 919-659-8254. If you have concerns about how participants are being treated in the study, you may contact North Carolina State University's Office of Research Protection at 919-515-4514.

Ineligible/Terminate Screen

Thank you for your time. Unfortunately, you are not eligible to take part in our study. Have a great day.

Appendix H:
Observation Rubrics

Handwashing Rubric



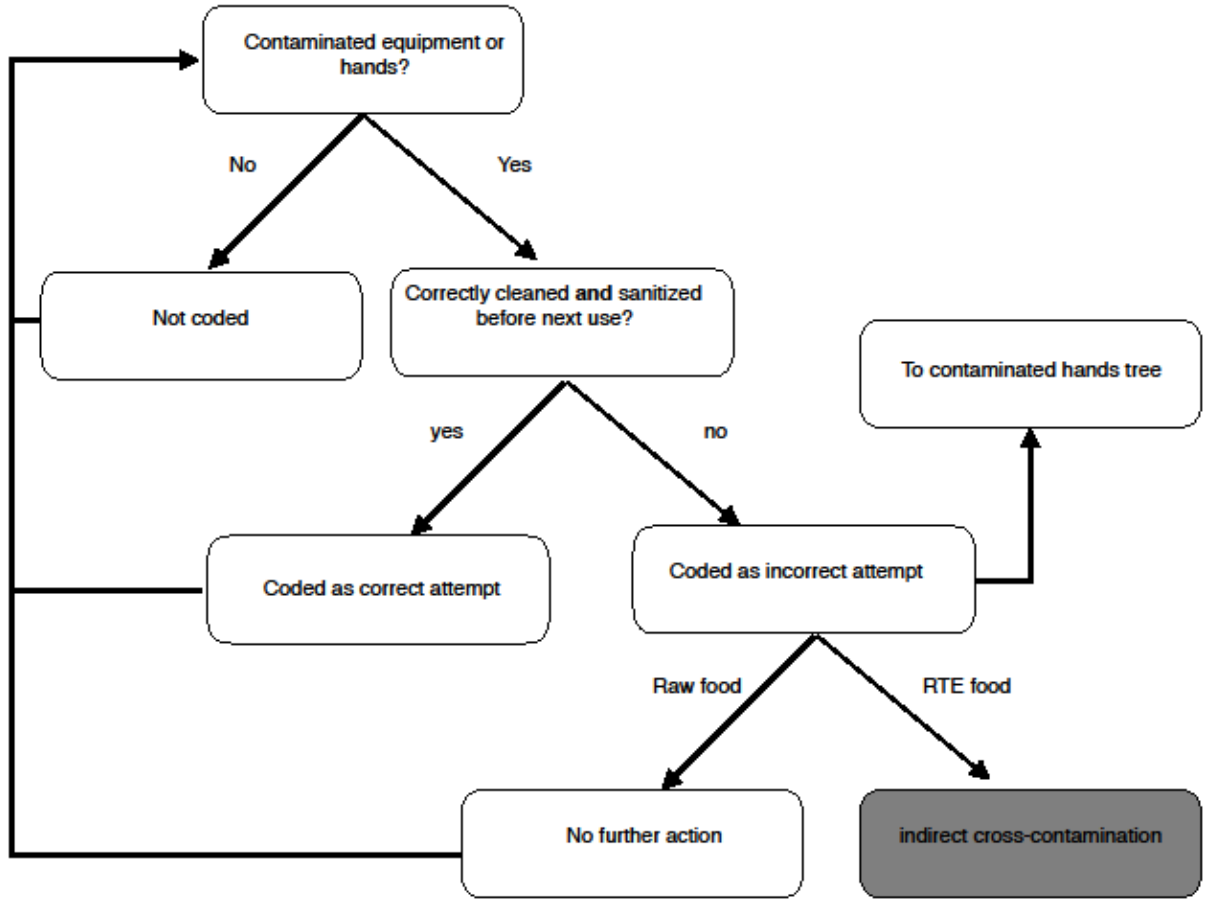
Notes and Definitions: Contaminated hands: Hands that have come into contact with potentially contaminated material (raw food, contaminated equipment, touching of face or other parts of body or clothing) and that have not been washed according to CDC's recommended guidelines for proper handwashing.

Elements of handwashing:

- Wet your hands with clean, running water (warm or cold), turn off the tap, and apply soap.
- Lather your hands by rubbing them together with the soap. Be sure to lather the backs of your hands, between your fingers, and under your nails.
- Scrub your hands for at least 20 seconds.
- Rinse your hands well under clean, running water.
- Dry your hands using a clean (one use/paper) towel or air dry them. https://www.cdc.gov/handwashing/when-how-handwashing.html

For a successful handwashing attempt, all elements should occur in the sequence listed above.

Indirect Cross-Contamination Rubric



Notes and Definitions:

Contaminated equipment: Equipment that has come into contact with potentially contaminated food or another potentially contaminated surface and that has not been properly washed and sanitized.

Was it cleaned and sanitized before next use?

Contaminated equipment (or surface) was considered cleaned if the participant used soap and water to scrub the surface and wiped it dry with a clean, one-use towel. Contaminated equipment or surface was considered sanitized if the participant used one of the provided sanitizers (containing chlorine bleach, quaternary ammonia, or alcohol-based) to spray the equipment/surface and wiped it dry with a clean, one-use towel. For an attempt to be considered successful, the contaminated equipment or surface had to first be cleaned and then sanitized. Contaminated hands: Hands that have come into contact with potentially contaminated material (raw food, contaminated equipment, touching of face or other parts of body or clothing) and that have not been washed according to CDC's recommended guidelines for proper handwashing.

Thermometer Rubric