

Food Worker Hand Washing Practices: An Observation Study

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ABSTRACT

Improvement of food worker hand washing practices is critical to the reduction of foodborne illness and is dependent upon a clear understanding of current hand washing practices. To that end, this study collected detailed observational data on food worker hand washing practices. Food workers ($n = 321$) were observed preparing food, and data were recorded on specific work activities for which hand washing is recommended (e.g., food preparation, handling dirty equipment). Data were also recorded on hand washing behaviors that occurred in conjunction with these work activities. Results indicated that workers engaged in approximately 8.6 work activities per hour for which hand washing is recommended. However, workers made hand washing attempts (i.e., removed gloves, if worn, and placed hands in running water) in only 32% of these activities and washed their hands appropriately (i.e., removed gloves, if worn, placed hands in running water, used soap, and dried hands) in only 27% of these work activities. Attempted and appropriate hand washing rates varied by work activity—they were significantly higher in conjunction with food preparation than other work activities (46 versus $\leq 37\%$ for attempted hand washing; 41 versus $\leq 30\%$ for appropriate hand washing) and were significantly lower in conjunction with touching the body than other work activities (13 versus $\geq 27\%$ for attempted hand washing; 10 versus $\geq 23\%$ for appropriate hand washing). Attempted and appropriate hand washing rates were significantly lower when gloves were worn (18 and 16%) than when gloves were not worn (37 and 30%). These findings suggest that the hand washing practices of food workers need to be improved, glove use may reduce hand washing, and restaurants should consider reorganizing their food preparation activities to reduce the frequency with which hand washing is needed.

Food workers can spread foodborne illness in the food service environment through hand contact with pathogens from their gastrointestinal tracts or objects or food contaminated with pathogens and subsequent passage of pathogens to food (19). Thus, worker hand contact with foods represents a potentially important mechanism by which pathogens may enter the food supply (10). Indeed, the review by Guzewich and Ross (10) of 81 foodborne illness outbreaks attributed to food contaminated by food workers found that 89% of these outbreaks involved the transmission of pathogens to food by workers' hands.

In response to evidence that a substantial proportion of foodborne illness outbreaks are caused by food contaminated by food workers, the U.S. Food and Drug Administration (FDA) included guidelines on methods to prevent food contamination from food workers' hands in the FDA Food Code for retail establishments (10, 22). These methods include hand washing and the prevention or minimization of bare hand contact with food. Proper hand washing can significantly reduce the transmission of pathogens from hands to food and other objects (10, 14, 16). The Food

Code provides a list of situations in which hands should be washed, such as before food preparation and after handling dirty equipment. The Food Code also indicates that hand washing should take at least 20 s and include running warm water, soap, friction between hands for 10 to 15 s, rinsing, and drying with clean towels or hot air.

As hand washing does not remove all pathogens from hands (2, 5, 6, 10, 16), the Food Code also specifies that bare hand contact should be prevented when working with ready-to-eat food (RTE; i.e., foods that are safe to eat without further cooking) and minimized when working with non-RTE food by the use of barriers such as disposable gloves, deli tissue, and utensils. Anecdotal evidence suggests that food service establishments most commonly use disposable gloves as barriers between bare hands and food. Proper glove use can be effective in decreasing the transfer of pathogens from hands to food (14, 15). However, some food safety researchers and practitioners believe that glove use can promote poor hand washing practices (7, 12). For example, research suggests that some workers believe that glove use negates the need for hand washing (9).

Because the transmission of pathogens from food worker hands to food is a significant contributor to foodborne illness outbreaks, improvement of food worker hand

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washing practices is critical. Such improvement is dependent upon a clear understanding of current hand washing practices. This understanding can be obtained through descriptive studies. People tend to overreport the frequency with which they engage in socially desirable behaviors, such as safe food preparation practices; thus, it has been argued that observations, as opposed to self-reports, provide the best descriptive data concerning the food preparation practices of food workers (3). Most observational studies on food worker practices report whether a specific food preparation practice or regulation violation was observed in food service establishments (1, 13, 18, 23). For example, the FDA reported that improper hand washing by employees was observed in 73% of full-service establishments (23). Although such studies are informative, they typically provide data only on whether specific practices occur in establishments; they do not provide detailed data on how often or in what situations these practices occur. A study by Clayton and Griffith (3) provides these additional data. They found that, on average, food workers washed their hands adequately in 9% of those instances in which they touched their face or hair and in 25% of those instances in which they touched potentially contaminated objects (3). Studies such as this provide the detailed descriptive data needed to understand food workers' hand washing practices, yet few such studies have been undertaken.

The present study was designed to collect detailed observational data on food worker hand washing practices. Given concerns about glove use and the promotion of poor hand washing practices, this study also examined the relationship between glove use and hand washing.

MATERIALS AND METHODS

Restaurants. This study was conducted by the Environmental Health Specialists Network (EHS-Net), a network of environmental health specialists focused on the investigation of contributing factors to foodborne illness, including food preparation practices and hand washing practices. EHS-Net is a collaborative project of the Centers for Disease Control and Prevention (CDC), the FDA, the U.S. Department of Agriculture, and nine states (California, Connecticut, New York, Georgia, Iowa, Minnesota, Oregon, Rhode Island, and Tennessee; Colorado also participated until 2005).

The sample was composed of randomly selected restaurants located in the catchment areas of six EHS-Net states (Colorado, Connecticut, Georgia, Minnesota, Oregon, and Tennessee). The catchment areas were determined by convenience and were composed of from 2 to 20 local public health jurisdictions (e.g., county and city health departments). In Connecticut, these jurisdictions included New London and Tolland counties. In Colorado, these jurisdictions included Boulder, Broomfield, Denver, and Jefferson counties and the Tri-County area (Adams, Arapahoe, and Douglas counties). In Georgia, these jurisdictions included Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Fulton, Forsyth, Henry, Gwinnett, Newton, Paulding, Pickens, Spalding, Rockdale, and Walton counties. In Minnesota, these jurisdictions included Blue Earth, Carver, Dakota, McLeod, Olmsted, Scott, Stearns, and Steele counties and the cities of St. Cloud and St. Paul. In Oregon, these jurisdictions included Columbia, Hood River, Josephine, Lane, Linn, Lincoln, and Yamhill counties, and in Tennessee, these jurisdictions included Davidson

County and the city of Nashville. While there is variability among these jurisdictions in the extent of their adoption of the Food Code, all had hand washing guidelines similar to the FDA's, and none had regulations concerning bare hand contact prevention.

Only restaurants, defined as establishments that prepare and serve food or beverages to customers but that are not institutions, food carts, mobile food units, temporary food stands, supermarkets, restaurants in supermarkets, or caterers, were eligible for participation in the study. Only one restaurant from regional or national chains was included per catchment area.

Data collection. In each restaurant, data collectors conducted a standardized interview with a manager, owner, or other employee about restaurant characteristics; visually surveyed the kitchen and collected information about the physical environment; and conducted a 55- to 60-min observation of a worker who was preparing food. Workers who were engaged in food preparation and who could be observed relatively unobtrusively were chosen for observation. To limit the observers' influence on food workers, observed workers were not made aware of precisely which aspects of their behavior were being recorded. The observation method used was derived from the notational analysis observation method developed by Clayton and Griffith (3). No data were collected during the first 10 to 15 min of this observation to give workers time to adjust to their observer. During the remaining 45 to 50 min of the observation, data collectors recorded data on specific work activities for which hand washing is recommended and the hand washing behaviors associated with those work activities. The work activity types were derived from the 2001 Food Code (22) and are described in Table 1. For the activities of preparing food and putting on gloves for food preparation, hand washing should occur before the activities; for all other activities (preparing raw animal products; eating, drinking, or using tobacco; coughing, sneezing, or using tissue; handling dirty equipment; and touching human body parts other than clean hands or arms), hand washing should occur after the activity and before beginning another task. (Data were also collected on the activity of preparing raw produce; however, because of inconsistencies in the way specialists defined raw produce, these data were excluded from analysis.)

Data collectors also collected data on hand washing behaviors that occurred in conjunction with (either before or after the activity, depending on the activity) each of the observed work activities. They recorded whether workers placed their hands under running water, whether they used soap and dried their hands, how they dried their hands (e.g., paper towel, cloth towel, clothes), and whether gloves were worn and removed at the point at which hand washing should occur. Data were also recorded on whether hand sanitizer was used; those data are not reported here. Given the difficulties associated with observing workers' hand washing activities after use of the toilet room, data were not collected on these activities. Additionally, given concerns about the amount and type of data that data collectors could effectively observe and record, data were not collected on the length of time hands were placed under running water, the temperature of the water, or whether workers created friction between their hands during hand washing.

Before data collection, the study protocol was reviewed and approved by the CDC's Institutional Review Board and the appropriate institutional review boards in the six participating states. Additionally, all data collectors participated in training designed to promote coding consistency. They watched a videotape showing vignettes of food workers engaging in specific work and hand washing activities and then coded the activities by the study's coding scheme. The videotape also described how the activities

TABLE 1. *Work activities for which observational data were collected*

Work activity	Description	When hand washing should occur
Food preparation	Engaging in food preparation, including working with exposed food, cleaning equipment and utensils, and unwrapping single-use articles	Before the activity
Putting on gloves for food preparation	Putting on gloves to engage in food preparation (see above)	Before the activity
Preparing raw animal products	Preparing raw animal products (animal products that have not been cooked or processed, such as uncooked eggs, meat, poultry, and fish)	After the activity and before beginning another activity
Eating, drinking, using tobacco	Eating, drinking, or using tobacco (drinking is acceptable from a closed beverage container if the container is handled to prevent contamination of hands)	After the activity and before beginning another activity
Coughing, sneezing, using tissue	Coughing, sneezing, or using a handkerchief or disposable tissues	After the activity and before beginning another activity
Handling dirty equipment	Handling dirty equipment, utensils, or cloths	After the activity and before beginning another activity
Touching body	Touching human body parts other than clean hands and clean, exposed arms	After the activity and before beginning another activity

should be coded so that the data collectors could ensure their coding was accurate. Subsequent tests of coding consistency of 12 hand washing behaviors described in four written scenarios indicated that the data collectors' coding agreement was 100% for eight behaviors, 88% for three behaviors, and 50% for one behavior.

Data analysis. Data analysis focused on the proportion of all work activities in which hand washing occurred. For the purposes of this study, we focused on two hand washing measures: (i) attempted hand washing, defined as removing gloves, if worn, and placing hands under running water; and (ii) appropriate hand washing, defined as removing gloves, if worn, placing hands under running water, using soap, and drying hands with paper or cloth towels. (Hot air was also considered an acceptable drying method; however, this method was not observed.) We also conducted *t* tests to determine if there were any differences in hand washing practices by work activity type and glove use. Because the workers engaged in multiple work activities over the obser-

vation period, the work activities in which each worker engaged were treated as repeated measures. Analyses were conducted with the SUDAAN software package (RTI International, Research Triangle Park, N.C.) to account for the repeated-measures aspect of these data. Because of the low frequency of their occurrence, the categories of eating, drinking, or using tobacco and coughing, sneezing, or using tissue were combined into one category called eating/coughing for all analyses.

RESULTS

Restaurant demographics. Of the 1,073 establishments we contacted, 808 were eligible to participate (i.e., met our definition of a restaurant, were open for business, and did not belong to a chain that already had a participating restaurant). Of these, 333 agreed to participate, yielding a response rate of 41%. Because of missing observation data, data are reported on 321 restaurants. A total of 196 (61%) of these restaurants were independently owned, and 121 (38%) were chains or franchises. Ownership information was not obtained for four (1%) restaurants. The restaurants in the sample served a median of 150 meals per day (25% quartile = 75; 75% quartile = 322).

Work activities. The median observation length per worker was 48 min (25% quartile = 45; 75% quartile = 48). Observed workers engaged in 2,195 work activities for which hand washing is recommended. The median number of work activities observed per hour per worker was 8.6 (25% quartile = 5; 75% quartile = 12.3).

Hand washing behaviors. In 532 (24%) of the 2,195 work activities that needed hand washing, workers were wearing gloves at the point at which hand washing should occur. Thus, any hand washing attempt would require that these workers first remove their gloves. Gloves were removed at the point hand washing should occur in 192 (36%) of 532 activities in which they were worn.

Workers removed their gloves, if worn, and placed their hands under running water (i.e., attempted hand washing) in 32% of work activities (Table 2). Along with re-

TABLE 2. *Number and percentage of work activities for which hand washing behaviors occurred (N = 2,195)*

Hand washing behavior	<i>n</i>	%
Removed gloves, if worn, and placed hands under running water (i.e., attempted hand washing)	707	32
Removed gloves, if worn, placed hands under running water, and used soap	612	28
Removed gloves, if worn, placed hands under running water, and dried hands with paper or cloth towels	691	31
Removed gloves, if worn, placed hands under running water, and dried hands on clothes	7	<1
Removed gloves, if worn, placed hands under running water, and did not dry hands	37	2
Removed gloves, if worn, placed hands under running water, used soap, and dried hands on paper or cloth towels (i.e., appropriate hand washing)	588	27

moving gloves and placing their hands under running water, workers used soap in 28% of work activities; dried their hands with paper or cloth towels in 31% of work activities; dried their hands on their clothes in less than 1% of work activities; and did not dry their hands at all in 2% of work activities. Workers removed their gloves, if worn, placed their hands under running water, used soap, and dried their hands with paper or cloth towels (i.e., appropriate hand washing) in 27% of work activities.

Attempted hand washing. Attempted hand washing varied by work activity. Specifically, attempted hand washing proportions were significantly larger before food preparation than in conjunction with any other activity; significantly larger before putting on gloves for food preparation than after handling dirty equipment; and significantly smaller after touching the body than in conjunction with any other activity (Table 3).

Attempted hand washing also varied by glove use—attempted hand washing proportions were significantly larger in work activities in which gloves were not worn at the point hand washing should occur (i.e., nonglove work activities) than in work activities in which gloves were worn at the point hand washing should occur (i.e., glove work activities), $P \leq 0.01$. This pattern of significant differences in attempted hand washing by glove use was also found for the individual work activity types of food preparation, handling dirty equipment, and preparing raw animal products, $P \leq 0.01$.

In nonglove work activities, attempted hand washing proportions were significantly larger before food preparation than in conjunction with any other activity; significantly larger before putting on gloves for food preparation than after handling dirty equipment; and significantly smaller after touching the body than in conjunction with any other activity (Table 3). In glove work activities, attempted hand washing proportions were significantly larger before food preparation and putting on gloves for food preparation than after handling dirty equipment and touching the body and after preparing raw animal products than after touching the body.

Appropriate hand washing. Appropriate hand washing varied by work activity. Specifically, appropriate hand washing proportions were significantly larger before food preparation than in conjunction with any other activity; significantly larger before putting on gloves for food preparation than after handling dirty equipment; and significantly smaller after touching the body than in conjunction with any other activity (Table 4).

Appropriate hand washing also varied by glove use—appropriate hand washing proportions were significantly larger in nonglove work activities than in glove work activities, $P \leq 0.01$. This pattern of significant differences in appropriate hand washing by glove use was also found for all individual work activity types, except for eating/coughing, $P \leq 0.01$.

In nonglove work activities, appropriate hand washing proportions were significantly larger before food preparation than in conjunction with any other activity and signif-

TABLE 3. Number and percentage of nonglove work activities, glove work activities, and all work activities in which hand washing was attempted

Work activity	Nonglove work activities ^a			Glove work activities ^b			All work activities		
	N	n	% ^c	N	n	%	N	n	%
Food preparation ^d	410	209	51 A	104	28	27 A	514	237	46 A
Putting on gloves ^d	129	56	43 B	95	26	27 A	224	82	37 B
Preparing raw animal products	280	102	36 BC	104	19	18 AB	384	121	32 BC
Eating/coughing	84	26	31 BC	6	1	17 ABC	90	27	30 BC
Handling dirty equipment	620	194	31 C	166	21	13 BC	786	215	27 C
Touching body	140	22	16 D	57	3	5 C	197	25	13 D
All activities	1,663	609	37	532	98	18	2,195	707	32

^a Work activities in which gloves were not worn at hand washing point.

^b Work activities in which gloves were worn at hand washing point.

^c In these columns, percentages with different letters within the column are significantly different, $P \leq 0.01$.

^d For these activities, figures refer to hand washing before the activity; for all other activities, figures refer to hand washing after the activity.

TABLE 4. Number and percentage of nonglove work activities, glove work activities, and all work activities in which appropriate hand washing occurred

Work activity	Nonglove work activities ^a			Glove work activities ^b			All work activities		
	N	n	% ^c	N	n	%	N	n	%
Food preparation ^d	410	185	45 A	104	24	23 AC	514	209	41 A
Putting on gloves ^d	129	43	33 B	95	24	25 AB	224	67	30 B
Preparing raw animal product	280	75	27 B	104	14	13 CD	384	89	23 BC
Eating/coughing	84	22	26 B	6	1	17 BCDE	90	23	26 BC
Handling dirty equipment	620	162	26 B	166	19	11 DE	786	181	23 C
Touching body	140	17	12 C	57	2	4 E	197	19	10 D
All activities	1,663	504	30	532	84	16	2,195	588	27

^a Work activities in which gloves were not worn at hand washing point.

^b Work activities in which gloves were worn at hand washing point.

^c In these columns, percentages with different letters within the column are significantly different, $P \leq 0.01$.

^d For these activities, figures refer to hand washing before the activity; for all other activities, figures refer to hand washing after the activity.

icantly smaller after touching the body than in conjunction with any other activity (Table 4). In glove work activities, appropriate hand washing proportions were significantly larger before food preparation and putting on gloves for food preparation than after handling dirty equipment and touching the body; significantly larger before putting on gloves for food preparation than after preparing raw animal products; and significantly larger after preparing raw animal products than after touching the body.

DISCUSSION

Rates of food worker hand washing were relatively low in this study, suggesting that workers either do not know when to wash their hands or sometimes choose not to wash their hands. However, appropriate hand washing rates were only five percentage points lower than attempted hand washing rates (27 versus 32%), indicating that when workers do attempt to wash their hands, they usually use running water and soap and dry their hands with cloth or paper towels. Additionally, workers dried their hands in 31% of activities but used soap in only 28% of activities, indicating that when workers omit a component of hand washing, it is usually soap.

Attempted and appropriate hand washing rates were significantly higher before food preparation than in conjunction with other work activities. These results are not surprising—washing hands before preparing food is likely one of the best known guidelines concerning hand washing. These results are also positive in that they indicate that at least some workers may be aware that food needs to be protected from contamination from hands.

Attempted and appropriate hand washing rates tended to be significantly lower after touching body parts than in conjunction with other activities. Workers may not consider it feasible to stop their work to wash their hands after they have touched themselves or may not even realize when they have touched themselves. Risk of hand contamination with pathogens is likely to vary by body part; for example, it may be less risky to touch the neck than to touch the nose or mouth. We did not collect data on specific body parts touched; additional studies on this topic would be useful.

The activities included in the eating/coughing work activity category (eating, drinking, using tobacco, coughing, sneezing, and using a tissue) are likely to involve hand-to-mouth contact and could potentially entail a relatively high risk of hand contamination with pathogens. It is discouraging that workers washed their hands only about one third of the time after eating/coughing. Yet, it is encouraging that hand washing rates were significantly higher after eating/coughing than after touching the body, as this finding suggests that workers see a distinction between touching their mouths and other potentially less risky body parts.

Perhaps one of the more disturbing findings is that hands were washed appropriately after only 23% of activities in which raw animal products were prepared. This activity is arguably one of the riskiest food preparation practices; depending on the activities in which workers engage after preparing raw animal products, those who do not wash

their hands could contaminate work surfaces, equipment, or RTE food with pathogens found in raw animal products.

The pattern of findings concerning hand washing and glove use indicated that (i) workers who were wearing gloves at the point hand washing should occur were less likely to wash their hands than workers who were not wearing gloves at that point and (ii) workers who were going to be wearing gloves during their work activities were less likely to wash their hands before those activities than workers who were not going to be wearing gloves during their work activities. These findings support the contention that glove use may reduce hand washing. However, this study does not allow us to make causal inferences about the relationship between glove use and hand washing—we cannot determine if wearing gloves caused workers to wash their hands less frequently or if there is some other explanation for this relationship. More research is needed to determine the causal nature of this relationship.

Risk of contamination associated with lack of hand washing likely varies by work activity. For example, failing to wash hands after preparing raw animal products is likely to be riskier than failing to wash hands after touching the body. Additionally, risk varies according to the sequence of work activities. For example, failure to wash hands after preparing raw animal products is likely to be riskier if the worker's next activity is preparing RTE foods than if the worker's next activity is handling dirty equipment. This study did not assess work activity sequence; additional studies in this area are needed to further understand food worker hand washing practices.

The findings reported here indicate that the hand washing practices of food workers need to improve. Understanding current practices is an important step in developing successful improvement programs, and this study contributes to that effort. However, researchers and health practitioners have noted that efforts to successfully change food safety behavior must be multidimensional and address the range of personal, social, and environmental factors that influence behavior (4, 8, 20, 21). More study is needed to determine the range of factors that affect hand washing behavior and the intervention strategies that could most effectively improve this behavior.

Limitations of this study include the following: the relatively low response rate, which may have resulted in an overrepresentation of better and safer restaurants in the sample; the lack of data collection on several aspects of hand washing that have been shown to affect hand washing effectiveness or are considered important by the FDA (e.g., water temperature, hand washing length, whether workers created friction between their hands and used a nail brush) (10, 14, 16, 22); and the fact that the observed workers' behavior may have been affected by the observation. However, it is unlikely that these conditions would have caused worker hand washing practices to appear less prevalent than they are in reality; indeed, it is more likely that these conditions caused hand washing practices to appear more prevalent than they are in reality.

Workers in this study engaged in approximately 8.6 activities per hour for which hand washing should have

occurred. Workers in the study by Clayton and Griffith (3) engaged in approximately 17 such activities per hour. This higher rate is likely explained by the fact that Clayton and Griffith did not limit their observations to specific activities as we did and instead examined every food worker action. Additionally, because they videotaped food workers, Clayton and Griffith were probably more effective at recording all worker actions. Assuming 20-s hand washings, a rate of 8.6 hand washings per hour represents almost 3 min of hand washing per hour, and a rate of 17 hand washings per hour represents 6 min of hand washing per hour. These time estimates are likely to be conservative because they do not take into account the time workers need to get to and from hand sinks. Given the time pressure inherent in the food service industry and that food workers have identified time pressure as a significant barrier to hand washing (4, 9, 11), devoting this much time to hand washing may seem unfeasible to food workers and managers. Clayton and Griffith (3) suggested that restaurants would benefit from evaluating their food preparation activities to determine if they could be reorganized to decrease the number of activities that require hand washing. This reduction in needed hand washings should decrease the time pressure for food workers and increase the likelihood that they will engage in the remaining needed hand washings. Environmental health specialists responsible for restaurant food safety could assist restaurants in such evaluations.

The extended observations undertaken for this study provided detailed information about how often and in what situations food workers engage in hand washing activities. Such information is valuable for improving hand washing practices, as it permits the identification of areas in need of improvement and subsequent targeted interventions in those areas. Although restaurant inspections typically include observations of food workers (17), most do not include the collection of detailed data on their activities. Given the potential value of these data, food safety programs may wish to consider the feasibility of the occasional use of methods such as the one used in this study to allow a thorough assessment of food worker hand hygiene behaviors.

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