

CONSUMER POULTRY HANDLING BEHAVIORS

by

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ABSTRACT

Understanding how consumers handle poultry can highlight gaps in consumer knowledge and practice of food safety. Quantitative research provides only a partial image, whereas qualitative data is helpful in gaining a complete picture of a shopper's behaviors. The objective of this study was to determine what poultry product microbes could potentially be transferred during purchasing and home storage; using a shop-along observational technique to observe actual shopping, transporting, and storing behavior of consumers with raw poultry products. In 71% (n=97) of the situations observed there was no visible hand sanitizer or wipes in the meat section of the grocery store. Plastic bags could be found in the meat section 85% (n=97) of the time, which only 25% of shoppers (n=82) used the bag for their poultry products. During transportation, the consumer bagged the poultry separately from other products in 71% of the observations. A majority of shoppers (59%) stored poultry without using a plastic bag or other container. Overall, there needs to be an increase in food safety education on the handling of poultry during purchasing, transporting, and storage.

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Chapter 1 - LITERATURE REVIEW

POULTRY CONSUMPTION TRENDS

Poultry meat production in the United States totals over 43 billion pounds annually. When discussing poultry productions most research divides it into four categories: broiler, eggs, turkey, and other chicken. A broiler is defined by the federal code of regulation as a young chicken that is tender meated with soft, pliable, smooth textured skin and flexible breastbone. This accounts for over eighty percent of U.S. poultry meat production (24). The value of broilers produced during 2013 was \$30.7 billion, up 24 percent from 2012, Table 1-1 (43). Broiler production occurs mainly in the south eastern portion of the United States; Figure 1-1. Turkey accounts for the next biggest portion of poultry meat production, the U.S. turkey industry producing over one-quarter billion birds annually, with the live weight of each bird averaging over 25 pounds (24). Turkeys sold in the United States are in clusters across the United States,

.

Table 1-1 Poultry Value of Production – United States: 2012 and 2013

Year	Broilers ¹	Eggs	Turkeys	Chickens ²	Total
	(1,000 dollars)	(1,000 dollars)	(1,000 dollars)	(1,000 dollars)	(1,000 dollars)
2012	24,827,800	7,851,830	5,452,135	79,086	38,210,851
2013	30,679,781	8,498,935	4,839,072	87,861	44,105,649

¹ Excludes States which produced less than 500,000 broilers.

² Value of sales

³ Adapted from USDA Poultry- production and value 2013 Summary (43)

Figure 1-1

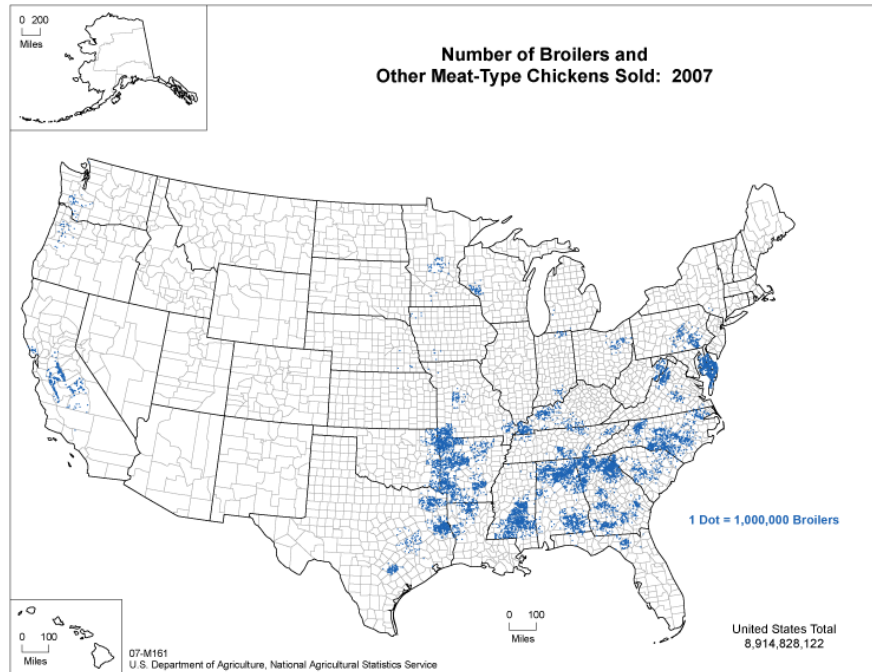
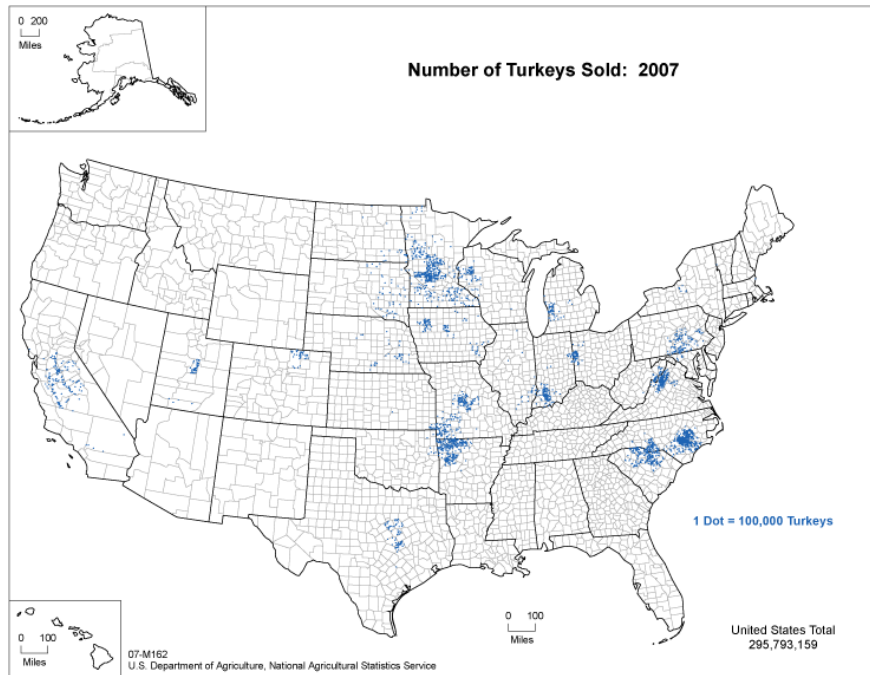


Figure 1-2



¹ Maps from USDA **2007** Census Ag Atlas Maps (5)

Consumer meat trends were captured by the National Health and Nutrition Examination Survey (NHES), Carrie Daniel et al has compiled this data to help summarize consumer trends, seen in Table 1-2. They found several interesting trends. Compared with women, men consumed more poultry per day (statistically significant ($P= 0.0005$)). Peak poultry consumption occurred in adults aged 20–49 years. Black customers consumed the highest amount of poultry (54.4 g/d) compared to Whites ($P , 0.0005$) and Hispanics ($P , 0.001$). Poultry consumption appeared to increase with education level (14).

Table 1-2 Meat intake (g/day)

Factor	Mean
Gender	
Men	48.8
Women	38.1
Age (years)	
2–11	30.6
12–19	46.2
20–49	51.7
50–69	37.2
70+	29.9
Race	
White	41.4
Black	54.2
Hispanic	41.3
Other	48.8
Education	
< High School	39.7
High School	44.8
> High School	47

[†] Information from Daniel et al (14)

FOOD SAFETY CONCERN

In the United States, there are an estimated 3,000 foodborne illness cases ending in death each year (11), as well as over 45 million foodborne illnesses contracted (38, 39, 40). Reducing the spread of foodborne illness in the U.S. by even a small percentage could potentially keep millions of people from getting sick each year. Out of the more than 30 pathogens known to cause foodborne illness (39, 40), *Salmonella* and *Campylobacter* spp. are ranked within the top five for the following three categories: overall foodborne illness, hospitalization due to foodborne illness, and foodborne illnesses resulting in death (11). Poultry products such as chicken can have high incidents of *Salmonella* and *Campylobacter* (6, 35, 46) which makes focusing on poultry food safety pertinent to efficiently decreasing foodborne illness.

Salmonella. *Salmonella* is the most commonly diagnosed bacterial agent causing foodborne illness (1, 12). An estimated 1.2 million cases occur annually in the United States; of these, approximately 42,000 are laboratory-confirmed cases reported to CDC (1). *Salmonella* serotypes Enteritidis, Typhimurium, and Newport account for about half of culture-confirmed *Salmonella* isolates reported by public health laboratories to the National Salmonella Surveillance System. Typhimurium has been the most common serotype since 1997(1). The amount of *Salmonellist* reported varies across the country, Figure 1-3 and Figure 1-4.

Figure 1-3 Age- standardized rate of Salmonella serotype Enteritidis per 100, 000 population, by county, 2006 to 2011

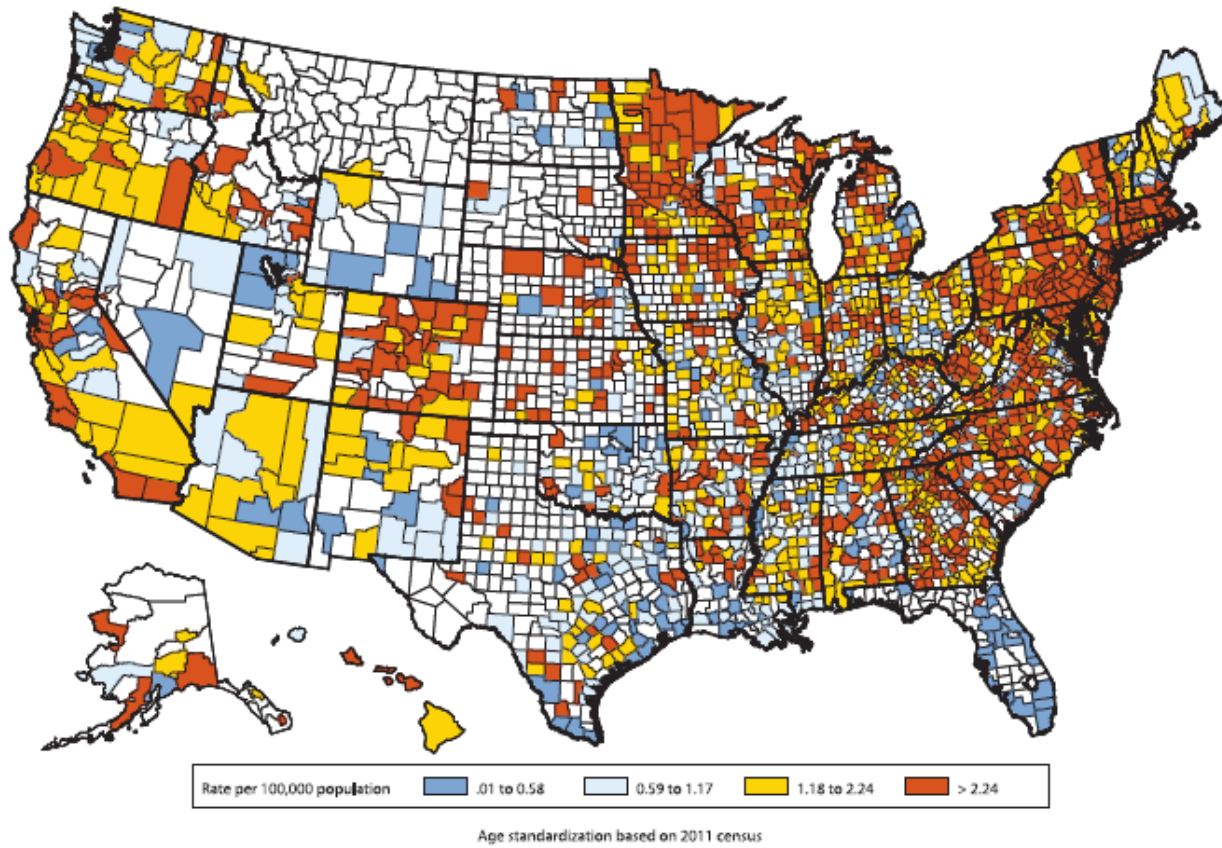
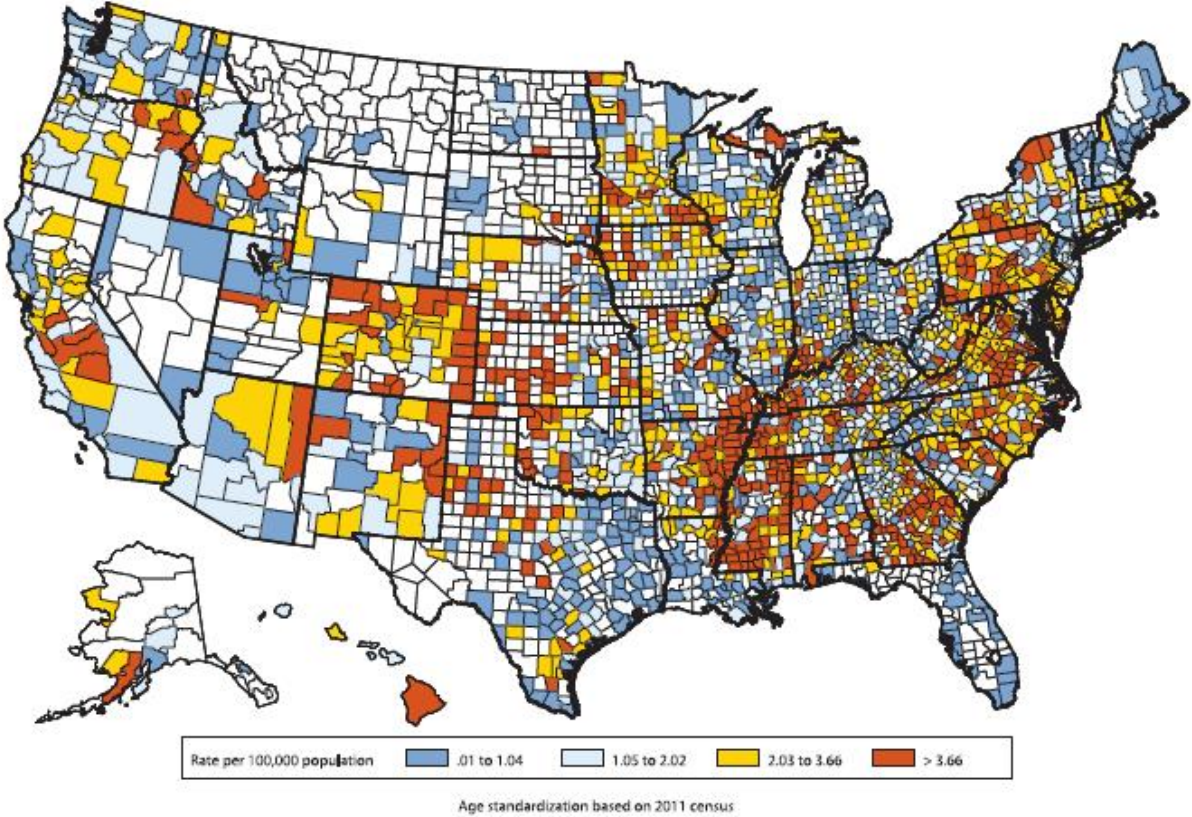


Figure 1-4 Age- standardized rate of Salmonella serotype Typhimurium per 100, 000 population, by county, 2006 to 2011



Campylobacter. *Campylobacter* is the most commonly isolated gastrointestinal bacterial pathogen in the United States (3, 17, 36). An estimated 1.3 million people are affected each year. In addition to being the most commonly isolated GI pathogen Campy is of interest because infection can lead to Guillain-Barré syndrome, a paralysis that lasts several weeks and usually requires intensive medical care (36). Approximately 1 in 1000 diagnosed Campy infections lead to this disease. *Campylobacter* is capable of surviving in a wide range of environments, such as rivers, estuarine, and coastal waters, and it is routinely found in cattle, sheep, swine, and avian species (28). *Campylobacter* infections are sporadic, that is, they involve individual cases not wide spread out breaks(28) .

Farm to Table. There is widespread agreement among sectors including regulators, educators, consumers, health authorities, research scientists, and the food industry that there should be proactive efforts to reduce, eliminate or control pathogens at all stages of the food chain(42, 45). This farm to table approach focuses on holding every step of the meat handling process accountable to food safety standards. This starts at the pre harvest in which several steps can be taken including: reduction of additional contamination, appropriate manure treatment and disposal procedures, and upholding water and food crop cleanliness (42). Feed additives such as: antibiotics, prebiotics, probiotics and symbiotic used for the control of *Salmonella* are also currently being evaluated (45). In response to the need for cleanliness to be started at the production level, the USDA/FSIS implemented a new inspection regulation which requires meat and poultry plants to: (i) establish sanitation standard operating procedures; (ii) operate under the HACCP system; and, (iii) meet microbiological performance criteria and standards for *E. coli* biotype I and *Salmonella*, as a verification of HACCP (18). The meat animal processing industry in the United States has employed extensive pathogen reduction interventions for carcass decontamination in their efforts to meet trade specifications for the raw materials (e.g., raw fresh meat). These interventions produce, comply with regulatory requirements, and provide safer

products to consumers (15, 16, 41) . Control of pathogens at the retail, food service, and consumer level involves activities that prevent introduction of additional contamination, recontamination or cross-contamination, and inactivation or inhibition of existing contamination (42) . Instances of *Salmonella* and *C. jejuni* at different process stages in poultry can be seen in Table 1-3 and

Table 1-5 (8) .

Food Safety Intervention. Types of antimicrobial interventions used to control pathogens in further processed meat or other food products are of physical, physicochemical or biological nature (19) . Physical hurdles include low and high temperature, irradiation, high pressure, steam, and -ultrasound; these hurdles have been used to meet decontamination requirements and it has specifically been evaluated in poultry safety (7, 42) . Physicochemical interventions include acidity or low pH, reduced water activity or drying, modification of the oxidation/reduction potential through packaging, and application of antimicrobial additives. Interventions of a biological nature include microbial competitors (lactic acid bacteria) or their antimicrobial products (42, 46) .

Table 1-3 Prevalence of Salmonella on poultry products

Product	Stage of process	Type of samples	Number of samples	Percentage positive	References
Turkey carcasses	After picking	Swab	46	63	32
	After washing		33	18	
	After washing		50	10	
	After chilling		58	17	
	At packaging		150	114	33
Turkey products	After chilling	Swab	40	25	
	During cutup		270	27	
	Further processed		73	21	213
Chicken	Enter chill tank	Swab	171	21	
	Exit chill tank		69	35	63
Chicken, cut up	Retail	Rinse	2330	19	131
Chicken necks	Processed		2330	12	
	Kitchens		757	17	
Chicken livers	Processed		240	51	137
chicken	Processing/retail	Neck skin rinse	120	46	51
Chicken	Processing/ retail	Neck skin rinse	41	7	214
Poultry Chicken	Supermarkets	25g	330	39	129
	Before scalding	Rinse	330	18	
	After inspection	Ceca cutting	330	22	
	After chilling	Rinse	331	94	169
Chicken carcasses	Unloading		25	44	
	After chilling		108	22	77
Chicken	Enter final wash	Rinse	108	6	37
	Enter chill tank		215	12	
	Exit chill tank		24	42	123
	Fully processed	Skin blended	48	19	
Turkey	Fully processed	Breast/thigh	45	49	167
Chicken	While processed	Neck skin	862	4	78
	Retail	Swab	168	2	
Turkey	Retail	Swab	69	3	83
Fresh chickens	Supermarkets	Swab	670	60	113

Table 1-4 Prevalence of Salmonella on poultry products cont'd

Product	Stage of process	Type of samples	Number of samples	Percent positive	References
Chicken	Chill tank	Neck rinse	230	69	
Turkey	Chill tank	Rinse	48	100	92
Chicken	Pre chill	Rinse	103	58	
Chicken	Post chill	Rinse	142	61	20
Chicken carcasses and parts	Retail	Rinse	81	54	57
Chicken	Retail	Rinse	286	24	233
Chicken	Processing plants and meat shops	25, 10, 1 g	300	57	127
Chicken		swab	57	11	97
Chicken	After chilling	Rinse	14	21	
	At packaging		214	45	166
Chicken	Hospital kitchen	Rinse	249	47	172
Chickens, chilled frozen	Retail	4 parts	347	64	
	(3 surveys)		160	58	93
Chicken carcasses	Preevisceration	Rinse	160	48	
	pre-chill		158	72	
	Cut up		154	77	
Chicken carcasses	After chilling	Rinse			236
	Plant A		112	26	
	Plant B		112	32	
	Plant C		112	77	
	Plant D		112	38	
	Plant E		112	30	

Table 1-5 Prevalence of C jejuni on poultry products

Product	Stage of process	Type of samples	Number of samples	Percent positive	References
Chicken parted	Frozen 3 weeks	165	2	202	
Chicken parted	Before packaging	Swab	50	72	193
	At packaging	50	48		
	After delivery	25	48		
	Water chilled	10	80		
Turkey	Air chilled		6	83	
	Water chilled	5	100		
	Air chilled				
Chicken	Frozen		23	100	65
Chicken	Retail	Rinse	100	58	156
Turkey	Eviscerated	Swab	33	94	126
	Water chilled	Swab	83	34	
	Ceca, just killed	Cutting	600	100	
	Viscera	Swab	24	33	
Chicken chilled livers	Retail	20 g			80
			52	67	
	frozen livers	44	4		
			143	12	
			16	0	
Frozen chickens	Retail	Rinse	82	22	145
Chicken livers	Processing	25 g	60	85	42
Chicken gizzards			64	89	
Chicken wings	Supermarket	94	83	103	
Chicken, carcasses	Before freezing	Rinse	120	49	153
			40	73	
			220	50	
			20	65	
Turkey wings	Supermarket	Rinse	184	64	165
Chicken, carcasses	Before chilling	Rinse neck	60	77	237

livers	After chilling Giblet chiller	Skin Rinse	36	69	
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Table 1-6 Prevalence of C jejuni on poultry products cont'd

Product	Stage of process	Type of samples	Number of samples	Percent positive	References
hearts			60	57	
Turkey, neck skin	Before chilling	Rinse	60	23	241
	After chilling	60	0		
wings			36	0	
hearts			60	0	
livers			18	0	
Chicken, chilled	Supermarket	Rinse	22	68	74
Chicken, frozen			37	16	
Turkey wings, chilled			184	64	
frozen			81	56	
Chicken livers	Processing			209	
chilled frozen		25 g slice	40	30	
Mechanically deboned, chilled		40	14		
frozen			40	13	
Chicken, carcasses			40	0	
livers	Before freezing	Swab	120	49	151
gizzards			40	73	
hearts			20	50	
Chicken			20	65	
Chicken	Abattoir market	10g	70	59	180
	restaurants				
	Retail markets	Rinse	360	30	210
Chicken	Before cooling	Swab	40	83	99

Chicken carcasses	After cooling	40	78
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CONSUMER TRENDS IN POULTRY HANDLING

In the Grocery Store. It has been observed that poultry cross-contamination can occur from two major pathways; directly from raw meat to products that will not receive further heat treatment, or indirectly via work surfaces, hands, or other objects (13, 21, 26, 33, 34) . One form of indirect conduct is the poultry juice or fluid on the outside of the package. Harrison et al. (2001) emphasized that cross-contamination from external poultry packaging needs further research to investigate its role in foodborne illnesses (23) . Research done in the United Kingdom determined that both *Salmonella* and *Campylobacter* were present on the external packaging of raw meats (9) . This fact makes it a key factor to determine if consumer are using measures to protect themselves from the cross contamination that could occur in the cart. A national consumer reported survey found that while grocery shopping the majority of consumers kept poultry separate from other foods. In the same study over 65% of consumers reported placing raw poultry in a separate plastic bag before putting it in their shopping cart or making an effort to keep it from touching other foods in their cart (30) . A study completed in the United Kingdom reported only 10% of the samples collected in stores offered plastic bags for storing the meat (9) . Current studies focus on consumer poultry handing when preparing the meat in the kitchen, using laboratory and interviews (2, 4, 10, 25, 27, 44) .

In the Kitchen . Hand washing is a major form of indirect contamination that has been evaluated. Inadequate hand washing is a larger contributor to cross contamination than other forms of cross contamination such as utensil contamination (44) .One observational study found that a majority of participants (60 percent) washed their hands before beginning food preparation, but only 16 percent rubbed their hands together for the recommended 20 seconds (10) . During food preparation, an alarming percent of consumers do not wash their hands with soap and water after touching raw poultry and then touching ready-to-eat produce (4, 10) . However, the majority of consumers reported washing their hands after handling raw poultry

product in a national study using consumer reported answers (30) . Most studies have shown that consumers do not follow proper food safety procedures when it comes to hand hygiene.

One study found that the most common indirect transfer agents leading to cross-contamination were hands (51%), counters (18%), and utensils (16%) (4) . A national study reported that after using a cutting board or other surface to prepare raw poultry at home, 94.4% of consumers reported following practices to prevent cross-contamination by either washing the cutting board or other surface with soap or bleach disinfectant or using a different cutting board for preparing the next food product (30) . In a study conducted in Asia a total of 31% of participating Korean, 24% of Indian, and 30% of Thai consumers used the same cutting board for different foods, such as meats and vegetables and did not take measures to decontaminate the cutting board between uses (29) . Similar inadequate preparation was seen in an Italy study as well with 78.7% of consumers affirmed using the same cutting board for raw and cooked foods (32) . One-third of the participants did not keep raw chicken separated from ready-to-eat food (10) . Overall education of consumers in proper poultry handling in the kitchen is seen across several countries.

The Refrigerator. Another contributing factor to food safety is poultry storage. Previous research reports once home only about 17% of consumers correctly stored raw on the bottom shelf of their refrigerators in a sealed container or plastic bag (30) . A study conducted in Asia found that consumers stored raw meat on the top or middle shelf of the refrigerator creating the potential for poultry juice to drip onto other items on lower shelves (16% of Indian, 17% of Korean, and 21% of surveyed Thai consumers). A study that evaluated the refrigerator conditions of consumers reported that 11% of all respondents had a thermometer in their refrigerator prior to research; after all respondents were give thermometers 28% of the respondents reported their refrigerator temperatures were above the recommended temperature of 40_F (31) . A study in Italy collected information on various refrigerator habits in the home a found the following; avoiding frequent opening of the refrigerator occurred 64.1% of the time, a not placing the

refrigerator near heat sources occurred in 36.4% of respondents, as well as 22.3% reported that their refrigerator was over full (32) .Consumers could benefit from education on how to keep refrigerated foods at a safe temperature (31, 32) .

Thermometer. A vast majority of participants do not use a thermometer to determine if chicken is cooked to a safe temperature (4, 10) . One third of the participants undercooked their chicken (44) . Only 12 to 26% of consumers in a national survey reported using a thermometer to measure the internal temperature of cuts of poultry smaller than the whole bird; about 35% of consumers reported reheating leftovers until steaming hot or using a food thermometer to check the internal temperature (30) . Survey data indicated that 30 subjects owned a food thermometer, and six of those owning a food thermometer reported using it often or always in cooking. Of those subjects who reported owning a food thermometer, 48% (n=14) reported being very confident in using a food thermometer correctly (4) .

OBSERVATIONAL RESEARCH

Consumer behavior questionnaires provide only a partial image of how consumers handle poultry while shopping. For behavioral data, self-reported information may be biased and show incorrect information because there can be a substantial difference between what people say they do and what they actually do(20) .Context is necessary to understand consumer food handling habits (22) . In a comprehensive review of consumer food safety habits it was seen that the use of interviews was found to be the most common method for obtaining information on consumer food safety habits, accounting for 48% of studies, followed by self-completion questionnaires that accounted for 27% of studies (37) . Furthermore a mix off all data is needed to fully grasp consumer habits. For example, young adults in this study were observed performing only 25% of recommended hand-washing practices, despite reporting that they perform half of these practices and correctly answering nearly three-quarters of the knowledge questions related to hand washing (2). In addition, almost every young adult observed self-rated their food safety skill as at least fair, however as a whole, they only performed 50 percent of the recommended safe food handling practices. Thus, this sample shows that relying on self-reported behavior fails to truly reflect actual food handling behaviors (10) .

OBJECTIVE

To date observational data of how poultry is handled in the grocery store has not been adequately evaluated. This study determined how poultry microbes could potentially be transferred during purchasing and home storage using a shop-along observational technique to observe the actual shopping, transporting, and storing behaviors of consumers with raw poultry products. This allowed the researcher to view the shopper's poultry habits first hand.

References

1. Anonymous. December 18, 2014 . Center for Disease and Control: Salmonella. Available at: <http://www.cdc.gov/salmonella/>. Accessed March 8 2015.
2. Abbot, J. M., C. Byrd-Bredbenner, D. Schaffner, C. Bruhn, and L. Blalock. 2007. Comparison of food safety cognitions and self-reported food-handling behaviors with observed food safety behaviors of young adults. *Eur. J. Clin. Nutr.* 63:572-579.
3. Allos, B. M. 2001. Campylobacter jejuni Infections: update on emerging issues and trends. *Clin. Infect. Dis.* 32:1201-1206.
4. Anderson, J. B., T. A. Shuster, K. E. Hansen, A. S. Levy, and A. Volk. 2004. A camera's view of consumer food-handling behaviors. *J. Am. Diet. Assoc.* 104:186-191.
5. Anonymous. 03 May 2012. 2007 Census Ag Atlas Maps - Livestock and Animals. Available at: http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Ag_Atlas_Maps/Livestock_and_Animals/Livestock,_Poultry_and_Other_Animals/07-M162.php. Accessed 03April 2015.
6. Blackburn, C., and P. J. McClure (ed.). 2009. Foodborne pathogens: hazards, risk analysis and control, 2nd Ed. CRC Press, Boca Raton, FL.
7. Boysen, L., H. Rosenquist. 2009. Reduction of thermotolerant Campylobacter species on broiler carcasses following physical decontamination at slaughter. *J. Food Prot.*72:497-502.
8. Bryan, F. L., M. P. Doyle. 1995. Health Risks and Consequences of Salmonella and Campylobacter-Jejuni in Raw Poultry. *J. Food Prot.* 58:326-344.
9. Burgess, F., C. Little, G. Allen, K. Williamson, and R. Mitchell. 2005. Prevalence of Campylobacter, Salmonella, and Escherichia coli on the external packaging of raw meat *J. Food Prot.* 68:469-475.
10. Byrd-Bredbenner, C., J. Maurer, V. Wheatley, E. Cottone, and M. Clancy. 2007. Observed food safety behaviours of young adults. *Br. Food J.* 109:519-530.
11. Centers for Disease Control and Prevention. 17 April 2014. CDC Estimates of Foodborne Illness in the United States. Available at: <http://www.cdc.gov/foodborneburden/estimates-overview.html>. Accessed 26 May 2015.
12. Chittick, P., A. Sulka, R. V. Tauxe, and A. M. Fry. 2006. A summary of national reports of foodborne outbreaks of Salmonella Heidelberg infections in the United States: Clues for disease prevention. *J. Food Prot.* 69:1150-1153.

13. Cogan, T. A., S. F. Bloomfield, and T. J. Humphrey. 1999. The effectiveness of hygiene procedures for prevention of cross-contamination from chicken carcasses in the domestic kitchen. *Lett. Appl. Microbiol.* 29:354-358.
14. Daniel, C. R., A. J. Cross, C. Koebnick, and R. Sinha. 2011. Trends in meat consumption in the USA. *Public Health Nutr.* 14:575-583.
15. Dickson, J. S., M. E. Anderson. 1992. Microbiological decontamination of food animal carcasses by washing and sanitizing systems: a review. . *J. Food Prot.* 55:133-140.
16. Dorsa, W. J. 1997. New and established carcass decontamination procedures commonly used in the beef-processing industry. . *J. Food Prot.* 60:1146-1151.
17. Fields, P. I., D. L. Swerdlow. 1999. Campylobacter jejuni. *Clin. Lab. Med.* 19:489-+.
18. Food Safety and Inspection Service. 1996. Pathogen Reduction; Hazard Analysis and Critical Control Point (HACCP) Systems: Final Rule. 9CFR Part 304, et al., Federal Register 61, 38805–38989. *FSIS* .
19. Foods, L. M. I. 2005. Achieving continuous improvement in reductions in foodborne listeriosis—a risk-based approach. *J. Food Prot.* 68:1932-1994.
20. Anonymous, Observational research: A tool for collecting behavioral data and validating surveys. Summer Program in Sensory Evaluation Symposium. Available at: http://www4.hcmut.edu.vn/~dung/spise2009/fullpapers/ObservationalResearch_Godwin.pdf Accessed: January; 2009.
21. Gorman, R., S. Bloomfield, and C. C. Adley. 2002. A study of cross-contamination of food-borne pathogens in the domestic kitchen in the Republic of Ireland. *Int. J. Food Microbiol.* 76:143-150.
22. Gustafson, A., S. Hankins, and S. Jilcott. 2012. Measures of the Consumer Food Store Environment: A Systematic Review of the Evidence 2000-2011. *J. Community Health* 37:897-911.
23. Harrison, W., C. J. Griffith, D. Tennant, and A. Peters. 2001. Incidence of Campylobacter and Salmonella isolated from retail chicken and associated packaging in South Wales. *Lett. Appl. Microbiol.* 33:450-454.
24. Harvey, D. Monday, May 28, 2012 2015. USDA Economic Research Department: Background. Available at: <http://www.ers.usda.gov/topics/animal-products/poultry-eggs/background.aspx>. Accessed 03 May 2015 .

25. Hoelzl, C., U. Mayerhofer, M. Steininger, W. Brüller, D. Hofstädter, and U. Aldrian. 2013. Observational trial of safe food handling behavior during food preparation using the example of *Campylobacter* spp. . *J. Food Prot.* 76:482-489.
26. Humphrey, T. J., K. W. Martin, J. Slader, and K. Durham. 2001. *Campylobacter* spp. in the kitchen: spread and persistence. *J. Appl. Microbiol.* 90:115S-120S.
27. Jay, L. S., D. Comar, and L. D. Govenlock. 1999. A video study of Australian domestic food-handling practices. *J. Food Prot.* 62:1285-1296.
28. Keener, K. M., M. P. Bashor, P. A. Curtis, B. W. Sheldon, and S. Kathariou. 2004. Comprehensive review of *Campylobacter* and poultry processing. *Compr Rev Food Sci F* 3:105-116.
29. Koppel, K., S. Suwonsichon, U. Chitra, J. Lee, and E. Chambers IV. 2014. Eggs and poultry purchase, storage, and preparation practices of consumers in selected Asian countries. *Foods* 3:110-127.
30. Kosa, K. M., S. C. Cates, S. Bradley, I. Chambers, and S. Godwin. 2015. Consumer-Reported Handling of Raw Poultry Products at Home: Results from a National Survey. *J. Food Prot* 78:180-186.
31. Kosa, K. M., S. C. Cates, S. Karns, S. L. Godwin, and D. Chambers. 2007. Consumer home refrigeration practices: Results of a web-based survey. *J. Food Prot* 70:1640-1649.
32. Langiano, E., M. Ferrara, L. Lanni, V. Viscardi, A. M. Abbatecola, and E. De Vito. 2012. Food safety at home: knowledge and practices of consumers. *Journal of Public Health* 20:47-57.
33. Luber, P., S. Brynstad, D. Topsch, K. Scherer, and E. Bartelt. 2006. Quantification of *Campylobacter* species cross-contamination during handling of contaminated fresh chicken parts in kitchens. *Appl. Environ. Microbiol.* 72:66-70.
34. Mattick, K., K. Durham, M. Hendrix, J. Slader, C. Griffith, M. Sen, and T. Humphrey. 2003. The microbiological quality of washing-up water and the environment in domestic and commercial kitchens. *J. Appl. Microbiol.* 94:842-848.
35. Nachamkin, I., C. M. Szymanski, and M. J. Blaser. 2008. *Campylobacter*, 3rd ed. ASM Press, Washington D.C .

36. National Center for Emerging and Zoonotic Infectious Diseases. National Center for Emerging and Zoonotic Infectious Diseases: Campylobacter. Available at:
<http://www.cdc.gov/nczved/divisions/dfbmd/diseases/campylobacter/technical.html>.
37. Redmond, E. C., C. J. Griffith. 2003. A comparison and evaluation of research methods used in consumer food safety studies. *Int J of Consum Stud* 27:17-33.
38. Scallan, E., December 2010. New U.S. Foodborne Illness Estimates. Available at
http://www2c.cdc.gov/podcasts/media/pdf/EID_01-11_FoodborneIllness.pdf. Accessed 26 May 2015.
39. Scallan, E., P. M. Griffin, F. J. Angulo, R. V. Tauxe, and R. M. Hoekstra. 2011. Foodborne illness acquired in the United States—unspecified agents. *Emerging infectious diseases* 17:16.
40. Scallan, E., R. M. Hoekstra, F. J. Angulo, R. V. Tauxe, M. Widdowson, S. L. Roy, J. L. Jones, and P. M. Griffin. 2011. Foodborne illness acquired in the United States—major pathogens. *Emerging infectious diseases* 17:7.
41. Sofos, J. N., G. C. Smith. 1998. Nonacid meat decontamination technologies: Model studies and commercial applications. *Int. J. Food Microbiol.* 44:171-188.
42. Sofos, J. N. 2008. Challenges to meat safety in the 21st century. *Meat Sci.* 78:3-13.
43. USDA, National Agricultural Statistics Service. Poultry - Production and Value 2013 Summary. Available at: <http://usda.mannlib.cornell.edu/usda/current/PoulProdVa/PoulProdVa-04-29-2014.pdf>.
44. Van Asselt, E., A. Fischer, A. E. De Jong, M. J. Nauta, and R. De Jonge. 2009. Cooking practices in the kitchen—Observed versus predicted behavior. *Risk analysis* 29:533-540.
45. Van Immerseel, F., K. Cauwerts, L. Devriese, F. Haesebrouck, and R. Ducatelle. 2002. Feed additives to control Salmonella in poultry. *Worlds Poult. Sci. J.* 58:501-513.
46. Van Immerseel, F., J. Russell, M. Flythe, I. Gantois, L. Timbermont, F. Pasmans, F. Haesebrouck, and R. Ducatelle. 2006. The use of organic acids to combat Salmonella in poultry: a mechanistic explanation of the efficacy. *Avian Pathol.* 35:182-188.

Chapter 2 - Consumer Poultry Handling Behavior

ABSTRACT

Considerable work on consumer's food safety habits has highlighted issues associated with home food preparation. However consumer handling of foods such as poultry during shopping and storage has not been noted. The objective of this study was to determine consumer behaviors during purchasing and initial storage of raw poultry to determine potential cross-contamination issues. A shop-along observational study to determine actual shopping, transportation, and storage behavior of consumers who purchase raw poultry products. No visible hand sanitizer or wipes were observed in 71% of grocery store meat sections of the grocery store. Plastic bags could be found in the meat section 85% of the time, but only 25% of shoppers used the bag for their raw poultry purchases. During checkout the poultry was bagged separately from other products 71% of the time. A majority of shoppers stored raw poultry in the original package without an additional container or an overwrap. Overall, there needs to be an increase in food safety education on the handling of poultry during purchasing, transportation, and storage.

INTRODUCTION

The United States Department of Agriculture (USDA) predicts more than 40 billion pounds of poultry meat will be produced in the United States in 2014 (16) . Poultry products such as chicken can have high incidents of *Salmonella* and *Campylobacter*(3, 19) , which makes focusing on poultry food safety pertinent to efficiently decreasing foodborne illness. Many studies have been conducted on food safety in the home (1, 2, 5, 11, 14, 25) , however observational studies focused on actual shopping behavior have not yet been found. Typical shopping behavior studies occur in a laboratory setting (12) . Gaining a better understanding of how consumers handle poultry in the grocery store, during transport, and initial storage could highlight gaps in consumer's knowledge and practice related to food safety.

In the United States there are over 45 million foodborne illnesses contracted a year(21, 22, 23) , with an estimated 3,000 foodborne illness cases ending in death (6) . Reducing the spread of foodborne illness in the U.S. by a small percentage could potentially keep millions of people from getting sick each year. Out of the more than 30 pathogens known to cause foodborne illness (22, 23) *Salmonella* and *Campylobacter* spp. are ranked among the top five for the following three categories; overall foodborne illness, hospitalization due to foodborne illness, and foodborne illnesses resulting in death(6) . Knowing how these two pathogens can spread through unsafe handling can help improve practices that reduce their potential for contamination and, consequently, lower these illnesses every year.

Cross-contamination has been identified as an important factor in food borne illness dissemination and has been noted specifically for *Campylobacter* (8, 13) . It has been observed that poultry cross-contamination can occur from two major pathways; directly from raw meat to products that will not receive further heat treatment, or indirectly via work surfaces, hands, or other objects (7, 8, 13, 15, 17) . One form of indirect conduct is the poultry fluid or leakage on the outside of the package. Harrison et al. (2001) emphasized that cross-contamination from

external poultry packaging needs further research to investigate its role in foodborne illnesses (10) . Research done in the United Kingdom indicated that both *Salmonella* and *Campylobacter* were present on the external packaging of raw meats. This same study also reported only 10% of the samples collected in stores offered plastic bags for bagging the meat (4) . Studies such as these indicate that poultry packaging could be contaminating other products, but little is known about which products or other surfaces might be contaminated. Improvement, through education or other methods, for safe poultry handling is needed in order to decrease the spread of foodborne pathogens found on poultry.

Consumer behavior questionnaires provide only a partial image of how consumers handle poultry while shopping. A number of data collecting instruments have been developed for measuring food environment, the majority of which were developed to track food availability (20) . Context is necessary to understand consumer food handling habits (9) . Observational data is helpful in gaining a complete picture of a shopper's behaviors. However it is pertinent to choose the right method of observational data collection. For example, a study gathering distance traveled to the grocery versus actual proximity to the grocery store showed that more people reported shopping 1 mile away from their home than actually lived 1 mile away from a grocery store (18) . Thus, actual concrete observation may be necessary to determine what people actually do

This study determined current consumers behaviors that could potentially contribute to poultry microbial spread to none poultry items. Observations were during purchasing and home storage of poultry products using a shop-along observational technique, which observes actual shopping, transporting, and storage behaviors of consumers with raw poultry products.

MATERIALS AND METHODS

Participants. One hundred and two consumers who did at least 40% of their households' grocery shopping, regularly purchased raw poultry, and had plans to purchase poultry on their next shopping trip, were recruited from three cities (Manhattan, Kansas; Kansas City area, Kansas/Missouri; Nashville, Tennessee). A time was scheduled for two observers to meet and “shop-along” with each consumer, to observe the consumer on their grocery shopping trip, and to observe them storing their purchased poultry products at home. Usable data was collected from 96 consumers; some participants could not be used because of retailer hostility and not purchasing poultry.

Observation guide. An observational guide was developed to create consistency between all three research facilities. The guide was divided into four major segments in order to collect information on: items the customer touched after touching poultry when in the store, any product being purchased that came in direct contact with the poultry, availability of food safety measures in the grocery store or used by staff, and the transport and home storage of the poultry. Other behaviors also were recorded to conceal the actual purpose of the study.

Because of the amount of information collected, to protect the safety of the interviewers and consumers, as well as the unpredictable environment of an observational study, each shop-along required two researchers to gather observations. Thus, the observation guide was divided into a guide for “Researcher A” and a guide for “Researcher B”. Researcher A recorded observations in which categorical responses had been created in preliminary observational shopping trips. Researcher A also recorded the products the poultry touched on the conveyor belt after the cashier scanned the item, as well as any items bagged with the poultry. The at home portion of the study was also formatted into questions with categorical responses and was the responsibility of Researcher A. The observation guide for “Researcher A” is in Figure 2-1.

Researcher B recorded the open ended observations. Thus, there was particular need to be cognizant of the study goals to ensure appropriate items and information were recorded. For example, Researcher B recorded the three items the consumer touched directly after touching poultry. However, any item touched after the shopper used hand sanitizer or wipes was not considered to be at risk of poultry contamination. The items the poultry package touched when placed directly in the cart were also recorded by Researcher B. If the shopper placed the poultry product in a bag before placing it with other items, the items were not considered to have come in contact with the poultry. Researcher B also recorded any products the poultry came in contact with on the conveyor belt before reaching the cashier at checkout. The observation guide for “Researcher B” is in Figure 2-2.

Figure 2-1 Researcher A Observation Guide

Meat/ Seafood Section of the Store

- 1) Are there any bags available to put meat products in?
 Yes
 No
- 2) Are there any forms of sanitizing wipes or hand wash?
 Yes, Sanitizing wipes
 Yes, Hand sanitizer
 No
- 3) Did the customer use the bag for their poultry product?
 Yes
 No
- 4) Was there any noticeable dripping, leakage, or damage from the packages?
 Yes
 No
- 5) If they noticed dripping or leakage did they put the package back on the shelf?
 Yes
 No
 N/A
- 6) Where did they put the poultry in the cart?
 Child seat area
 Main basket
 Underneath main basket
 Other _____
- 7) Did the customer use sanitizing wipes or hand wash?
 Yes, they used on their hands
 Yes, they used on other object in cart
 Yes, they used on poultry product
 Yes, they used on other area ; Describe: _____
 No
- 8) If yes, where did they get it?
 Meat Section
 Front of Store
 Brought with them
 Other _____
 N/A

Check Out

- 1) Take note of any additional items that poultry comes in contact with during the bagging process.

- 2) Does the cashier wrap the poultry in a plastic bag before it is placed in another bag?
 Yes
 No
- 3) Is the poultry placed in a separate bag from other products?
 Yes, in a bag with just poultry
 No, it was placed in a bag with products other than raw meat.
Take note of all items in the bag with the poultry product

Home Storage

Poultry product _____

1) What surfaces did the poultry touch before being stored? (this is outside of the bag)

- Counter
- Kitchen table
- Sink
- Other, describe _____
- None

2) How was the poultry stored?

- It was placed directly in the refrigerator
- It was placed directly in the freezer
- Placed (or left) in a bag and then placed in the freezer
- Placed (or left) in a bag and then placed in the refrigerator
- Taken out of original package and bagged then but in the freezer
- Taken out of the original package and bagged and then but in the refrigerator
- Other; please elaborate

3) Was the poultry placed directly on top of anything when stored? Comment on what the poultry was placed on.

4) What shelf was the poultry placed on? Please describe any noteworthy observations.

- Lowest shelf, there was no possibility of liquid dripping down on other food
- Middle or higher self, there is possibility of liquid dripping onto other products
- Middle or higher self, no possibility of liquid dripping onto other products
- Other, please elaborate

5) If purchased were the eggs stored in the container they were bought in?

- Yes
- No, describe how they were stored
- Not applicable

Follow up Question

1) Do you have a meat thermometer?

- Yes
- No

2) Is it digital or dial?

- Digital
- Dial
- Other _____

3) How often do you calibrate?

Figure 2-2 Researcher B Observation Guide

Poultry

1) List any poultry product the customer touches. Followed by the next three items that they touch. If the product is put in the cart list any items the poultry touched in the cart.

i. Poultry product touched _____

List the three products that the customer touched after touching the poultry.

- 1. _____
- 2. _____
- 3. _____

List any products the poultry touched in the cart.

- 1. _____
- 2. _____
- 3. _____
- 4. _____
- 5. _____
- 6. _____
- 7. _____
- 8. _____

ii. Poultry product touched _____

List the three products that the customer touched after touching the poultry.

- 1. _____
- 2. _____
- 3. _____

List any products the poultry touched in the cart.

- 1. _____
- 2. _____
- 3. _____
- 4. _____
- 5. _____
- 6. _____
- 7. _____
- 8. _____

Section 3: Check Out

4) Take note of any additional items that poultry comes in contact with during the placement on the conveyer belt.

Researcher Training. Research staff and managers from research facilities at Tennessee State University (Nashville), and the Sensory Analysis Center at Kansas State University (Manhattan and Kansas City area locations) attended a one day training workshop. The researchers were given observation guides developed to aid in uniform data collection and were given various scenarios to help prompt any situational questions that could arise. The training session included an actual shop-along followed by a debriefing session.

During training, appropriate shop-along observational behavior also was reviewed and emphasized. For example, one behavior discussed was that researchers and consumers were allowed only minimal talking to each other after introductions and consent forms were signed. In addition, the researchers needed to respect the personal space of their shop-along consumers and other shoppers, in order to, help with conducting an unobtrusive study as well as helping keep the retailer's establishment easy for other shoppers to maneuver. Not interfering with the participants shopping, such as not helping carry items or picking up anything that was dropped, also was discussed to maintain as much of a natural experience as possible. Before conducting an unsupervised shop-along observation, researchers at each facility were required to have attended the researcher training session, or complete training that included at least one shop-along under the guidance of the facility manager who was present at the training session.

Analysis. The questions that could be answered in a multiple choice format were coded accordingly. The data that involved listing products was coded by a single researcher to allow for consistency. The items potentially contaminated by poultry were separated into 11 categories: beverages, cart, dry goods, eggs, fresh produce, frozen products, fixed features, meat or poultry, non-food products, personal items, and refrigerated products. Percentages were calculated for all questions and categories to understand potential issues that occurred with poultry shopping, handling, and initial storage behaviors.

RESULTS AND DISCUSSION

Meat Section. Ninety-six shoppers were observed while grocery shopping and buying poultry (one shopper went to two stores, thus the following percentages reflect 97 poultry shopping observations). In only 29% of the shopping situations were hand sanitizer or wipes visibly available in the meat section of the store. Only three of the participants used hand sanitizer in the meat sections and two of those participants brought their own hand sanitizer. Hand hygiene is a key component of good practice in the community and can produce significant benefits in terms of reducing the incidence of infection (24) . That the majority of stores observed did not have any hand sanitizer or wipes available in the meat section is a problem that could be corrected. However, it is important to note that of the 30% that did have hand sanitizer or wipes available, only one participant used it. Therefore, it also is important to educate shoppers on the importance of using hand sanitizer in the meat section after touching poultry packages (Table 2-1).

Because shoppers are not practicing good hand hygiene when handling poultry in the grocery store meat section, there are a variety of items that could be contaminated as a result of contact with their hands. The list of items that the shopper's hands came directly in contact with after touching poultry packages can be seen in Table 2-2. An item of major concern is the grocery cart. The cart was touched directly after handling poultry 85 of the time, which could potentially mean the cart is a risk factor for *Salmonella* and *Campylobacter* spp. The bacteria potentially left on the car could affect other shoppers, not just the participant being observed. A shopper who is not purchasing poultry, or is purchasing poultry and is following safety precautions, could still be exposed to poultry contaminates via the cart. This is especially concerning for those that are at higher risk, such as infants or young children and the elderly. With young children, they may be placed in the basket of the cart and come in contact with the

handle. Thus, food-borne illness potentially could be spread because of another person’s lack of proper precaution when handling poultry products. Mitigation by using sanitizing wipes on cart handles at the store entrance should be specifically promoted, in addition to consumers sanitizing hands in the meat section.

The other categories frequently touched after touching poultry were dry goods, refrigerated items, other meat and poultry, and personal items. This can be attributed, in part, to store layout. The majority of stores are set up so that after the meat section the closest area is the refrigerated food section. Additionally the shopper can turn into the center of the store which usually stores dry goods. Of particular concern is the percentage of consumers who touched a personal item, including children, immediately after touching raw poultry. Direct transfer of microbes to children is an especially problematic behavior because children are particularly vulnerable to food borne illness.

Table 2-1 Observation with a sanitizer available in the meat section

Sanitizer Type	% of observations available (n=96)
Sanitizing wipes	26%
Hand Sanitizer	3%
No Sanitizer noticed	71%

Table 2-2 Percent of shoppers that touched items types within three touches after touching poultry packages.

Item touched	Shopper % (n=96)
Cart	85
Dry goods	49
Meat or poultry	33
Refrigerated items	33
Personal Item (child, purse, etc.)	31
Frozen foods	16
Fresh produce	9
Beverages	5
Non-food products (medicine, cleaning supplies)	7
Eggs	4
Fixed feature at Grocery (shelf displays etc.)	4

Plastic bags could be found in the meat section during 85% of the shop-along visits. Retailers are taking a step in the right direction by having bags available for meat storage in the meat section. However, of the observations where plastic bags were available only 25% of shoppers used the bag for their poultry products. Using a bag for poultry at this point in the shopping trip could decrease the potential for cross-contamination of other products in the cart, and during checkout, transport, and storage in the consumers' homes. This is a particularly easy behavior change that could result in considerable reduction in cross-contamination.

Contact with other products occurred frequently in the cart, which could result in cross-contamination. The shoppers placed the poultry in the main basket of the grocery cart 84% of

the time. Dry goods, fresh produce, and refrigerated items were the items that came into direct contact with poultry in the cart most often. The list of items that were touched directly by the poultry can be seen in Table 2-3. Produce is a product that is most likely prepared with a minimal amount of heat, yet it was the third most likely product to come in direct contact with poultry in the grocery cart. Thus, education is needed for shoppers to emphasize separating poultry items from fresh produce items in the cart. The frequency of dry goods contact can be attributed to larger number of dry goods purchased while shopping. The prevalence of refrigerated items coming into contact with poultry is problematic because these items frequently provide a moist environment that could promote a moist environment that could promote transfer and growth of microbes. In addition, some of these items, such as milk, are handled repeatedly in the home, which could result in multiple cross-contamination from a single product.

Table 2-3 Percentage of items that were in contact with poultry in the cart

Items	% total items touched (n=276)
Dry goods	33
Fresh Produce	18
Refrigerated	18
Meat or poultry	11
Frozen	10
Beverages	7
Non-food products (medicine, cleaning supplies)	2
Eggs	2

Checkout. A minimal amount of contact with other products occurred on the conveyor belt.

Although poultry’s contact with the conveyer belt was not a focus of this study it should be noted that contamination of the conveyer is a potential concern. In some instances, the clerk did wipe down the conveyor belt with a wipe or spray and paper toweling, but the frequency of that was not studied here. Poultry was bagged separately from other products in 71% of the observations. When poultry was bagged with other products it sometimes was already in a plastic bag from the meat section or wrapped in a plastic bag at check out. Therefore, 82% of the shopping occasions observed would seem to have minimal cross contamination from sharing a bag with poultry products. The bagging process is one area in the grocery shopping experience where either the cashier, bagger, or the customer understands the importance of the food safety measures. When educating shoppers about food safety, the proper way to bag poultry appears to be understood by a majority of people; educational messages probably only need to confirm this behavior.

Home Storage. When viewing how shoppers store poultry in their home, it was noticed that 33% of the shoppers placed the poultry directly on the counter before placing it into storage.

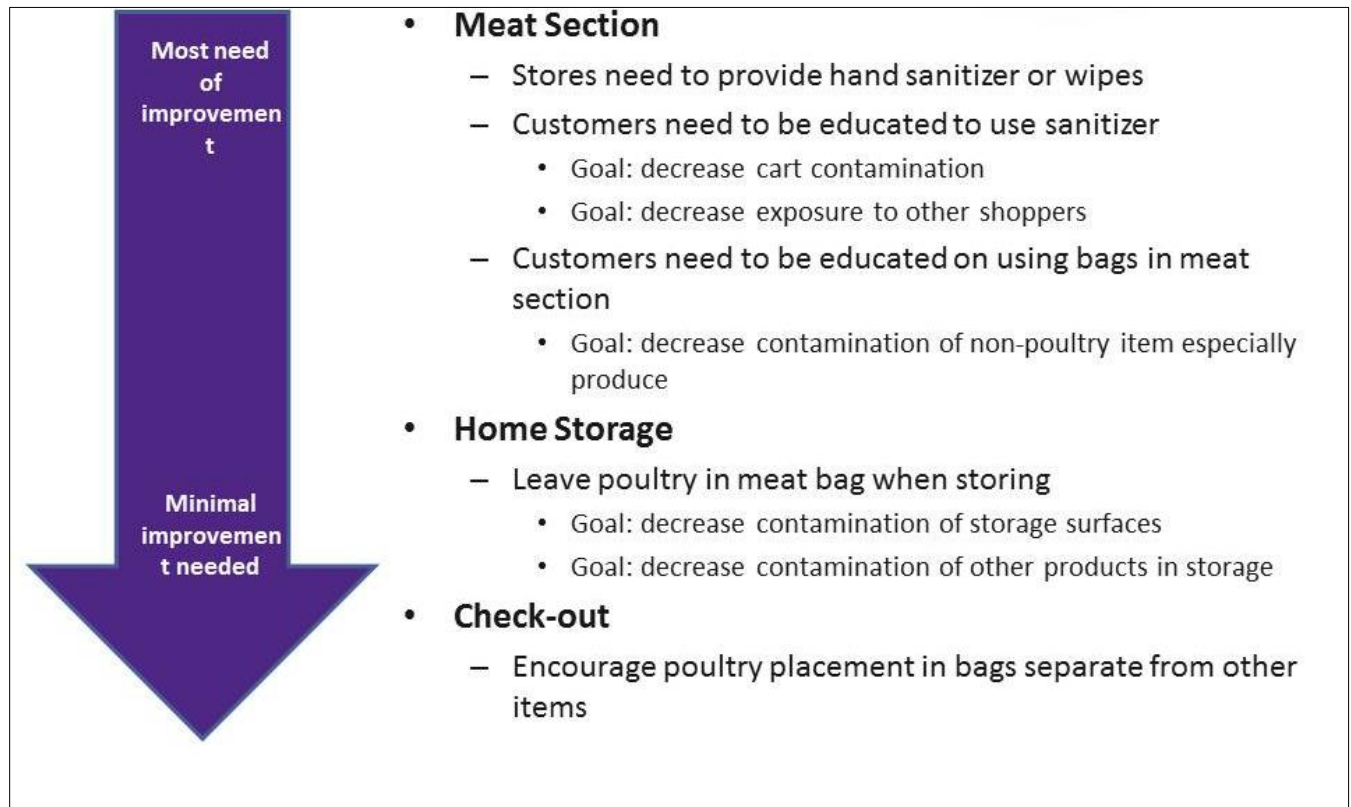
This made the counter a potential risk area for cross-contamination. Another prime area for potential contamination could be placing the poultry directly into the refrigerator or freezer. A majority of shoppers (59%) stored poultry either in the refrigerator or freezer in its original packaging without storing it in either another plastic bag or other container. Consequently, this action could allow cross-contamination with other items the poultry touched in the refrigerator or freezer. This is a concern because participants stored poultry in a way where it was in contact with a non-poultry item 20% of the time.

Education of shoppers is needed on at home storage methods of poultry products. Not only are shoppers not taking necessary precautions with their home storage of poultry products but they may be undoing the precautions that were taken at the store. A majority of shoppers left the store with poultry in its own bag (82%) however they took it out of this protective layer when placing the product in the refrigerator or freezer.

CONCLUSION

Overall, there needs to be an increase in food safety practices when handling poultry during purchasing, transport, and initial storage. The area that would potentially be the most beneficial to improve would be shopper behavior in the meat section of the store, with the goal of stopping poultry cross-contamination during the rest of the shopping trip. Increasing the use of protective bags in the meat section could go a long way in decreasing potential poultry contamination. The bags are available, but are not being used by consumers. Additional availability and use of hand sanitizers or wipes in the meat section would be helpful along with a concomitant push for their use to decrease the spread of potential bacteria or germs. Simply using the wipes available at the front of many stores to wipe down the cart handle at the beginning of the shopping trip would help to prevent cross contamination from prior shoppers. It appears that most checkout clerks are handling and separating poultry appropriately and these

practices need to continue. It also is important to increase the number of consumers who store their raw poultry in a plastic bag (e.g. the one from the meat section) or other container.



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References

1. Abbot, J. M., C. Byrd-Bredbenner, D. Schaffner, C. Bruhn, and L. Blalock. 2007. Comparison of food safety cognitions and self-reported food-handling behaviors with observed food safety behaviors of young adults. *Eur. J. Clin. Nutr.* 63:572-579.
2. Anderson, J. B., T. A. Shuster, K. E. Hansen, A. S. Levy, and A. Volk. 2004. A camera's view of consumer food-handling behaviors. *J. Am. Diet. Assoc.* 104:186-191.
3. Blackburn, C., and P. J. McClure (ed.). 2009. Foodborne pathogens: hazards, risk analysis and control, 2nd Ed. CRC Press, Boca Raton, FL.
4. Burgess, F., C. Little, G. Allen, K. Williamson, and R. Mitchell. 2005. Prevalence of Campylobacter, Salmonella, and Escherichia coli on the external packaging of raw meat. *J. Food Prot.* 68:469-475.
5. Byrd-Bredbenner, C., J. Maurer, V. Wheatley, E. Cottone, and M. Clancy. 2007. Observed food safety behaviours of young adults. *Br. Food J.* 109:519-530.
6. Centers for Disease Control and Prevention. 17 April 2014. CDC Estimates of Foodborne Illness in the United States. Available at: <http://www.cdc.gov/foodborneburden/estimates-overview.html>. Accessed 26 May 2015.
7. Cogan, T. A., S. F. Bloomfield, and T. J. Humphrey. 1999. The effectiveness of hygiene procedures for prevention of cross-contamination from chicken carcasses in the domestic kitchen. *Lett. Appl. Microbiol.* 29:354-358.
8. Gorman, R., S. Bloomfield, and C. C. Adley. 2002. A study of cross-contamination of food-borne pathogens in the domestic kitchen in the Republic of Ireland. *Int. J. Food Microbiol.* 76:143-150.
9. Gustafson, A., S. Hankins, and S. Jilcott. 2012. Measures of the Consumer Food Store Environment: A Systematic Review of the Evidence 2000-2011. *J. Community Health* 37:897-911.
10. Harrison, W., C. J. Griffith, D. Tennant, and A. Peters. 2001. Incidence of Campylobacter and Salmonella isolated from retail chicken and associated packaging in South Wales. *Lett. Appl. Microbiol.* 33:450-454.
11. Hoelzl, C., U. Mayerhofer, M. Steininger, W. Brüller, D. Hofstädter, and U. Aldrian. 2013. Observational trial of safe food handling behavior during food preparation using the example of Campylobacter spp. *J. Food Prot.* 76:482-489.

12. Hui, S. K., E. T. Bradlow, and P. S. Fader. 2009. Testing Behavioral Hypotheses Using an Integrated Model of Grocery Store Shopping Path and Purchase Behavior. *J. of Consumer Research* 36:478-493.
13. Humphrey, T. J., K. W. Martin, J. Slader, and K. Durham. 2001. Campylobacter spp. in the kitchen: spread and persistence. *J. Appl. Microbiol.* 90:115S-120S.
14. Jay, L. S., D. Comar, and L. D. Govenlock. 1999. A video study of Australian domestic food-handling practices. *J. Food Prot.* 62:1285-1296.
15. Lubber, P., S. Brynestad, D. Topsch, K. Scherer, and E. Bartelt. 2006. Quantification of Campylobacter species cross-contamination during handling of contaminated fresh chicken parts in kitchens. *Appl. Environ. Microbiol.* 72:66-70.
16. Mathews, K. 14 March 2014. Livestock, Meat , and Poultry Outlook. Available at: <http://www.ers.usda.gov/media/1332547/ldp237.pdf> . Accessed 26 May 2015.
17. Mattick, K., K. Durham, M. Hendrix, J. Slader, C. Griffith, M. Sen, and T. Humphrey. 2003. The microbiological quality of washing-up water and the environment in domestic and commercial kitchens. *J. Appl. Microbiol.* 94:842-848.
18. Moore, L. V., A. V. Diez Roux, J. A. Nettleton, and D. R. Jacobs Jr. 2008. Associations of the local food environment with diet quality--a comparison of assessments based on surveys and geographic information systems: the multi-ethnic study of atherosclerosis. *Am. J. Epidemiol.* 167:917-924.
19. Nachamkin, I., C. M. Szymanski, and M. J. Blaser. 2008. Campylobacter, 3rd ed. ASM Press, Washington D.C .
20. Rimkus, L., L. M. Powell, S. N. Zenk, E. Han, P. Ohri-Vachaspati, O. Pugach, D. C. Barker, E. A. Resnick, C. M. Quinn, J. Myllyluoma, and F. J. Chaloupka. 2013. Development and Reliability Testing of a Food Store Observation Form. *J. of Nutr Educ and Behav* 45:540-548.
21. Scallan, E., December 2010. New U.S. Foodborne Illness Estimates. Available at http://www2c.cdc.gov/podcasts/media/pdf/EID_01-11_FoodborneIllness.pdf. Accessed 26 May 2015.
22. Scallan, E., P. M. Griffin, F. J. Angulo, R. V. Tauxe, and R. M. Hoekstra. 2011. Foodborne illness acquired in the United States—unspecified agents. *Emerging infectious diseases* 17:16.

23. Scallan, E., R. M. Hoekstra, F. J. Angulo, R. V. Tauxe, M. Widdowson, S. L. Roy, J. L. Jones, and P. M. Griffin. 2011. Foodborne illness acquired in the United States—major pathogens. *Emerging infectious diseases* 17:7.
24. Todd, E. C., J. D. Greig, B. S. Michaels, C. A. Bartleson, D. Smith, and J. Holah. 2010. Outbreaks where food workers have been implicated in the spread of foodborne disease. *J. Food Prot.* 73:2306-2320.
25. Van Asselt, E., A. Fischer, A. E. De Jong, M. J. Nauta, and R. De Jonge. 2009. Cooking practices in the kitchen—Observed versus predicted behavior. *Risk analysis* 29:533-540.

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2. The terms set forth in the relevant Order Confirmation, and any terms set by the Rightsholder with respect to a particular Work, govern the terms of use of Works in connection with the

Service. By using the Service, the person transacting for a republication license on behalf of the User represents and warrants that he/she/it (a) has been duly authorized by the User to accept, and hereby does accept, all such terms and conditions on behalf of User, and (b) shall inform User of all such terms and conditions. In the event such person is a “freelancer” or other third party independent of User and CCC, such party shall be deemed jointly a “User” for purposes of these terms and conditions. In any event, User shall be deemed to have accepted and agreed to all such terms and conditions if User republishes the Work in any fashion.

3. Scope of License; Limitations and Obligations.

3.1 All Works and all rights therein, including copyright rights, remain the sole and exclusive property of the Rightsholder. The license created by the exchange of an Order Confirmation (and/or any invoice) and payment by User of the full amount set forth on that document includes only those rights expressly set forth in the Order Confirmation and in these terms and conditions, and conveys no other rights in the Work(s) to User. All rights not expressly granted are hereby reserved.

3.2 General Payment Terms: You may pay by credit card or through an account with us payable at the end of the month. If you and we agree that you may establish a standing account with CCC, then the following terms apply: Remit Payment to: Copyright Clearance Center, Dept 001, P.O. Box 843006, Boston, MA 02284-3006. Payments Due: Invoices are payable upon their delivery to you (or upon our notice to you that they are available to you for downloading). After 30 days, outstanding amounts will be subject to a service charge of 1-1/2% per month or, if less, the maximum rate allowed by applicable law. Unless otherwise specifically set forth in the Order Confirmation or in a separate written agreement signed by CCC, invoices are due and payable on “net 30” terms. While User may exercise the rights licensed immediately upon issuance of the Order Confirmation, the license is automatically revoked and is null and void, as if it had never been issued, if complete payment for the license is not received on a timely basis either from User directly or through a payment agent, such as a credit card company.

3.3 Unless otherwise provided in the Order Confirmation, any grant of rights to User (i) is “one-time” (including the editions and product family specified in the license), (ii) is non-exclusive and non-transferable and (iii) is subject to any and all limitations and restrictions (such as, but not limited to, limitations on duration of use or circulation) included in the Order Confirmation or invoice and/or in these terms and conditions. Upon completion of the licensed use, User shall either secure a new permission for further use of the Work(s) or immediately cease any new use of the Work(s) and shall render inaccessible (such as by deleting or by removing or severing links or other locators) any further copies of the Work (except for copies printed on paper in accordance with this license and still in User's stock at the end of such period).

3.4 In the event that the material for which a republication license is sought includes third party materials (such as photographs, illustrations, graphs, inserts and similar materials) which are identified in such material as having been used by permission, User is responsible for identifying, and seeking separate licenses (under this Service or otherwise) for, any of such third party materials; without a separate license, such third party materials may not be used.

3.5 Use of proper copyright notice for a Work is required as a condition of any license granted under the Service. Unless otherwise provided in the Order Confirmation, a proper copyright notice will read substantially as follows: “Republished with permission of [Rightsholder’s name], from [Work's title, author, volume, edition number and year of copyright]; permission conveyed through Copyright Clearance Center, Inc. ” Such notice must be provided in a reasonably legible font size and must be placed either immediately adjacent to the Work as used (for example, as part of a by-line or footnote but not as a separate electronic link) or in the place where substantially all other credits or notices for the new work containing the republished Work are located. Failure to include the required notice results in loss to the Rightsholder and CCC, and the User shall be liable to pay liquidated damages for each such failure equal to twice the use fee specified in the Order Confirmation, in addition to the use fee itself and any other fees and charges specified.

3.6 User may only make alterations to the Work if and as expressly set forth in the Order Confirmation. No Work may be used in any way that is defamatory, violates the rights of third parties (including such third parties' rights of copyright, privacy, publicity, or other tangible or intangible property), or is otherwise illegal, sexually explicit or obscene. In addition, User may not conjoin a Work with any other material that may result in damage to the reputation of the Rightsholder. User agrees to inform CCC if it becomes aware of any infringement of any rights in a Work and to cooperate with any reasonable request of CCC or the Rightsholder in connection therewith.

4. Indemnity. User hereby indemnifies and agrees to defend the Rightsholder and CCC, and their respective employees and directors, against all claims, liability, damages, costs and expenses, including legal fees and expenses, arising out of any use of a Work beyond the scope of the rights granted herein, or any use of a Work which has been altered in any unauthorized way by User, including claims of defamation or infringement of rights of copyright, publicity, privacy or other tangible or intangible property.

5. Limitation of Liability. UNDER NO CIRCUMSTANCES WILL CCC OR THE RIGHTSHOLDER BE LIABLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL OR INCIDENTAL DAMAGES (INCLUDING WITHOUT LIMITATION DAMAGES FOR LOSS OF BUSINESS PROFITS OR INFORMATION, OR FOR BUSINESS INTERRUPTION) ARISING OUT OF THE USE OR INABILITY TO USE A WORK, EVEN IF ONE OF THEM HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. In any event, the total liability of the Rightsholder and CCC (including their respective employees and directors) shall not exceed the total amount actually paid by User for this license. User assumes full liability for the actions and omissions of its principals, employees, agents, affiliates, successors and assigns.

6. Limited Warranties. THE WORK(S) AND RIGHT(S) ARE PROVIDED "AS IS". CCC HAS THE RIGHT TO GRANT TO USER THE RIGHTS GRANTED IN THE ORDER CONFIRMATION DOCUMENT. CCC AND THE RIGHTSHOLDER DISCLAIM ALL

OTHER WARRANTIES RELATING TO THE WORK(S) AND RIGHT(S), EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ADDITIONAL RIGHTS MAY BE REQUIRED TO USE ILLUSTRATIONS, GRAPHS, PHOTOGRAPHS, ABSTRACTS, INSERTS OR OTHER PORTIONS OF THE WORK (AS OPPOSED TO THE ENTIRE WORK) IN A MANNER CONTEMPLATED BY USER; USER UNDERSTANDS AND AGREES THAT NEITHER CCC NOR THE RIGHTSHOLDER MAY HAVE SUCH ADDITIONAL RIGHTS TO GRANT.

7. Effect of Breach. Any failure by User to pay any amount when due, or any use by User of a Work beyond the scope of the license set forth in the Order Confirmation and/or these terms and conditions, shall be a material breach of the license created by the Order Confirmation and these terms and conditions. Any breach not cured within 30 days of written notice thereof shall result in immediate termination of such license without further notice. Any unauthorized (but licensable) use of a Work that is terminated immediately upon notice thereof may be liquidated by payment of the Rightsholder's ordinary license price therefor; any unauthorized (and unlicensable) use that is not terminated immediately for any reason (including, for example, because materials containing the Work cannot reasonably be recalled) will be subject to all remedies available at law or in equity, but in no event to a payment of less than three times the Rightsholder's ordinary license price for the most closely analogous licensable use plus Rightsholder's and/or CCC's costs and expenses incurred in collecting such payment.

8. Miscellaneous.

8.1 User acknowledges that CCC may, from time to time, make changes or additions to the Service or to these terms and conditions, and CCC reserves the right to send notice to the User by electronic mail or otherwise for the purposes of notifying User of such changes or additions; provided that any such changes or additions shall not apply to permissions already secured and paid for.

8.2 Use of User-related information collected through the Service is governed by CCC's privacy policy, available online here: <http://www.copyright.com/content/cc3/en/tools/footer/privacypolicy.html>.

8.3 The licensing transaction described in the Order Confirmation is personal to User. Therefore, User may not assign or transfer to any other person (whether a natural person or an organization of any kind) the license created by the Order Confirmation and these terms and conditions or any rights granted hereunder; provided, however, that User may assign such license in its entirety on written notice to CCC in the event of a transfer of all or substantially all of User's rights in the new material which includes the Work(s) licensed under this Service.

8.4 No amendment or waiver of any terms is binding unless set forth in writing and signed by the parties. The Rightsholder and CCC hereby object to any terms contained in any writing prepared by the User or its principals, employees, agents or affiliates and purporting to govern or otherwise relate to the licensing transaction described in the Order Confirmation, which terms are in any way inconsistent with any terms set forth in the Order Confirmation and/or in these terms and conditions or CCC's standard operating procedures, whether such writing is prepared prior to, simultaneously with or subsequent to the Order Confirmation, and whether such writing appears on a copy of the Order Confirmation or in a separate instrument.

8.5 The licensing transaction described in the Order Confirmation document shall be governed by and construed under the law of the State of New York, USA, without regard to the principles thereof of conflicts of law. Any case, controversy, suit, action, or proceeding arising out of, in connection with, or related to such licensing transaction shall be brought, at CCC's sole discretion, in any federal or state court located in the County of New York, State of New York, USA, or in any federal or state court whose geographical jurisdiction covers the location of the Rightsholder set forth in the Order Confirmation. The parties expressly submit to the personal jurisdiction and venue of each such federal or state court. If you have any comments or questions about the Service or Copyright Clearance Center, please contact us at 978-750-8400 or send an e-mail to info@copyright.com

APPENDIX B- SCREENER AND CONSENT FORMS

Grocery Store Shop-Along Study Phone Screener/Scheduler

Hello, this is _____ from The Sensory Analysis Center. May I please speak to _____?

(Hello, this is _____ from [facility].) I am calling in regards to grocery store survey you filled out online. We are working on a USDA (U.S. Department of Agriculture) funded research study about grocery habits and at home storage of food. We are looking for participants who are willing to let two researchers observe them grocery shopping and then storing their food products at home.

If you participate in this study, you will receive **\$25** as a token of our appreciation. Are you still interested in participating?

1. How soon is your next shopping trip, within the next week, 2 weeks or longer?
2. Would you be able to tell me what items you would be buying during this trip? I am going to read you a list of items please let me know which ones you plan on buying on this grocery trip.

- Broccoli
- Fresh Bread
- Raw or Frozen Chicken
- Frozen Pizza
- Soup
- Raw or Frozen Turkey
- Pasta
- Tomatoes

If they will not be able to tell you what is on the list now I have offered

If chicken or turkey are a yes continue if not terminate.

3. Excellent, we would like you to participate in the next couple of weeks. What day of the week is most convenient for you?

Informed Consent Statement

Sensory Analysis Center

Kansas State University

Justin Hall 139

Manhattan, KS 66506

1. I, (print) _____, agree to participate as a panelist in research for the Sensory Analysis Center at Kansas State University.
2. I understand that the purpose of this research is to participate in an observational study of shopping habits and storage of food.
3. I understand that I will be participating in this research project for the duration of my shopping trip and the at home storage of my food.
4. For this test, I will receive \$25 when I complete the session.
5. I understand that my performance as an individual will be treated as research data and will in no way be associated with me for other than identification purposes, thereby assuring confidentiality of my performance and responses.
6. I understand that I do not have to participate in research, and that if I choose not to participate there will be no penalty.
7. I understand that I may withdraw from this research at any time.
8. If I have any questions concerning this study, I understand that I may contact Dr. Edgar Chambers IV, Justin 143D, Kansas State University, Manhattan, KS at 785-532-0156.
9. If I have questions about my rights as a consumer or about the manner in which this research was conducted, I may contact Rick Scheidt, Chair, Committee on Research Involving Human Subjects, at 203 Fairchild Hall (785-532-3224).

Signature

Date

Address

City

State

Zip