

## Hand Washing Frequencies and Procedures Used in Retail Food Services

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### ABSTRACT

Transmission of viruses, bacteria, and parasites to food by way of improperly washed hands is a major contributing factor in the spread of foodborne illnesses. Field observers have assessed compliance with hand washing regulations, yet few studies have included consideration of frequency and methods used by sectors of the food service industry or have included benchmarks for hand washing. Five 3-h observation periods of employee ( $n = 80$ ) hand washing behaviors during menu production, service, and cleaning were conducted in 16 food service operations for a total of 240 h of direct observation. Four operations from each of four sectors of the retail food service industry participated in the study: assisted living for the elderly, childcare, restaurants, and schools. A validated observation form, based on 2005 Food Code guidelines, was used by two trained researchers. Researchers noted when hands should have been washed, when hands were washed, and how hands were washed. Overall compliance with Food Code recommendations for frequency during production, service, and cleaning phases ranged from 5% in restaurants to 33% in assisted living facilities. Procedural compliance rates also were low. Proposed benchmarks for the number of times hand washing should occur by each employee for each sector of food service during each phase of operation are seven times per hour for assisted living, nine times per hour for childcare, 29 times per hour for restaurants, and 11 times per hour for schools. These benchmarks are high, especially for restaurant employees. Implementation would mean lost productivity and potential for dermatitis; thus, active managerial control over work assignments is needed. These benchmarks can be used for training and to guide employee hand washing behaviors.

An estimated 250 to 350 million people in the United States have experienced acute gastroenteritis, and 25 to 30% of the cases are thought to have been foodborne illnesses (14). Viruses and bacteria have been identified as the most likely causative agents (8). Effective hand washing decreases the transfer of viruses and bacteria. Poor personal hygiene practices, including improper hand washing, have been identified as common causes of foodborne illness (12), and observational studies have revealed that hand washing is not done often enough in retail food service (9, 11, 13). The Centers for Disease Control and Prevention (CDC) identified hands as one of the most likely means by which enteric viruses are transmitted to foods (6). Individuals in charge of retail food services have the responsibility to follow good hand washing practices to ensure the safety of food prepared and served to customers.

Between January 1996 and November 2000, 348 outbreaks caused by Norwalk-like virus were reported to the CDC. Of these outbreaks, 39% occurred in restaurants, 29% in nursing homes and hospitals, 10% in vacation venues, and 9% in other settings (8). Although *Caliciviridae* virus infections are difficult to identify, these viruses may be the most common cause of known and probably unknown cases of foodborne illness (14).

It is important to identify causes of foodborne illnesses and to recognize contributing practices in food service establishments because research has indicated that foodborne outbreaks are likely to occur in food service operations (3, 5, 7, 12). Poor personal hygiene has been identified as a contributing factor to such outbreaks (5, 7, 12). In one study of retail food service establishments from 1988 to 1992, the two practices most commonly reported as contributing to foodborne illness were improper holding or storage temperatures and poor personal hygiene among food handlers (7). In two U.S. Food and Drug Administration (FDA) studies (19, 21), inadequate hand washing practices by workers were found in all types of retail food services.

Insufficient and inadequate hand washing by employees in retail food services is a well-known contributing factor to foodborne illnesses and is particularly critical when employees are preparing and serving food to vulnerable individuals such as young children and the elderly (20). Previous research identified employees' self-reports of hand hygiene behavior as complying with FDA Food Code (22) recommendations less than 30% of the time (10). In interviews conducted with the person in charge of the food service (1), only 52% of those individuals interviewed were able to correctly describe the hand washing procedure identified in the Food Code. Focus groups working with restaurant workers in two Oregon counties found that barriers to proper hand washing included multiple factors: time pressures, inadequate facilities and supplies, lack of account-

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ability, and lack of manager and coworker involvement (17).

A few field studies have included observations of employee hand washing practices in the work area, including health care (4, 15) and retail food services (11, 19, 21). In the FDA's follow-up report on the occurrence of foodborne illness risk factors in selected institutional, restaurant and retail store facility types (21), researchers found that employee noncompliance with personal hygiene standards in the Food Code remained high. The proportion of employees who were out of compliance with proper and adequate hand washing regulations ranged from 34% for hospital food service employees to 73% for employees at full-service restaurants. Green et al. (11) conducted an observational study of the hand washing practices of restaurant food workers in 333 restaurants located in a six-state region. They found 32% compliance with Food Code recommendations, with appropriate methods used only 27% of the time. Significantly higher compliance was observed for hand washing at appropriate times during food preparation tasks than for hand washing after touching parts of the body or when gloves were worn. The researchers concluded that higher compliance associated with food preparation tasks may be due to the understanding by workers of the importance of hand washing when handling food. In another study of the impact of frequent hand washing by nurses, skin irritation and dryness increased significantly when hands were washed with the unmedicated soap available in the hospital (4).

Paez et al. (16) pilot tested a structured hand washing observation form for deli-type food service establishments, a type of quick-service restaurant that serves ready-to-eat foods that require time and temperature control. Based on 30 h of direct observation, these researchers proposed benchmarks for employee hand washing of six times per hour during production and 11 times per hour during service. Benchmarking is a process of using established standards of best practice as a reference point for measurement or comparison. Managers and employees could use these benchmarks as a way to determine effectiveness of hand washing practices and to develop protocols to increase hand washing.

The current study is an elaboration on previous work by using the tested form in observations at four types of retail food service operations: assisted living centers, child-care centers, restaurants, and schools that served ready-to-eat foods (e.g., roast beef sandwich with a lettuce leaf). Observations were made during the food preparation, service, and cleaning phases. The purpose of this study was to analyze hand washing practices (frequency and procedures) of food service employees in operations that serve ready-to-eat food to vulnerable individuals and to propose hand washing benchmarks specific to these four sectors of retail food service.

## MATERIALS AND METHODS

As part of a larger project investigating cross-contamination in retail food services that offered no-cook foods requiring time and temperature controls and served vulnerable individuals, hand

washing practices of employees during production, service, and cleaning phases were observed. The data collection form and research protocol were approved by the Human Subjects Review Committee of the Institutional Review Board at Iowa State University.

**Sample selection.** A convenience sample of 16 retail food service locations from one midwestern state agreed to participate in the study. The sample consisted of four assisted living facilities for the elderly, four childcare centers, four restaurants, and four school districts serving children from kindergarten through 12th grade.

**Data collection instrument.** The Hand Washing Observation Form ([www.iowahaccp.iastate.edu](http://www.iowahaccp.iastate.edu)) was developed, pilot tested, and validated by Paez et al. (16) and was modified slightly for use as the data collection tool in this study. The instrument was organized in a table format, with all tasks identified in the 2005 Food Code as requiring hand washing listed in the left column of the page. Based on observations about hand drying methods in previous research (11, 21), an additional task was added: after touching aprons or clothing. The 16 tasks were grouped into four categories: personal hygiene, food preparation, cleaning, and other. Headings for each column included "should wash hands" and "did wash hands" and eight specific hand washing procedures identified in the 2005 Food Code, such as soap used and hands lathered for 10 to 15 s. Thus, the form allowed researchers to capture hand washing frequency and procedures used by observed employees. Researchers noted occasions when efforts to wash hands occurred and compliance with recommended procedures. The Hand Washing Observation Form also included space for the researcher to record visible demographic information, such as gender of employee. Through informal conversations, other information was gathered from the employees such as number of years worked in food service, status as full-time or part-time employee, and type of food safety training received.

**Procedure.** Trained observers scheduled five site visits of 3 h each (15 h total) for each of the 16 participating facilities. Thus, 240 h of observation data were collected, during which 80 employees were observed. Managers were aware of the overall purpose of the study (mitigation of cross-contamination), but employees were not informed of the specific focus on hand washing practices and were told that researchers were there for general observations. Employees at each retail food service were observed during production (approximately 6 h), service (approximately 6 h), and cleaning (approximately 3 h), for a total of 15 h at each site. Observations in each type of retail food service totaled 60 h. Typically, one or two employees were observed in each food service operation during the 3-h period, with observations recorded for only one employee at a time.

**Data analysis.** The Statistical Package for the Social Sciences was used for data analysis (SPSS for Windows, version 14, SPSS, Chicago, Ill.). Frequencies were calculated for each of the 16 tasks in categories of when employees should have washed hands, when employees did wash hands, and the procedure used for hand washing. Frequencies also were calculated for each type of retail food service establishment. Hand washing procedure was determined to be in compliance with the 2005 Food Code recommendations when the following actions were seen for the observed hand washings: soap was used, hands were lathered for at least 10 s, hands were dried with disposable towel or heated air, and faucet handles were not touched with hands after washing.

Benchmarks were calculated for each of the four sectors of retail food service for three phases of the operation: production,

TABLE 1. Characteristics of operations (n = 16) and employees (n = 80) observed in four sectors of retail food service: assisted living centers, childcare centers, restaurants, and schools

Characteristic	Assisted living centers	Childcare centers	Restaurants	Schools
No. of noon meals served (mean ± SD)	93 ± 63	103 ± 74	159 ± 97	337 ± 130
No. of employees in facility	44	15	110	65
Part time	24	9	91	38
Full time	20	6	38	27
No. of employees observed	17	14	22	27
No. of employees with food safety training <sup>a</sup>	8	7	0	15
Gender				
Male	3	4	14	3
Female	14	10	8	24
Years of food service experience per employee (mean ± SD)	9 ± 4	13 ± 8	5 ± 2	13 ± 8

<sup>a</sup> Defined as completion of a food handler's or ServSafe course.

service, and cleaning. The formula used for calculating benchmarks was

$$\begin{aligned} & \text{Hand washing benchmark per hour per employee} \\ &= \text{Total number of times observed employees should} \\ & \quad \text{have washed their hands} \\ & \div \text{Total number of observed employee work hours} \end{aligned}$$

## RESULTS

**Description of facilities and observed employees.** Table 1 shows characteristics of operations and demographics of employees observed in four sectors of retail food service. Within each sector, there was a large variation in the number of meals served; thus, standard deviations were high. Mean (±standard deviation [SD]) number of noon meals served ranged from 93 (±63) in assisted living centers to 337 (±130) in schools. Employees in schools had the most experience working in food service operations (13 ± 8 years), whereas employees in restaurants reported the least experience in food service (5 ± 2 years). Of the total 80 employees observed, 30 had received food safety training through a food handler's or ServSafe course.

**Production phase.** Table 2 shows observed hand washing frequency and compliance with the 2005 Food Code recommendations during production phases. In assisted living facilities for the elderly, hand washing was observed most frequently for the following tasks during production: before engaging in food preparation (hands were washed 18 of 25 times when they should have been washed), upon entering the food preparation area (washed 8 of 10 times), and after handling soiled equipment, utensils, or dishware (7 of 11 times). There was low compliance with hand washing standards for the following tasks: before donning gloves to work (15 of 53 times), when changing tasks (7 of 46 times), and after eating or drinking (2 of 7 times). When employees entered the food preparation area during production and washed their hands, soap was used and a disposable towel or heated air was used for drying

on each of the eight occasions, yet lathering for the recommended 10 to 15 s occurred only twice. Thus, compliance with the 2005 Food Code recommendations for hand washing procedures was only 25%.

During production observations in childcare centers, there were 199 times when employees should have washed hands, and hands were washed on only 60 of these occasions. Tasks with lowest compliance with Food Code frequency recommendations were after eating or drinking (hands actually were washed 1 of 13 times when hands should have been washed) and before donning gloves to work with food (washed 3 of 22 times). Compliance with recommended hand washing procedures was high for some of the steps in the process. When hands were washed, soap was used 59 of the 60 times, and hands were lathered for 10 to 15 s on 44 of the 60 occasions. Hands were dried with a disposable towel or heated air all 60 times, yet the faucet was turned off with the towel only 39 times.

During production in restaurants, hands should have been washed a total of 582 times but actually were washed only 39 times, for a compliance rate of 7% with Food Code recommendations for hand washing frequency. Hands were washed during production most frequently before engaging in food preparation (23 of 32 times). Specific tasks for when hand washing should have occurred but did not were after touching clothing or aprons (0 of 80 times), when changing tasks (3 of 153 times), and before handling different types of food products (3 of 68 observations). On occasions when hands were washed before engaging in food preparation, soap was used 14 of the 23 times but hands were not lathered for the full 10 s and hands were not dried properly on 12 occasions. Thus, there was 0% compliance with Food Code recommendations for hand washing procedures.

During production phase in schools, hands should have been washed a total of 300 times but actually were washed 69 times, a frequency compliance rate of 23%. Soap was used on 62 of the 69 occasions, although lathering was observed only 37 times. Highest compliance with procedure





was seen when employees entered the work area (hands were washed 12 of 19 times for a frequency rate of 63%), soap was used 11 of these times, and lathering for 10 s was observed on nine occasions. Failure to wash hands after critical steps in production occurred after eating or drinking (hands washed on 3 of 14 occasions), before donning gloves to work with food (washed 16 of 54 times), and when changing tasks, such as opening refrigerator door and returning to food portioning (washed 19 of 117 occasions).

**Service phase.** Observations of hand washing frequency and compliance with the 2005 Food Code recommended procedures for employees in assisted living centers, child-care centers, restaurants, and schools during service are presented in Table 3. During the service phase in assisted living facilities, hands should have been washed by the 14 employees on 149 occasions, but hands were washed only 35 times, for a compliance of 23% with Food Code frequency recommendations.

In childcare centers, rates of hand washing frequency during service were similar to those found during production. Hands were washed 70 of the 197 times when they should have been washed, a frequency of 36%. The task with greatest frequency of occurrence was “when entering the food prep area.” However, of these 20 observations of hand washing, compliance with the 2005 Food Code recommended hand washing procedures occurred only 35% of the time.

Hand washing during the service phase in restaurants was observed most frequently before employees engaged in food preparation (11 of 20 observations). Of these 11 observations before food preparation, soap was used on all occasions, all parts of the hand and lower arm were lathered five times, and drying with a disposable towel or heated air was seen seven times, yet compliance with the 2005 Food Code procedures was 0% because on no occasion were all critical action steps observed. Hands were washed after handling soiled dishware on only 2 of 142 occasions and before donning gloves to work on only 2 of 24 occasions.

Although observers noted 250 times in schools when hands should have been washed during service, efforts to do so were observed on only 31 of these occasions, for 12% compliance with Food Code recommendations. Although soap was used in 28 of the 31 hand washing occurrences, lathering and friction were seen only 11 times. During service, there were 19 occasions when staff handled soiled equipment or dishware, yet hands were washed only eight of these times.

**Cleaning phase.** The compliance with frequency of hand washing during the cleaning phase for all types of retail food service operations is shown in Table 4. The frequency of compliance was higher (43%) during the cleaning phase than during the production and service phases in assisted living centers, with hands washed 45 of the 104 times that washing should have occurred. However, compliance with recommended hand washing procedures occurred only about one-third of the time. Soap was used on 39 of these 45 occasions, but hands were lathered for at least 10 s only 13 times.

During cleaning activities in childcare centers, hands were washed 70 of the 176 times they should have been, a frequency of 40%. Hand washing occurred 17 of the 99 times employees handled soiled equipment, utensils, or dishware. On these occasions, proper procedures were followed 55% of the time.

In restaurants, none of the employees that engaged in cleaning and sanitizing tasks washed their hands after touching clothes or aprons (22 observations) or touching bare skin (19 observations) or when changing tasks (32 observations). Low frequency of hand washing also was seen after handling soiled equipment (6 of 83 observations) and after handling money (4 of 26 observations). Of the six employees who washed hands after handling soiled equipment, utensils, or dishware, all used soap but hands were lathered for the recommended 10 s on only two occasions, for a 33% compliance with Food Code procedural recommendations.

During the cleaning phase in schools, 90 occasions were identified when hands should have been washed, but hands actually were washed on only 42 occasions, for a frequency of 47%. Hand washing during cleaning was low when changing tasks (hands were washed 3 of the 18 times when they should have been washed) and after eating or drinking (zero of the seven observed times). Hands were washed after handling soiled equipment 34 of the 56 times when they should have been, and soap was used on each occasion, but hands were lathered for at least 10 s on less than half of these occasions.

Overall employee compliance with Food Code recommendations for hand washing frequency for combined production, service, and cleaning phases was low. Restaurant employees should have washed their hands a total of 1,763 times but did so only 92 times, for a frequency compliance of 5%. School employees should have washed their hands a total of 640 times but did so only 142 times (frequency compliance of 22%). Childcare and assisted living center frequency compliance was similar, 31 and 33%, respectively. Hand washing should have occurred 572 times in childcare centers and 439 times in assisted living centers but did occur on only 176 and 146 occasions, respectively.

Proposed benchmarks for the number of times employees should wash their hands per hour for each of the four sectors of the food service industry during production, service, and cleaning are presented in Table 5. These benchmarks are based on observations from the current study and are proposed as a baseline for operations. For example, during production in assisted living facilities, hands should have been washed a total of 186 times during the 26 employee hours of observation; thus, a benchmark of seven times per employee per hour was calculated. Overall benchmarks determined by sector of retail food service indicate restaurant employees should wash their hands 29 times per hour, school food service employees should wash their hands 11 times per hour, and childcare workers should wash their hands 9 times per hour.

## DISCUSSION

Findings from this study support previous observational research indicating that hand washing is not done fre-

TABLE 3. Observed hand washing frequency and compliance with 2005 Food Code recommendations during service in assisted living centers (AL), childcare centers (CC), restaurants (R), and schools (S)

Task <sup>a</sup>	No. of times hands should have been washed					No. of times hands were washed					% compliance with Food Code frequency					No. of times hands were washed in compliance with Food Code procedure <sup>b</sup>					% compliance with Food Code procedure <sup>b</sup>																			
	AL	CC	R	S	S	AL	CC	R	S	S	AL	CC	R	S	S	AL	CC	R	S	S	AL	CC	R	S	S	AL	CC	R	S											
<b>Personal hygiene</b>																																								
After touching bare skin	11	16	34	6	6	1	0	2	0	0	9	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
After touching clothing	1	6	194	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
After coughing, sneezing	1	0	3	2	1	0	0	0	1	100	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
After using handkerchief	1	1	0	0	1	1	1	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
After eating, drinking	0	3	41	20	0	1	1	1	3	0	33	2	2	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
<b>Food preparation</b>																																								
Before engaging in food preparation	5	5	20	9	1	3	11	1	1	20	60	55	11	0	2	0	1	0	1	0	67	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
When entering food preparation area	10	26	11	7	4	20	1	4	4	40	77	9	57	1	7	0	0	25	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Before handling different types of food products	11	7	4	16	1	3	0	0	0	9	43	0	0	0	1	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
When switching between raw food and RTE food	10	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Before donning gloves	49	13	24	37	14	1	2	4	2	28	8	8	11	4	1	0	2	28	100	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
After handling PHF	2	3	1	3	0	1	0	2	2	0	100	0	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Cleaning</b>																																								
After cleaning equipment, utensils	9	19	48	20	6	5	1	2	2	67	26	2	10	1	1	0	0	17	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
After handling soiled equipment, utensils, dishware	15	43	142	19	4	17	2	8	2	27	40	1	42	1	13	0	4	25	76	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
After cleaning	0	2	7	3	0	1	4	2	2	0	50	57	67	0	1	0	1	0	100	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Other</b>																																								
When changing tasks	24	51	318	93	2	15	0	3	3	8	29	0	3	1	9	0	1	50	60	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
After handling money	0	0	83	5	0	0	2	1	0	0	0	2	20	0	0	0	1	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Other	0	2	0	0	0	2	0	0	0	0	100	0	0	0	1	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	149	197	930	250	35	70	26	31	31	8	38	0	10	8	38	0	10	8	38	0	10	8	38	0	10	8	38	0	10	8	38	0	10	8	38	0	10	8	38	

<sup>a</sup> RTE, ready-to-eat; PHF, potentially hazardous food.

<sup>b</sup> In compliance with Food Code procedure when the following actions were observed: soap was used, lathering occurred for at least 10 s, hands were dried with disposable towel or heated air, and faucet handles were not touched with hands after washing.

TABLE 4. Observed hand washing frequency and compliance with 2005 Food Code recommendations during cleaning in assisted living centers (AL), childcare centers (CC), restaurants (R), and schools (S)

Task <sup>a</sup>	No. of times hands should have been washed					No. of times hands were washed					% compliance with Food Code frequency					No. of times hands were washed in compliance with Food Code procedure <sup>b</sup>					% compliance with Food Code procedure <sup>b</sup>				
	AL	CC	R	S	S	AL	CC	R	S	S	AL	CC	R	S	S	AL	CC	R	S	AL	CC	R	S		
<b>Personal hygiene</b>																									
After touching bare skin	2	6	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
After touching clothing	2	2	22	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
After coughing, sneezing	0	0	2	0	0	0	0	1	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	
After using handkerchief	0	0	1	0	0	0	0	1	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	
After eating, drinking	1	7	20	7	1	3	1	0	0	100	43	5	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Food preparation</b>																									
Before engaging in food preparation	0	0	10	0	0	0	5	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	
When entering food preparation area	6	14	11	1	5	9	6	0	0	83	64	54	0	2	3	0	0	40	33	0	0	0	0	0	
Before handling different types of food products	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
When switching between raw food and RTE food	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Before donning gloves	3	4	6	1	0	0	1	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	
After handling PHF	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Cleaning</b>																									
After cleaning equipment, utensils	15	20	15	4	7	2	1	3	47	10	7	75	0	1	0	2	0	50	0	0	0	0	0	67	
After handling soiled equipment, utensils, dishware	61	99	83	56	28	29	6	34	46	29	7	61	7	16	0	5	0	55	0	15	0	0	0	0	
After cleaning	0	1	1	0	0	1	1	0	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	
Other	14	20	32	18	4	2	0	3	28	10	0	17	3	0	0	2	75	0	0	0	0	0	0	67	
When changing tasks	0	0	26	1	0	0	4	1	0	0	15	100	0	0	0	0	0	0	0	0	0	0	0	0	
After handling money	0	0	0	1	0	0	0	1	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	104	176	251	90	45	46	27	42	12	20	0	9													

<sup>a</sup> RTE, ready-to-eat; PHF, potentially hazardous food.

<sup>b</sup> In compliance with Food Code procedure when the following actions were observed: soap was used, lathering occurred for at least 10 s, hands were dried with disposable towel or heated air, and faucet handles were not touched with hands after washing.

TABLE 5. Hand washing benchmarks during operational phases of production, service, and cleaning in assisted living centers (AL), childcare centers (CC), restaurants (R), and schools (S)<sup>a</sup>

Operation phases	AL	CC	R	S
Production benchmark	7	9	28	11
No. of times hands should have been washed	186	199	582	300
Total observed hours	26	21	21	27
Service benchmark	7	9	33	12
No. of times hands should have been washed	149	197	930	250
Total observed hours	20	21	28	21
Cleaning benchmark	7	10	23	8
No. of times hands should have been washed	104	176	251	90
Total observed hours	14	18	11	12
Overall benchmark	7	9	29	11
No. of times hands should have been washed	439	572	1,763	640
Total observed hours	60	60	60	60

<sup>a</sup> Benchmarks are the number of times an employee's hands should be washed per hour.

quently enough in retail food service establishments and that recommended methods are not followed. During this study, employees were seen making some efforts to wash hands at the times recommended in the Food Code. During production, frequency of compliance ranged from 7% for restaurant employees to 35% for assisted living center workers. Green et al. (11) reported that the number of hand washing attempts by restaurant employees during tasks related to food preparation was higher (32% compliance) than the number of attempts during other activities. Almost all observed employees in all sectors during all phases failed to wash their hands between handling raw and handling ready-to-eat foods, a concern previously noted (11). Findings from this study indicated that institutional sectors of retail food service placed a higher value on formal food safety training than did restaurants; about half of workers in assisted living, childcare, and school sectors had completed food safety training whereas all restaurant workers identified on-the-job training as their only source of food safety information. Given the part-time employment status of most workers in restaurants and high employee turnover in this industry, this lack of training is not surprising. Low compliance with hand washing frequency in restaurants was not surprising because workers usually had multiple job responsibilities and performed various tasks during each phase of operation. The hectic nature of compressed meal periods for all sectors increased the risk of cross-contamination because of infrequent and improper hand washing during service, a situation exacerbated in the restaurant setting. Management consideration for reconfiguration of job assignments, previously suggested in the literature (11), is supported by observations from this study. However, the procedures used to wash hands at these recommended times were not compliant with FDA recommendations; thus, hand washing was not effective or hands could have become recontaminated. Employees at childcare centers had the highest compliance rate for hand washing procedures recommended in the Food Code among the four types of retail food services for most tasks in production, service, and

cleaning phases, with procedural compliance rates of 20 to 100%. This high procedural compliance rate may be due to emphasis on hand hygiene as part of childcare licensing standards.

Mechanical ware-washing equipment was common in all retail food services, but in almost all assisted living, childcare, and restaurant operations, only one person was assigned to operate the equipment. Observations of low hand washing frequency compliance in the dishroom during the cleaning phase in childcare and assisted living centers are particularly troubling because production equipment, service utensils, and dishware can become recontaminated from soiled hands, and this contamination can pose a threat to these vulnerable groups of people. The relatively high overall compliance for hand washing frequency during the cleaning phase in schools may be due to job assignments in the dish room, in which one person loaded soiled dishware and another removed cleaned and sanitized items from the machine. This scheduling framework improved frequency compliance for schools during the cleaning phase.

Although further education to increase awareness of when and how to wash hands properly is needed, barriers to good hygiene practices as recently identified by Pragle et al. (17) also need to be addressed. The barrier of time pressure is high in the restaurant industry, perhaps because of the scope of the menus, high staff turnover, and competitive markets. Workers in restaurants typically have multiple responsibilities that include food or beverage preparation, service, and cleaning. Thus, the nature of commercial retail food service presented greater risk of contamination of food contact surfaces via hands than did the noncommercial operations participating in the study. Observations from this study indicated that restaurant employees should wash their hands an average of 29 times per hour. Obviously, this rate is unrealistic because the time spent hand washing (20 s for 29 times each hour) would reduce productivity significantly and result in skin irritations for employees, a concern previously reported (4, 11). Managers and employees should consider reconfiguration



of job duties and train staff on effective sequencing and arrangement of work tasks to reduce the number of times hands should be washed. The motivation of employees to practice known safe food handling also has been identified as a barrier (2), but supervisors and managers can impact this barrier by establishing policies and standards, holding employees accountable for their actions, serving as role models, controlling rewards and punishment, providing training that includes reasons why proper hand washing and other safe food handling behaviors are important, and providing needed resources. Typical age range, years of food service work experience, gender, food safety training, and part-time job status of line employees in restaurants is different than that in noncommercial sectors of the food service industry. The scope of the menus, style of service, and reward systems may contribute to the lack of attention given to hand washing by restaurant workers. Training methods and task assignments may need frequent review within organizations. Compliance with Food Code recommendations for hand washing frequency and procedures needs improvement in all types of retail food service establishments.

One training strategy may be to provide benchmarks of hand washing frequency. Because of variability in production systems, the form of purchased foods, turnover of staff, and service options, benchmarks for different sectors of retail food service are proposed. Benchmarks should be useful to operators by making them aware of how often hands are supposed to be washed and by providing guidance to staff on hand washing frequency. In previous work (16), suggested benchmarks for deli-type food service establishments serving ready-to-eat foods were 6 times per employee per hour during production and 11 times per employee per hour during service. These proposed benchmarks are comparable to those for assisted living centers, childcare centers, and schools, perhaps because of the limited menu offered in a deli. Full-service restaurants have a much higher benchmark because of the expanded scope of the menu and thus the number of times hands should be washed. Food service operators may need to develop a hand washing benchmark specific for their operation and then seek methods to reach that benchmark.

These proposed benchmarks can be used by managers to develop training materials specific to their type of operation and to establish internal guidelines of hand washing behaviors. The benchmark data also can help managers identify the need to reconfigure work schedules such as assigning two people to operate the dishwashing machine (one to load and one to unload) and assist staff in organization of work tasks to minimize need for hand washing, such as having the bus staff clear soiled dishware and the host or wait staff reset tables. The benchmarks identified in this study should be used in initial training that also addresses proper frequency and procedures for hand washing. Because of concerns related to lost productivity and potential skin irritations, management and staff should consider work organization, staffing, and employee motivations to ensure hands are properly washed when needed. The use of benchmarks is one tool to emphasize the importance of

hand washing at the recommended times using proper procedures.

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