Chelsea Paulin, Ingrid E. Lofgren and Lori F. Pivarnik*

Nutrition and Food Sciences, University of Rhode Island, Fogarty Hall, Kingston, RI 02881, USA

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6200 Aurora Ave., Suite 200W, Des Moines, IA 50322-2864

An Assessment of Consumer Food Safety Handling Practices of Produce at Grocery Stores in Rhode Island

ABSTRACT

Produce contributed to more foodborne illnesses from 2004 to 2013 than any other food category. While the main focus has been on produce contamination on a farm or distribution center, little has been done to understand the role of consumers' food safety practices in the grocery store. This area is of particular importance, since any contamination could be made worse with improper food safety practices in the home. The purpose of this study was to use direct observation and a smartphone application to observe food safety handling and hygiene practices of consumers shopping for produce at grocery stores in Rhode Island. A total of 80 individual consumer observations of produce handling and hygiene practices took place at five grocery stores (16 observations per location). Observed unsafe food safety handling practices of consumers included manipulating produce, putting produce back on the shelf, and tasting produce, in addition to poor personal hygiene practices. Produce scales were unclean in a majority of observations. Results from this study revealed that some consumers at Rhode Island grocery stores engage in unsafe food safety practices when shopping for produce. Education at the point of purchase about best practices of handling produce is needed in order to decrease cross-contamination and exposure of other consumers to contamination.

INTRODUCTION

Foodborne illness remains an important public health issue in the United States. It is estimated that 1 in 6 Americans contract a foodborne illness each year, resulting in approximately 3,000 deaths annually *(9)*. From 2004 to 2013, produce was responsible for more illnesses than any other food category and had the largest number of outbreaks for any single food category *(7)*. The 2015 Dietary Guidelines for Americans recommend an increase in fruit and vegetable consumption *(21)*, and it is projected that produce intake will increase approximately 4% by 2020 *(25)*. A rise in the consumption of produce has the potential to cause an increase in foodborne illness,

* Corresponding author: Phone: +1 401.874.2972; Fax: +1 401.874.2994; E-mail: lpivarnik@uri.edu

especially because a great deal of produce is consumed raw *(5)*. While produce-related outbreaks are often linked to contamination from a farm or distribution center, measures to prevent foodborne illness are necessary throughout the entire production process from farm to table.

Consumers play a key role in their own safety and are considered the last line of defense against foodborne illness in the production process *(27)*. Poor food safety practices in the home have been reported, with high-risk food behaviors more common among males and those with higher household income *(1, 19)*. Up to 30% of consumers report not always washing fruits and vegetables before preparation or eating, and 33% report not always washing their hands before eating or handling food *(24)*. These results are of particular concern because contamination of foods by hand contact is one of the confirmed risk factors identified during outbreak investigations *(8)*. Since raw food can act as a vehicle for infective pathogens, washing hands and produce are considered important food safety practices for the reduction and prevention of foodborne illness *(29, 30)*. In the grocery store, a potential source of cross-contamination could be repetitive handling of produce by consumers.

Evidence on consumer food safety practices at the point of purchase is lacking, and available data have the limitations of self-reporting and inconsistent results *(19)*. In a 2002 survey, fewer than 30% of consumers reported separating fresh produce from meat, poultry, and fish when both were purchased *(19)*. Additional assessments of after-purchase practices provide variable results. In the same 2002 survey some consumers reported not washing produce such as apples or melons in one section of the survey but indicated washing all fruits and vegetables in another section. These results demonstrate the flaws of self-reported data and the need for a more reliable way to measure consumer food safety practices.

Direct video observation of produce washing has demonstrated that compliance with recommended practices may not be as high as suggested by results of surveys, and consumers frequently commit food safety violations during routine food preparation in the home *(3, 28)*. Overall, consumers are unaware of the food safety risk involved with produce *(17, 19, 27)*. A 2010 U.S. Food and Drug Administration survey reported that 36–40% of consumers do not think it is likely that fruits and vegetables contain germs that can make them sick *(17)*. Despite this false sense of security, it remains a fact that produce has been associated with more illnesses than any other food category and with the largest number of outbreaks of any single food category *(7)*. Therefore, it is important to understand consumers' food safety practices at all points, including at the grocery store, since they are not performing proper food safety habits in the home. The store is a potential control point for cross-contamination, and insight into this area of consumer behavior would provide more understanding on the potential transmission of pathogens.

Direct observation can be an ideal technique for assessing consumers' food safety practices in the grocery store *(39)*. This method allows an observer to pose as a typical consumer, without the observed consumer being aware of the observation *(39)*. In addition, it allows for the observer to capture behaviors directly rather than relying on self-report. The observational method is the preferred technique in consumer food safety studies, and offers a more reliable method to evaluate consumer food safety practices than traditional methods such as surveys *(26)*. A smartphone application (SA) has been used successfully as a data collection tool *(4, 37)*. While previous research has successfully used a SA to observe behavior at farmers markets, this tool has yet to be used in other capacities. Thus, the purpose of this study was to use a SA to record direct observations of food safety practices among consumers shopping for produce at grocery stores in Rhode Island (RI).

MATERIALS AND METHODS

Study design

This was a descriptive study using direct observation of consumers at RI grocery stores. An Android mobile SA, Food Safety Surveys, was used for primary data collection as described in previous research *(20, 37)*. This study was approved by the University of Rhode Island (URI) Institutional Review Board.

Selection of grocery stores

Grocery stores were selected for observation in areas of similar socioeconomic status according to median household income level *(32)*. Two towns were chosen where the household income level fell within the middle half of the income distribution as defined by the United States Census Bureau *(12)*. The towns were further delineated as urban or rural according to the urban and rural Census Places definitions *(33)*. A town was considered urban if the population was > 50,000 and rural if the population was ≤ 50,000 *(33)*. Based on these definitions, one town was considered urban and the other rural. Three stores were selected in the urban town and two in the rural town.

Four types of grocery stores were selected for observation to ascertain whether shopping behavior varied depending on the type of store. Grocery stores were defined as (1) Price-saving (limited-assortment), (2) Locally owned and operated marketplace (other/small grocery), (3) Traditional supermarket store or (4) Supercenter *(6)*. Price-saving grocery stores were defined as low-priced grocery stores offering a relatively small assortment of center-store and perishable items *(6)*. Locally owned and operated marketplaces were defined as smaller corner grocery stores that carry a limited selection of staples and other convenience goods *(6)*. Grocery stores were considered traditional if they

offered a full line of groceries, meat, and produce, with the possibility of offering a service deli, a service bakery, and/or a pharmacy *(6)*. Supercenters were defined as a hybrid of a large traditional supermarket store and a mass merchandiser, offering a wide variety of food and non-food merchandise *(6)*. Five grocery stores were chosen for observation in this study: one price-saving, two locally owned and operated, one traditional, and one supercenter.

Selection of consumers

The sample population of interest consisted of individuals who appeared to be 18 years of age or older who were shopping alone at one of the selected grocery sites. Observations focused on patrons shopping for/handling produce considered to be associated with higher risk, such as cucumbers, tomatoes, and other ready-to-eat fruits and vegetables; these foods are generally consumed without additional processing or cooking *(35, 37)*.

Development of the smartphone application

The SA "Food Safe Surveys" was developed at AHG, Inc. (State College, PA) through collaboration with the Research Nutrition and Food Sciences Department, URI, and the Department of Food Science, The Pennsylvania State University *(20, 37)*. This system allows users to design custom questionnaires, surveys, or checklists via a web-based system. The surveys are then downloaded to the Food Safe Surveys program on the mobile device to be used in applications for an easy-to-use interface. This SA has been used by other research groups to assess behavior of farmers' market vendors *(20, 37)*, and was adapted for use in this study.

Application questions

Survey questions used for the SA were designed using the procedures described previously *(20, 37)*. Questions were developed to assess handling practices of fresh fruits and vegetables by consumers shopping at the grocery stores. The survey instrument was pilot tested at a variety of grocery stores between June and September of 2015. The final survey used for data collection reflected the revisions based on results of pilot observations.

A total of 37 questions were developed for the survey and uploaded to the website Food Safe Surveys (http://www.ahg.com:8180/PSUFoodSci/html/) as described in previous research *(20, 37)*. The items were entered in the general order they would be answered during a direct observation session and consisted of yes/no, multiple choice, and free-form text entry questions.

The questions in the first section (10 questions) related to grocery store demographics and characteristics, including location, classification, and time of day; all were answered upon arrival of the observer to the grocery store and prior to the beginning of direct observations. Once the observer was inside the grocery store, cleanliness of the scale and condition of the produce were noted in free-form text entry. Cleanliness of the scale was noted as debris and/or dried liquid remnants on the produce scale. The criteria for condition of the produce included the presence of fruit flies, mold, bruises, or other visible damage. The questions in the second category (3 questions) were answered after a consumer had been selected to be observed at the grocery store. Consumers were observed entering the produce section of the grocery store and chosen for observation based on eligibility criteria stated previously. Questions pertained to the start time of each observation, with additional details including the gender and approximate age of the consumer. Questions in the third category (11 questions) pertained to consumer-handling practices of produce (e.g., "Did the shopper use a form of containment (e.g., a plastic bag) for their produce?"). Using the SA, the observer watched the consumer inconspicuously from a distance and monitored all food safety behaviors and interactions as they occurred during the visit to the produce section. Finally, the questions in the fourth category (12 questions) related to the hygiene practices of the consumer during the visit to the produce section (e.g., "Did the consumer touch their body while shopping?") and the time the observation was complete. An observation was considered complete once the consumer left the produce section of the grocery store. Once an observation was complete, the observer began the next observation. The fifth category recorded the time of departure from the store.

Supermarket consumer observations

Observations were conducted around the same time of day on one weekday and one weekend day (Friday and Saturday) between September and December of 2015. This specific window of time was used to maintain a consistent, structured protocol. Observations were conducted on the busier days of the week, on which handling of produce may have been highest, to allow the observer to be less noticeable while conducting assessments *(14, 16)*. One observer conducted all observations for consistency. For the five stores in this study, 16 consumers were observed at each store. Thirty-four visits were used to obtain a total of 80 individual shopper observations (16 consumers per store) with 1–5 people observed per visit.

Data analysis

Data analysis was performed using SPSS version 23.0 for Windows. Descriptive statistics were assessed. Categorical variables are presented by frequencies and percentages and continuous variables were presented as means ± standard deviations. Chi-square tests or Fisher's Exact test (when the cells had an expected count less than five) were performed to compare (1) Location (urban and rural); (2) Type of grocery store (price-saving, local, traditional, and superstore); and (3) Day of observation (Friday or

Saturday). The *P*-value for significance was set at $P < 0.05$; $P < 0.1$ (but greater than 0.05) was considered to indicate a trend toward significance *(2, 41)*.

RESULTS

The mean time at each grocery store was 24.9 ± 11.3 minutes. Consumers were observed for a mean of 2.2 ± 1.0 minutes per observation. Approximately 58% of the observations took place on a Friday and the remainder on a Saturday. A majority of consumers observed were female (79%). The mean estimated age of consumers was 50 ± 13 years (data not shown). The most frequently observed types of higher-risk produce handled by consumers were apples (24%), grapes (18%) and peppers (11%) *(Fig. 1)*. Other types of produce observed being handled by consumers were asparagus, cucumbers, green beans, lettuce, parsley, peaches, pears, tomatoes, and zucchini.

Figure 2 shows characteristics of the five grocery stores observed. A sanitizing wipe dispenser was present during all grocery store visits and was empty only 4 times at local stores. The presence of bruised or moldy fruit was observed on 8 visits (24%): 3 at the price-saving grocery store, 3 at local marketplaces, 1 at a traditional grocery store, and 1 at a super store. Fruit flies were observed on 3 visits (9%). For all grocery store visits completed, produce scales were free of debris, and dried liquid remnants were seen only one time.

Handling practices

Observed consumer produce handling practices are reported in *Table 1*. While there were no significant differences between locations, store types, or days of the week (Friday vs. Saturday) with regard to produce-handling practices, there was a trend toward significance in the difference between price-saving stores and the other types of grocery stores for putting produce back on the shelf more often ($P = .073$) and increased use of containment ($P = .056$). A majority of consumers (71%) manipulated produce with their hands. While 3% of consumers smelled produce while shopping, 10% tasted grapes before selection. More than half of consumers (54%) put produce back on the shelf after handling. No produce was observed being dropped. Of consumers who used a form of containment for their produce (74%), all selected a plastic bag.

Hygiene practices

Hygiene practices of consumers can be seen in *Table 2*. While there were no significant differences seen between location, store type, or day of the

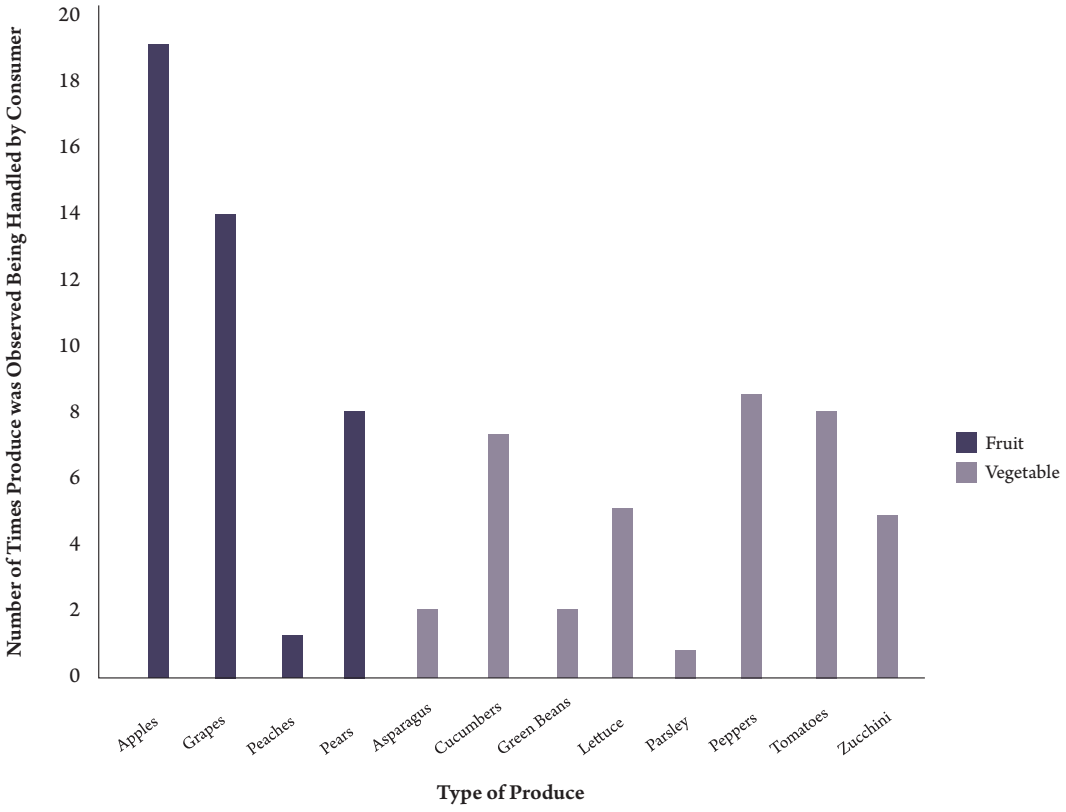
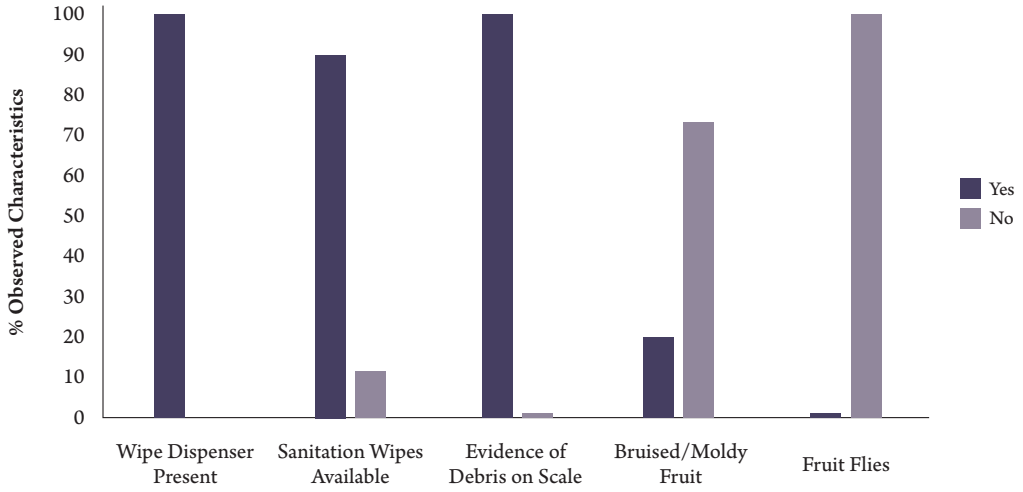


Figure 1. Observed types of produce handled by consumers at grocery stores in Rhode Island (n = 80)



n = 5 stores, 16 consumers observed per store, resulting in 80 total consumer observations.

Figure 2. Specific characteristics observed at grocery stores (n = 5) in Rhode Island

week (Friday vs. Saturday) with regard to hygiene practices, there was a trend toward significance in the relationship between type of store and touching of hair; those observed shopping at a supercenter ($P = .053$) appeared to touch their hair more often than consumers who shopped at other types of stores. Eating while shopping was observed in 11% of consumers. While no consumers were observed drinking while shopping, some consumers were observed touching a part of their body. Overall, the most frequently observed types of consumer hygiene practices of food safety concern were touching hair (15%), licking fingers to open a plastic bag (13%), touching ears, face, or mouth (10%), touching glasses (5%) and touching clothing (4%). Only 3% of consumers were observed coughing, and none were observed sneezing. Only 1% of consumers were observed touching their phone.

DISCUSSION

This study showed that consumers at RI grocery stores have produce handling and hygiene practices that could increase the risk of spreading pathogens. Additionally, this study showed that produce scales are often unclean and need more attention by grocery store staff. Furthermore, it showed the SA was an effective tool in allowing the observer to record observations of consumer produce handling and hygiene practices.

Consumers were engaged in multiple activities that could contribute to food safety concerns regarding produce handling at grocery stores. For example, 71% of consumers manipulated their produce before selection, and 54% put that produce back on the shelf. Additionally, 10% of consumers in this study tasted produce despite the recommendations set forth by NSF International to avoid sampling foods before selection *(23)*. It is well known that contaminated hands can transmit pathogens *(11)*, as tasting and handling produce could increase the potential for foodborne illness. Bacteria/viruses on a consumer's hand can be transferred to and remain on the produce, whether it is selected for personal consumption or put back on the shelf for the next consumer. Furthermore, more than one person may be touching and putting back the same or multiple pieces of produce. Although the Food and Drug Administration recommends washing all produce thoroughly under running water before preparing and/or eating *(36)*, approximately 25–30% of individuals report not washing fruits or vegetables before preparing and eating them *(24)*. Since consumers may not be washing produce at home after it has been in contact with multiple hands at the grocery store, the point of purchase may be an especially important location for education to minimize produce handling and maximize produce washing.

Another important observation that could increase food safety risk was that 26% of consumers were observed touching their bodies. Poor personal hygiene has been documented as one of the leading contributory factors in causing foodborne illness *(34)*, because of the risk of transferring pathogens directly from the body to food. Individuals can act as a source or vector of microorganisms, and precautionary measures therefore need to be taken while shopping for produce *(18)*. Consumers should limit direct contact with clothes and the body, particularly the face and hair, and make safe hygienic practices a priority during their shopping for produce *(18)*. This is necessary to prevent transfer of pathogens such as *Escherichia coli (20)* and norovirus *(31)* to foods from other foods and from infected consumers.

All stores were observed to have a sanitizing wipe dispenser, which was stocked 85% of the time. However,

TABLE 1. Observed produce-handling practices of consumers at grocery stores in Rhode Island by all, urban and rural location, supermarket type, and day of week

Observed Produce-handling Action	Manipulating % (n)	Smelling % (n)	Tasting % (n)	Putting Back on Shelf % (n)	Using Containment % (n)
Total (n = 80)	71 (57)	3 (2)	10 (8)	54 (43)	74 (59)
Urban (n = 48)	71 (34)	0 (0)	13 (6)	60 (29)	77 (37)
Rural (n = 32)	72 (23)	6 (2)	6 (2)	44 (14)	69 (22)
Supercenter (n = 16)	81 (13)	6 (1)	13 (2)	31 (5)	56 (9)
Price Saving (n = 16)	75 (12)	0 (0)	6 (1)	75 (12)	94 (15)
Local (n = 32)*	69 (22)	3 (1)	6 (2)	59 (19)	78 (25)
Traditional (n = 16)	63 (10)	0 (0)	19 (3)	44 (7)	63 (10)
Friday (n = 46)	78 (36)	2 (1)	13 (6)	61 (28)	74 (34)
Saturday (n = 34)	62 (21)	3 (1)	6 (2)	44 (15)	74 (25)

*Represents two local grocery stores, 16 observations per store.

TABLE 2. Observed hygiene practices of consumers at grocery stores in Rhode Island by all, urban and rural location, supermarket type, and day of week

Observed Hygiene Practice	Eating % (n)	Touching Body						Coughing % (n)	Touching Phone % (n)
		Hair % (n)	Licked Fingers to Open Plastic Bag % (n)	Ears, Face, Mouth % (n)	Glasses % (n)	Clothes % (n)	Purse % (n)		
Total (n = 80)	11 (9)	15 (12)	13 (10)	10 (8)	5 (4)	4 (3)	1 (1)	3 (2)	1 (1)
Urban (n = 48)	15 (7)	13 (6)	15 (7)	8 (4)	6 (3)	2 (1)	2 (1)	0 (0)	0 (0)
Rural (n = 32)	6 (2)	19 (6)	9 (3)	13 (4)	3 (1)	6 (2)	0 (0)	6 (2)	3 (1)
Price Saving (n = 16)	6 (1)	6 (1)	6 (1)	6 (1)	13 (2)	6 (1)	0 (0)	0 (0)	0 (0)
Local (n = 32)*	6 (2)	6 (2)	22 (7)	16 (5)	3 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Traditional (n = 16)	25 (4)	25 (4)	13 (2)	0 (0)	0 (0)	0 (0)	6 (1)	0 (0)	0 (0)
Supercenter (n = 16)	13 (2)	31 (5)	0 (0)	13 (2)	6 (1)	13 (2)	0 (0)	13 (2)	6 (1)
Friday (n = 46)	15 (7)	22 (10)	9 (4)	13 (6)	4 (2)	4 (2)	0 (0)	2 (1)	2 (1)
Saturday (n = 34)	6 (2)	6 (2)	18 (6)	6 (2)	6 (2)	3 (1)	3 (1)	3 (1)	0 (0)

*Represents two local grocery stores, 16 observations per store

previous research showed that relatively few consumers are using the wipes *(10)*. In the first year Purell wipe dispensers were installed in a store, only 5% of customers used them, and the brand SaniCart wipes were used by only 15–20% of consumers when provided *(10)*. *S. aureus* and other bacteria have frequently been found on food-contact surfaces such as shopping carts, and it is reasonable to assume that bacteria could be transferred to a consumer's hands and then to produce if proper precautions are not taken *(13)*. It is evident that questionable personal hygiene practices take place throughout the grocery store, and consumers may not be aware of the potential risks associated with handling raw produce or the benefits of using sanitizing wipes. Public health messages focusing on the importance of personal hygiene practices in the grocery store may be warranted.

One safe practice observed was that most (74%) consumers put their produce in a form of containment before putting it in their cart. These results are similar to those of previous research by Li-Cohen et al. *(19)*, who reported that approximately 70% of respondents bagged their produce in a way that separated it from sources of contamination. A barrier between produce and the cart is necessary to reduce exposure to pathogens and the potential transmission of microbial infections among consumers *(15)*. Shopping carts are known to be contaminated, as a result of direct handling of raw food products or contamination of the cart by previous users, with microorganisms such as *E. coli* and *S. aureus (15, 22)*.

The lack of produce scale cleanliness could be an important contributor to cross-contamination. As is true of checkout conveyer belts, produce scales are a potential source of contamination because of the frequent contact with raw produce *(40)*. Yan found that of 100 conveyer belt surfaces tested for microbes, 100% had significant populations of total aerobic bacteria counts, yeasts, molds, and staph, with 8% of belts being positive for coliforms. Contamination of produce scales may be similar, and further investigation is needed. This study observed that 99% of produce scales were unclean, which suggests that increased emphasis should be placed on sanitation requirements of produce scales.

Although there were some limitations associated with the study, the strengths reflect the value of the study. The population of this study consisted of consumers at grocery stores in RI, and the results may not be generalizable to other regions. In addition, multiple grocery stores of similar type could be investigated. However, the frequencies reported in *Tables 2 and 3* demonstrate what potentially may be occurring on a larger scale and more frequently. In addition, observations took place during a time of year when some varieties of fruits and vegetables were out of season. Different food safety handling practices may be seen at other times of the year. Strengths of this study include the use of a SA to record direct observations of consumer produce handling and hygiene practices. Another strength was in its sample size: 16 individual consumer observations at each location, for a total of 80 observations. Furthermore, a heterogeneous mix of grocery store types were chosen (price-saving, local, traditional, and supercenter) in different locations (urban and rural) to allow for an adequate representation of the population *(38)*.

CONCLUSION

Results of this study revealed that consumers at RI grocery stores engage in handling practices that could impact the safety of produce. Furthermore, location and type of grocery store do not seem to matter in terms of consumer produce handling and hygiene practices. This study also supported the use of the SA Food Safe Surveys as a successful device for the recording of consumer produce handling and hygiene practices without observer detection. Future research to expand upon this study could investigate stores in areas of differing socioeconomic status in different states. An emphasis on consumer education is needed regarding best practices related to produce safety in the grocery store in order to decrease cross-contamination. This education might work best directly at or before the point-of-purchase, with a specific emphasis on limiting direct hand contact with produce and proper hygiene practices while shopping. Although completely eliminating consumers' contact with produce is highly unlikely, an alternative approach to deal with potential cross-contamination would be to limit bare-hand contact with produce. This could be accomplished with the use of single-use tissue similar to that found in a self-service bakery department. Finally, produce scale cleanliness demands more attention from grocery store employees and management for the sake of safety of the consumers.

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