

Food Handling Behaviors Observed in Consumers When Cooking Poultry and Eggs

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ABSTRACT

Previous research has shown that many consumers do not follow recommended food safety practices for cooking poultry and eggs, which can lead to exposure to *Salmonella* and *Campylobacter*. Past research has been done primarily through surveys and interviews, rather than observations. The objective of this project was to determine through observations whether consumers follow food safety guidelines. Consumers ($n = 101$) divided among three locations (Manhattan, KS; Kansas City, MO area; and Nashville, TN) were observed as they prepared a baked whole chicken breast, a pan-fried ground turkey patty, a fried egg, and scrambled eggs. The end point temperature for the cooked products was taken (outside the view of consumers) within 30 s after the consumers indicated they were finished cooking. Thermometer use while cooking was low, although marginally higher than that of some previous studies: only 37% of consumers used a thermometer for chicken breasts and only 22% for turkey patties. No one used a thermometer for fried or scrambled eggs. Only 77% of the chicken and 69% of the turkey was cooked to a safe temperature (165°F [74°C]), and 77% of scrambled and 49% of fried eggs reached a safe temperature (160°F [71°C]). Safe hand washing was noted in only 40% of respondents after handling the chicken breast and 44% after handling the ground turkey patty. This value decreased to 15% after handling raw eggs for fried eggs and to 17% for scrambled eggs. These results show that there is a high prevalence of unsafe behaviors (undercooking and poor hand washing technique) when cooking poultry and eggs and a great need for improvement in consumer behavior with poultry and eggs.

Key words: Consumer behaviors; End point temperature; Poultry safety, Thermometer use

Every year an estimated one in six Americans (~48 million people) is affected by foodborne illness. Of those affected, ~128,000 people are hospitalized and 3,000 die (7). These foodborne illnesses not only affect individual lives, but also are a burden on public health, contributing to the cost of health care. As a result, many guidelines for public health have targeted increasing the proportion of consumers who follow food safety practices as part of their goals (33, 34).

Retail meats and poultry are a significant source of pathogens in the food supply; thus, consumers need to be aware of the risk and practice good food safety behaviors (32, 37). Many foodborne illnesses occur in the home, and they can be prevented through proper food handling (4). Medeiros et al. (26) found that there were five pathogen control factors that could be improved in consumers: practice personal hygiene, cook foods adequately, avoid cross-contamination, keep foods at safe temperatures, and avoid food from unsafe sources.

In a review of food safety behaviors from 1988 to 2010, some indications were found that food safety behaviors were slowly improving among consumers (16). Subsequent

surveys in 2011 and 2014 have found that most consumers report washing their hands with soap for the required full 20 s before preparing food (2, 20). A nationally representative telephone survey found that the percentage of consumers who owned a food thermometer had increased from 49% in 1998 to 70% in 2010. Of those who owned a thermometer, 82% said they used it for roasts, 53% said they used it for chicken parts, and 23% said they used it for hamburgers (23). A separate large Web-based survey in 2014 of U.S. adults similarly found that 62% of adults owned a food thermometer. Of those who owned a thermometer, 73% used it for whole turkeys, but only 12 to 26% used it for smaller cuts of poultry (22).

In 2003, Cody and Hogue (10) indicated that increasing thermometer use among consumers presented the greatest potential positive change in the U.S. population. The lack of use of a thermometer may be attributed to lack of knowledge, inconvenience, and laziness (21, 25). Understanding consumer beliefs and behaviors may help with the development of better materials for improving food safety. According to the Health Belief Model, consumers will adopt health-related behaviors when they believe that they are susceptible to a condition, that it would have serious consequences, that an action will reduce their susceptibility

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to or severity of the condition, and that the benefits of taking action outweigh the costs of the action (8).

Although the reported increase in hand washing and thermometer ownership is good, previous studies have also shown that consumers are not following food safety practices as much as they report. For example, in a 2008 study, between 73 and 100% of those participants who reported washing their hands after handling raw chicken in a research study were found to still have *Campylobacter jejuni* on their hands (13). Dharod et al. (14) observed 60 households in the United States in 2007 and found that even though a majority of the participants reported following safe behaviors, such as washing their hands while using poultry, only a fraction were found to actually follow correct procedures when they were observed. Food safety studies with young adults have found that although many are willing to practice food safety and have positive food safety beliefs, their self-reported behaviors were less than ideal (6, 15). Young adults also failed to exhibit many safe food handling behaviors when they prepared a meal under observation (1, 5).

A 2015 study also found disagreement between reported and observed food handling practices. For example, although 100% of participants reported that they washed their hands before meal preparation, only 20% were observed to do so. Similarly, 23% reported that they used a thermometer for poultry items, but only 5% were observed to do so (24). Other studies have also shown that reported behaviors do not agree with observed behaviors, with consumers underreporting behaviors that they believe are “bad” (28, 29, 31). This disconnect between self-reported and observed behaviors makes it difficult to evaluate current food safety behaviors in the home, especially when there are relatively few observational studies (3, 9, 12, 17, 19, 24, 28, 30, 31).

The objective of this study was to examine observed food safety behaviors of consumers when cooking poultry and eggs and to measure the end point temperature achieved in those foods.

MATERIALS AND METHODS

Subject recruiting. An observational study to observe consumer food safety behavior with poultry and eggs was conducted at three locations: Manhattan, KS; Kansas City, MO area; and Nashville, TN. A convenience sample of 101 consumers was selected from existing consumer research databases for these three cities and from additional flyers and advertisements to participate in a shopping study. There were 33 participants in Manhattan and 34 each in Kansas City and Nashville. To qualify for the study, consumers had to do more than 40% of the cooking at home, had to have previously cooked each of the items they would cook in the test using the same method of cooking as that used in the study, and could not have taken formal cooking classes. Other demographics were not used to determine whether a participant qualified. Participants were told they were part of a study examining how people cook.

Cooking and observation. Participants were asked to prepare four items: a baked whole chicken breast, a ground turkey patty on the stovetop, a fried egg, and scrambled eggs. Home-style kitchens were used at each of the locations, and the

participants were asked to prepare each item as they would at home. A variety of ingredients and equipment were supplied, but the consumers were not given specific instructions as to what supplies or ingredients to use apart from the overall method of cooking (e.g. in the oven or on the stovetop). Before cooking, the participants were given time to orient themselves in the kitchen and determine the location of all of the items. A standard dial-type food thermometer was provided in a drawer with the rest of the utensils, but it was not pointed out by the observer. The items were prepared one at a time to prevent the participants from being distracted with a separate item. Participants were observed as they cooked the products, with the observer in sight of the participant and their cooking, and food safety behavior including hand washing and thermometer use in each of the products was noted. Participants were instructed that once they had finished cooking each item, they should leave it in the pan or dish in which it was cooked, place it on a hot pad, and notify the observer that they were finished cooking that item.

Once participants removed the product from the heat source and stated they were finished, the product was immediately taken from the participants, hidden from view, and then the temperature was measured by the observer. The temperature was measured using a traceable thermometer (model 15-077-968, Fisher Scientific, Pittsburgh, PA) with a Type K probe attached. For the poultry dishes, the probe was inserted from the side of the poultry, with the tip extending into the center of the thickest part of the meat. The probe was inserted into the center of the yolk for the fried egg and into the center of several pieces for the scrambled eggs; for the scrambled egg measurements, the lowest temperature was recorded. This was usually completed within 30 s after removing the product from the heat source, although it occasionally took longer if participants measured the products' temperature with a thermometer or otherwise took longer to determine the food was cooked (“done”) to their satisfaction.

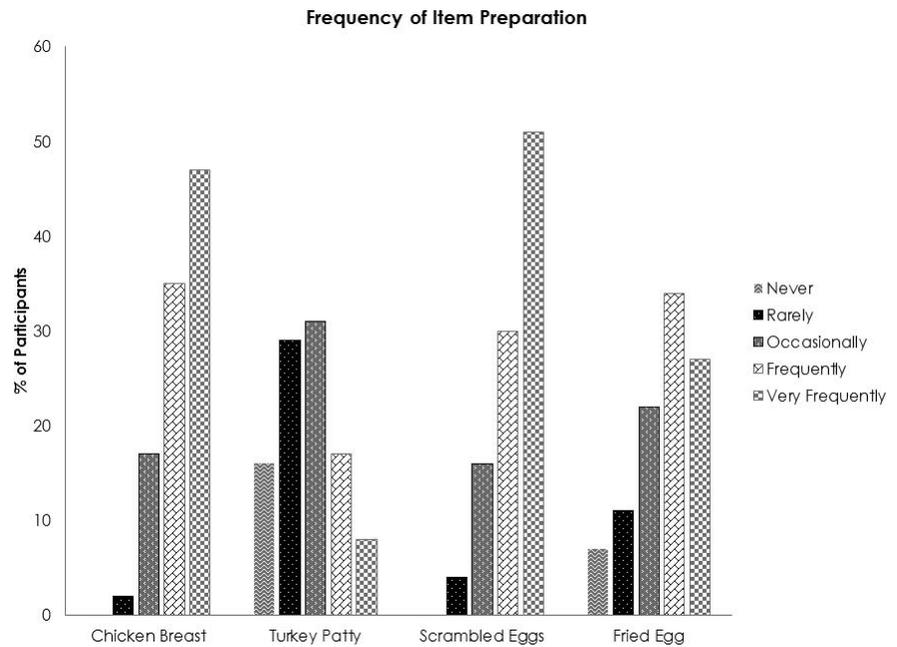
Survey and interview. A brief survey was given to the participants about their cooking abilities and where they got their cooking information. They also were interviewed to assess how similar the preparation of the items was compared to what they would do at home, if they thought the items they cooked were done, how they determined the items were finished cooking, and whether it was the same method they would use at home to check whether the products were done. The survey and interview were given to the participants after they completed cooking all items to avoid biasing their food safety behaviors during their observations.

Statistical analysis. The data were compiled and summarized with basic statistics (including means, standard deviations, and percentages) in Excel (Microsoft Corporation, Redmond, WA). Pearson's chi-square tests were calculated using R (R Core Team, Vienna, Austria). Statistics were calculated without regard to location because splitting the results into location would leave groups too small to make valid conclusions, and because demographic make-up such as race, income, and age were different among locations.

RESULTS

Demographics. From 23 April to 23 May 2014, 101 subjects (70 females and 31 males) participated in the study. Fifty-four percent of subjects were in the 25- to 44-year age range, 39% were in the 45- to 64-year age range, 5% were in the 18- to 24-year age range, and 3% were >65 years old. The majority of the participants were white (67%), with 20%

FIGURE 1. Frequency of responses to “How often do you prepare this item at home?”



African American, 7% Asian, 4% mixed, and 2% Hispanic or Latino. Household annual income was fairly evenly distributed, with 27% earning <US\$30,000; 31% earning between \$30,000 and \$45,000; 21% earning between \$60,000 and \$90,000; and 21% earning >\$90,000. The demographics among the different locations were fairly similar in most respects. The largest differences among the locations were annual income and race. The respondents in Olathe, KS, had the largest number of participants that earned >\$90,000 annually, with 19 respondents (56%) compared to 7 in Manhattan and 5 in Nashville. Owing to the convenience sampling used to recruit for the study, the participants may not represent the general public.

Cooking ability. Although the subjects had to state that they knew how to cook (and had previously cooked) each type of item to participate in the study, they were also asked how often they cooked each item at home to ascertain their familiarity with the items and their cooking process. As seen in Figure 1, the majority of participants cooked all of the items at least occasionally, with the least familiar item being the turkey patty. For those who stated they “Never” or “Rarely” cooked the turkey patty, all of them said they were familiar with cooking a ground beef patty (hence why they qualified for the study) and that they used the same method to determine the turkey patty was done as they would have if it was ground beef. For those who stated they never cooked fried eggs, they did state that they had cooked them in the past. Some also stated that although they did not normally fry eggs for themselves, they would prepare them for another person in the household.

As part of the questionnaire (Table 1), subjects also rated their own cooking abilities, with 11% rating themselves as a novice or having basic skills, 42% rating themselves as having average abilities, and 46% having better than average abilities.

Cooking information. The most common sources of cooking information reported in the questionnaire were friends and family (88%), text on the Internet (78%), cookbooks (66%), magazines (53%), television (40%), and videos on the Internet (24%). Subjects were also asked how often they watched cooking shows, with 21% never watching, 25% watching once a month, 32% watching once a week, and 23% watching daily. The discrepancy between those who reported using the television as a source of cooking information (40%) and those who watched cooking shows at least once a month (85%) was due, in part, to the type of cooking shows the respondents watched. This information shows that although many of the participants watched cooking shows, they did not necessarily use them to get cooking advice. The subjects also reported the names of the television shows watched, with many of the shows being entertainment-type food shows rather than instructional shows (i.e. with recipes), such as *Iron Chef*; *Diners, Drive-ins & Dives*; and *Hell’s Kitchen*.

Organic chicken. As markets have seen an increase in popularity of organic poultry, there is also a perception that purchasing organic poultry leads to a safer and more nutritious product, although this added safety has not been shown in previous research (35, 36). The subjects in this study expressed some of these same views, with more than half (59%) responding that they believed organic chicken was more healthful and 65% responding that they believed organic chicken to be safer than its nonorganic counterpart.

Egg disposal. Forty-four percent of respondents reported that they always finished their egg carton, regardless of other factors such as age of the eggs. In contrast, 23% disposed of eggs at the expiration date, 14% disposed of them after the expiration date, 17% used either smell or appearance, and 9% used other methods to determine when they should dispose of an egg.

TABLE 1. Consumer responses to questionnaire

Question	Response	% response (n = 101)
1. How would you rate your cooking abilities?	Novice	1
	Basic skills	11
	Avg	42
	Better than avg	44
	Expert	2
2. Where do you get your cooking information? (choose all that apply)	Friends and family	88
	Internet (written)	78
	Cookbooks	66
	Magazines	53
	Television	40
3. How often do you watch cooking shows?	Internet video (YouTube, etc.)	24
	Never	21
	Once a month	25
	Once a week	32
4. Do you think organic chicken is more healthful than nonorganic chicken?	Daily	23
	Yes	59
	No	41
5. Do you think organic chicken is safer than nonorganic chicken?	Yes	65
	No	35
6. When do you normally dispose of your eggs?	I always finish the carton	44
	At the expiration date	23
	After the expiration date	14
	Based on appearance	12
	Based on smell	5
	Other	9

Hand washing. Proper hand washing was defined as washing hands with soap for a minimum of 20 s immediately after touching the raw product and without touching anything else. During the preparation and cooking process, 40% of the participants correctly washed their hands after handling the chicken, 46% correctly washed their hands after handling the turkey, 15% correctly washed their hands after handling the eggs used to prepare the fried eggs, and 14% correctly washed their hands after handling the eggs used to prepare the scrambled eggs.

Thermometer use. As seen in previous studies, actual thermometer use was low for all items. For the chicken breast, 37% used a thermometer to measure temperature; 22% used a thermometer with the turkey patty; and none used a thermometer with the eggs (either fried or scrambled). If participants used a thermometer, they either used it with both poultry items or with just the chicken breast; there were no participants who used a thermometer with only the turkey patty. Thus, the percentage of participants that used a thermometer for any item was 37%.

In the one-on-one interviews after the cooking was completed, the participants were asked whether they used the same methods at home as they did during the observation to check whether an item was done. The majority stated they

would have used the same methods at home, with 89% stating they used the same methods for the poultry items, 95% stating they used the same methods for fried eggs, and 99% stating they used the same methods for scrambled eggs at home.

The observers also recorded whether the thermometers were used correctly by the participants; that is, the thermometer was inserted from the side, with the tip extending into the center of the thickest part of the meat. Of the participants who used a thermometer, about one-third (36%) did not use it correctly in the chicken breast, the turkey patty, or both.

Final temperature. As measured by the observer, 76% of the chicken and 68% of the turkey was cooked to a safe temperature (above 165°F [74°C]), whereas 76% of the scrambled eggs and only 47% of the fried eggs were cooked to a safe temperature (above 160°F [71°C]).

Interestingly, the use of thermometer did not necessarily improve the ability of the participants to reach the correct end point temperature. For the chicken breast, 78% of those who used a thermometer reached a final temperature above 74°C, compared to 75% for those who did not use a thermometer. In the turkey patty, 77% of participants using a thermometer reached at least 74°C, whereas 66% of participants who did not use a thermometer reached at least 74°C.

Determination of doneness. Participants in the study used a variety of techniques to determine that each product was done cooking, with more than half of the participants using more than one technique for the poultry items, and >40% using more than one technique for the egg items. Observers recorded any methods that they saw the participants using, and the participants were also asked during the one-on-one interviews what methods they used to determine doneness for each item to ensure accuracy. Observational data generally agreed with the interview results, with the interview often clarifying what exactly the participants were looking for to determine each product was done.

For the chicken breast (Table 2), the most common method used to determine doneness was cutting into the chicken (50%), followed by color (33%) and thermometer use (33%). Of the 33% that used color, about half (15% of the total) did not cut into the chicken, meaning that they only used external color. For the turkey patty, the most common indicator used was color (39%), followed by cutting into it (30%), using a thermometer (22%), and looking at the juices (18%). Of the 39% that used color for the turkey patty, two-thirds (26% of the total) used only external color. For the egg products (Table 3), the methods mainly relied on visual appearance. In the fried eggs, for example, the main determinant used was the overall appearance (43%), followed by the yolk consistency (31%), overall color (20%), texture (19%), and opaque or clear whites (17%). The main indicator for scrambled eggs was the amount of liquid left in the eggs (51%), followed by overall appearance

TABLE 2. *Methods used by participants to determine the poultry items were cooked*

	% of participants	
	Chicken breast	Turkey patty
Cut into	50	30
Thermometer	33	22
Color	33	39
Time	20	9
Juices	11	18
Texture	8	10
Visual only	6	22
Used probe (fork, spatula)	6	16
Smelled	1	1
Multiple techniques	56	54

(44%), overall texture (27%), puffiness or fluffiness (17%), and color (11%).

DISCUSSION

This study looked at known risk factors for cooking both poultry and egg dishes, quantifying them and relating them to the end point temperature of the products. This was done through observation, a questionnaire, and a one-on-one interview. Combining observations with the self-reported behaviors allowed us to avoid some of the inconsistencies that have been seen in previous studies that only looked at self-reported behaviors, while gaining insight into their thought processes (20, 24, 28, 29).

Cooking ability. As seen in Figure 1, the majority of participants cooked the items on a somewhat regular basis. Although the turkey patty was the least commonly cooked item, all participants stated that they were familiar with cooking ground patties (usually beef). This shows that the participants were familiar with cooking the items and therefore familiar with determining doneness based on their own criteria. To see whether their familiarity with the items affected whether they used a thermometer, the subjects were grouped into two categories, with the “occasionally prepares” group including those in the first three categories (never, rarely, and occasionally) and the “regularly prepares” group including those in the second two categories (frequently, very frequently). A chi-square test for each individual item showed that there was no difference between those who cooked the item occasionally and those who did so on a regular basis with regard to their ability to cook an item to the correct temperature.

A similar chi-square test was also run by grouping the participants according to their self-assessed level of cooking abilities. By grouping those who stated they had better than average or above average cooking abilities together, and those who stated they were average or lower in their cooking abilities in another group, a statistical test showed there was no difference in their use of a thermometer, in their ability to cook an item to the correct temperature, or in their hand washing. The one exception to this was in the chicken breast, where those who considered themselves above

TABLE 3. *Methods used by participants to determine the egg items were cooked*

	% of participants	
	Fried egg	Scrambled eggs
Appearance only	43	44
Color	25	11
Yolk consistency	31	
Amount of liquid	20	51
Texture	19	27
Opaque white	17	
Time	3	1
Puffy or fluffiness		17
Multiple techniques	43	42

average in cooking skill were more likely to cook the chicken breast to the appropriate temperature ($P = 0.052$). However, this suggests that neither frequency of preparation of an item nor self-assessed skill level plays a critical role in a person's ability to safely cook an item at the correct temperature.

Cooking information. In the survey, the subjects responded that they got their cooking information from a variety of sources. The majority of the subjects (85%) used more than one source for their cooking information, with the most common source being friends and family, followed by written Internet sources. The source of cooking information can be useful to know if food safety educators want to have the greatest impact on a wide range of people. As the second most common source of cooking information is from the Internet, this medium should be used more for safe food handling information. Incorporation of that information into Web sites where cooking information is found as well as food safety sites is needed.

Hand washing. Hand washing was low among the participants, as seen in previous studies (14, 24). Only “correct” hand washing is shown in Table 4, meaning the use of soap and water without touching other items. Even among those who did wash their hands correctly *at some point during the study*, there was potential for cross-contamination of other items before washing their hands if not done immediately after handling. Many subjects simply rinsed their hands after touching the raw items, or did not wash them at all, choosing instead to simply wipe them on a paper towel. Hand washing in eggs was especially low, and much lower than in the poultry items, showing that many people are unaware of the potential bacteria on raw eggshells and the need to wash their hands after touching them (18, 27). Thus, many do not consider eggs (specifically their shells) to be a risk in food safety. Despite efforts by safety and regulatory agencies to promote hand washing when handling raw food, there is still a need for improvement among consumers, as seen in this and other studies.

Thermometer use. Although thermometer use is the only reliable method to determine the final cooked

TABLE 4. *Observed food safety practices*

Food handling behavior	% observed (overall %)
Chicken breast	
Washed hands	39.6 (39.6)
Used thermometer	36.6 (36.6)
Correct thermometer use	70.3 (25.7)
Final temp $\geq 74^{\circ}\text{C}$	76.2 (76.2)
$\geq 74^{\circ}\text{C}$, used thermometer	78.4 (28.7)
$\geq 74^{\circ}\text{C}$, did not use thermometer	75.0 (47.5)
Turkey patty	
Washed hands	43.6 (43.6)
Used thermometer	21.8 (21.8)
Correct thermometer use	72.7 (15.8)
Final temp $\geq 74^{\circ}\text{C}$	68.3 (68.3)
$\geq 74^{\circ}\text{C}$, used thermometer	77.3 (16.8)
$\geq 74^{\circ}\text{C}$, did not use thermometer	65.8 (51.5)
Fried egg	
Washed hands	14.9 (14.9)
Used thermometer	
Final temp $\geq 71^{\circ}\text{C}$	48.5 (48.5)
Scrambled eggs	
Washed hands	16.8 (16.8)
Used thermometer	0.0 (0.0)
Final temp $\geq 71^{\circ}\text{C}$	76.2 (76.2)

temperature of an item, the observed use in this study was low for all items. For this study, small items were chosen for the participants to cook because of frequency of cooking and because this typically is where the lowest level of thermometer use is seen among consumers (22, 23). In addition, a whole muscle item (chicken breast) and a ground meat item (turkey patty) were chosen as each presents a different challenge for safe preparation. The two cooking methods (baking and frying) were also chosen to see how the participants would handle the different methods when checking for end point temperature. Thermometer use for the poultry items in this study was higher than in an observational study (24), but lower than that of some of the self-reported surveys (22, 23). These numbers were verified during the one-on-one interviews, where 89% reported that they would use the same method to check the item at home. Still, with only 37% using a thermometer for the chicken and 22% using a thermometer for the turkey, there is considerable room for improvement.

For the turkey patty, the participants were allowed to form their own patties after seasoning them. They were initially given 0.25 lb (113 g) of turkey, and many of their patties were fairly thick. This could partially explain why a large number of patties did not reach the recommended cooking temperature; by simply using appearance, the outside of the patty could have been overcooked, while the interior was still undercooked.

Perhaps more concerning than the lack of use of a thermometer for the poultry items is the final temperature reached for the items. As measured by the researchers, 24%

of the baked chicken breasts and 32% of the turkey patties were not cooked to at least 74°C . Furthermore, a chi-square test showed there was no statistical difference between those who did and did not use a thermometer in achieving an end point temperature of at least 74°C , in both the chicken and the turkey items. Much of the message of food safety is aimed at getting people to simply *use* a food thermometer. If using a food thermometer does not improve a consumer's ability to cook items to the correct temperature, due to improper use or to lack of knowledge as to what the final temperature should be, then perhaps more focus needs to be placed on teaching consumers *how* to use a food thermometer in addition to simply owning a thermometer.

Although it was not expected that any of the participants would use a thermometer for either the fried eggs or the scrambled eggs, it is worth noting that their final temperatures were often below the recommended safe temperature for cooking eggs. Scrambling and frying eggs have been found to be inadequate to destroy bacteria such as *Salmonella* (11). During the one-on-one interviews, the majority of the participants said they cooked the egg according to their personal preferences, looking at it from an appearance or texture point of view, as opposed to a safety point of view that is common in poultry items. Those who like their eggs with a runny yolk, or to be more "wet" when scrambling them will be unlikely to ever reach the recommended safe temperature of 71°C . This was reflected in the 51% who said their fried eggs were done when they were still below 71°C .

Determination of doneness. The data show that the subjects relied on multiple methods to determine when their items were "fully cooked" as perceived by individual participants. Consumers still rely mainly on visual and textural cues to determine whether a product is fully cooked. Even those who used a thermometer would check the poultry items by using other methods, such as cutting them open or looking at the juices before they decided they were done. Thus, it seems that color and appearance continue to be key aspects of determining doneness. For the poultry items, thermometer use was higher in the chicken breast than in the turkey patty. It may be that there is a different level of risk associated with either the turkey or with patties by the consumers, since even some of those who used a thermometer with the chicken did not use it with the turkey patty. Based on the one-on-one interviews, it is likely that the subjects saw the turkey patties as being the same as hamburger patties in terms of cooking, which have typically had very low levels of thermometer use (23).

It also is apparent that the consumers considered the egg products to be a lower risk than the poultry products, as evidenced by their lack of thermometer use and their much lower rates of hand washing when preparing the eggs.

These observations show that there is still a great need for improvement in food safety education for consumers with regard to poultry and eggs. Although some participants did use a thermometer to measure the end temperature of the chicken and turkey, some did not use it properly, and the use of a thermometer did not improve their final end point

temperatures. For the poultry products, many of the participants either washed or rinsed their hands after handling the raw products, but many did not wash their hands until after they had contaminated other areas of the kitchen by touching objects such as spices, utensils, or cooking surfaces. They were also more conscientious about washing their hands after touching the chicken and turkey than after touching the eggs. No participants used a thermometer to determine whether their eggs were properly cooked, and many used alternative methods such as color and texture appearance to judge doneness of all four poultry and egg products cooked. Future education efforts with consumers should focus on not only using a thermometer, but also on how to use a thermometer properly. Efforts should also be made to make consumers more aware of the risk of bacterial contamination with eggs and the necessity of cooking their eggs to a safe temperature.

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