

Research

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RESEARCH Current Research A Camera's View of Consumer Food-Handling Behaviors JANET B. ANDERSON, MS, RD; THOMAS A. SHUSTER, PhD; KELEE E. HANSEN, MBA, RD; ALAN S. LEVY, PhD; ANTHONY VOLK ABSTRACT Objective To compare consumer food-handling behaviors with the Fight BAC! consumer food-safety recommendations. Design Subjects were videotaped in their home while preparing a meal. Videotapes were coded according to Fight BAC! recommendations. A food-safety survey was administered and temperature data was collected. Subjects/Setting A market research company randomly recruited subjects by telephone. Ninety-nine consumers participated (92 women, seven men). Statistical Analysis Performed Descriptive statistics were used. Results Overall, subjects did not follow the Fight BAC! recommendations for safe food handling. Handwashing was inadequate. The average hand wash length was significantly lower than the 20-second recommendation. Only one-third of subjects' hand wash attempts were with soap. Surface cleaning was inadequate with only one-third of surfaces thoroughly cleaned. Moreover, one-third of subjects did not attempt to clean surfaces during food preparation. Nearly all subjects cross-contaminated raw meat, poultry, seafood, eggs, and/or unwashed vegetables with ready-to-eat foods multiple times during food preparation. Unwashed hands were the most common cross-contamination agent. Many subjects undercooked the meat and poultry entrees. Very few subjects used a food thermometer. Applications/Conclusions Consumers make many food-handling errors during food preparation, increasing their risk of foodborne illness. Dietetics professionals need to familiarize themselves with the Fight BAC! consumer food-safety recommendations; understand where consumers

are making food-handling errors; increase food safety awareness; and educate consumers, especially those in high-risk populations, about safe food handling at home. *J Am Diet Assoc.* 2004; 104: 186-191. F J. B. Anderson is a clinical associate professor with Utah State University, Logan. T. A. Shuster is managing partner with Spectrum Consulting, North Logan, UT. K. E. Hansen is assistant director of the Safe Food Institute, North Logan, UT. A. S. Levy is chief of the Consumer Studies Branch, Center for Food Safety and Applied Nutrition, US Food and Drug Administration, College Park, MD. A. Volk is president of Volk Enterprises, Norcross, GA. Address correspondence to: Kelee E. Hansen, MBA, RD, 1770 N Research Pkwy, North Logan, UT 84341. E-mail: hansen@safefoodinstitute.org Copyright © 2004 by the American Dietetic Association. 0002-8223/04/10402-0005\$30.00/0 doi: 10.1016/j.jada.2003.11.010 186 Journal of THE AMERICAN DIETETIC ASSOCIATION

Foodborne diseases are estimated to cause approximately 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths in the United States each year (1). Research indicates that 25% of reported outbreaks are due to inappropriate consumer food-handling and preparation practices in the home (2). Mead et al (1) reported that surveillance of foodborne illness is complicated by several factors such as underreporting of incidence, mildness of some cases, and lack of complete knowledge about the pathology of foodborne illness. The Partnership for Food Safety Education's Fight BAC! campaign, created and endorsed by the US Departments of Agriculture, Education, and Health and Human Services, and 10 food industry organizations in 1997, was developed to reduce the incidence of foodborne illness in the home by educating Americans about safe food-handling

practices (3). The Fight BAC! campaign recommends consumers follow four steps: clean, separate, cook, and chill to keep food safe from harmful bacteria (3). © 2004 by the American Dietetic Association Fight BAC! recommendations, specific to each step, are available to educators, media groups, and consumers via their Web site (www.fightbac.org). To be most effective, consumer education programs about foodborne illness should be based on valid and reliable information about consumer food-handling and preparation behavior. Current knowledge of consumer food-handling and preparation behavior is surprisingly limited, especially in the United States (4, 5). Data from most previous studies are based on anecdotal evidence or self-reports (2, 5-7). Research methods that rely on self-reported data are flawed because there is often a substantial difference between what people say they do and what they actually do, people forget what they do, people tend to answer with what is considered appropriate, and people tend to say what they think the interviewer would like to hear (8). Because self-reports are essentially secondhand information and relevant behavior is not being observed directly by the researcher, the accuracy of the data may be questionable (8, 9). The purpose of this study was to develop a consumer kitchen observation and measurement system to compare observed consumer food-handling and preparation behaviors with the Fight BAC! consumer food-safety recommendations. Because of the seriousness and prevalence of foodborne illness and the need to evaluate and target educational efforts, a more rigorous and scientific method based on direct observation for collecting data on consumer food-handling and preparation behavior was needed. Direct observation methodology has two advantages

over self-report and anecdotal methods: observation captures actual behavior and behavior is captured in context (10). Redmond and Griffith (5) suggest, " Observational studies provide a more realistic indication of the food hygiene practices actually used in domestic food preparation. " Direct observation research yields valid and reliable information upon which to base educational efforts. MATERIALS AND METHODS Utah State University's Institutional Review Board for Human Participants reviewed and approved this research study. A convenience sample was used for subject selection because participation was voluntary and required videotaping of the subject in their home and recruitment was limited to a geographic area. Subjects were randomly recruited over the telephone with the help of a professional market research firm that specializes in recruitment of subjects for product testing. Subject selection required that the participant be the primary person responsible for food preparation in the household. Subjects were recruited under the pretense of market research for food preparation practices in an effort to eliminate bias for food safety research. Prospective subjects were asked if they would agree to be videotaped while preparing a single entree and salad in their home. Subjects were given the choice of preparing a beef, chicken, or fish entree. Subjects were also asked to complete a food-handling survey. As an incentive, subjects were offered the food for the meal and a \$50 payment. Ninety-nine subjects, residents of a county in the western United States that consists of a small urban area surrounded by rural communities, agreed to participate in the study. The subjects reflected the overall demographics of the area, which are predominately white and middle-class residents. The majority of subjects

were females (92 women; seven men); reflective of national data showing that women prepare 90% of meals (11). Consumer food-handling observational studies have shown that consumers are making food-handling errors in their homes and are doing so repeatedly, which increases their risk of foodborne illness. At the subject's home, a research assistant reviewed the informed consent, which included an overview of the study, risks and benefits of participation, confidentiality assurances, and contact information, and obtained a signed copy before each videotaping session. The video camera technician set up three small surveillance cameras around the kitchen in various positions that allowed videotaping of relevant food-preparation behavior. A research assistant provided the subject with the food, including precut meat, raw ingredients, and whole vegetables, and a recipe for their entree of choice and a salad. During the videotaping session, subjects were asked to prepare a multiple-ingredient salad (lettuce, carrots, cucumber, and tomato) with bottled dressing and a single entree (chicken breast, meatloaf, or halibut) from raw ingredients. The chicken breast and meatloaf recipes included raw egg. The halibut recipe included a citrus marinade. They were instructed to prepare the food and handle interruptions as normal. The video camera technician was instructed to capture the subject's hand movements on videotape by switching to and recording from various cameras throughout the meal preparation session. When the subject finished food preparation and cleanup, the video cameras were turned off. Then, a research assistant administered the food-handling survey while the video camera technician tested the subject's oven and refrigerator temperatures using a calibrated thermocouple. The food-handling survey

included questions about the observed food preparation session, perceptions about food safety and foodborne illness risk, internal cooking temperatures, handwashing, surface cleaning, and food storage. Upon completion of the survey, the research staff left the subject's home. Research assistants viewed each tape and tracked handwashing and failures to wash hands, surface cleaning, vegetable cleaning, cross-contamination, attempts to check doneness of the cooked entree, and food storage practices. Two research assistants viewed every 10th tape, and the data was compared to ensure inter-rater reliability. The tapes were coded to examine the relationship between consumer food preparation behaviors and the Fight BAC! recommendations. Because of constraints inherent in the methodology, information on all Fight BAC! recommendations could not be obtained. The videotapes were coded for some behaviors not included in the Fight BAC! campaign, but deemed important such as vegetable cleaning. The observation and survey data was analyzed using Journal of THE AMERICAN DIETETIC ASSOCIATION 187 Fight BAC! recommendations-Cleana Wash hands in hot soapy water before preparing food and after using the bathroom, changing diapers, and handling pets. For best results, consumers should use warm water to moisten their hands and then apply soap and rub their hands together for 20 seconds before rinsing thoroughly Wash cutting boards, knives, utensils, and counter tops in hot soapy water after preparing each food item and before going on to the next one Consider using paper towels to clean up kitchen surfaces. Or, if using cloth towels, consumers should wash them often in the hot cycle of the washing machine Direct observation and survey results Ninety-seven subjects attempted to wash

their hands at least one time. Forty-five subjects attempted to wash their hands before beginning food preparation, of which 38 used soap. The typical attempted hand wash averaged 4.4 seconds, without soap, and hands were dried on a cloth towel. Two subjects did not attempt to wash their hands while preparing food, and 32 subjects did not use soap when attempting to wash their hands. Of the 433 observed hand washes, 34% (n = 127) were with soap, and 3.5% (n = 15) were for the recommended length of 20 seconds or longer. Overall, 70 subjects attempted to clean the food preparation surfaces. Of the 228 cases in which raw meat directly contacted a surface, only 29% (n = 66) of the surfaces were rated as adequately cleaned after food preparation. Seventy-three subjects used cloth towels, 17 used paper towels, and 10 used sponges to clean kitchen surfaces.

Figure 1. Fight BAC! clean recommendations compared to observed behavior (N = 99). Because of methodological constraints, data related to all Fight BAC! recommendations could not be obtained. The Statistical Package for the Social Sciences (SPSS Inc, Chicago, IL) for descriptive statistics.

RESULTS The results presented are specific to the population studied and do not represent the entire population.

Fight BAC! Step 1: Clean Handwashing. The majority of handwashing attempts observed in the study did not meet Fight BAC! standards, as shown in Figure 1. For coding purposes, attempted handwashing was defined as placing hands under running water. Failure-to-wash-hands behavior was observed and recorded. A failure to wash hands was defined as a behavior that should have prompted subjects to wash their hands and their failure to do so. An average of seven failure-to-wash-hands behaviors were observed per subject per session. Of the 727 failure-

to-wash-hands observations, the most common (20.4%) failure-to-wash-hands behavior occurred when switching between raw meat, poultry, seafood, and/or egg and ready-to-eat food (salad). Other common failure-to-wash-hands behaviors were touching the face and body; touching unclean surfaces, such as a contaminated cloth towel or the garbage can; leaving the room to engage in unknown activities; and eating or smoking.

Surface Cleaning.

Surface cleaning, by subjects, was inadequate. To assess the adequacy of surface cleaning attempts, incidences were coded in which raw meat directly contacted a kitchen surface. Adequate cleaning was defined as using hot soapy water or another cleaning agent to thoroughly clean the surface. Figure 1 presents data on observed surface cleaning.

Vegetable Cleaning.

The Food Safety and Inspection Service of the United States Department of Agriculture recommends washing produce under cold running water to remove any dirt and reduce bacteria (12). The Food Safety and Inspection Service suggests consumers should scrub firm fruits and vegetables with a brush and trim any damaged or bruised areas where bacteria can thrive (12). Direct observation showed that subjects' vegetable washing was inadequate. All subjects prepared a salad with lettuce, carrots, tomato, and cucumber. Six subjects made no attempt to clean any of the vegetables that were used to prepare the salad. Seventy subjects rinsed the lettuce, 93 rinsed the tomato, 47 rinsed the carrots, and 55 rinsed the cucumber with water. The Table presents data on the amount of time spent cleaning the various vegetables.

Fight BAC! Step 2: Separate Cross-Contamination.

Nearly all subjects handled food in a manner that caused cross-contamination, either direct or indirect, from meat, poultry, seafood,

egg, and/or raw Table. Time spent cleaning various vegetables Vegetable
Average (sec) Standard deviation Range (sec) Lettuce Cilantro (only used in
the meatloaf entree) ´ Onion (only used in the meatloaf entree) ´ Tomato
Cucumber Carrot 12. 4 12 7. 5 5. 6 5. 5 4. 8 9. 0 9. 9 2. 3 5. 2 3. 8 3. 0 2-27
3-48 2-40 1-55 1-32 1-16 188 February 2004 Volume 104 Number 2 Fight
BAC! recommendations-Separate a Store raw meat, poultry, and seafood on
the bottom shelf of the refrigerator, so juices do not drip onto other foods
Always wash cutting boards, knives, and other utensils with hot soapy water
after they come in contact with raw meat, poultry, and seafood Never place
cooked food on a plate, which previously held raw meat, poultry, or seafood
Direct observation and survey results Sixty-three subjects stored raw meat,
poultry, or seafood on the middle or top shelf of the refrigerator, with 24
subjects storing the raw meat, poultry, or seafood on the bottom shelf of the
refrigerator Two subjects did not cross-contaminate from meat to ready-to-
eat food due to proper cleaning and sanitizing of hands and surfaces An
average of four cross-contamination incidents occurred from raw meat,
poultry, seafood, egg, and/or unwashed vegetables to ready-to-eat food(s)
per subject Of the 477 observed cross-contamination incidents, 84% (n 401)
were from raw meat, poultry, seafood, or egg to ready-to-eat food(s) and
16% (n 76) were from unwashed vegetables to ready-to-eat food(s); 94% (n
448) were indirect and 6% (n 29) were direct None of the subjects served the
entree on the same unwashed plate that held raw ´ meat, poultry, or seafood
Figure 2. Fight BAC! separate recommendations compared to observed
behavior (N 99). aBecause of methodological constraints, data related to all
Fight BAC! recommendations could not be obtained. vegetables to ready-to-

eat food, as shown in Figure 2. The most common indirect transfer agents leading to crosscontamination were hands (51%), counters (18%), and utensils (16%).

Fight BAC! Step 3: Cook Determining Doneness of the Entree. Many subjects did not follow the Fight BAC! cook recommendations.

Subjects' attempts to check doneness of the entree did not vary considerably by the type of entree (chicken breast, meatloaf, or halibut) they prepared. Ninety-four subjects attempted to check doneness of the meat entree using various methods, as shown in Figure 3. Six subjects used more than one method to determine doneness of the entree. Research assistants measured the internal temperature of the meat entree using a calibrated thermocouple. Many subjects undercooked or overcooked the meat entree without regard to the type of entree, as detailed in Figure 4.

Thermometers. Very few of the subjects (n 5) used a food thermometer to determine doneness of the meat, poultry, or seafood entree (Figure 3).

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

Figure 3. Methods used to determine doneness of meat, poultry, and seafood entrees (N 94). a food thermometer, 48% (n 14) reported being very confident in using a food thermometer correctly.

Internal Cooking Temperatures. Nearly one-half of the subjects reported not knowing the recommended internal cooking temperature for chicken (n 43) and ground beef (n 44). When asked the internal recommended internal cooking temperature for chicken, the mean response was 185°F with a range of responses from 140°F to 375°F.

Thirty-one subjects reported the correct temperature, or within 20°F above

the correct temperature, for chicken. When asked the internal recommended internal cooking temperature for ground beef, the mean response was 178°F with a range of responses from 70°F to 450°F. Thirty-four subjects reported the correct temperature, or within 20°F above the correct temperature, for ground beef. Oven Temperatures. Oven temperature data was measured at each subject's home. The majority (n 61) of ovens were hotter than 5°F of the set temperature. Twenty-one subjects had ovens that were cooler than 5°F below the oven temperature setting. Only 17 subjects' ovens were within 5°F of the oven temperature setting. Oven temperatures ranged from 95°F above the setting to 39°F below the setting. Thirteen subjects reported having checked the accuracy of their oven temperature gauge. Fight BAC! Step 4: Chill Chilling. Subjects' chilling and marinating practices did not follow the Fight BAC! recommendations, as reported in Figure 5. Subjects were asked what they would do with a large pot of leftover soup or stew. Fifty-seven subjects reported that they would put it in the refrigerator after cooling it to room temperature. Thirty-eight subjects reported they would put it in the refrigerator immediately. When asked about the type of container they would use to store the leftover pot of soup or stew, 35 subjects reported they would store it in a large, deep container with a cover. Thirty-three subjects reported they would store it in the original pot. And, 25 subjects reported they would store it in a small, shallow container with a cover. Thawing. Forty-five subjects reported thawing frozen meat, poultry, or seafood in the microwave, and 36 reported thawing meat, poultry, or seafood in the refrigerator. Refrigerator Temperatures. Refrigerator temperature data was measured at each subject's home. Twenty-nine of the

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recommendations-Cooka Use a meat thermometer, which measures the internal temperatures of cooked meat and poultry, to make sure that the meat is cooked all the way through Cook roasts and steaks to at least 145°F. Whole poultry should be cooked to 180°F for doneness. Poultry breasts should be cooked to 170°F for doneness. Cook ground meat, where bacteria can spread during grinding, to at least 160°F Direct observation and survey results Seventy-six subjects attempted to check doneness of the meat, poultry, or seafood entree by using a knife or another utensil to cut or poke the entree to evaluate ' ' changes in color and texture (Figure 3) Five subjects used a food thermometer to evaluate the doneness of the meat, poultry, or seafood entree ' Researchers questioned the knowledge and skill of those that used a food thermometer The internal temperatures of the chicken breast entree ranged between 132°F and ' 191°F The entree that was most frequently undercooked was the chicken breast, with 20 ' of 33 (61%) of subjects failing to meet the Fight BAC! temperature standards The internal temperatures of the meatloaf ranged from 129°F to 197°F Seventeen of 36 (46%) subjects undercooked the meatloaf entree according to ' Fight BAC! recommendations Figure 4. Fight BAC! cook recommendations compared to observed behavior (N 99). aBecause of methodological constraints, data related to all Fight BAC! recommendations could not be obtained. subject's refrigerators had an air temperature greater than 40°F, and seven were greater than 45°F. Measured refrigerator air temperatures ranged from 28°F to 52°F. Subjects reported that the refrigerator should be set at 38°F (average response) with a range of responses from 0°F to 55°F.

Thirty subjects reported not knowing the appropriate temperature setting for the refrigerator, with 12 reporting recommended temperatures greater than 40°F. Seventeen subjects reported having checked the temperature of their refrigerator. DISCUSSION The consumer food-handling observation findings from this study are consistent with other published data in this area of study. However, research in this area is very limited. A thorough comparison of 15 observational studies in the United States, United Kingdom, and Australia of consumer food-safety practices indicates that a significant number of consumers use unsafe food-handling practices in their home (13). Jay et al (14) conducted a study in Melbourne, Australia, in which consumer kitchens were continuously videotaped for one to two weeks. The Australian study reported " infrequent hand washing, poor hand-washing technique, lack of hand washing prior to food preparation, inadequate cleaning of kitchen surfaces, involvement of pets in the kitchen, touching of the face, mouth, nose, and/or hair during food preparation, and lack of separate hand and dish towels were the most Fight BAC! recommendations-Chilla Never defrost (or marinate) food on the kitchen counter. Use the refrigerator, cold running water, or the microwave Divide large amounts of leftovers into small, shallow containers for quick cooling in the refrigerator Do not pack the refrigerator. Cool air must circulate to keep food safe common unhygienic practices observed" (14). At the Second National Sanitation Foundation International Conference on Food Safety in 2000, Redmond, Griffith, and Peters presented results of a study that used an observational approach to examine repeatability and reproducibility of consumers' food safety practices (unpublished data). The study, conducted

in the United Kingdom, concluded that consumer food-handling behaviors, including errors, were consistent with repeated preparation of the same meal as well as reproducible when the same consumer prepared different types of meals (unpublished data). Therefore, consumer food-handling observational studies have shown that consumers are making foodhandling errors in their homes and are doing so repeatedly, which increases their risk of foodborne illness. The Fight BAC! recommendations are based on proven principles. For example, Fight BAC! recommends consumers should use warm water to moisten their hands and then apply soap and rub their hands together for 20 seconds before rinsing thoroughly. Cogan et al (15) reports that participants who washed their hands and thoroughly rinsed under running water after handling Salmonella-containing chicken reduced the occurrence of Salmonella contamination from 40% to 16.7%. Unfortunately, survey data indicate that consumers are vaguely aware of the Fight BAC! recommendations, and observation indicates that consumers are not following the recommendations for safe food handling that have been es-

Direct observation and survey results Twenty-three of the 30 (77%) subjects that prepared the halibut entree, marinated the halibut on the kitchen counter Twenty of the 36 (56%) of the subjects that prepared the meatloaf entree stored the leftovers in a separate container Sixteen of the 36 (44%) of the subjects that prepared the meatloaf entree stored the leftovers in the original cooking container with foil or plastic covering. The leftover meatloaf entree was approximately 1 to 2 to 3 lb, and none of the subjects cut the leftovers into smaller pieces From video observation, 50 refrigerators were visible, and 49 were not. Of the refrigerators that were

visible, 31 were rated as overcrowded by the coders Figure 5. Fight BAC! chill recommendations compared to observed behavior (N 99). aBecause of methodological constraints, data related to all Fight BAC! recommendations could not be obtained. 190 February 2004 Volume 104 Number 2 tablished by The Partnership for Food Safety Education. Survey data shows consumers do know more about food safety than their behavior demonstrates.

Consumer food safety knowledge and attitude survey data collected during this study does not correspond with observed behavior, which is similar to other food safety studies' findings that self-reported practices do not correspond to observed behaviors (5). It is unknown why consumers are not following recommendations and practicing risky behaviors. According to data presented by Redmond, Griffith, and Peters at the Second National Sanitation Foundation International Conference on Food Safety in 2000, food preparation is habitual, and consumers appear be somewhat unaware of their own actions in their own kitchens (unpublished data). Findings from Medeiros et al (16) suggest improving awareness is a major step in improving food handling behavior in the home. The data from this study are instructive, but are not representative of the entire population. The relative risk of the consumer food-handling errors is unknown. Risk assessment is necessary to identify the most critical messages that educators need to share with consumers. Dietitians can raise awareness and educate consumers about risky food-handling behaviors among specific client/patient populations in terms of living arrangements, types of food prepared and consumed, food preparation techniques, and risk factors related to health status. CONCLUSIONS â— â— â— Dietetics

professionals need to familiarize themselves with the Fight BAC! consumer food safety recommendations; understand areas where consumers are making food-handling errors; and raise awareness and educate consumers, especially those in high-risk populations, about safe food handling. Consumer education can raise awareness by addressing how pathogens cause foodborne illness, the seriousness of foodborne illness, and what to do to prevent and control foodborne illness. When educating consumers about food safety, stick to the basics and use quick sound-bite bits of information to ensure they retain key food safety principles (4). For instance, a dietitian can select one of the Fight BAC! steps to emphasize per client/patient visit or educational class. Food safety messages can be incorporated into the following but are not limited to: outpatient visits, consults, cooking demonstrations, educational materials, seminars, recipes, and public service announcements. Dietitians working with high-risk populations especially need to educate their clients/patients about the seriousness of foodborne illness, their increased risk, and outline the Fight BAC! practical recommendations they can implement in their homes to prevent foodborne illness. References 1. Mead PS, Slutsker L, Dietz V, McCraig LF, Bresee JS, Shapiro C, Griffin PM, Tauxe RV. Food-related illness and death in the United States. *Emerg Infect Dis.* 1999; 5: 607-625. 2. Williamson DM, Gravani RB, Lawless HT. Correlating food safety knowledge with home food-preparation practices. *Food Technol.* 1992; 46: 94-100. 3. Partnership for Food Safety Education. Four steps to Fight BAC! Available at: <http://www.fightbac.org>. Accessed June 11, 2001. 4. Peregrin T. Teaching food-handling safety: stick to the basics. *J Am Diet Assoc.* 2001; 101: 1339. 5.

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