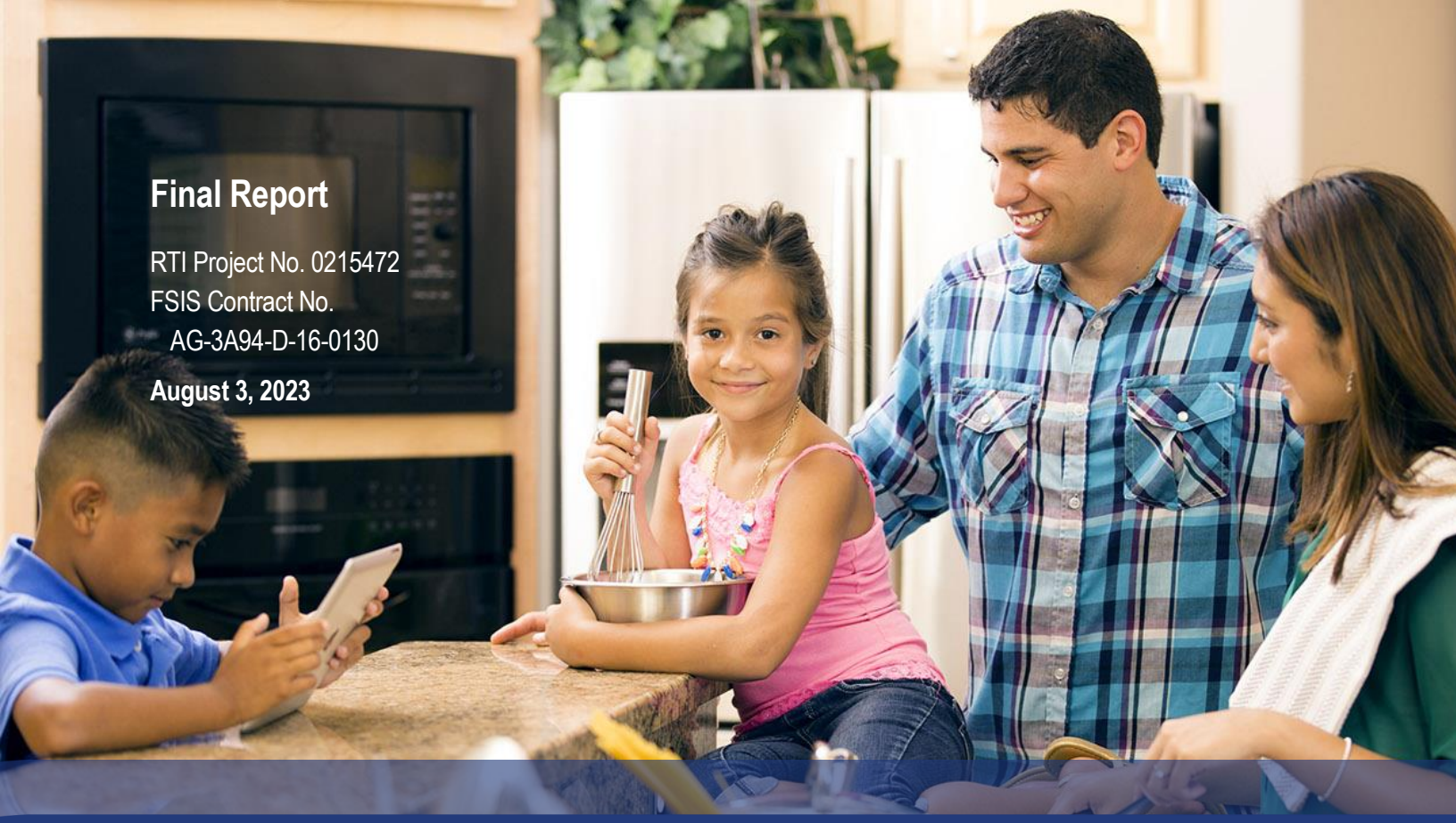

Final Report

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Food Safety Consumer Research Project: Meal Preparation Experiment on Breakfast

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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 conducted five separate iterations of meal preparation experiments 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 fifth iteration of the meal preparation experiment.

ES.1 Study Methods

RTI and NCSU conducted the study in a test kitchen facility located in Raleigh, North Carolina (Wake County), with three identical test kitchens. The study examined participants' adherence to recommended food safety practices when the mandated Safe Handling Instructions (SHI) label has been removed from meat packaging and safe handling instructions are integrated into the manufacturer's cooking instructions (MCI). Participants were randomly assigned to the (1) control group: separate SHI label and MCI on sausage packaging ($n = 125$) or (2) intervention group: intervention label with safe handling instructions integrated into the MCI ($n = 126$). For the outcomes of interest, we conducted statistical testing for the difference between the control versus the treatment group.

Participants were observed (while being video-recorded) cooking breakfast sausage (inoculated with harmless traceable nonpathogenic *E. coli* strain DH5-Alpha) and shell eggs and preparing a fruit salad with cantaloupe. Participants' behaviors were coded to measure adherence to recommended food safety practices, including thermometer use, handwashing, cleaning and sanitizing, safely preparing shell eggs, and washing produce. Following meal preparation, the study team collected microbiological samples from surfaces and cantaloupe from the prepared fruit salad and analyzed the samples for prevalence and level of DH5-Alpha. Participants participated in a post-observation interview to collect information on their usual food preparation practices and response to the intervention label.

ES.2 Key Findings

The key findings from the study are summarized below.

Impact of Intervention Label

- The intervention label did not impact the rate of food thermometer use for the sausage, the rate of handwashing attempts (before or during meal preparation), or the rate of cleaning/sanitizing attempts for the surface used to prepare the sausage.

- The results of the microbiological analysis suggest that the intervention label did not have an impact on cross-contamination during meal preparation.
- When asked about thermometer use in the post-observation interviews, 40% of treatment group participants reported using a thermometer because of the instruction on the label compared with 16% of the control group (the control group label provided the endpoint temperature in the MCI but did not have instructions to use a food thermometer). These results suggest that the intervention label may have influenced thermometer use in the test kitchen, although the rates of thermometer use were not significantly different for the treatment and control groups.
- Most (59%) treatment group participants did not offer any suggestions for improving the intervention label; 79% said the length of the label was about right, and 20% believed it was too long.

Thermometer Use

- Fifty percent of the control group and 55% of the treatment group used a thermometer to check doneness of the sausage patties. The difference between the two groups was not statistically significant. Some participants reported that they used a thermometer in the test kitchen, although this is not their usual behavior when cooking at home.
- Among participants using a thermometer, the mean number of sausage patties checked for doneness was three (most participants cooked four patties) for each group.
- Among participants using a thermometer, most participants failed to insert the thermometer in the proper location when checking doneness of the sausage patties.
- Comparing thermometer use among control group participants for Years 1 through 5 of the study, thermometer use varied by the type of product cooked. Excluding the not-ready-to-eat frozen, breaded stuffed chicken breasts—given the different characteristics of this product—the rate of thermometer use was significantly higher for hamburgers (58%), bratwurst (55%), and breakfast sausage (50%) compared with turkey burgers (34%).

Handwashing

- Rates of handwashing attempts *before* meal preparation were similar for the two groups: 44% for the control group and 42% for the treatment group.
- Rates of handwashing attempts *during* meal preparation were similar for the two groups: 17% for the control group and 18% for the treatment group.
- As in Years 1 through 4, few handwashing attempts included all steps necessary to be considered an adequate handwashing event as defined by the Centers for Disease Control and Prevention's (CDC's) recommended steps, and the most documented reason for not successfully washing hands was failing to rub hands with soap for at least 20 seconds.
- For handwashing before meal preparation, the rate of attempting handwashing for Years 4 and 5 (44%) was significantly lower compared with rates observed for study

Year 2 (74%) and Year 3 (71%) among control group participants.[1] We speculate that the lower rate for Years 4 and 5 may be because participants used the hand sanitizer station upon arrival, which was not present in prior years, as a COVID-19 precaution. Other reasons are possible, such as differences in the characteristics of the study sample and social distancing measures during the participant introduction to the test kitchen, which led them to touch meal preparation surfaces (e.g., drawers/cabinets), thus commencing meal preparation before washing their hands. Additional analysis is needed to understand why the rates are different.

Cleaning and Sanitizing

- Attempts to clean and sanitize immediately after handling sausage were similar for the two groups (about one-third of participants), with over half of the attempts unsuccessful because the participant cleaned but did not sanitize the surface.
- At the end of meal preparation, 65% of control group participants and 58% of treatment group participants attempted cleaning and sanitizing; the difference was not statistically significant. The rate of successful attempts (cleaned and then sanitized) was around 70% for both groups.

Cross-contamination and Microbiological Analysis

- Across all participants, the most often contaminated surface was the kitchen basin (38% of participants). The rate of contamination for the cantaloupe was the next highest, at 25%.
- Rates of contamination were relatively low for the juice glasses used to plate the meal (9%), spice containers (5%), and the tablet (3%). No differences were observed by group for prevalence or level of contamination.

Preparing and Cooking Eggs

- Less than half (43%) of participants attempted to wash their hands after cracking eggs; of those, only 1% successfully did so according to CDC's recommended steps.
- Sixty-nine percent of participants who cooked scrambled eggs reported cooking them until the yolk was firm. Among participants who fried the eggs, only 20% cooked them until the yolk was firm, preferring instead for their eggs to be over easy or over medium, with the yolks still runny.

Washing Produce

- The rate of washing attempts for the cantaloupe among all participants was 25%; and among these, 75% were successful.
- The rate of washing attempts for the mint among all participants was 43%. Of these, only 29% rubbed the mint with their hands, the recommended practice.

[1] For Year 1, data were not available by when handwashing took place (i.e., before the start of or during meal preparation).

1. Introduction

This report describes the methods and presents the results from a meal preparation study related to cooking breakfast (shell eggs, raw pork breakfast sausage, and fruit salad) conducted as part of the Food Safety Consumer Research Project (FSCRP). The study, conducted in test kitchens, used an experimental design to measure consumers' adherence to recommended food safety practices between participants who were exposed to an intervention (in the form of a revised label on the sausage packaging) and those who were not. The breakfast study is the last of five iterations of a meal preparation experiment in which consumers were 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 Year 5 meal preparation experiment. Additionally, the report compares key behavioral outcomes for Years 1 through 5 of the study.

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 the 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 social media, Ask USDA (an online database of frequently asked food safety questions), the Meat and Poultry Hotline, the FSIS web site, FoodSafety.gov, publications, and events. These messages are focused on the four core food safety behaviors: clean, separate, cook, and chill. Additionally, OPACE strives to reach Spanish-speaking and underserved audiences with its public education and outreach initiatives.

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 from fiscal year 2017 through fiscal year 2022. RTI partnered with researchers at North Carolina State University (NCSU) to conduct the research. This behavioral research includes 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 addressed different research questions and used a different sample of consumers. This research will provide insight into the effect FSIS consumer outreach campaigns have on consumers' food safety

behaviors. FSIS can use the results of this research to enhance messaging and accompanying materials to improve consumers' food safety behaviors.

1.2 Objectives of Breakfast Preparation Experiment

Previous research suggests that self-reported data collected through surveys on consumers' food safety practices may be 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 often a preferred approach for collecting information on consumers' 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 actions that are different from the ones they took (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 for certain raw meat and poultry products.

Each iteration of the meal preparation experiment addressed a specific consumer behavior. The fifth iteration examined participants' adherence to recommended food safety practices when the mandated Safe Handling Instructions (SHI) label is removed from meat packaging and safe handling instructions are integrated into the manufacturer's cooking instructions (MCI). The study examined participant thermometer use, handwashing practices, cleaning and sanitizing practices, and adherence to U.S. Food and Drug Administration (FDA)-recommended practices for preparing shell eggs and a fruit salad made with cantaloupe. Participants were randomized to one of two groups: (1) the control group that was provided with sausage labeled with the mandatory SHI label and voluntary MCI label (similar to labels for commercially available sausage products) and (2) the treatment group that was provided with sausage packaging without the SHI label and a label that incorporated safe handling instructions (from the SHI label) into the MCI (referred to as the intervention label). Participants were asked to cook breakfast sausage and shell eggs and prepare a fruit salad with cantaloupe. The study also assessed pathogen transfer during meal preparation and included the collection of microbiological samples from cantaloupe (from the prepared fruit salad) and kitchen surfaces. We observed participants throughout meal preparation to determine whether they followed recommended safe handling practices. Post-observation interviews collected information on participants' reasons for following or not following recommended food safety practices during the meal preparation and their response to the intervention label.

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 Questions	Data Source	Location in Report
Is the rate of thermometer use on the sausage patties higher for the treatment group compared with the control group?	Observations	Section 3.2; Table 3-4
Is the mean number of sausage patties checked for doneness higher for the treatment group compared with the control group?	Observations	Section 3.2; Table 3-4
What methods are used to determine doneness of sausage patties in lieu of a food thermometer for the control and treatment groups?	Observations, post-observation interviews	Section 3.2; Table 3-4
Is the rate of handwashing attempts higher for the treatment group compared with the control group?	Observations	Section 3.3; Tables 3-7, 3-8
Is the rate of cleaning/sanitizing attempts higher for the treatment group compared with the control group?	Observations	Section 3.4; Table 3-11
What is the rate of handwashing after cracking shell eggs? Where do participants store the egg carton with unused eggs?	Observations	Section 3.5; Table 3-12
Did participants attempt to clean up egg if raw egg got on the counter when cracking? To what doneness did participants cook eggs? Are participants aware of FDA recommendations?	Post-observation interviews	Section 3.5; Table 3-13
Did participants successfully wash the cantaloupe and fresh mint when preparing the fruit salad? Did participants clean and sanitize the knife and surface used to cut the cantaloupe?	Observations	Section 3.6; Table 3-14
Is the prevalence of contamination for cantaloupe (from the fruit salad) and sampled kitchen locations/items lower for the treatment group compared with the control group?	Microbiological sampling data	Section 3.7; Table 3-15
Did the food safety instructions on the sausage messaging influence how you prepared the meal today? If yes, how	Post-observation interviews	Section 3.8; Table 3-16
What was the treatment group's response to the intervention label?	Post-observation interviews	Section 3.8; Table 3-17
What differences are there between key behavioral outcomes for Years 1–5 of the study?	Observations	Section 3.3; Table 3-6, Table 3-10

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 thermometer use, handwashing compliance, and other behaviors, as well as participants' responses to the intervention label.
- Section 4 concludes the report by summarizing the key findings and discussing the implications of the study results.

The final report includes the following appendixes:

- Appendix A: Labels and Salad Recipe
- Appendix B: Observation Script
- Appendix C: List of Equipment Provided in Each Test Kitchen
- Appendix D: Microbiological Methods
- Appendix E: Post-observation Interview Guide
- Appendix F: Screening Questionnaire
- Appendix G: 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, and the approach for coding and analyzing the observations and post-interview data. The Office of Management and Budget (OMB control number 0583-0169, expiration date 8/31/2023) 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 fifth meal preparation experiment examined participants' adherence to recommended food safety practices when the mandated SHI label is removed from meat packaging and safe handling instructions are integrated into the MCI (see Figure 2-1). The study examined participants' thermometer use for the pork sausage, handwashing practices, cleaning and sanitizing practices, and adherence to FDA-recommended practices for preparing shell eggs and washing produce. Participants were randomized to one of two groups: (1) the control group that was provided with sausage labeled with the mandatory SHI label and voluntary MCI label (similar to labels for commercially available sausage products) and (2) the treatment group that was provided with sausage packaging without the SHI label and a label that incorporated safe handling instructions (from the SHI label) into the MCI (referred to as the intervention label). Appendix A provides a copy of the packaging for the raw pork breakfast sausage for the control and treatment groups.

Figure 2-1. Intervention Label that Integrates Safe Handling Instructions into the MCI

The COVID-19 pandemic and subsequent requirements for social distancing and other precautions to ensure the safety of participants and research staff limited the number of participant appointments that could be scheduled each day and the number of microbiological samples that could be processed each day. The target sample size was 250 participants. We used a balanced design, with half of the participants assigned to the control group and half to the treatment group. The actual number of participants was 125 for the control group and 126 for the treatment group.

2.1.2 Study Procedures

Figure 2-2 summarizes the study procedures. We conducted the study in a test kitchen facility located in Raleigh, North Carolina (Wake County) with three identical test kitchens. Each test kitchen had a sink, refrigerator, and stove/oven and was stocked with the same meal preparation equipment (dishes, knives, utensils, cutting boards, thermometer).In each test kitchen, eight cameras recorded participants' actions at various locations throughout the kitchen and recorded the meal preparation from beginning to end. We implemented procedures to mitigate risks of COVID-19 to participants and research staff.

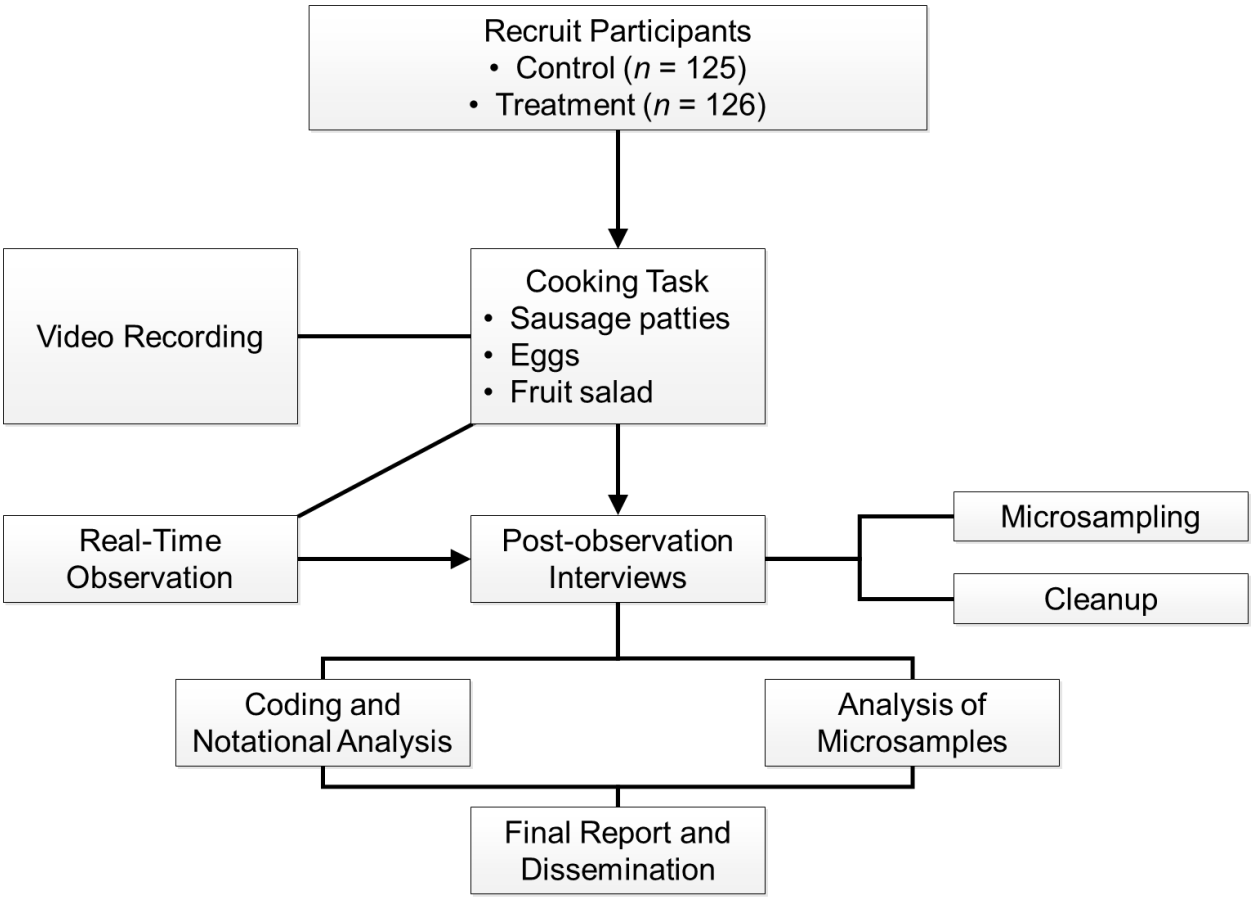
We used convenience sampling to recruit participants using a variety of approaches. Section 2.2 describes the participant screening criteria and recruitment procedures. Participants received a $75 gift card and gift (food thermometer, mentioned after the completion of the research) for taking part in the study, which could take up to 2 hours. Participant recruitment began March 27, 2022. We conducted observations beginning on April 15, 2022, and ending October 18, 2022.

We randomly assigned participants to the control or the treatment group when the appointment was scheduled with the goal of 125 participants in each group. The study team scheduled appointments at the test kitchen location based on kitchen availability with observations scheduled during the week, on weekends, and at different times of day (e.g., morning, afternoon, and evening). 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 (see Appendix B), the study team member described what participants could expect during the study. Initially, we told participants the purpose of the study was that we were working with a manufacturer to test new packaging for their breakfast sausage. Consistent with the approach used in other observation studies, we informed participants of the real purpose of the study following the post-observation interview and why it was important from a scientific perspective to inform them after the

study was completed[2] (Chapman, Eversley, Fillion, MacLaurin, & Powell, 2010; DeDonder et al., 2009).

Figure 2-2. Study Procedures for Meal Preparation Experiment on Cooking Breakfast



A study team member instructed participants to cook enough sausage patties for two people (from a 1-pound roll) and prepare four eggs (carton with half dozen eggs) as they would if they were making breakfast for two people at home. They were told to cook the eggs however they wished (e.g., if some family members usually eat fried and some scrambled, then do it that way, however they usually prepare breakfast). Participants were instructed to prepare the items in the order as they would at home. Participants were told that the recipe for the fruit salad was on an iPad (see Appendix A) and were instructed on how to access the recipe on a tablet (the tablet was sampled for the microbiological analysis). Participants were instructed to plate the breakfast for two people and pour each person a glass of orange juice (the two juice glasses were sampled for the microbiological analysis) when they were finished cooking.

[2] After being informed of the study's purpose, participants could opt out of the study and have their data excluded from the analysis. No participants chose to opt out of the study.

Participants were told that the ingredients were located in the refrigerator (perishable items) or on the counter, and a study team member pointed out that cabinets contained utensils, dishes, pans, and cleaning supplies and were labeled accordingly. Appendix C provides a list of equipment provided in each test kitchen and a picture of one of the test kitchens. Participants were asked to clean up as they would at home once they were done cooking.

Before the observation and food preparation, we inoculated the sausage with a traceable, nonpathogenic surrogate, the *E. coli* strain (DH5-Alpha) tagged with green fluorescent protein (Niebuhr, Laury, Acuff, & Dickson, 2008), that was approved by the FSIS Office of Public Health Science and used as a surrogate for *Salmonella* for the Year 2 study on chicken thighs and as a surrogate for *E. coli* for the Year 4 study on ground beef. NCSU conducted lab studies and determined that DH5-Alpha survives in breakfast sausage rolls; thus, it was a suitable surrogate for this study. The inoculated sausage was packaged in 1-pound rolls with either the control or treatment label.

We cleaned and sanitized all accessible kitchen surfaces (e.g., counters, drawer pulls, stove top) and appliances after each participant to ensure that any potentially remaining *E. coli* DH5-Alpha contamination was removed before the next participant entered the kitchen. Additional cleaning protocols were put into place to reduce the risk of COVID-19 transmission to participants and research staff. Meal preparation items (e.g., knives, utensils, plates) were cleaned and sanitized in the dishwasher. Items that could not be placed in the dishwasher were cleaned and disinfected using either a disinfectant spray or wiped three times with a disinfecting wipe after each observation.

To confirm effective decontamination of the kitchen between participants, one cleaning validation surface swab was taken before a participant began preparing the meal. We collected samples from the cantaloupe used in the fruit salad and the following surfaces/items: kitchen basin, spice containers, tablet used to prepare the fruit salad, and the two juice glasses. An NCSU lab team member processed the swabs to determine the presence and concentration of the *E. coli* DH5-Alpha. Appendix D provides a complete description of 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. Interviews lasted approximately 20 minutes (see Appendix E for the post-observation interview guide). Participants were told that the total time for the observation and interview was up to 2 hours, but most participants were finished within approximately 90 minutes.

2.1.3 Pilot Testing

Before initiating the full-scale data collection, we conducted a pilot study to test the study materials, procedures, and the time allotted for data collection. We conducted the pilot with two subjects recruited through mutual acquaintances of NCSU staff working on the project. Based on the pilot observations, we made minor modifications to the post-observation interview guide to improve understanding. Following the pilot study, NCSU submitted the study protocol and materials to its IRB for approval.

2.2 Recruitment Procedures

The study team used convenience sampling with quotas to obtain a mix of participants with regard to race, ethnicity, age, education level, and presence of children in the household. We recruited participants using social media outlets (e.g., Facebook, Twitter) and online advertising platforms (e.g., Craigslist).

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

- are 18 to 64 years old (excluded individuals 65 years or older because of increased COVID-19 risk)
- speak English
- cook breakfast using shell eggs and breakfast meat made from raw pork (i.e., not heat and serve) on average at least once a month
- have cooked breakfast sausage within the past 6 months
- have experience cutting melons (as a safety precaution for cutting cantaloupe)

The exclusion criteria were as follows:

- have cooked or worked professionally in a food preparation setting in the past 5 years
- have received any type of food safety training, such as ServSafe, in the past 5 years
- participated in a study about cooking within the past 4 years

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 F). 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 broad participant pool. After an appointment was scheduled, we sent one confirmation email and two text messages leading up to the scheduled appointment. These reminders included a reminder about the mandatory use of face coverings. The consent form included an

addendum describing the additional cleaning/sanitizing procedures taking place, as well as requirements for face coverings and social distancing. Each participant was required to state that they had not interacted with someone who had been diagnosed with or exhibited symptoms of COVID-19, that they were not experiencing any symptoms of COVID-19, that they agreed to follow all safety procedures, and that they allowed their information to be recorded for potential contact-tracing purposes.

A total of 251 people participated in the experimental study: 125 in the control group and 126 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 32%. Among the 251 study participants, we recruited 73% using social media (Facebook and Twitter), 15% using Craigslist, and 12% using other recruiting efforts such as word of mouth. The no-show rate, not including cancellations, was 16%.

2.3 Coding of Observation Data and Analysis

We used notational analysis to assess recorded actions and their frequencies during meal preparation. 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). 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).

We developed coding rubrics (see Appendix G) to characterize thermometer usage and other methods to determine doneness of breakfast sausage and handwashing compliance according to Centers for Disease Control and Prevention (CDC) guidelines. A trained coder viewed each video and followed the rubric to indicate level of adherence to recommended behaviors while observing the participants. Coders were trained by reviewing the coding rubric and using practice food safety handling scenarios to compare inter- and intracoding reliability. Incorrect and inconsistent coding situations were discussed with coders to ensure that proper and consistent training occurred.

For each behavior of interest (identified by the use of bold text in the result tables shown in Section 3), we calculated proportions for the control and treatment groups using a chi-squared test for the differences between the two groups. We used a p value of $\leq .05$ to indicate statistical significance.

2.4 Microbiological Data and Analysis

As previously noted, a nonpathogenic strain of *E. coli* DH5-Alpha that fluoresces under ultraviolet (UV) light was used as the surrogate. We determined the concentration of DH5-Alpha on swab samples by enumerating the bacteria on selective media and visualizing colonies under UV light. For each surface and cantaloupe sample, we calculated prevalence and level of contamination by study group. For prevalence, we conducted statistical testing using a chi-squared test for the differences between groups (control vs. treatment). For level of contamination, we conducted statistical testing using repeated measures of analysis of variance (i.e., ANOVA) for the differences between groups (control vs. treatment). We used a p value of $\leq .05$ to indicate statistical significance.

2.5 Post-observation Interviews and Analysis

The post-observation interviews collected information on participants' self-reported behaviors while preparing the breakfast sausage, eggs, and fruit salad in the test kitchen and their usual behavior at home and other information. For the treatment group, the interviewer probed for participants' response to the intervention label (Appendix E provides the interview guide).

We audio-recorded the interviews and transcribed and coded the interview transcripts. Most of the questions were open-ended, so to analyze the data, we coded the responses. We used QSR International NVivo, Version 12 software to organize and code the data. We assigned a unique case number to each participant to link the screener data and post-observation data. We outputted the coded data to Excel and tabulated the responses by the two study groups.

3. Results

This section describes the characteristics of the study sample and presents the results of the meal preparation experiment for using a thermometer, handwashing compliance, cleaning and sanitizing, preparing eggs, and washing produce. We also present the results of the microbiological analysis that assessed cross-contamination during meal preparation.

3.1 Sample Characteristics

Of the 251 participants in the study sample, 74% were White and 89% were non-Hispanic. Participants represented a variety of ages with 31% in the 18- to 34-years-old age category, 49% in the 35- to 54-years-old age category, and 20% in the 55 years or older age category. More than a third (38%) of participants had a 4-year college degree or more education, and 57% had at least one child living in the household (≤17 years). About 25% 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). Table 3-2 compares the demographic characteristics of the study sample to the recruiting targets that were set for the study. The study generally met the recruiting targets.

The screening questionnaire collected information on participants' experience with cooking breakfast using shell eggs, breakfast meat, and raw fruit (Table 3-3). About half of participants (53%) cook breakfast 4 or more times per month. Seventy-eight percent of participants reported cooking breakfast sausage purchased in a tube or a roll used to make patties at least once in the past 6 months. Participants also had experience cutting watermelon (64%), cantaloupe (50%), and honeydew melon (17%).

Table 3-1. Sample Characteristics

	All Participants (*n* = 251)	**Control (*n* = 125)**	**Treatment (*n* = 126)**
Race			
Caucasian or White	74% (186)	73% (91)	75% (95)
Black or African American	18% (45)	19% (24)	17% (21)
Other race[a]	8% (20)	8% (10)	8% (10)
Ethnicity			
Not Hispanic or Latino	89% (224)	90% (112)	89% (112)
Hispanic or Latino	11% (27)	10% (13)	11% (14)

(continued)

Table 3-1. Sample Characteristics (continued)

	All Participants (*n* = 251)	Control (*n* = 125)	Treatment (*n* = 126)
Gender Identity			
Female	66% (166)	66% (82)	67% (84)
Male	32% (81)	34% (42)	31% (39)
Transgender	1% (3)	0% (0)	2% (3)
None of these	0% (0)	0% (0)	0% (0)
Prefer not to answer	0% (1)	1% (1)	0% (0)
Age			
18–34	31% (77)	31% (39)	30% (38)
35–54	49% (124)	50% (62)	49% (62)
55–64[b]	20% (50)	19% (24)	21% (26)
Education			
Less than high school, high school diploma/ GED, or technical or vocational school	20% (51)	21% (26)	20% (25)
Some college or 2-year associate's degree	41% (104)	45% (56)	38% (48)
Bachelor's degree	24% (60)	22% (27)	26% (33)
Postgraduate degree	14% (36)	13% (16)	16% (20)
Have children (0–17) in household	57% (142)	59% (74)	54% (68)
Have at-risk individual living in household[c]	25% (64)	21% (26)	30% (38)

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

[b] People 65 years or older were excluded from the study because of increased COVID-19 risk.

[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.

Note: Responses may not sum to 100% because of rounding.

Source: 2022 meal preparation experiment—screening questionnaire.

Table 3-2. Comparison of the Study Sample with Recruitment Targets

Characteristic	Study Sample (*n* = 251)	Recruitment Target (%)
Race		
White	74% (186)	76%
Black or African American or other race[a]	26% (65)	24%
Ethnicity		
Not Hispanic or Latino	89% (224)	90%
Hispanic or Latino	11% (27)	10%
Age		
18–34	31% (77)	30%
35–54	49% (124)	50%
55–64[b]	20% (50)	20%
Education		
Less than high school, high school diploma/GED, or technical or vocational school	20% (51)	25%
Some college or 2-year associate's degree	41% (104)	40%
Bachelor's degree	24% (60)	22%
Postgraduate degree	14% (36)	13%
Household status		
Children (0–17)	57% (142)	60%
No children	43% (109)	40%

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

[b] People 65 years or older were excluded from the study because of increased COVID-19 risk.

Note: Responses may not sum to 100% because of rounding.

Source: 2022 meal preparation experiment—screening questionnaire.

Table 3-3. Self-reported Participant Experience with Preparing Breakfast

	All Participants (%)	Control (%)	Treatment (%)
Frequency of cooking breakfast using shell eggs and breakfast meat made from raw pork			
At least once a month	14% (36)	13% (16)	16% (20)
At least twice a month	15% (37)	15% (19)	14% (18)
At least 3 times per month	18% (45)	19% (24)	17% (21)
4 or more times per month	53% (133)	53% (66)	53% (67)
Types of breakfast meats made from raw pork (i.e., not heat and serve) cooked during the past 6 months[a]			
Bacon	57% (142)	54% (68)	59% (74)
Breakfast sausage links	76% (191)	76% (95)	76% (96)
Pre-made breakfast sausage patties	59% (147)	59% (74)	58% (73)
Breakfast sausage purchased in a tube or a roll used to make patties	78% (197)	78% (97)	79% (100)
Chorizo	29% (72)	23% (29)	34% (43)
Canadian bacon	5% (12)	6% (7)	4% (5)
Types of fruits with experience cutting[a]			
Cantaloupe	50% (125)	54% (67)	46% (58)
Watermelon	64% (160)	65% (81)	63% (79)
Honeydew melon	17% (42)	15% (19)	18% (23)
Number of participants	251	125	126

[a] Respondents could select more than one response, so the percentages may sum to more than 100%.
Note: Responses may not sum to 100% because of rounding.
Source: 2022 meal preparation experiment—screening questionnaire.

3.2 Sausage Preparation and Thermometer Use

For the control group, the MCI on the sausage packaging stated: "Cook sausage until internal temperature reaches 165°F." The packaging also had the SHI label with the instruction to "Cook thoroughly." For the treatment group, the intervention label stated the following in bold, colored text after the cooking instructions: "Use a food thermometer to make sure the sausage reaches a temperature of 165°F to be safe to eat."

Table 3-4 summarizes how participants prepared the sausage and methods for determining doneness, including thermometer use. Most participants used a knife and their hands to make the sausage patties. Participants most often used a cutting board as the surface for making the sausage patties, either by hand, cutting into slices, or using both a knife and their hands.

Fifty percent of the control group and 55% of the treatment group used a thermometer for checking doneness of the sausage patties. The difference between the two groups was not statistically significant (p = .413). Among participants using a food thermometer, the number of sausage patties checked for doneness averaged three for each group. The recommendation is to check the temperature of each patty being cooked because of possible variations in temperatures.

Table 3-4. Observed Preparation and Cooking of Sausage Patties

	Control (%)	Treatment (%)	p value[a]
Preparing Sausage Patties	*n* = 125	*n* = 126	
Method for preparing sausage patties			
Sliced sausage roll with knife	7% (9)	14% (18)	
Made patties using hands	29% (36)	29% (37)	
Used both knife and hands	62% (78)	56% (70)	
Squeezed meat out of packaging directly into pan	2% (2)	1% (1)	
For handmade patties, surface used to make patties	*n* = 36	*n* = 37	
Cutting board	61% (22)	46% (17)	
Countertop	6% (2)	22% (8)	
Plate/Bowl	19% (7)	24% (9)	
Other	14% (5)	8% (3)	
For sliced patties, surface used to cut patties	*n* = 9	*n* = 18	
Cutting board	89% (8)	94% (17)	
Plate/Bowl	0% (0)	6% (1)	
Sliced with hands	11% (1)	0% (0)	
For sliced patties, sausage roll was still wrapped when patties were cut	11% (1)	17% (3)	
For sliced patties, cleaned knife after slicing	100% (9)	94% (17)	
Cooking Sausage Patties			
Used food thermometer to check doneness	**50% (62)**	**55% (69)**	**.413**
Method used to determine doneness	*n* =125	*n* = 126	
Only used thermometer	10% (12)	13% (16)	
Only used touch (e.g., firmness)	35% (44)	29% (37)	
Only used time	6% (8)	3% (4)	
Only used visual cue (i.e., cut open to look inside)	2% (2)	2% (2)	
Observed using more than one method, including thermometer	40% (50)	42% (53)	
Observed using more than one method, not including thermometer	7% (9)	11% (14)	
Number of patties checked for doneness	*n* = 62	*n* = 69	
Only one	15% (9)	14% (10)	
Some	35% (22)	22% (15)	
All	50% (31)	64% (44)	

(continued)

Table 3-4. Observed Preparation and Cooking of Sausage Patties (continued)

	Control (%)	Treatment (%)	p value[a]
Mean number checked[b]	**3.05**	**3.17**	**.556**
	SD = 1.18	SD = 1.28	

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

[b] Participants were instructed to prepare sausage patties for four people. Nearly all participants made four patties, with the exception of five participants who made two patties and four participants who made more than four patties.

Notes: Responses may not sum to 100% because of rounding. SD = standard deviation

Source: 2022 meal preparation experiment—coding of food preparation.

Some participants attempted to determine doneness of the sausage patties using indicators other than a thermometer. For the control group, 35% of participants relied solely on firmness (e.g., touch), 6% relied solely on time, and 2% relied solely on a visual cue (e.g., color). Forty percent used a thermometer *and* another indicator to determine doneness. Similar results were found for the treatment group.

According to the post-observation interviews (Table 3-5), participants most often reported using a thermometer because of the instruction on the label and/or to make sure the sausage was done. About 40% of treatment group participants reported using a thermometer because of the instruction on the label, compared with 16% for the control group (the control group label provided the endpoint temperature in the MCI but did not have the instruction to use a food thermometer). Overall, nearly half of participants who reported owning a thermometer and using it in the test kitchen said they do not usually use one when cooking sausage patties at home, suggesting that their behavior in the test kitchen may not reflect their usual practices. Participants reported hearing recommendations to use a thermometer from a variety of sources, including family members (23%), cooking shows (18%), school classes (10%), and product packaging/recipes (16%).

Table 3-5. Self-reported Thermometer Use

	All Participants (%)	Control (%)	Treatment (%)
If reported using thermometer in test kitchen, reason(s) for use[a]	*n* = 125	*n* = 57	*n* = 68
Instruction on the label	29% (36)	16% (9)	40% (27)
Make sure it is done	26% (32)	26% (15)	25% (17)
New formulation for sausage	12% (15)	19% (11)	6% (4)
Availability of thermometer in test kitchen	11% (14)	14% (8)	9% (6)
Habit	7% (9)	7% (4)	7% (5)
Other	14% (17)	18% (10)	10% (7)
Not asked by the interviewer	2% (2)	0% (0)	3% (2)
If reported owning thermometer and used thermometer in test kitchen, usually use one when cooking sausage patties at home	*n* = 116	*n* = 55	*n* = 61
Yes	46% (53)	44% (24)	48% (29)
Sometimes	10% (12)	15% (8)	7% (4)
No	44% (51)	42% (23)	46% (28)
If no, reason(s) for not using thermometer at home when cooking sausage patties[a]	*n* = 51	*n* = 23	*n* = 28
Use visual cues to determine doneness	29% (15)	35% (8)	25% (7)
Comfortable with cooking the product (prior experience)	18% (9)	9% (2)	25% (7)
Make thinner patties at home so do not feel necessary	14% (7)	9% (2)	18% (5)
Not with sausage patties but generally use with other meats	10% (5)	13% (3)	7% (2)
Other	29% (15)	35% (8)	25% (7)
If reported using thermometer in test kitchen, source for hearing or learning about recommendation	*n* = 125	*n* = 57	*n* = 68
Family member	23% (29)	26% (15)	21% (14)
Cooking show	18% (23)	19% (11)	18% (12)
School classes	10% (13)	11% (6)	10% (7)
Product packaging/recipe	16% (21)	15% (8)	19% (13)
When learning to cook	6% (7)	5% (3)	6% (4)
Internet (not specified)	4% (5)	4% (2)	4% (3)
Social media (e.g., Instagram, YouTube) and podcasts	4% (4)	0% (0)	5% (4)
Other (e.g., precautions, safe habits, prevent overcooking)	16% (20)	16% (9)	16% (11)
Not asked/unclear response	2% (3)	5% (3)	0% (0)

(continued)

Table 3-5. Self-reported Thermometer Use (continued)

	All Participants (%)	Control (%)	Treatment (%)
If reported using thermometer in test kitchen, self-reported temperature for sausage patties	*n* = 125	*n* = 57	*n* = 68
<165°F	8% (10)	5% (3)	10% (7)
165°F or higher	90% (113)	95% (54)	87% (59)
Could not read	2% (2)	0% (0)	3% (2)
If reported using thermometer in test kitchen, source for information on cooking temperature[b]	*n* = 125	*n* = 57	*n* = 68
Instructions on sausage packaging	41% (51)	49% (28)	34% (23)
Website (not specified)	23% (29)	23% (13)	24% (16)
Food thermometer packaging	10% (12)	12% (7)	7% (5)
USDA website	6% (8)	5% (3)	7% (5)
Other	19% (24)	11% (6)	26% (18)
Not asked	2% (2)	2% (1)	1% (1)

[a] The number of participants who self-reported using a thermometer (*n* = 125) is slightly lower than the number observed using a thermometer (*n* = 131).

[b] Respondents could select more than one response, so the percentages may sum to more than 100%.

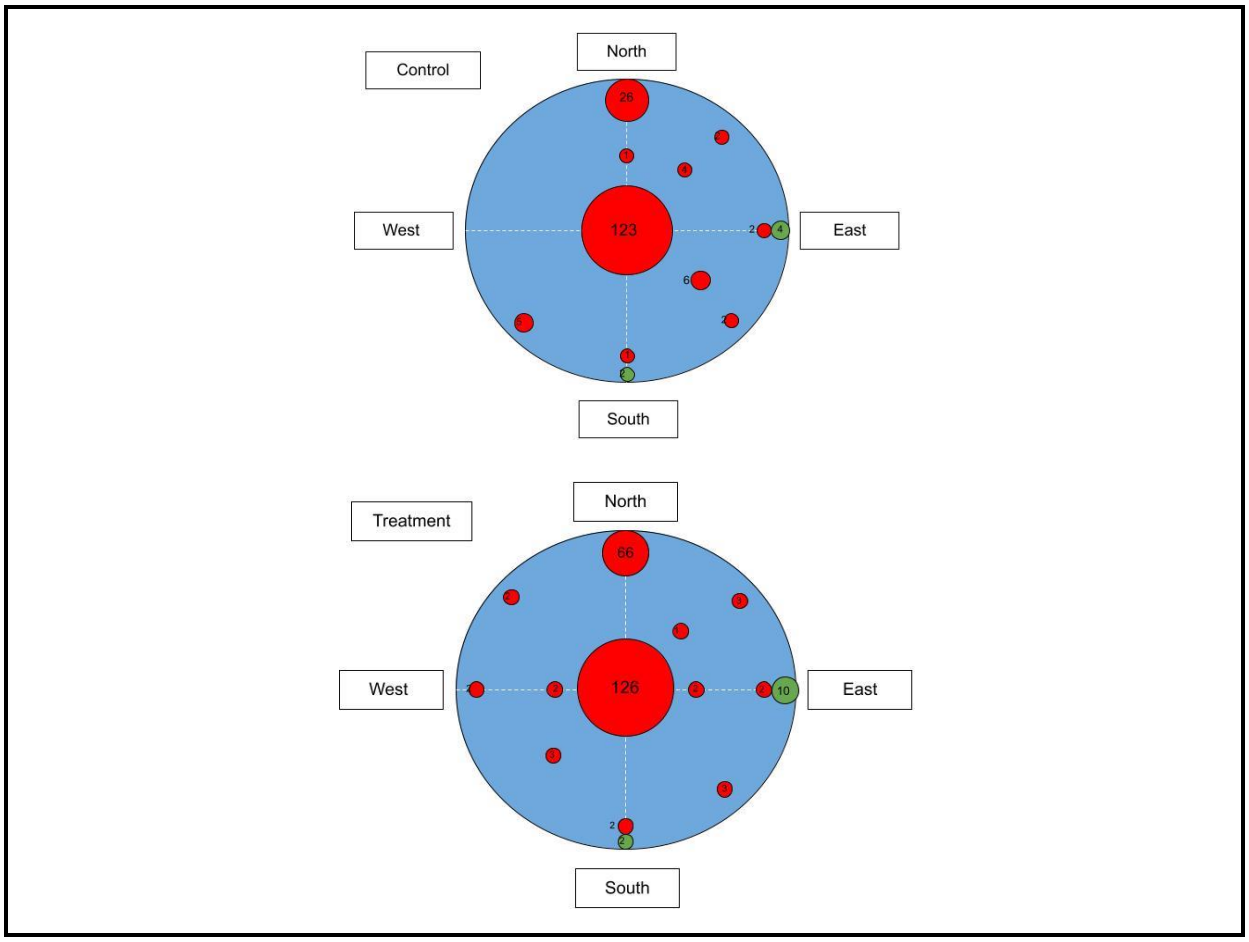
Note: Responses may not sum to 100% because of rounding.

Source: 2022 meal preparation experiment—post-observation interview.

We attempted to code the final endpoint temperature by viewing the videos but were unable to ascertain the temperature for most participants. Participants frequently stood in front of the camera or turned the thermometer away from them (and the camera) to read it, so few temperatures were visible. Because of the small number of participants with usable data (*n* = 21), these data are not shown.

Figure 3-1 is a diagram of a sausage patty with a heat map indicating thermometer placement for the control and treatment group participants. The red-colored dots indicate points of thermometer insertion from the top, while the green-colored dots indicate insertion from the side. For most sausage patties checked for doneness, participants in both groups inserted the thermometer into the top of the patty, whereas the correct placement is into the side of the patty (green dots). For all patties checked for doneness using a thermometer, the rate of correct placement into the side of the patty was 7% (6% for the treatment group, 8% for the control group).

Figure 3-1. Sausage Patty with Heat Maps Showing Thermometer Placement by Group



Note: "North" is the part of the stovetop that is farthest from the participant. Red dots indicate thermometer insertion into the top of the patty. Green dots indicate thermometer insertion into the side of the patty. Heat maps reflect the number of sausage patties that were checked for doneness. *n* = 178 patties (control), *n* = 227 patties (treatment)

Source: 2022 meal preparation experiment—coding of food preparation.

Table 3-6 compares the results for Years 1 through 5 for thermometer use for control group participants (i.e., not exposed to an intervention). In Year 1, participants prepared turkey burgers with a garnish and a chef salad (Cates et al., 2018); in Year 2, participants who self-identified as poultry washers prepared chicken thighs and a mixed green salad; in Year 3, participants prepared breaded not-ready-to-eat (NRTE) chicken cordon bleu from frozen (Cates et al., 2020); and in Year 4, participants grilled burgers and bratwurst. Thermometer use varied depending on the product cooked; the rate was highest for the NRTE chicken product and lowest for turkey burgers. Pairs of superscripted letters indicate proportions that are significantly different at $p \leq .05$. These differences may be due to the type of product cooked, the cooking instructions provided on the product, or increased thermometer use over time. Excluding the NRTE chicken product—given its different

characteristics—the rate of thermometer use was significantly higher for hamburgers (58%), bratwurst (55%), and breakfast sausage (50%) compared with turkey burgers (34%).

Among thermometer users, checking the temperature of multiple items ranged from 76% for chicken thighs to 92% for hamburgers.

Table 3-6. Comparison of Thermometer Use for Annual Meal Preparation Experiments (Control Group Participants)

	Year 1 Turkey Burgers	Year 2 Chicken Thighs	Year 3 Frozen, Breaded NRTE Stuffed Chicken Breasts	Year 4 Bratwurst	Year 4 Ham-burgers	Year 5 Breakfast Sausage
% used thermometer on at least one item	**34%[a,b,c,d]**	**44%[e]**	**77%[a,e,f,g,h]**	**55%[b,f]**	**58%[c,g]**	**50%[d,f,h]**
% checked temperature of multiple items (among thermometer users)	79%	76%	85%	89%	92%	85%
Number of participants in control group	185	154	196	66	66	125

NRTE = not ready to eat.

Notes: For bolded variable, we calculated *p* value significance testing using a chi-squared test for the difference between years. Pairs of superscripted letters indicate proportions that are significantly different at $p \leq .05$.

Sources: 2017, 2018, 2019, 2020–2021 and 2022 meal preparation experiments—coding of food preparations.

3.3 Handwashing Compliance

Inadequate handwashing has been identified as a contributing factor to foodborne illness, especially when preparing raw meat, poultry, and eggs. 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.

For the control group, the sausage packaging had the SHI label with the instruction, "Wash working surfaces (including cutting boards), utensils, and hands after touching raw meat or poultry." For the treatment group, the intervention label stated, "Wash [bold, colored text] hands before cooking" and "Keep raw meat separate [bold, colored text] from other foods. Wash hands, utensils, and work surfaces if they touch raw meat."

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 (including touching items, surfaces, or food in the test kitchen before starting meal preparation)
- anytime between touching the sausage or its package, cracked eggs, or unwashed cantaloupe and then touching a different item
- after touching another person or oneself
- after touching a cell phone
- after multitasking (chores)
- after touching contaminated (post-meal) trash or a 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. Our analysis only considered compliance with CDC's handwashing criteria; we did not consider risk reduction from participants following some but not all required steps of a successful handwashing event. It is estimated that proper handwashing results in approximately 1 log reduction (Montville et al., 2002). 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 1 additional log reduction (Huang et al., 2012).

Rates of handwashing attempts *before* meal preparation were similar for the two groups: 44% for the control group and 42% for the treatment group (Table 3-7). Among handwashing attempts before meal preparation, very few contained all steps of a correct handwashing event according to CDC's criteria and were considered successful attempts: 7% for the control group and 11% for the treatment group. The most common reason for unsuccessful handwashing before meal preparation was not rubbing hands with soap for at least 20 seconds (82% for the control group and 87% for the treatment group), followed by not wetting hands with water (78% for the control group and 60% for the treatment group).

Table 3-7. Observed Handwashing Compliance before Meal Preparation

	Control (%)	Treatment (%)	*p* value[a]
Did not attempt	56% (70)	58% (73)	
Attempts[b]	**44% (55)**	**42% (53)**	**.757**
Successful attempts[c]	7% (4)	11% (6)	
Unsuccessful attempts	93% (51)	89% (47)	
If attempted, average number of seconds hands were rubbed together	14.5 seconds SD = 8.1	15.7 seconds SD = 8.9	
Reasons for unsuccessful attempt[d]	*n* = 51	*n* = 47	
Did not first wet hands with water	78% (40)	60% (28)	
Did not use soap	2% (1)	2% (1)	
Did not rub hands with soap for at least 20 seconds	82% (42)	87% (41)	
Did not rinse hands with water	10% (5)	13% (6)	
Did not dry hands	4% (2)	0% (0)	
Dried hands with surface other than clean, one-use towel (e.g., wiped hands on clothing or used previously used towel)	4% (2)	0% (0)	
Number of participants	*n* = 125	*n* = 126	

[a] For bolded variable, we calculated *p* value significance testing using a chi-squared test for the difference between groups (control vs. treatment). Differences between groups 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%.

Note: Responses may not sum to 100% because of rounding. SD = standard deviation.

Source: 2022 meal preparation experiment-observed behavior.

Table 3-8 summarizes handwashing compliance *during* meal preparation. For each group, we observed between 1,260 (control) and 1,202 (treatment) cases in which a handwashing event was required to prevent cross-contamination during meal preparation. Required handwashing events varied by participant based on each participant's handling behaviors; as a result, some participants had a greater number of required handwashing events than others (e.g., touched the eggs more often).

Table 3-8. Observed Handwashing Compliance during Meal Preparation

	Control (%)	Treatment (%)	*p* value[a]
Handwashing event required[b]	*n* = 1,260	*n* = 1,202	
Did not attempt	83% (1,045)	82% (986)	
Attempts[c]	**17% (215)**	**18% (216)**	**.525**
Successful attempts[d]	4% (9)	1% (3)	
Unsuccessful attempts	96% (206)	99% (213)	
If attempted, average number of seconds hands were rubbed together	10 seconds SD = 8.9	8.9 seconds SD = 8.2	
Reasons for unsuccessful attempt[e]	*n* = 206	*n* = 213	
Did not wet hands with water	46% (94)	31% (67)	
Did not use soap	17% (34)	24% (51)	
Did not rub hands with soap for at least 20 seconds	91% (188)	92% (196)	
Did not rinse hands with water	22% (46)	31% (66)	
Did not dry hands	19% (39)	20% (42)	
Dried hands with surface other than clean, one-use towel (e.g., wiped hands on clothing or used previously used towel)	28% (57)	28% (59)	

[a] For bolded variable, we calculated *p* value significance testing using a chi-squared test for the difference between groups (control vs. treatment). Differences between groups are statistically significant if the *p* value is ≤ .05.

[b] Required handwashing events include after touching raw sausage, cracked eggs, unwashed cantaloupe, contaminated equipment or surfaces, or face or other parts of body or clothing.

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

[d] 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.

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

Note: Responses may not sum to 100% because of rounding. SD = standard deviation

Source: 2022 meal preparation experiment—observed behavior.

The percentage of handwashing attempts *during* meal preparation was similar for the two groups: 17% for the control group and 18% for the treatment group. Among handwashing attempts during meal preparation, few contained all steps of a correct handwashing event according to CDC's criteria and were considered successful attempts: 4% for the control group and 1% for the treatment group. The most common reason for unsuccessful handwashing during meal preparation was not rubbing hands with soap for at least 20 seconds (91% in the control group and 92% for the treatment group), followed by not wetting hands with water as a first step (46% in the control group and 31% in the treatment group).

We asked participants about their handwashing behaviors during the post-observation interview (see Table 3-9). Overall, most participants (89%) said they washed their hands before starting to cook in the test kitchen, whereas the observed rate for attempting handwashing before meal preparation was much lower (42% for the treatment group and 44% for the control group). Possible differences between actual and reported behavior may be due to self-reporting bias (i.e., overstating actual behavior) or the coding rubric for handwashing before meal preparation, which specified that handwashing was considered not attempted if the participant touched anything in the test kitchen (i.e., equipment or surfaces) before starting meal preparation—whereas participants may have reported washing their hands as long as they did so before touching any food.

Similar to Year 4, we asked about handwashing habits since the COVID-19 pandemic. Sixty-two percent of participants said their handwashing habits had changed and 34% said they stayed the same. Four percent of participants said their handwashing habits initially changed but then reverted back to "normal." One participant remarked, *"Probably just think about it more. Before COVID, I probably wouldn't think about it, just start making breakfast or whatever. But now it's maybe a little more conscious in my mind to, 'Hey, you should wash your hands before you start doing something like this.'"*

Table 3-9. Self-reported Handwashing Behaviors

	All Participants (%)	Control (%)	Treatment (%)
Self-reported washing hands before cooking			
Yes	89% (223)	87% (109)	90% (114)
No	11% (28)	13% (16)	10% (12)
If washed hands before cooking, this is usual practice when cooking at home	*n* = 223	*n* = 109	*n* = 114
Yes	98% (218)	98% (107)	97% (111)
No	1% (2)	1% (1)	1% (1)
Sometimes	1% (3)	1% (1)	2% (2)
If did not washed hands before cooking, reason why	*n* = 28	*n* = 16	*n* = 12
Forgot	54% (15)	50% (8)	58% (7)
Confidence in hand cleanliness	7% (2)	13% (2)	0% (0)
Other reasons	32% (9)	38% (6)	25% (3)
Not asked	7% (2)	0% (0)	17% (2)
Used hand sanitizer before coming into test kitchen	25% (64)	25% (31)	26% (33)
Heard about government recommendations for handwashing during COVID-19 pandemic			
Yes	87% (219)	86% (108)	88% (111)
No	12% (31)	14% (17)	11% (14)
Doesn't remember	0% (1)	0% (0)	1% (1)

(continued)

Table 3-9. Self-reported Handwashing Behaviors (continued)

	All Participants (%)	Control (%)	Treatment (%)
Handwashing habits since COVID-19			
Changed	62% (156)	62% (78)	62% (78)
Stayed the same	34% (86)	34% (42)	35% (44)
Initially changed, but reverted back to pre-pandemic practices	4% (9)	4% (5)	3%(4)
Number of participants (unless otherwise noted because questions were skipped)	251	125	126

Note: Responses may not sum to 100% because of rounding.

Source: 2022 meal preparation experiment—post-observation interview.

Table 3-10 compares the results for Years 1 through 5 for handwashing compliance among control group participants. The handwashing rate for before meal preparation, which should not be influenced by the type of food prepared, was significantly lower for Years 4 and 5 (44%) compared with Year 2 (74%) and Year 3 (71%). We speculate that the lower handwashing rate for Years 4 and 5 may be due in part to participants using hand sanitizer upon arrival as a COVID-19 precaution. Two hand sanitizer stations, which were not provided in previous years of the study, were available to participants before they entered the kitchen. For Year 5, 25% of participants reported using hand sanitizer before coming into the test kitchen.

Social distancing measures may also have influenced handwashing, leading to lower rates of handwashing before meal preparation. In previous years of the study, researchers were able to walk the participant around the kitchen during the introduction and clearly show the participant the location of utensils and dishes in drawers and cabinets. Because of mandatory social distancing, the introduction and orientation were limited. As previously noted, the self-reported handwashing rate was much higher compared to the observed rate. The lower observed handwashing rates might reflect participants opening cabinets and drawers to become familiar with the kitchen (these participants would have been coded as not washing their hands before starting meal preparation even if they then washed their hands before touching any food), whereas participants may have considered that they washed their hands before meal preparation if they did it before touching any food. Among participants who reported not washing their hands, the most common reason for failing to do so was because they forgot. Other reasons for differences in handwashing rates by study year are also possible, such as differences in the characteristics of the study sample. The study sample for Year 4 was limited to people who cook on an outdoor grill and had a larger percentage of males relative to Years 2 and 3. For Year 5, the study sample was limited to people who reported cooking breakfast at home.

For handwashing during meal preparation, the rates for attempting handwashing were 26% for Year 2, 3% for Year 3, 25% for Year 4, and 17% for Year 5. The results suggest that handwashing rates varied by product. The rates for chicken thighs and bratwurst/hamburgers were similar (about 25%), whereas the rate for the NRTE frozen, breaded chicken was significantly lower (3%) compared with these products. This may be because it was frozen and not a fresh, raw product. Consistent with prior years, most Year 5 participants who attempted handwashing before and during meal preparation did so unsuccessfully and the most common reason for failure was not rubbing hands with soap for 20 seconds.

Table 3-10. Comparison of Handwashing Compliance for Annual Meal Preparation Experiments (Control Group Participants)

	Year 1 Turkey Burgers	Year 2 Chicken Thighs	Year 3 Frozen, Breaded NRTE Stuffed Chicken Breasts	Year 4 Bratwurst and Hamburgers	Year 5 Breakfast Sausage
Handwashing event required before the start of or during meal preparation[a]	1,195	—	—	—	—
% did not attempt	69%	—	—	—	—
% attempt	31%	—	—	—	—
% successful attempt (out of all attempts)	3%	—	—	—	—
Handwashing before the start of meal preparation	—	154	196	66	125
% did not attempt	—	26%	29%	56%	56%
% attempt	**—**	**74%[a]**	**71%**	**44%[a,b]**	**44%[a,b]**
% successful attempt (out of all attempts)	—	1%	4%	3%	7%
Handwashing event required during meal preparation	—	1,145	499	570	1,259
% did not attempt	—	74%	97%	75%	83%
% attempt	**—**	**26%[a]**	**3%[a,b]**	**25%[b]**	**17%**
% successful attempt (out of all attempts)	—	1%	0%	3%	4%
Number of participants	185	154	196	66	125

[a] For Year 1, data were not available by when handwashing took place (i.e., before the start of or during meal preparation), so the combined data are presented.

Note: For bolded variable, we calculated *p* value significance testing using a chi-squared test for the difference between years. Pairs of superscripted letters indicate proportions that are significantly different at $p \leq .05$.

Sources: 2017, 2018, 2019, and 2020–2021 meal preparation experiment—coding of food preparations.

3.4 Cleaning and Sanitizing

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 an 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.

For the control group, the sausage packaging had the SHI label with the instruction, "Keep raw meat and poultry separate from other foods. Wash working surfaces (including cutting boards), utensils, and hands after touching raw meat or poultry." For the treatment group, the intervention label stated, "Keep raw meat separate [bold, colored text] from other foods. Wash hands, utensils, and work surfaces if they touch raw meat."

Tables 3-11 provides information on the surface where the sausage patties were prepared, the number of attempts to clean the surface, successful attempts (cleaning and then sanitizing), and unsuccessful attempts (e.g., cleaning only or sanitizing only) by study group. Results are shown for two events: immediately following handling of the sausage and at the end of the observation. Most participants (over 80% for both groups) placed the sausage on a cutting board to prepare the sausage patties. A few participants (4% in the control group and 8% in the treatment group) prepared the sausage patties on the counter, which is not recommended.

Attempts to clean and/or sanitize immediately after handling the sausage were similar for the two groups (about one-third of participants). The rate of successful attempts (cleaned and then sanitized) was 53% for the treatment group and 58% for the control group. Most of the unsuccessful events were because participants only cleaned (without sanitizing).

At the end of meal preparation, 65% of control group participants and 58% of treatment group participants attempted cleaning and sanitizing; the difference was not statistically significant. The rate of successful attempts (cleaned and then sanitized) was around 70% for both groups. Most of the unsuccessful events were because participants only cleaned (without sanitizing).

Table 3-11. Observed Cleaning and/or Sanitizing Surface Where Sausage Patties Were Made

	Control (%)	Treatment (%)	*p* value[a]
Surface where patties were prepared (made into patties or sliced)	*n* = 120	*n* = 122	
Cutting board	83% (100)	80% (98)	
Counter	4% (5)	8% (10)	
Plate	10% (12)	11% (14)	
Other[b]	3% (3)	0% (0)	
Event—Immediately following handling sausage	*n* = 120	*n* = 122	
Attempt[c]	**30% (36)**	**35% (43)**	**.384**
Successful attempts[d] (cleaned and then sanitized)	58% (21)	53% (23)	
Unsuccessful attempts	42% (15)	47% (20)	
Water only[e]	7% (1)	25% (5)	
Clean only[f]	87% (13)	70% (14)	
Sanitize only[g]	7% (1)	5% (1)	
Did not attempt	70% (84)	65% (79)	
Event—End of observation	*n* = 120	*n* = 122	
Attempt[c]	**65%** (78)	**58%** (71)	**.497**
Successful attempt[d] (cleaned and then sanitized)	69% (54)	70% (50)	
Unsuccessful attempts	31% (24)	30% (21)	
Water only[e]	4% (1)	14% (3)	
Clean only[f]	96% (23)	81% (17)	
Sanitize only[g]	0% (0)	5% (1)	
Did not attempt	5% (6)	7% (8)	
Cleaned and/or sanitized immediately after handling sausage (excluded from analysis)	30% (36)	35% (43)	

[a] For bolded variables, we calculated *p* value significance testing for categorical variables using a chi-squared test for the difference between groups (control vs. treatment). Differences between groups are statistically significant if the *p* value is ≤ .05.

[b] Other includes items such as a baking sheet or a pan.

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

[d] "Successful" refers to cleaning the surface, followed by sanitizing.

[e] "Water only" refers to if the participant only used water to rinse the surface and did not use soap, detergent, or any of the provided sanitizers.

[f] "Clean only" refers to the use of only soap or detergent to clean.

[g] "Sanitize only" refers to the use of 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.

Note: Responses may not sum to 100% because of rounding. 5 control group participants and 4 treatment group participants opened the packaging on tin foil, plastic wrap, or paper towels that were laid on the counter and then discarded these items, so these participants were excluded from the analysis.

Source: 2022 meal preparation experiment—observed behavior.

3.5 Preparing Eggs

Participants were instructed to prepare four eggs as if they were preparing them at home for two people. They were told to cook the eggs however they wished (e.g., if some family members usually eat fried and some scrambled, do it that way). Most participants (80%) scrambled the eggs, and one-fourth fried the eggs (see Table 3-12). FDA recommends that consumers wash their hands after cracking eggs. Less than half (43%) of participants attempted to wash their hands after cracking eggs; of those, only 1% successfully washed their hands. Unsuccessful handwashing attempts were due to not washing for 20 seconds and failing to rinse hands with water.

Table 3-12. Observed Preparation and Cooking of Eggs

	All Participants (%)	Control (%)	Treatment (%)
Method(s) for cooking eggs[a]			
Scrambled	80% (200)	82% (102)	78% (98)
Omelet	4% (9)	5% (6)	2% (3)
Fried	25% (64)	24% (30)	27% (34)
Boiled	0% (1)	0% (0)	1% (1)
Location of discarded empty shells			
Trash can	37% (93)	36% (45)	39% (48)
Egg carton	23% (57)	26% (32)	20% (25)
Plate	10% (26)	10% (12)	11% (14)
Other[b]	30% (75)	29% (36)	31% (39)
Handwashing attempts attempted after cracking eggs (multiple attempts possible if multiple methods used to prepare eggs)	*n* = 387	*n* = 192	*n* = 195
Yes	43% (167)	44% (84)	43% (83)
No	57% (220)	56% (108)	57% (112)
If attempted[c]	*n* = 167	*n* = 84	*n* = 83
Successful attempts[d]	1% (1)	0% (0)	1% (1)
Unsuccessful attempts	99% (166)	100% (84)	99% (82)
Reasons for unsuccessful attempt[e]	*n* = 166	*n* = 84	*n* = 82
Did not first wet hands with water	28% (46)	31% (26)	24% (20)
Did not use soap	40% (67)	35% (29)	46% (38)
Did not rub hands with soap for at least 20 seconds	99% (164)	99% (83)	99% (81)
Did not rinse hands with water	48% (80)	44% (37)	52% (43)
Did not dry hands	14% (24)	17% (14)	12% (10)
Dried hands with surface other than clean, one-use towel (e.g., wiped hands on clothing or used previously used towel)	27% (45)	27% (23)	27% (22)

(continued)

Table 3-12. Observed Preparation and Cooking of Eggs (continued)

	All Participants (%)	Control (%)	Treatment (%)
After cooking, placement of carton with unused eggs			
Refrigerator	84% (211)	82% (103)	86% (108)
Countertop	8% (20)	9% (11)	7% (9)
Other	8% (19)	8% (10)	7% (9)
Discarded carton	0% (1)	1% (1)	0% (0)
If refrigerator, location within the refrigerator	*n* = 211	*n* = 103	*n* = 108
Inside door	<1% (1)	0% (0)	<1% (1)
Placed on shelf in the interior of refrigerator	99% (210)	100% (103)	99% (107)
Number of participants (unless otherwise noted)	251	125	126

[a] Respondents could make more than one type of egg per meal, so the percentages may sum to more than 100%.

[b] Other examples include a cutting board, baking sheet, or a bowl that were used for discarding empty shells.

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

[d] 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.

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

Notes: Responses may not sum to 100% because of rounding. SD = standard deviation

Source: 2022 meal preparation experiment—coding of food preparation.

During the post-observation interview, participants were asked about their handwashing behavior and preparation methods after preparing eggs (see Table 3-13). Similar to handwashing before cooking, the self-reported handwashing rate after cracking eggs (77%) was higher compared with observed behavior (43%). Among participants who reported not washing their hands, the most common reasons given for not handwashing were not getting egg on their hands (28%) and not thinking about washing their hands (23%).

FDA recommends that consumers cook eggs until the yolks are firm. Sixty-nine percent of participants who cooked scrambled eggs reported cooking them until the yolk was firm. Among participants who fried the eggs, only 20% cooked them until the yolk was firm, instead preferring their eggs to be over easy or over medium, with the yolks still runny. Among all participants who did not follow the FDA recommendation, only 28% were aware of the recommendation to cook eggs until the yolks are firm.

Table 3-13. Self-reported Behaviors for Preparing and Cooking Eggs

	All Participants (%)	Control (%)	Treatment (%)
Self-reported washing hands after cracking eggs	*n* = 251	*n* = 125	*n* = 126
Yes	77% (193)	74% (93)	79% (100)
No	16% (40)	20% (25)	12% (15)
Does not remember	3% (7)	2% (3)	3% (4)
Not applicable (hard-boiled egg)	0% (1)	0% (0)	1% (1)
Not asked	4% (10)	3% (4)	5% (6)
If washed hands, reason why	*n* = 193	*n* = 93	*n* = 100
Usual practice for family	12% (23)	12% (11)	12% (12)
Protect from *Salmonella*	17% (33)	17% (16)	17% (17)
(Possible) egg on hands	33% (64)	35% (33)	31% (31)
Cross-contamination	20% (38)	18% (17)	21% (21)
Other[a]	18% (35)	17% (16)	19% (19)
If did not wash hands, reason why	*n* = 40	*n* = 25	*n* = 15
Did not get egg on hands	28% (11)	32% (8)	30% (3)
Did not think about it	23% (9)	20% (5)	27% (4)
Other	50% (20)	48% (12)	53% (8)
If cracked eggs, self-reported got raw egg on counter or other surface	*n* = 250	*n* = 125	*n* = 125[b]
Got raw egg on counter and cleaned it up	37% (92)	37% (46)	37% (46)
Got raw egg on counter and did not clean it up	2% (5)	3% (4)	1% (1)
Did not get raw egg on counter	56% (141)	54% (67)	59% (74)
Not asked	5% (12)	6% (8)	3% (4)
Reported doneness if participant prepared scrambled eggs	*n* = 199	*n* = 103	*n* = 96
Still soft/runny	31% (61)	27% (28)	34% (33)
Firm	69% (138)	73% (75)	66% (63)
Reported doneness if participant prepared fried eggs	*n* = 66	*n* = 30	*n* = 36
Sunny side up (did not flip)	15% (10)	20% (6)	11% (4)
Over easy with the yolk still runny	30% (20)	27% (8)	33% (12)
Over medium so the yolk is slightly runny	35% (23)	40% (12)	31% (11)
Over well so the yolk is hard	20% (13)	13% (4)	25% (9)
If participant did not cook eggs (includes all preparation methods) until yolk is firm, aware of FDA recommendation	*n* = 114	*n* = 54	*n* = 60
Yes	28% (32)	28% (15)	28% (17)
No	66% (75)	67% (36)	65% (39)
Not asked	6% (7)	6% (3)	7% (4)

(continued)

Table 3-13. Self-reported Behaviors for Preparing and Cooking Eggs (continued)

	All Participants (%)	Control (%)	Treatment (%)
Reported location for storing eggs at home	*n* = 251	*n* = 125	*n* = 126
Refrigerator door	6% (15)	6% (7)	6% (8)
Interior of refrigerator	91% (228)	90% (113)	91% (15)
Countertop	2% (5)	3% (4)	1% (1)
Unclear	1% (2)	0% (0)	2% (2)
Not asked	0% (1)	1% (1)	0% (0)
Perceived safety of eggs based on source	*n* = 251	*n* = 125	*n* = 126
Eggs from farmer's market are safer	14% (35)	18% (23)	10% (12)
Eggs from retail grocery store are safer	25% (63)	23% (29)	27% (34)
Equally safe	50% (125)	45% (56)	55% (69)
Never thought about it	2% (5)	2% (2)	2% (3)
Unsure	9% (23)	12% (15)	6% (8)

[a] Other reasons include mention of bacteria, potential for foodborne illness, and raw state of eggs.

[b] Excludes one participant who boiled the eggs, so the eggs were not cracked during food preparation.
Note: Responses may not sum to 100% because of rounding.
Source: 2022 meal preparation experiment—post-observation interview.

3.6 Washing Produce

Table 3-14 summarizes participants' behaviors for washing the cantaloupe and mint when preparing the fruit salad. FDA recommends that consumers wash produce with a firm rind, such as cantaloupe, by rubbing it under cold running water. The rate of washing attempts for the cantaloupe among all participants was 25%. Among these, 75% were successful. Among all participants, 74% of participants reported awareness of FDA's recommendation to wash cantaloupe before cutting (during the post-observation interview).

Among all participants, the rate of washing attempts for the mint was 43%. Of these, only 29% rubbed the mint with their hands, the recommended practice. Most simply rinsed the mint under running water.

Table 3-14. Observed Preparation of Fruit Salad

	All Participants (%)	Control (%)	Treatment (%)
Cantaloupe	*n* = 251	*n* = 125	*n* = 126
Attempt washing rind	25% (63)	26% (32)	25% (31)
Successful attempt—rubbed with hands or brush under running water[a]	75% (47)	72% (23)	77% (24)
Unsuccessful attempt[b]	25% (16)	28% (9)	23% (7)
Did not attempt washing rind	75% (188)	74% (93)	75% (95)
If attempted to wash cantaloupe rind, washed hands after washing cantaloupe	*n* = 63	*n* = 32	*n* = 31
Yes	3% (2)	3% (1)	3% (1)
No	97% (61)	97% (31)	97% (30)
Cleaned and/or sanitized knife after cutting cantaloupe	*n* = 251	*n* = 125	*n* = 126
Yes	95% (238)	95% (119)	94% (119)
No	5% (13)	5% (6)	6% (7)
If yes, method used (among participants who cleaned knife immediately after use; excludes participants who cleaned knife at end of observation)	*n* = 92	*n* = 45	*n* = 47
Rinsed under running water	32% (29)	29% (13)	34% (16)
Wiped with towel	4% (4)	4% (2)	4% (2)
Placed in dishwasher	29% (27)	29% (13)	30% (14)
Washed with soap and water	35% (32)	38% (17)	32% (15)
Cleaned and/or sanitized cutting board after cutting cantaloupe (among participants who used a cutting board)	*n* = 238	*n* = 119	*n* = 119
Yes	61% (146)	62% (74)	61% (72)
No	39% (92)	38% (45)	39% (47)
If yes, method used	*n* = 146	*n* = 74	*n* = 72
Rinsed under running water	3% (5)	4% (3)	3% (2)
Wiped with towel	1% (1)	1% (1)	0% (0)
Placed in dishwasher	66% (97)	65% (48)	68% (49)
Washed with soap and water	29% (43)	30% (22)	29% (21)
Sanitized with spray	0% (0)	0% (0)	0% (0)

(continued)

Table 3-14. Observed Preparation of Fruit Salad (continued)

	All Participants (%)	Control (%)	Treatment (%)
Mint			
Attempted washing mint			
Yes	43% (108)	44% (55)	42% (53)
No	57% (143)	56% (70)	58% (73)
If washed mint, method used[c]	*n* = 108	*n* = 55	*n* = 53
Rinsed under running water	99% (107)	100% (55)	98% (52)
Soaked in bowl of water	1% (1)	0% (0)	2% (1)
Washed in colander	2% (2)	0% (0)	4% (2)
Rubbed with hand	29% (31)	29% (16)	28% (15)
Number of participants	251	125	126

[a] Number of participants that used brush = 7 (3 in control group and 4 in treatment group).

[b] Unsuccessful attempts including rinsing with water without rubbing and soaking in water.

[c] May not add up to 100% if participants used more than one method.

Note: Responses may not sum to 100% because of rounding.

Source: 2022 meal preparation experiment—observed behavior

3.7 Cross-Contamination and Microbiological Analysis

To assess the extent of cross-contamination during meal preparation, we examined the spread of *E. coli* DH5-Alpha from the raw sausage to various surfaces in the kitchen and the prepared fruit salad. Lack of or failed handwashing attempts and failure to properly clean and sanitize surfaces that come into contact with raw meat can spread pathogens to high-touch surfaces through contact of contaminated hands to surfaces and foods.

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, the sausage) comes into direct contact with a ready-to-eat (RTE) food or a food handling surface or utensil, and the area is not cleaned and sanitized after contact. Indirect cross-contamination is when utensils, surfaces, or hands make contact with a contaminant and then are not cleaned or sanitized adequately before the next use (e.g., 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 for the kitchen basin, spice containers, juice glasses, the tablet used to view the fruit salad recipe, and the cantaloupe from the prepared fruit salad.

Table 3-15 shows the prevalence and level of contamination by location or item sampled. Across all participants, the surface most often contaminated was the kitchen basin (37.5% of participants). The rate of contamination for the cantaloupe was the next highest at 25.1%. Rates of contamination were relatively low for the juice glasses used to plate the

meal (8.8%), spice containers (5.2%), and the tablet (2.8%). No differences were observed by group for prevalence or level of contamination.

Table 3-15. Prevalence of Surrogate Contamination and Level of Contamination by Location or Item Sampled

Location	All Participants	Control	Treatment	*p* value[a]
Piece of cantaloupe from the fruit salad				
Prevalence contaminated % (*n*)	25.10% (*63*)	26.40% (*33*)	23.81% (*30*)	.636
Level of contamination ± SD, log CFU/25 g (*n*)	2.84 ± 0.31	1.57 ± 0.70	2.93 ± 0.29	.162
Kitchen basin				
Prevalence contaminated % (*n*)	37.45% (*94*)	34.40% (*43*)	40.48% (*51*)	.320
Level of contamination ± SD, log CFU/100 cm² (*n*)	2.03 ± 0.19	2.04 ± 0.19	2.02 ± 0.19	.916
Spice containers				
Prevalence contaminated % (*n*)	5.18% (*13*)	6.40% (*8*)	3.97% (*5*)	.391
Level of contamination ± SD, log CFU/surface (*n*)	1.84 ± 0.21	1.81 ± 0.24	1.87 ± 0.19	.907
Tablet accessed to view fruit salad recipe				
Prevalence contaminated % (*n*)	2.79% (*7*)	4.00% (*5*)	1.59% (*2*)	.246
Level of contamination ± SD, log CFU/surface (*n*)	1.31 ± 0.22	1.18 ± 0.32	1.44 ± 0.12	.251
Juice glasses				
Prevalence contaminated % (*n*)	8.76% (*22*)	5.60% (*7*)	11.90% (*15*)	.077
Level of contamination ± SD, log CFU/surface (*n*)	1.54 ± 0.29	1.57 ± 0.22	1.50 ± 0.36	.816
Number of participants	251	125	126	

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

Notes: A positive result was any colony that fluoresced under ultraviolet light when grown on selective media; (*n*) = number of samples used in the analysis.

Source: 2022 meal preparation experiment—microbiological samples.

3.8 Participants' Responses to Label on Sausage Packaging

During the post-observation interviews, we collected information about participants' responses to the label on the sausage packaging (see Table 3-16). These questions were asked of both the control and treatment groups because we had told participants we were testing a new label for the sausage.

Most participants in the control and treatment groups (91% and 84%, respectively) noticed information on the package on how to prepare the sausage. About two-thirds of all participants reported that the food safety instructions did not influence how they prepared the sausage. About half of all participants reported they usually look for and read the instructions when preparing breakfast sausage at home, with most looking for information on cooking method, cooking time, and cooking temperature.

As previously noted, when asking about thermometer use in the post-observation interviews (see Table 3-5), participants most often reported using a thermometer because of the instruction on the label and/or to make sure the sausage was done. About 40% of treatment group participants reported using a thermometer because of the instruction on the label, compared with 16% of the control group (the control group label provided the endpoint temperature in the MCI but did not have the instruction to use a food thermometer). These results suggest that the intervention label may have influenced thermometer use in the test kitchen.

Table 3-16. Participants' Response to Label on Sausage Package

	Control (%)	Treatment (%)
Did you notice information on the package on how to prepare the sausage?		
Yes	91% (114)	84% (106)
No	9% (11)	16% (20)
If yes, what did you notice?[a]	*n* = 114	*n* = 106
Recommended internal temperature	61% (69)	58% (62)
Cooking time	32% (36)	40% (42)
Cooking method	34% (39)	15% (16)
Food safety instructions	22% (25)	33% (35)
Number of slices for sausage patties	25% (28)	11% (12)
Refrigeration instructions	3% (3)	8% (8)
Information about foodborne illness	2% (2)	2% (2)
Other	5% (6)	6% (6)
Did not specify	3% (3)	1% (1)
Did the food safety instructions influence how you prepared the meal today?		
Yes	33% (41)	37% (47)
No	65% (81)	60% (76)
Not asked/unclear	2% (3)	2% (3)

(continued)

Table 3-16. Participants' Response to Label on Sausage Package (continued)

	Control (%)	Treatment (%)
If yes, in what way?	*n* = 41	*n* = 47
Cooking to a safe internal temperature	41% (17)	53% (25)
Followed the cooking instructions	15% (6)	15% (7)
Followed cooking time	10% (4)	11% (5)
Served as a general reminder	12% (5)	6% (3)
Size of patties	7% (3)	4% (2)
Wash hands	5% (2)	4% (2)
Other	10% (4)	6% (3)
Do you usually look for and read the instructions when preparing breakfast sausage at home?		
Yes	43% (54)	53% (67)
No	54% (68)	47% (59)
Not asked / unclear	2% (3)	0% (0)
If yes, for what information are you looking?[a]	*n* = 54	*n* = 67
Cooking method	37% (20)	24% (16)
Cooking time	37% (20)	31% (21)
Cooking temperature	19% (10)	16% (11)
Recommended internal temperature	15% (8)	9% (6)
Serving size	11% (6)	9% (6)
Cooking instructions	9% (5)	0% (0)
Nutritional information	11% (6)	7% (5)
Ingredients	7% (4)	7% (5)
Other	9% (5)	6% (4)
Number of participants (unless otherwise noted because questions were skipped)	125	126

[a] Respondents could select more than one response, so the percentages may sum to more than 100%.

Note: Responses may not sum to 100% because of rounding.

Source: 2022 meal preparation experiment—post-observation interview.

Regarding the treatment group participants' responses to the intervention label (Table 3-17), nearly all participants agreed that the label instructs consumers on how to prepare the product so that it is tasty and also ensures food safety. The majority (59%) did not offer any suggestions for improving the label; 79% said the length of the label was about right, and 20% believed it was too long.

When probed for suggestions to improve the label, participants offered the following suggestions:

> *"So I am red, green colorblind. And I'm getting older, so it gets a little harder to read some of that because of the size of the font and the red is a little difficult for me to read. So I don't know if there's another color to use. I know it's kind of trying to work in with that red color right there, but it's a challenge for me."*
>
> *"Get safety down to four easy-to-remember rules, because this is a wall of text."*

Table 3-17. Treatment Group Participants' Responses to Intervention Label

Question	Treatment (%)
Do you think the label instructs consumers on how to prepare the product so that it is tasty and also ensures food safety?	*n*=126
Yes	99% (125)
No	0% (0)
Unclear answer	1% (1)
Do you have any suggestions for improving the label so that consumers prepare the product to ensure that it tastes good and is safe?	*n*=126
No improvements suggested	59% (74)
Change formatting	13% (16)
Include safe internal temperature	5% (6)
Provide more information about storage	2% (3)
Other	21% (27)
What are your thoughts on the length of the label?[a]	*n*=117
Too long	20% (23)
Too short	1% (1)
Just right	79% (93)

[a] Question added after the start of data collection so the number of participants for this question is 117.

Note: Responses may not sum to 100% because of rounding.

Source: 2022 meal preparation experiment—post-observation interview.

4. Conclusion

The breakfast meal preparation experiment examined participants' adherence to recommended food safety practices when the mandated SHI label is removed from meat packaging and safe handling instructions are integrated into the MCI. Participants prepared pork breakfast sausage, shell eggs to their liking, and a fruit salad made with cantaloupe and mint. Participants' thermometer use, handwashing practices, cleaning and sanitizing practices, and adherence to FDA-recommended practices for preparing shell eggs and washing produce were observed. Additionally, cross-contamination was examined by using a surrogate and sampling the cantaloupe from the fruit salad and several kitchen surfaces/items (sink basin, spice containers, tablet for fruit salad recipe, and juice glasses). Participants were randomly assigned to the control group (separate SHI label and MCI on sausage packaging) or the intervention group (intervention label with safe handling instructions integrated into the MCI).

The intervention label did not impact the rate of thermometer use for the sausage, the rate of handwashing attempts (before or during meal preparation), or the rate of cleaning/sanitizing attempts for the surface used to prepare the sausage. Additionally, the results of the microbiological analysis suggest that the intervention label did not have an impact on cross-contamination during meal preparation.

When asked about thermometer use in the post-observation interviews, 40% of treatment group participants reported using a thermometer because of the instruction on the label, compared with 16% for the control group (the control group label provided the endpoint temperature in the MCI but did not have the instruction to use a food thermometer). These results suggest that the intervention label may have influenced thermometer use in the test kitchen, although the rates of thermometer use were similar for the treatment and control groups.

Most (59%) of the treatment group participants did not offer any suggestions for improving the intervention label; 79% said the length of the label was about right and 20% believed it was too long.

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Appendix A:
Labels and Salad Recipe

Control Label—Current Label, Separate SHI and MCI

Treatment/Intervention Label—Integrates Safe Handling Instructions from the SHI Label with MCI

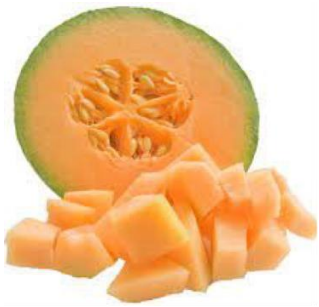
Breakfast Cantaloupe Salad

Ingredients:

- 1 medium cantaloupe, seeded and cut into 1-inch chunks
- 3 fresh mint sprigs, stemmed, and chopped
- Crumbled feta
- Spice blend

Preparation:

1. Cut cantaloupe into 1-inch chunks. Place into large bowl.



2. Top with crumbled feta and mint.

3. Sprinkle spice blend over all ingredients.

Appendix B:
Observation Script

Check-In Script

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 breakfast as part of a study to test a new sausage formulation and the look and feel of the new product packaging.

We will interview you after you finish cooking. The cooking and interview will last no longer than 2 hours.

Observation Script

Pre-cooking Script
Before we start, I need you to **read and sign the consent form**.

Please let me know if you have any questions or concerns.

After Consent Form Is Signed
Today, you will be preparing breakfast like you would at home.

Please do not eat any of the food or take any home with you. We will interview you after you are finished cooking. The cooking and interview will last up to 2 hours.

As previously noted, we are working with a manufacturer to test a new label for their breakfast sausage, so please be sure to spend a few minutes looking at the label, both the front and the back. During the interview, I will ask for your feedback on the new logo, use of photos, and the instructions on how to prepare the product. This is the area where you will be cooking.

We would like for you to prepare sausage patties, eggs, and a fruit salad for two people. Please prepare the items in the order as you would at home.

Please cook enough sausage patties for two people and prepare four eggs as you would if you were making breakfast for two people at home. For example, if some family members usually eat fried eggs and some scrambled, then do it that way, however prepare as you usually do at home.

[**OPEN FRIDGE]** There's a half dozen eggs and here is the sausage with the new label that we will ask you about during the interview.

[MOVE TO IPAD] The recipe for the fruit salad is on this iPad. To unlock, please press here. [**POINT**] Scroll up for the recipe titled Breakfast Cantaloupe Salad. The ingredients for the salad are in the refrigerator and the spice blend is on the counter.

When you are done cooking, please plate the breakfast for two people and pour each person a glass of orange juice.

All the available utensils and dishes are in these drawers/cabinets. [Note: open a few cabinets and drawers and be sure to open the drawers with the thermometer, cleaning/sanitizing solution].

[OPEN FRIDGE] Again, here are the ingredients, including the sausage.

After you are done cooking, please clean up as you would at home. You can load the dishwasher, but please do not turn it on. We ask that if you take anything out of the drawers or cabinets, please do not put them back in after handling. Please leave the items on the counter and we will put them away for you.

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 observation room.

After food preparation

Now that you have finished the cooking portion of the study, we are ready to begin the interview. It should take about 20 minutes to complete. Do you need a break before we begin?

Appendix C:
List of Equipment Provided in Each Test Kitchen

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

Kitchenware

Countertop Grill

Skillet

- Medium-sized skillet (9–12 inch)

Frying pans (store frying pans in the cabinets)

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

Saucepans

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

Knives

- Chef's knife

- Paring knife/fruit knife

Baking dishes

- 9 x 13 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 cup)
- 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
- Hand soap
- Dish drain board/dish rack
- Paper towels
- Sponge
- Sponge caddy
- Vegetable scrubbing brush
- Paper towel holder
- Apron
- Oven mitts
- Potholders
- Dishwashing detergent

Cleaning items for under sink

- Windex
- Clorox bleach
- 409 cleaner
- Lysol spray
- Lysol wipes

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

- First aid kit
- Toolbox

Food

Recipe card

- iPad

Ingredients

- Orange Juice
- Cantaloupe
- Feta
- Mint
- 1 pound chub package
- 6 eggs
- Spices
- Oil

Appendix D:
Microbiological Methods

D.1 DH5-Alpha Stock Selection and Preparation

In the second year of the annual FSCRP study, NCSU's microbiology team provided scientific justification for using a nonpathogenic *Escherichia coli* strain, tagged with green fluorescent protein (GFP) (*E. coli* DH5-Alpha), as a surrogate for pathogenic *Salmonella* in whole chicken pieces, with the approval of OPHS. For the research conducted in the fifth year of the annual FSCRP study, we used the same nonpathogenic *E. coli* strain as a surrogate for pathogenic *E. coli*, such as O157, found in ground sausage. Ground sausage was inoculated with the surrogate and packaged in chub-like bags simulating commonly purchased breakfast sausage. A GFP and kanamycin resistance gene were contained in the pBIT plasmid that would allow the differentiation of bacterial contamination from improper handling of the ground sausage 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 bacterium that is naturally occurring and not indicating cross-contamination.

The DH5-Alpha strain 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 40 mL of trypticase soy broth with 30 ug/mL of kanamycin and mixed. The culture was then incubated with 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.

D.2 Ground Sausage Inoculation

Inoculation was performed by mixing a prepared culture of the surrogate with a specified weight of ground sausage in a Kitchen Aid mixer. One pound of ground sausage was used for each meal preparation event, and it was inoculated with the surrogate twice a week to keep the bacterial concentration high and keep the ground sausage within its shelf life. The surrogate was cultured overnight, shaking at 37°C in a trypticase soy broth with kanamycin. The culture was then spun down at 3000 x g for 5 minutes at 4°C. The supernatant was then poured off and the pelleted surrogate was resuspended in 0.1% buffered peptone water (BPW). One pound of ground sausage, purchased within 24 hours of inoculation, was then placed into the mixing bowl of a Kitchen Aid mixer with 40 mL of resuspended surrogate and mixed for a minimum of 3 minutes. The sausage was then packaged into chub-like bags and sealed with metal hog rings. After packaging, the chubs were transported to the test kitchens where they were stored at 4°C and used within 7 days.

D.3 Inoculation Validation

Inoculation validation and shelf-life stability of the inoculated ground sausage were performed before the data collection phase of the study. Ground sausage was inoculated, packaged, and stored as described above. Aliquots of the sausage were pulled from the sample daily for 7 days and processed for enumeration of the surrogate. A 25-g aliquot of ground sausage was added to 50 mL of 0.1% BPW and stomached for 1 minute at 260 rpm. The liquid was serially diluted and plated on TSA Kan30 and incubated upside down overnight at 37°C aerobically. Colonies were counted and visualized under UV light, and an average of the surrogate per 1 g of ground sausage was determined. No significant loss of the surrogate was found in the ground sausage for the 7-day storage period.

D.4 Environmental Sampling and Cantaloupe Collection

Environmental sampling was performed to assess cross-contamination that occurred during meal preparation. Pur-Blue swabs in Letheen broth (World Bioproducts, Libertyville, IL) were used to sample the kitchen surfaces, and a 25-g sample of the cantaloupe was collected in a Ziplock bag for each meal preparation event. Irregular surfaces were swabbed entirely, including the tablet screen, which was 430 cm^2, while flat surfaces were swabbed using a 100-cm^2 template.

D.5 Detection and Quantification of DH5-Alpha on Environmental Samples and Cantaloupe

The environmental and cantaloupe samples were analyzed at an NCSU lab within 24 hours. The samples were kept at 4°C until they were processed. For environmental samples, the outside of the swabs were wiped down with ethanol to remove any kitchen surface contamination. The swabs were vortexed for 15 seconds, and then tenfold dilutions were made for each swab using 9 mL of 0.1% BPW. The samples were briefly vortexed to mix, then 100 μL were plated in duplicate for each swab per dilution onto TSA Kan30 plates and incubated aerobically upside down at 37°C for 24 hours. The plates 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 cantaloupe sample, 25 g were weighed into a filtered WhirlBag and stomached at 260 rpm for 1 minute with 20 mL 0.1% BPW. Tenfold serial dilutions were prepared in 9 mL of 0.1% BPW and vortexed briefly to mix. 100 μL of the dilutions were plated on TSA Kan30 plates and incubated aerobically upside down at 37°C for 24 hours. The plates were examined under UV light, and glowing colonies were counted as a positive result. The counts were adjusted for total volume and dilution and then recorded.

D.6 Sanitation After Meal Preparation Event

Kitchens were sanitized following meal preparation in accordance with NCSU's guidelines for sanitizing laboratory work surfaces, a requirement of the university, with additional requirements due to COVID-19. First, a cleaning agent was applied to remove any debris from surfaces before sanitation. We then applied household bleach diluted to a 10% concentration to hard surfaces with a contact time of 30 seconds before wiping them clean with a disposable paper towel. The efficacy of this sanitation procedure was confirmed during in-lab optimization studies and the pilot conducted in the test kitchen. A cleaning validation swab sample was also taken at the beginning of all meal preparation observations, and if a cleaning validation sample showed signs of remaining contamination on kitchen surfaces, that participant's microbiological data would be discarded, and not included in the overall analysis. All the utensils (i.e., knives, cutting boards, and bowls) were cleaned in dishwashers.

Appendix E:
Post-observation Interview Guide

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. Now I would like to ask you a few follow-up questions about how you prepared the meal, for example why you did or did not do something. There are no right or wrong answers, we are just trying to understand your cooking habits. 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 and begin checkout process (provide gift card, get participant signature).

If **yes**: Proceed.

Observation Follow-Up (use trigger form for context)

1. Handwashing

- Did you wash your hands or not before you started cooking today?
    - [If yes] Do you usually wash your hands before preparing breakfast at home? Why?
    - [If no] Can you tell me why you didn't wash your hands?
    - [If no] Do you usually wash your hands before preparing breakfast at home?
    - Did you happen to use hand sanitizer just prior to coming into the kitchen?
    - At what other points, if any, did you wash your hands when cooking today?
- [If not mentioned] What about after making the sausage patties, did you wash your hands or not?
    - [If yes] Is that what you usually do when cooking at home? Why?
- Have you heard about any government recommendations for handwashing since the start of the COVID-19 pandemic?
    - [If yes] Tell me what you have heard.
    - [If yes] What do you think about these recommendations?
    - [If yes] How did you respond to these recommendations?
- Have your handwashing habits changed or stayed since the start of the COVID-19 pandemic?
    - [If changed] Tell me more about the change you made and why you made these changes.

2. Food Thermometer

- Now let's talk about cooking the sausage patties. How did you determine the doneness of the sausage patties today?
- Is that how you usually determine doneness when cooking sausage patties at home?

- Can you tell me why you use this method?
- [If used thermometer]
    - Do you have a food thermometer at home?
        - [If yes] Do you usually use a food thermometer when cooking sausage patties at home?
            - [If have thermometer and do not use] Can you tell me why you usually don't use one at home?
    - Why did you use a food thermometer today?
        - [Probe **only if no reason is given** for using a food thermometer] Is this something your family usually does?
        - Is it a recommendation you saw somewhere?
    - Where did you hear or learn about the need to use a food thermometer?
        - [Probe **only if no source given AND** probe for specific source: for example, if participant mentions a website, ask which website].
    - How did you check the temperature using the food thermometer today?
        - [Probe **only if point of insertion not given**: How did you insert it into the patty?]
    - What temperature were you looking for?
    - What temperature did the sausage patties reach?
        - Where do you look for information on cooking temperatures for meat and poultry products?
        - [Probe **only if no source given AND** probe for specific source: for example, if participant mentions a website, ask which website].

3. Preparation of Eggs

- Now let's talk about preparing the eggs. Tell me how you prepared the eggs today from beginning to end.
- [Do not ask if prepared boiled eggs] What about washing your hands after cracking the eggs, is this something you did or did not do?
    - [If yes] Why?
    - [If yes] Is this something you usually do at home?
    - [If no] Can you tell me why not?
- [Do not ask if prepared boiled eggs] Did you happen to get egg yolk or white on the counter or other surface after cracking the eggs?
    - [If yes] What did you do?
    - [If yes] Why did you do that?
    - [If no or prepared boiled eggs] Assume you were cooking at home and got egg yolk or white on the counter or other surface after cracking the eggs. What would you do and why?
- [Ask if prepared scrambled eggs, poached eggs, or omelet] To what doneness did you cook the eggs, were they still soft/runny or firm?

- Can you tell me why you cooked to that doneness?
- Why did you prepare your eggs to this doneness?
- [If cooked soft/runny] The **Food and Drug Administration** advises consumers to cook eggs until they are no longer soft. Before today, were you aware of this recommendation?
    - What do you think about this recommendation?

- [Ask if prepared **fried eggs**] How did you prepare the fried eggs: (1) sunny side up [did not flip], (2) over easy, with the yolk still runny, (3) over medium, so the yolk is slightly runny, or (4) over well, so the yolk is hard. Why did you prepare your eggs to this doneness?
    - [If cooked soft/runny] The **Food and Drug Administration** advises consumers to cook eggs until they are no longer soft. Before today, were you aware of this recommendation?
        - What do you think about this recommendation?
- Where do you usually store eggs at home?
    - [Probe: If refrigerator, where in the refrigerator?]
    - [Probe if needed: door vs. shelf in interior of refrigerator]
    - What do you think about the safety of eggs purchased from the farmer's market versus those purchased from a retail grocery store?
    - Do you think they are both equally safe or do you consider one source to be safer?
    - Can you tell me why you think that?

4. Preparation of Cantaloupe for the Fruit Salad

- Now let's talk about preparing the fruit salad. Tell me how you prepared the fruit salad from beginning to end.
- What about washing the cantaloupe before you cut it, is this something you did or did not do?
    - [If yes]
        - Why did you wash it?
        - How did you wash it?
        - [Probe **if needed**: rinse under running water, rub with hands, scrub with a brush, soak in water]
        - What about washing your hands after washing the cantaloupe, is this something you did or did not do?
            - [If yes] Why?
            - [If no] Can you tell me why you didn't wash the cantaloupe?
- The Food and Drug Administration advises consumers to wash cantaloupe before cutting them. Before today, were you aware of this recommendation?

5. Cleaning/Sanitizing

- Assume you just finished preparing eggs and sausage at home. Walk me through how you would usually clean up.
- [If not mentioned] What about sanitizing, for example, do you usually use chlorine bleach or another sanitizer when cleaning up after preparing breakfast foods like egg and sausage?
    - [If yes] Why do you do that?
    - [If yes] What would you use and how would you use it?
    - [If no] Can you tell me why not?

6. Questions about Food Safety Label

- Did you notice any information on the label on how to prepare the sausage?
    - [If yes] What did you notice?
    - [If yes] Do you recall seeing any specific information on food safety?
    - [If recalled information on food safety]
        - What did the label say about food safety?
- Did the food safety instructions influence how you prepared the meal today?
    - [If yes] In what way?
    - [If no] Can you tell me why not?
- Do you usually look for and read the label instructions when preparing breakfast sausage at home?
    - [If yes] What information are you looking for?

TREATMENT GROUP ONLY

- Here's the label that was on the sausage package. The purpose of the instructions is to instruct consumers on how to prepare the product so that it is tasty and also to help ensure food safety.
    - With this in mind, tell me what you think about whether the label provides this information or not.
    - Do you have any suggestions for improving the label so that consumers properly prepare the product to ensure that it is safe to eat?
    - [If yes] Please describe.
    - What did you think about the logo and pictures on the label?
    - What are your thoughts on the length of the instructions? Would you say they are too long, too short, or just right?
        - If too long: what information do you <u>not</u> need to know to safely prepare the sausage and could be deleted?
        - It too short: what information is missing that needs to be added to ensure the sausage is safely prepared?

If **no**: Thank you so much for your time; we will remove your data from our dataset and destroy any records. [Proceed with checkout including gift card–get signature].

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

Thank you again for your time and for your participation in our study today.

Please see the greeter on your way out to receive the $75 gift card and gift and information from USDA on food safety.

Appendix F:
Screening Questionnaire (Web Version)

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 08/31/2023. The time required to complete this information collection is estimated to average 8 minutes, 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 on recipe testing, you will be asked to prepare a meal while being videotaped and to participate in an interview. The study will last up to 2 hours, and you will receive a $75 gift card 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. Have you cooked or worked professionally in a food preparation setting in the past 5 years?
   - ☐ Yes ***Ineligible. Terminate.***
   - ☐ No

2. Have you received any type of food safety training, such as ServSafe, in the past 5 years?
   - ☐ Yes ***Ineligible. Terminate.***
   - ☐ No

3. Have you participated in any research studies about cooking in the past 4 years?
   - ☐ Yes ***Ineligible. Terminate.***
   - ☐ No

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

5. On average, how often do you cook breakfast at home using shell eggs and breakfast meat made from raw pork? (Please do not include breakfast that only includes cereal, grits, oatmeal, yogurt, toast, liquid eggs, or heat and serve breakfast meats that do not require cooking.)
   - ☐ Never ***Ineligible. Terminate.***

☐ Less than once per month ***Ineligible. Terminate.***
☐ At least once a month
☐ At least twice a month
☐ At least 3 times per month
☐ 4 or more times per month

6. Which of the following breakfast meats made from raw pork *(i.e., not heat and serve)* have you cooked during the past 6 months?

☐ Bacon
☐ Breakfast sausage links
☐ Pre-made breakfast sausage patties
☐ Breakfast sausage purchased in a tube or roll used to make your own patties (see photo)

☐ Chorizo
☐ Canadian bacon
☐ None of the above

Must select sausage (links, patties, tube, chorizo) to be eligible. If none of these are selected, Ineligible and Terminate.

7. Which of the following fruits do you have experience cutting?

☐ Cantaloupe
☐ Watermelon
☐ Honeydew melon
☐ None of the above ***Ineligible. Terminate.***

8. How do you currently describe yourself?

☐ Female
☐ Male
☐ Transgender
☐ None of these
☐ Prefer not to answer

9. Are you …?

☐ Hispanic or Latino
☐ Not Hispanic or Latino

10. 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

11. What is your age?
    ☐ Under 18 ***Ineligible. Terminate.***
    ☐ 18 to 34
    ☐ 35 to 54
    ☐ 55 to 64
    ☐ 65 to 75 ***Ineligible. Terminate***
    ☐ 76 or older ***Ineligible. Terminate***

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 did not get a degree
    ☐ 2-year associates degree
    ☐ 4-year college degree
    ☐ Postgraduate degree

13. Are you or any members of your household …? *(Select all that apply.)*
    ☐ 65 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

14. Where did you hear about this study?
    ☐ Facebook
    ☐ Twitter
    ☐ Craigslist
    ☐ Email from a North Carolina extension program
    ☐ Sign
    Specify location: _____
    ☐ Other
    Specify location: _____
    ☐ Don’t know

[COVID screening]

1. In the last 7 days, have you been in close contact with someone who has been diagnosed as having COVID-19 by a healthcare professional?
   ☐ Yes **Terminate.**
   ☐ No

2. Have you been diagnosed with COVID-19 in the past 14 days?
   ☐ Yes **Terminate.**
   ☐ No

3. Do you have any *(one or more)* symptoms of COVID-19 such as cough, fever, shortness of breath, chills, muscle pain, new loss of taste or smell?
   ☐ Yes **Terminate to COVID Screen**
   ☐ No

4. Are you willing to follow all COVID-19 safety and sanitation procedures while participating in this study including wearing appropriate personal protective equipment?
   ☐ Yes
   ☐ No **Terminate**

5. Do you have any of the following conditions that may increase your risk of serious illness from COVID-19? *(Select all that apply.)*
   ☐ Chronic lung disease or moderate to severe asthma
   ☐ Heart condition
   ☐ Immunocompromised. *(This can result from cancer treatment, bone marrow or organ transplantation, immune deficiencies, poorly controlled HIV or AIDS, and prolonged use of corticosteroids and other immune weakening medications)*
   ☐ Body mass index (BMI) of 40 or higher
   ☐ Diabetes or pre-diabetes
   ☐ Chronic kidney disease undergoing dialysis
   ☐ Liver disease
   ☐ None of the above

6. Thank you for taking the time to complete this survey to determine your eligibility for this study. We have determined that you are eligible to participate in the study!

   Due to the COVID-19 pandemic, there are some additional precautions we must take when you participate in the study. Please be on the lookout for an email from our research team within a few business days regarding how to prepare to come to your study session and what you should expect.
   ☐ Yes
   ☐ No ***Terminate.***

Contact Screen 1 (if no boxes checked in question 19)

Great! Please enter your name and telephone number so that a study team member can call you and schedule an appointment for the Breakfast Study at a day and time that works best for you and send you text message reminders. The study will last up to 2 hours, and you will receive a $75 gift card and a small gift for taking part in the study. Please note that additional screening for COVID-19 exposure and symptoms will occur upon arrival which may determine you ineligible at that time. If you'd like, you can download a copy of the consent form here for your review; you will also receive a paper copy upon arrival.

[ENTER NAME]

[ENTER TELEPHONE NUMBER]

[Go to Contact Screen 3]

Contact Screen 2 (if ANY boxes checked in question 19)

Great! Please enter your name and telephone number so that a study team member can call you and schedule an appointment for the Breakfast Study at a day and time that works best for you. The study will last up to 2 hours, and you will receive a $75 gift card and a small gift for taking part in the study. Please note that additional screening for COVID-19 exposure and symptoms will occur upon arrival which may determine you ineligible at that time. If you'd like, you can download a copy of the consent form here for your review; you will also receive a paper copy upon arrival.

Please note that you have indicated that because of experiences you may be at risk for developing severe illness should you contract COVID-19. Participation in this research requires in-person interaction which may result in contracting COVID-19. Precautions including physical distancing, wearing PPE and cleaning and disinfection, will be taken to mitigate possible transmission of COVID-19; however, you may want to take additional personal precautions.

Contact Screen 3

Please enter your email address so we can send you a confirmation email with directions. [ENTER EMAIL ADDRESS; REQUIRE DOUBLE ENTRY FOR VERIFICATION].

☐ No Email

[If no email] Please enter your mailing address. [STREET ADDRESS, CITY, NC, ZIP]

Thank you for your time. A study team member will call you in 1 or 2 days to schedule an appointment with you.

If you have any questions about the study or scheduling, you may contact Lisa Shelley at 919-659-8254. If you have concerns about your rights as a research participant, contact North Carolina State University's Office of Research Protection at 919-515-8754 or via email at irb-director@ncsu.edu.

Ineligible/COVID Screen

Thank you for your time. Unfortunately, you are not eligible to take part in our study. Please contact your medical provider to discuss your needs. In addition to contacting your medical provider, if you are an NC State University employee, use this form to self-report: Employee Self-Report Form. If you are an NCSU student, please use this form to report: Student Self Report Form. If you are unaffiliated with NC State University, please call your medical provider to report symptoms.

Ineligible/Terminate Screen

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

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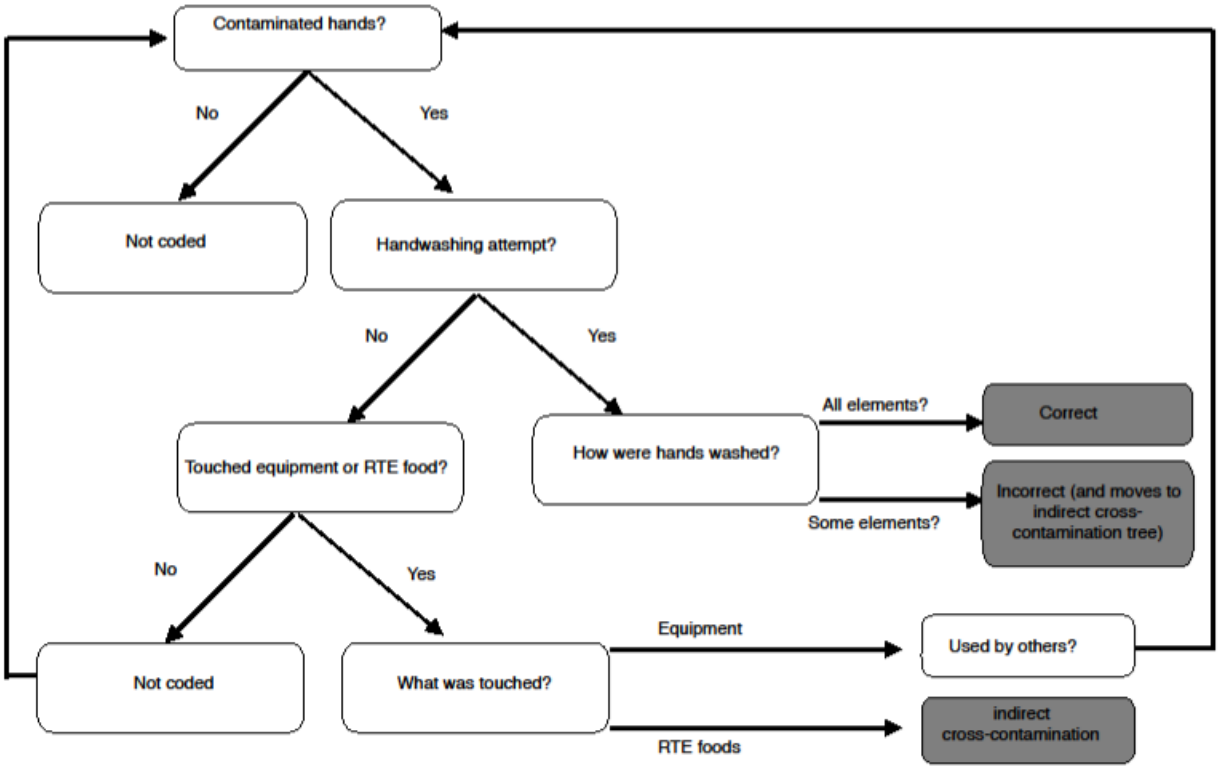
Appendix G:
Observation Rubric for Coding Participant Actions in the Kitchen

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 f or 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 airdry them.

Source: https://www.cdc.gov/handwashing/when-how-handwashing.html
For a successful handwashing attempt, all elements should occur in the sequence listed above.

Thermometer Use Rubric