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Consumer Vegetable and Fruit Washing Practices in the United States, 2006 and 2010

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ABSTRACT

Vegetables and fruits may become contaminated with pathogens anywhere along the farm-to-plate continuum. Therefore, the FDA recommends that vegetables and fruits that have not already been washed be washed by the consumer before slicing or consuming them. The FDA included in its 2006 and 2010 Food Safety Survey a series of questions about purchasing and washing of strawberries, tomatoes, cantaloupes, and bagged, pre-cut lettuce. The Food Safety Survey is a telephone survey tracking consumers' knowledge, attitudes and behaviors related to food safety. In 2006, of those who buy these products, 98% wash strawberries, 97% wash tomatoes, 57% wash cantaloupes and 54% wash bagged pre-cut lettuce. Overall, for both years, more women than men wash cantaloupes, and more men than women wash bagged pre-cut lettuce. Cantaloupe washing declined from 2006 to 2010 for men, while lettuce washing increased for women in the same period. Targeted education campaigns should emphasize the importance of washing produce, especially fruits with hard rinds.

INTRODUCTION

Fresh vegetable and fruit consumption in the United States increased 19% from 1970 to 2005 *(48)* and is projected to continue to increase through 2020 *(20)*. Vegetables and fruits play a major role in contributing to a healthful diet, and consumption of these products is therefore encouraged *(39)*. While the incidence of human pathogens on fresh produce is very low *(7, 12, 22)*, products sometimes become contaminated somewhere along the continuum from the farm to the consumer's plate. Indeed, vegetables and fruits have recently been implicated in several large, multi-state foodborne illness outbreaks and food recalls in the United States *(11, 40, 42, 43, 45)*.

Foodborne pathogens such as Norovirus and *Salmonella* cause an estimated 47.8 million illnesses and 3,037 deaths per year in the United States *(25, 34, 35)*. Consumers can help to mitigate the risk of becoming ill from contaminated produce by applying principles of safe food handling, including washing using recommended methods and avoiding cross-contamination *(4, 15, 24, 27)*. To wash produce, the U.S. Food and Drug Administration (FDA) recommends that consumers use a vegetable brush to scrub firm-skinned produce while holding it under running water *(44, 46)* and wash

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less firm-skinned produce, e.g., plums or tomatoes, by rubbing or rinsing them under running water. Although washing does not guarantee removal of pathogens if the item has become contaminated, it increases the likelihood that pathogens will be removed, compared with not washing or using washing methods that are not recommended *(3, 15)*. Soaking and use of any type of cleaner are not recommended washing methods *(39, 44, 46)*. Soaking does not remove contaminants as effectively as rubbing or rinsing produce under running water. Cleaners not meant for produce can introduce chemical contaminants, and produce washes are considered no more effective than water *(3, 18)*. Unlike other types of produce, almost all bagged, pre-cut lettuce in the market place is pre-washed. For bagged, pre-cut lettuce that is labeled as pre-washed, additional washing is not recommended as it (1) is not likely to enhance safety and (2) introduces the opportunity for cross-contamination of the product with pathogens that may be in the home kitchen *(26, 46)*.

Consumers are the last line of defense in preventing foodborne illness for food prepared at home. Consumer research on food safety attitudes and behavior has repeatedly found differences by demographic subgroups *(1, 2, 8, 16, 19, 21, 28, 32)*. In general, these studies have shown that women, those with less-than-college-level education, and middle aged adults have the safest food-handling behaviors. Food safety educators and risk communicators use this information to target different populations with tailored messages *(2, 17, 19)*.

This study extends the literature on consumer produce washing by comparing washing behaviors for produce that should be washed before consumption (strawberries, tomatoes, and cantaloupe) and for bagged, pre-cut lettuce, which should not. Using chi-square tests and logistic regression models, we evaluated the change in consumer washing behaviors for men and women between 2006 and 2010 and explored the effects of demographic characteristics on these washing behaviors.

MATERIALS AND METHODS

The Food Safety Surveys (FSS) are two of the nationally representative, cross-sectional, random-digit-dialed telephone tracking surveys conducted every three to five years by the Center for Food Safety and Applied Nutrition (CFSAN), FDA. The surveys track consumer knowledge, perceptions, attitudes, and behaviors on a variety of food safety topics. First implemented in 1988, the FSS has been conducted subsequently in 1993, 1998, 2001, 2006, and 2010. Questions about vegetable and fruit washing were first added in 2001 and substantially revised for the 2006 and the 2010 surveys. All FSS questions were pretested to ensure survey quality. Data from surveys in 2006 and 2010 were utilized for this study. For both surveys, telephone numbers were randomly selected using the GENESYS list-assisted method *(23)*. The respondent population included all non-institutionalized adults 18 years of age or older who spoke English or Spanish and who resided in households with telephones in the 50 states and the District of Columbia. In households with more than one adult 18 years old or older, the "most recent birthday" method *(33)* was used to select a respondent for the interview.

The total numbers of respondents for the 2006 and the 2010 FSS were 4,539 and 4,568, respectively, and both surveys intentionally over-sampled Hispanic respondents in order to match the distribution of Hispanic survey respondents to the distribution of Hispanics in the population. Using the Response Rate 3 formula developed by the American Association for Public Opinion Research *(36)*, the response rate was 33.8% for the 2006 FSS and 14% for the 2010 FSS. The FDA's Research Involving Human Subjects Protection Committee exempted the surveys from full Institutional Review Board review.

Vegetable and fruit washing questions

A split questionnaire survey design was used in 2006 and 2010 for the vegetable and fruit washing questions to reduce response burden *(30)*. Random assignment to versions was used in both survey years. The limitations of a split survey design are that within-year correlations between questions on separate versions cannot be measured. This design does not mitigate the strengths of the study design, which are that the data are nationally representative and allow us to compare, on average and at the population level, how people's practices vary between years. In the 2006 survey, half of respondents were asked questions about buying and washing strawberries and cantaloupes and the other half were asked about buying and washing tomatoes and bagged, pre-cut lettuce. In 2010, half of respondents were asked about buying and washing tomatoes, cantaloupes, and bagged, pre-cut lettuce and the other half were not asked any questions about washing vegetables and fruits. Questions about strawberries were omitted from the 2010 FSS, since data from the 2006 survey showed little differences between strawberries and tomatoes in purchasing and washing, and no recent, large foodborne illness outbreaks had been associated with strawberries.

Respondents who selected "yes" when asked if they buy a product were then asked if they usually wash or rinse it before they prepare or eat it. Those who said they wash or rinse strawberries, tomatoes, or cantaloupes were asked which one or more of the following washing methods they used: "(1) rub them under running water with a brush, cloth or your hands; (2) hold under running water without rubbing them; (3) soak them in a container of water, or (4) use a cleaner to wash them." Respondents who said they washed bagged, pre-cut lettuce were not asked about washing method. Instead, these respondents were asked "Of all the bags of precut lettuce available at the store, about how many of them contain lettuce that has already been washed?" Response options were "all of them," "most of them," "some of them," or "none of them." These responses were coded into a dichotomous variable with zero being "some" or "none" and one being "all" or "most."

Demographics and food handling questions

We investigated the differences in produce buying and washing by the following demographic characteristics: sex, age, education, and race/ethnicity. Age was coded into two categories: 18 to 45 years old and 46 years and older. These cutoffs were selected because preliminary analyses revealed very few differences within each of these age categories. Education was coded into three categories: (1) less than high school, (2) high school graduate and/or some college, and (3) college degree and higher. Race/ethnicity was coded into three categories: Non-Hispanic White, Non-Hispanic Black, and Hispanic. Those who selected

TABLE 1. Purchasing and washing behaviors and perceptions in 2006 compared to 2010 for selected vegetables and fruits

Question/Response			2006		2010
			%		%
Buys strawberries[1]		(N = 2038)[2,3]	87		~
If buys strawberries:					
Washes strawberries			98		~
If washes strawberries, how:					
Uses Cleaner			4		~
Soaks the fruit			16		~
Holds under running water			43		~
Rubs under running water			37		~
Buys tomatoes	($P < .001$)	(N = 2075)[4]	87	(N = 2102)[5]	93
If buys tomatoes:					
Washes tomatoes	(n.s.)		97		97
If washes tomatoes, how:	($P < .01$)				
Uses Cleaner			7		7
Soak			3		5
Hold under running water			19		17
Rub under running water			71		71
Buys cantaloupes	(n.s.)	(N = 2053)[3]	74	(N = 2094)[5]	74
If buys cantaloupes:					
Washes cantaloupes	($P < .001$)		57		50
If washes cantaloupes, how:	($P < .01$)				
Uses Cleaner			7		10
Soak			3		5
Hold under running water			21		21
Rub under running water			69		64
Buys bagged, pre-cut lettuce	(n.s.)	(N = 2077)[4]	72	(N = 2097)[5]	71
If buys lettuce:					
Washes bagged pre-cut lettuce	($P < .001$)		54		62
Think most/all is washed			65		59

Significance tests are chi-square comparisons between 2006 and 2010.
[1] The 2010 FSS did not include questions about strawberries.
[2] N's are numbers of respondents who answered the question.
[3] Some questions in the 2006 FSS were versioned. Questions about strawberries and cantaloupes were asked in Version 2 of the survey.
[4] Questions about tomatoes and bagged lettuce on the 2006 FSS were asked in Version 1 of the survey.
[5] Some questions in the 2010 FSS were versioned. In 2010 all vegetable and fruit washing questions were in version 2 of the survey.

more than one race/ethnicity or who selected another race/ethnicity were not included in this analysis, because there were too few in each category to make accurate population estimates.

We included a few questions related to general food handling practices that could impact vegetable and fruit washing behaviors as controls in our statistical models predicting washing cantaloupes and bagged, pre-cut lettuce. We included self-reported frequency of hand washing before preparing a meal as a behavioral measure of personal hygiene practices associated with food. "Washes hands" is a dummy variable based on the question: "Before you begin preparing food, how often do you wash your hands with soap? Would you say, all of the time, most of the time, some of the time, or rarely?" "All of the time" was coded as one; all

other responses were coded as zero. All respondents were asked how often they prepared the main meal in their homes, because preparing the main meal all or most of the time is associated with safer food handling behaviors *(8)*. Responses were coded into a dichotomous variable, where "never" and "only some of the time" were coded as zero and "all or nearly all of the time" was coded as one.

Data analysis

Chi-square tests of independence were used, with *P* values less than .05 considered statistically significant, to compare overall purchasing and washing of the vegetables and fruits between 2006 and 2010. Chi-square tests were also used to test for within-year sex differences and for within-sex differences across years for washing lettuce and cantaloupes. The Bonferroni Technique *(47)* was used to adjust for the risk of increased Type I error associated with performing multiple comparisons with the same data. In addition, two logistic regression models, one for men and one for women, were used to explore odds ratios associated with predictors of washing cantaloupes (0 = does not wash, 1 = washes). Similarly, two logistic regression models (men and women) were run for "washes bagged, pre-cut lettuce." Predictors included survey year (2006 = 0, 2010 = 1), demographics, hand washing before preparing meals, and being the main meal preparer. The models for lettuce also included as a predictor whether or not consumers believe that bagged, pre-cut lettuce available in the stores is already washed. Models were not run for washing strawberries (from the 2006 data) or tomatoes, because almost 100% of respondents reported washing these products. The data were weighted to adjust for probability of selection (based on number of telephone numbers and number of adults in the household) and to adjust the sample distributions to demographic distributions of the U.S. Census Bureau Current Population Survey *(38)*. All analyses were performed in Statistical Package for the Social Sciences (IBM SPSS, version 19).

RESULTS

Differences between 2006 and 2010

Table 1 shows the percent of consumers who reported buying and washing strawberries in 2006 (no data were collected on strawberries in 2010) and tomatoes, cantaloupes, and bagged, pre-cut lettuce in both 2006 and 2010. The table also shows the percent of consumers in 2006 and 2010 who reported that they thought that most or all bagged pre-cut lettuce was washed.

Table 1 demonstrates that reported prevalence of buying of each of the four vegetables and fruits in both survey years was high. There was a significant increase in the percent reporting purchasing tomatoes, from 87% in 2006 to 93% in 2010. There were no significant differences in reported purchasing behaviors for cantaloupes or bagged, pre-cut lettuce.

In 2006, nearly all consumers who bought strawberries reported that they washed them, with 37% of those who said they washed reporting that they rubbed the fruit under running water (the recommended method). However, most consumers who washed strawberries said they hold them under running water without rubbing (43%). There was no difference between 2006 and 2010 in the percent of tomato buyers who reported washing them (97%). Similarly, of those who washed tomatoes, there was virtually no difference in the distribution of washing method responses by year. For tomatoes, the overall pattern between years was very similar, despite the significant results of the chi-square test. The majority of consumers (71%) in both years reported washing tomatoes by rubbing while holding under running water, and almost 20% washed tomatoes by holding them under running water without rubbing. Of those who bought cantaloupes, fewer reported washing them in 2010 (50%) than in 2006 (57%). The distribution of responses for cantaloupe washing methods was generally the same for the two years; a large majority in both years washed cantaloupes by rubbing them under running water (69% in 2006 and 64% in 2010) and 21% in both years washed cantaloupes by holding them under water without rubbing. More consumers in 2010 than 2006 reported washing bagged, pre-cut lettuce (54% to 62%). Fewer consumers in 2010 who bought bagged, pre-cut lettuce believed that it was already washed (65% to 59%).

Washing behaviors in 2006 and 2010 by demographic characteristics

An initial analysis (top of Table 2) showed that there are some gender-related differences between 2006 and 2010 in washing behaviors for both cantaloupes and bagged, pre-cut lettuce. A chi-square test of the survey data showed that the percent of women who washed cantaloupe did not change between 2006 and 2010, while the percent of men who washed cantaloupe decreased from 59% to 46%. Although the percent of both men and women who washed bagged, pre-cut lettuce increased from 2006 to 2010, the change was larger for women (50% to 60%) than for men (59% to 64%). The finding of some between-year within-sex differences suggests further examination by sex is warranted. The bottom section of Table 2 shows a within-sex, demographic breakdown of the percent who reported buying and washing cantaloupes and bagged, pre-cut lettuce in 2006 and 2010. The demographic categories are race/ethnicity, age, and education. No demographic analyses are shown for washing strawberries or tomatoes because, as shown in Table 1, almost 100% of consumers who purchased the products reported washing them.

Cantaloupes

As previously stated, there was an overall decline from 2006 to 2010 in the washing of cantaloupes (Table 1). Table 2 gives details about the demographic categories that may account for the decline. For the three demographic categories, race/ethnicity, age, and education, there were no differences in the percentage of women who reported washing cantaloupes in 2006 compared to 2010. For men, on the other hand, there were significant differences in all race/ethnicity categories and some subcategories of age and education. Fewer Non-Hispanic Black men (from 85% to 64%), Hispanic men (from 77% to 60%), and Non-Hispanic White men (from 53% to 40%) reported washing cantaloupes in 2010 than in 2006. For the two age categories, there was a significant reported decline in only the 18 to 45 age group (from 68% to 40%). With regard to education, washing of cantaloupes declined significantly from 2006 to 2010 (from 59% to

TABLE 2. Percent of women and men who reported washing cantaloupes and bagged, pre-cut lettuce by race/ethnicity, age, and education in 2006 and 2010

	Washes Cantaloupes						Washes Lettuce					
	Female			Male			Female			Male		
	2006 (N=837)	2010 (N=844)		2006 (N=664)	2010 (N=705)		2006 (N=784)	2010 (N=759)		2006 (N=694)	2010 (N=721)	
All consumers	56	54	*n.s.*	59	46	***	50	60	***	59	64	†
Race/Ethnicity												
Non-Hispanic Black	69	64		85	64	*	56	74	**	75	92	**
Hispanic	70	65		77	60	**	65	74		71	62	
Non-Hispanic White	51	50		53	40	***	47	55	**	55	61	
Age												
18 to 45	56	55		68	40	***	46	59	***	62	66	
46+	55	53		51	49		52	59		54	63	*
Education												
< High School (HS)	58	61		77	64		73	82		77	74	
HS and Some College	56	54		59	45	***	46	59	***	58	64	
College Graduate or Higher	53	48		51	40		45	53		53	60	

†$P < .05$; * $P < .02$; ** $P < .01$; *** $P < .001$

45%) only among those men with a high school degree and some college.

Lettuce

Table 1 shows a significant increase from 2006 to 2010 in the percent of consumers reporting that they wash bagged, pre-cut lettuce. Table 2 shows which demographic categories account for this increase. Non-Hispanic Black women were significantly more likely to report washing lettuce in 2010 (74%) than in 2006 (56%). There was also a significant increase in the percent of Non-Hispanic White women reporting washing lettuce in the time period (from 47% to 55%). The differences for Hispanic women were not significant. Women in the 18 to 45 age group were significantly more likely to wash in 2010 (59%) than in 2006 (46%). Among education categories, only those women in the middle category, high school degree and some college, reported increased washing of lettuce from 2006 to 2010 (46% in 2006 and 59% in 2010).

For men, only two demographic subcategories had significant increases from 2006 to 2010 in washing bagged, pre-cut lettuce. Non-Hispanic Blacks had a reported increase from 75% in 2006 to 92% in 2010. Lettuce washing increased significantly in the male age category of 46+ (from 54% in 2006 to 63% in 2010).

Predictors of cantaloupes and lettuce washing behaviors

Table 2 describes the changes in washing practices for women and men between 2006 and 2010 by demographic subcategories. One limitation of this analysis is that the percentages reported do not take into account other demographics reported or other variables that may be related to washing cantaloupes and bagged, pre-cut lettuce. Table 3 displays odds ratios from four logistic regression models of consumers who wash cantaloupes and bagged, pre-cut lettuce in 2006 and 2010. Logistic regression models allowed us to control for the independent effects of each predictor on washing the product. We were interested in whether demographic characteristics, other behaviors, and survey years predict washing behaviors.

Cantaloupes

As shown in Table 3, there was no difference in the proportion of women who washed cantaloupes from 2006 to 2010. Non-Hispanic Black and Hispanic female cantaloupe buyers were almost twice as likely as Non-Hispanic White women to wash cantaloupes. There was no age or education difference in the probabilities of women washing cantaloupes. However, female cantaloupe buyers who washed their hands all the time before they began preparing food were about twice as likely to wash cantaloupes as those who did not always wash their hands. Lastly, female cantaloupe buyers who prepare the main meal all, or nearly all, of the time were 1.417 times as likely to wash cantaloupes, compared to female cantaloupe buyers who do not prepare the main meal as often.

The predictors of male cantaloupe buyers who washed cantaloupes were somewhat different from that of female cantaloupe buyers. Male cantaloupe buyers were about half as likely to wash cantaloupes in 2010 compared to 2006. Non-Hispanic Black male cantaloupe buyers were more than three times as likely, and Hispanics almost twice as likely as Non-Hispanic White male cantaloupe buyers to wash cantaloupes in the two survey years. Age did not influence the probabilities of washing cantaloupes for men. Men with less than

TABLE 3. Odds Ratios (OR) for logistic regression models of demographic and behavioral predictors, and the effect of year, for washing cantaloupes and bagged, pre-cut lettuce in 2006 and 2010

	Washes Cantaloupes				Washes Lettuce			
	Female		Male		Female		Male	
Variables	OR		OR		OR		OR	
Year (2006)								
2010	0.912		0.538	***	1.499	**	1.216	
Race/Ethnicity (Non-Hispanic White)								
Non-Hispanic Black	1.813	**	3.104	***	1.346		3.509	***
Hispanic	1.945	***	1.859	***	1.573	*	1.446	*
Age (18 to 45)								
46 y and older	1.042		0.917		1.277	*	0.842	
Education (College graduate plus)								
Less than High School	1.055		2.127	***	2.319	***	1.732	*
HS and Some College	1.203		1.209		1.084		1.061	
Washes hands	1.960	***	2.319	***	3.768	***	1.634	***
Main food preparer	1.417	**	0.921		0.874		0.908	
Thinks lettuce is already washed	~		~		0.278	***	0.488	***

* $P < .05$; ** $P < .01$; *** $P < .001$

a high school diploma were more than twice as likely as male college graduates to wash cantaloupes. Similar to the data on women who washed cantaloupes, men who washed their hands all the time before preparing food were 2.319 times as likely to wash cantaloupes as men who do not wash their hands all the time. For men, preparing the main meal had no effect on the probabilities associated with washing cantaloupes.

Lettuce

The probabilities associated with washing bagged, pre-cut lettuce among lettuce buyers are somewhat different for both women and men from those of washing cantaloupes. For women, there was a greater likelihood of washing bagged, pre-cut lettuce in 2010 than 2006. Women who are more likely to wash lettuce were Hispanic, were age 46 or older, had less than a high school diploma, wash their hands before beginning food preparation, and think the lettuce is not washed. There was no difference for men from 2006 to 2010 in the probability of washing bagged, pre-cut lettuce. Non-Hispanic Black men were 3.509 times as likely as Non-Hispanic Whites to wash lettuce, and Hispanic men were 1.446 times as likely. Those with the lowest education levels were 1.732 times as likely to wash lettuce as those with the highest levels of education. Those who wash hands before beginning food preparation were more likely to wash lettuce, and those who think the lettuce is already washed are about half as likely to wash it.

DISCUSSION

Washing raw vegetables and fruits before consumption may reduce the likelihood of ingesting pathogens, pesticide residues or dirt (*39, 41*). If vegetable and fruit packages do not indicate that the product has already been washed, the FDA recommends washing them by scrubbing (for firm-skinned produce) or rubbing (for delicate-skinned produce) the item while holding it under running water *(41, 44, 46)*.

One of the main findings of this study is that consumers reported different rates of washing vegetables and fruits depending on the type of product. Consumers are more likely to report washing strawberries and tomatoes where the entire product, including the skin, is eaten than to report washing products like cantaloupes that have a hard rind that is discarded prior to eating. The hard, rough skin of the cantaloupe provides a surface to which dirt can easily adhere, and although the skin of the cantaloupe is not typically eaten, a knife passing through the skin can carry dirt or other contaminants from the rind to the flesh *(37)*. Most consumers washed tomatoes using the FDA recommended method, rubbing while holding under running water, but a sizeable number reported they merely held them under running water. Like tomatoes, strawberries are soft skinned and should be cleaned by rubbing while holding under running water. About a third of consumers did that, but almost half reported that they only held them under running water. It is possible that the small size of strawberries likely makes rubbing each fruit difficult or inconvenient. It may be that for products like cantaloupe, consumers believe that not consuming the skin or rind prevents ingestion of pathogens.

Because a number of large, national foodborne illness outbreaks associated with produce occurred between 2006 and 2010, including one implicating cantaloupes from Honduras in 2008 *(40)*, we expected an increase in the number of consumers who washed cantaloupes. In fact, we observed a decrease in the percent of consumers who reported washing

cantaloupes and, equally as important, there was a decrease in the percent who reported scrubbing cantaloupes under running water. It is possible that the reason for the decrease is that the outbreak of *E. coli* O157:H7 from contaminated spinach, which killed three people, received nationwide media attention and caused the public to focus on green, leafy produce *(10)*. The relative importance to consumers of washing cantaloupes, compared with spinach or lettuce, may have declined in that time period. Indeed, there was a large, multi-state outbreak of *Salmonella* Poona associated with consuming cantaloupes from 2000 to 2002, in which there were multiple illnesses and hospitalizations, and two deaths *(5)*. The observed decline from 2006 to 2010 may be reflective of consumers having other produce products to worry about.

The reported increase in washing bagged, pre-cut lettuce may be the result of consumer reaction to the 2006 recall of fresh, raw spinach and other leafy greens, some of which were already prewashed. We also found a decrease in the percentage of consumers who think that bagged, pre-cut lettuce is washed. Ironically, rewashing bagged-precut lettuce introduces the potential for cross-contamination from the consumer's kitchen and would therefore be a more risky behavior than not washing the product *(6, 31)*. In addition, washing would not further decrease contaminants if they were localized within the food rather than on the surface.

We investigated washing behavior by demographic characteristics because other research on consumer food safety handling behaviors has shown that women, individuals with a high school education or less,, and mid-life consumers had safer food handling practices *(1, 8, 19)*. Studies of race/ethnicity differences in food safety handling have not yielded consistent results. Fein et al. *(8)* found that Non-Hispanic Black and Non-Hispanic White consumers had similar food handling behaviors, but that behaviors of Non-Hispanic Whites were safer than those of Hispanics. Patil et al. *(28)* found that behaviors of Hispanics and Non-Hispanic Whites were similar, but worse than those of Non-Hispanic Blacks. Our findings support the literature, but with important differences. We found that Non-Hispanic Black and Hispanic consumers were more likely than Non-Hispanic White consumers to wash cantaloupe (a safe food handling practice). On the other hand, Non-Hispanic Black and Hispanic men and Hispanic women were more likely than their White counterparts to wash bagged, pre-cut lettuce (a less safe practice). Similarly, men with a high school or less education were more likely than men with more education to wash cantaloupe. However, less educated men and women were more likely than their counterparts to wash lettuce. Possibly, Non-whites and consumers with less education make fewer assumptions regarding what produce can be eaten without further washing. Also, those with less education may perceive the risk to be greater should a family member become ill from a foodborne illness, since they may be in jobs less likely to offer sick leave and health insurance than those with higher levels of education.

The nuances of safe food practices may not be easy to convey to consumers, especially when different groups need different targeted information *(13, 24)*. Consumer food safety education efforts should emphasize washing all produce that is not labeled prewashed, but for hard skinned products like cantaloupes, they should focus on why it is important to scrub the products under running water prior to cutting them. Education efforts with regard to cantaloupes could focus particularly on Non-Hispanic White consumers and those with higher education, who as a group are less likely than Non-Hispanic Blacks and Hispanics to wash the fruit. Those with lower education, men, and Non-whites may benefit from campaigns that include information about avoiding washing vegetables that are labeled as already washed. Furthermore, individuals with better hand hygiene practices, those who always wash their hands before preparing foods, may be more aware than others of the need for food safety measures. However, in the case of bagged lettuce, this sensitivity is misguided.

This study has some strengths and limitations. One of the limitations is that the data are self-reported. We rely on consumers' ability to both remember what they do and convey it accurately. Self-reporting is also subject to the desire to give socially desirable responses; an observational study of consumer produce washing showed that far fewer consumers actually wash produce than report doing so in surveys *(29)*. Also, the findings would have been more useful if we had asked consumers why they washed cantaloupes and bagged, pre-cut lettuce. Finally, our survey suffered from the increasingly common problem of low response rates for household surveys, although this does not necessarily bias the survey results. Some of the main strengths of this study are the sampling method, large sample size and weighting strategy, which allows our findings to be representative of the population *(9, 14)*. This allows us to make comparisons at the population level.

Food Safety practices should begin on the farm and be rigorously applied along the entire chain so that food products are safe for human consumption without the need for extraordinary measures. Consumers, however, are the critical endpoint along the food supply chain. Educational efforts with respect to product washing should focus on explaining why it is important to wash hard rind produce such as cantaloupe before cutting, but not rewashing produce that is ready to be eaten.

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