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Developing and Testing Consumer Educational Material at Farmers' Markets

ABSTRACT

Farmers' markets are becoming increasingly popular in communities as a way for consumers to access fresh local produce. Yet, produce remains a commodity implicated in foodborne outbreaks. This study identified, created, and tested the efficacy of educational material at farmers' markets. Formative research with growers and consumers identified an unsafe behavior. A semi-structured interview with growers (N = 6) and an online consumer survey (N = 225) found that consumers demonstrated inconsistent knowledge and behavior towards washing produce. A local artist designed messaging guided by health-literacy principles, using the Centers for Disease Control and Prevention: Clear Communication Index Score Sheet. A posttest-only quasi-experimental design evaluated a 4-week farmers' market intervention. A total of 326 respondents took part in the survey at either the control or experimental sites. The efficacy of the "Wash Your Produce" signage had a modest effect in improving consumer compliance with regard to washing produce right before cooking it or eating it raw. Overall, 40.7% of the respondents perceived organic produce to be less likely to have germs/bacteria that can make people sick. As respondent educational attainment increased, those who indicated they washed produce to remove GMOs decreased. Farmers' markets are an important part of one's community and represent an appropriate location to present consumer food safety education at the point of purchase.

INTRODUCTION

Since 2015, a 2.3% growth in farmers' markets continues to meet consumers' demands for local food and produce nationwide *(6, 21)*. Farmers' markets positively contribute to the local community and increase access to nutritious foods for food-insecure populations *(8)*. The increased access to fresh fruits and vegetables encourages individuals to consume a produce-rich diet and maintain good health *(2)*. However, produce is estimated to contribute to foodborne illnesses (46%) *(23)*. Foodborne pathogens have been isolated on both conventional and organic produce ready for consumers

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to purchase *(33)*, highlighting potential contamination at the farm, during transportation, or at the retail environment to consumers. In the farm-to-fork continuum, consumers represent the "last line of defense" but continually demonstrate unsafe food handling behaviors *(19)*. Since 1988, the Food and Drug Administration (FDA) has continued to document ways in which consumers demonstrate poor knowledge and behavior with regard to produce *(9, 30)*. Other consumer misconceptions regarding organic produce safety *(13)* and pesticide residues *(16)* may make consumers additionally vulnerable to foodborne risks.

Farmers' markets have been the implicated location for several outbreaks and case reports in recent years in the United States *(31)*. Farmers' markets may continue to be a susceptible environment for future outbreaks and cases because of their unique open air environment, people (vendors and customers), and transient infrastructure *(12)*. Even in a best case scenario, food safety education for consumers is scanty at farmers' markets *(29, 31)*. Growers are concerned about the widening disconnect between consumers and their food and want continuing consumer education to ensure safe food handling along the supply chain *(7)*. Farmers' market vendors have brief and meaningful interactions with customers to deliver unique point-of-purchase safe produce handling messages, an activity that is not well studied.

This study involved formative research that provided an evidence-based process to identify a risky consumer produce handling behavior and to address the risk by creating evidence-based educational material(s). The researchers used health literacy strategies to develop the signage, which was then tested in a posttest-only quasi-experimental intervention, to measure the efficacy of the "Wash Your Produce" sign. Formative research was in the form of semi-structured interviews and an online-consumer survey. A semi-structured interview allowed farmers' market vendors to expand on an open-ended questioning route *(11)*. An online-consumer survey consisted of closed-ended items. Surveys are an important tool in food safety studies investigating consumer trends *(9, 31)*. The theme of washing produce was identified and triangulated with literature to strengthen the formative results *(19, 31)*. Signage was chosen as the educational delivery method because of its portability at farmers' markets. Consumer messaging using health literacy strategies would align with being more inclusive of people of low to high health literacy levels. Health literacy, an emerging focus of advancing wellness in America *(1)*, is defined as the ability to understand basic health information and make appropriate decisions *(5)*. Consumers possessing health literacy skills are valuable to food safety educators who want consumers to act upon various food safety messages.

The objectives of the study reported here are to: (1) conduct formative research to triangulate an unsafe consumer produce behavior gap, (2) create evidence-based signage, using health literacy strategies, (3) create resources to support vendors in their efforts to educate consumers on safe food handling, and (4) determine whether "Wash Your Produce" is an effective educational tool at farmers' markets.

MATERIALS AND METHODS

The University of Maryland, College Park Institutional Review Board approved all methods and materials. The study was implemented in three parts. Part one was the formative research (semi-structured vendor interviews and consumer online survey); part two was developing the educational materials; and part three was piloting the efficacy of the signage "Wash Your Produce."

Part one: Semi-structured interviews with farmers' market vendors

For all six semi-structured interviews, the researcher followed a pre-scripted questioning route designed to lead a 20-minute conversation. Questions were bundled into several categories about the vendor's business, food safety, and consumer messaging. Examples of questions asked include "How long have you been selling at farmers' markets? Do customers ever ask you food safety questions in relation to your produce and if so, what are their main concerns? Do you have enough time to talk to them?" A vendor, Extension-agriculture agent, and produce-consumer specialist reviewed the questioning guide for face validity *(25)* prior to the semi-structured interview.

During January 2016, vendors from local farmers' markets were recruited by word of mouth to participate in a semi-structured interview. Vendors were eligible if they identified themselves as (1) being 18 years of age or older; (2) selling fresh produce at a farmers' market, and (3) willing to hold the interview over the phone or at the researcher's office. Handwritten notes documented the conversations to enhance grower privacy, and there was no participant compensation.

Part one: Online consumer survey development and dissemination

Emerging themes from the semi-structured interviews with farmers' market vendors were further explored in a 5-minute consumer online survey that consisted of 15 Likert and/or multiple-choice items. Key questions were guided by the semi-structured interviews and literature, which focused on: (1) consumer values (e.g., cleanliness), (2) food safety knowledge, (3) food safety behavior, (4) barriers to behavior, (5) cues to action, (6) material delivery, and (7) demographics *(19, 30)*. Key questions helped researchers further identify the unsafe produce handing behavior, to reduce consumers' barriers to engage in the recommended behavior, identify possible cues to action, determine whether a subset of the population required specific targeting, and ascertain what delivery method was appropriate. An Extension-agri-

culture agent and two Department of Agriculture employees reviewed the survey for face validity *(24)*. The survey was adjusted as an online consumer survey using the Qualtrics™ platform (Qualtrics, Provo, UT).

Surveys were administered between February and April 2016, using convenience sampling by way of an academic and an amateur-athletic club ListServs. These ListServs reached the entire state. Participants self-enrolled if they identified themselves as (1) being 18 years of age or older and (2) purchasers of fresh produce two or more times a year at one of the state's farmers' markets.

Part one: Data analysis

A final report presented the common themes vendors believed their customers lacked in terms of safe produce handling knowledge and behavior. Survey analysis used IBM SPSS Statistics version 24.0 (IBM Corp., Armonk, NY, USA), to test whether a difference would be observed between graduate degree as the referent group. The one individual who responded "don't know/refused" to the question about educational attainment was removed. Educational attainment was chosen as the referent group because a previous meta-analysis by Patil et al. observed that individuals with an education beyond high school reported a larger difference between their knowledge and safe food handling behavior, compared with individuals of other demographic categories *(24)*. Race/ethnicity was collapsed, so that for purposes of analysis, the Hispanic ethnicity included Hispanic African American and/or Black, and Hispanic-Caucasian, White. A codebook was created, and nonparametric tests consisted of cross tabulations, chi-square, Fisher's exact test, and frequencies, where a *P*-value of $P < 0.05$ was significant.

Part two: Developing the farmers' market educational material

Results of the formative research and a literature search indicated that the educational signage needed to be created around washing produce. A local artist was hired to illustrate and design the "Wash Your Produce" signage *(Fig. 1)*. The objectives of the evidence-based signage was to: (1) create a visually appealing food safety message that would not be offensive or threatening to a vendor's business; (2) explain the "Why's" and "How's" of washing produce; (3) be inclusive to all races/ethnicities; (4) show a variety of produce; and (5) show credible logos of state entities. The design team kept several health literacy strategies in mind: (1) use plain language, (2) accommodate cultural differences, (3) use clear messaging, and (4) make it easy to read *(22, 28)*.

To ensure that the signage was of high quality, the Modified CDC Clear Communication Index Score was used to assess the signage. The score sheet consists of four parts, with a total of 13 items that weighted to total a score of 100. The score sheet examines: (1) core, (2) behavioral recommendations, (3) numbers, and (4) risk *(4)*. Four separate reviewers used the score sheet, a health literacy specialist, grower/vendor, Extension agent, and produce-consumer specialist provided their comments for final modifications.

To help promote the recommended behavior, a combination scrub brush-peeler had the credible logos of state entities printed on them and were used as a consumer give-away for vendors while supplies lasted (100 scrub brush-peelers per vendor) *(15)*.

Part three: Piloting the "Wash Your Produce" signage

The signage was evaluated in a posttest-only quasi-experimental design; the ability to control the flow of farmers' market patrons in a city is not feasible, because of individuals' unique food procurement practices *(27)*. Two control and two intervention farmers' markets were identified. The intervention sites received the signage and brush/peeler for display over a four-week period between August and September 2016. The control sites would not display any of the educational materials over the same four-week period but would receive the signage and brush/peeler afterwards. Market managers helped communicate with the vendors that display of the signage and brush/peelers was voluntary, and the items were to be displayed only at these particular farmers' markets until a certain date. This was necessary because some vendors were out of state or worked multiple farmers' markets in the area throughout the week. Control and intervention farmers' markets were matched as well as possible, based on the city's demographic data, and were fairly equivalent (data not shown) *(15)*.

Part three: Development and administration of the post-survey

A post-intervention survey was created for control and intervention farmers' market sites. The control survey for consumers consisted of 15 items, while the intervention survey consisted of 21 items. The control survey took about 2–5 minutes to complete, while the intervention survey took about 3–7 minutes to complete *(15)*. Both surveys used Likert, yes/no, and multiple-choice items. Surveys were similar in that they were both based on the existing literature, asking about produce perceptions, washing habits, self-efficacy to wash, knowledge of washing, and demographics *(19, 30, 32)*, and were to be administered face to face *(15)*. The intervention survey had additional questions to evaluate the signage and the washing message. The compensation for completing either the control or intervention survey was a $5 token that respondents could use at the farmers' market *(15)*. For statistical analysis to be performed a total of 170 completed surveys from the control (n = 85 completed surveys per farmers' market) and intervention (n = 85 completed surveys per farmers' market) farmers' markets were predetermined before the four-week intervention period began.

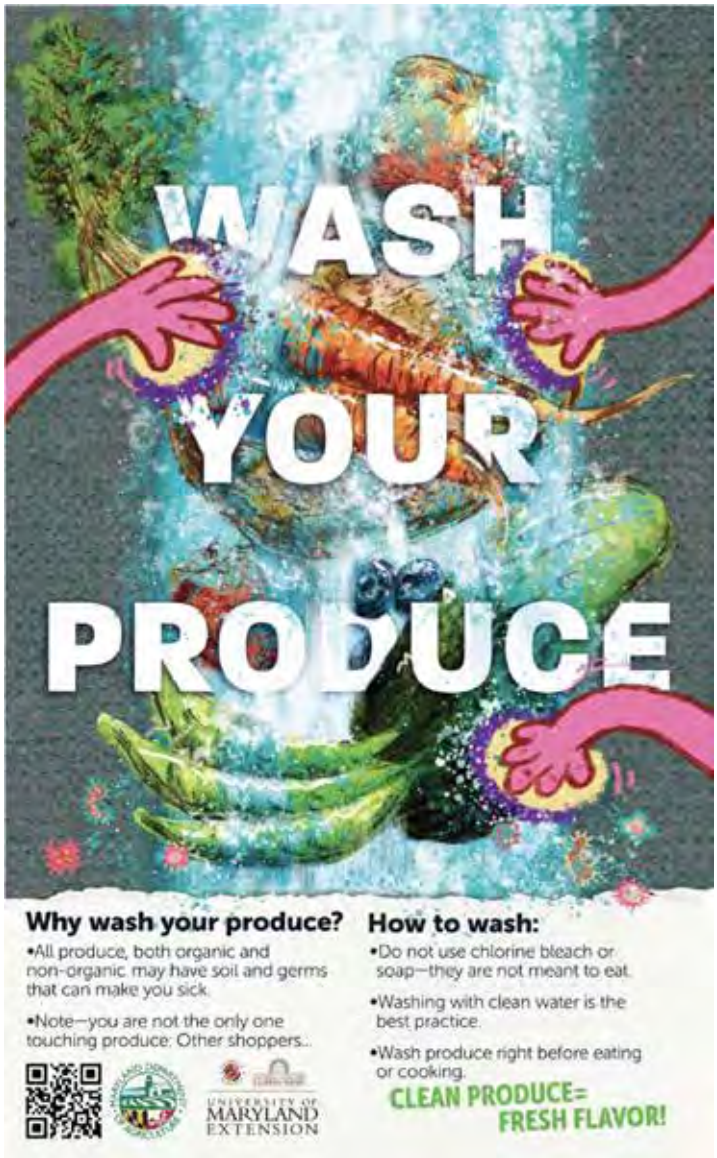

Figure 1. A 12 by 18 inch sign used to educate consumers at farmers' markets about why and how to wash produce.

Sampling parameters to determine statistical significance were the same as in Henley et al. *(14)*.

At the end of the four-week intervention, face-to-face surveys with patrons were administered *(15)*. Patrons qualified for the control survey if they: (1) were 18 years or older, (2) prepared meals using produce, (3) had not attended the intervention farmers' markets in the past month, and (4) had not previously completed the farmers' market survey. Patrons qualified for the intervention survey if they: (1) were 18 years or older, (2) prepared meals using produce, (3) had not completed the farmers' market survey, and (4) had not attended the current farmers' market in the past month.

Part three: Data analysis

All analyses for piloting the efficacy of the signage used R version 3.1.0 (www.r-project.org).

To estimate the impact of the signage on the self-reported washing behavior of respondents at farmers' markets, the responses were examined for "washing produce before eating raw" and "washing produce before cooking," using the Wilcoxon-Mann-Whitney rank sum. The responses for these questions were given on a scale of 1–5, with 1 being most unlikely to wash and 5 being most likely to wash.

Perceptions were examined for differences between organic and non-organic produce in carrying germs/bacteria that could make people sick. For individuals across all sites,

this perception score used questions 1 and 2 on the survey, which asked how likely are organic and non-organic produce to have germs/bacteria that could make people sick. These questions are reported on a scale of 1 to 5, again with 1 being "Not at all likely" and 5 being "Very likely". The perception score took 3 values (-1, 0, 1): 0 represented no difference in scores reported in questions 1 and 2. A score of 1 meant that an individual reported a higher score for non-organic produce than for organic produce, while a score of -1 meant an individual reported a higher score for organic produce than for non-organic produce with regard to the likelihood of a food carrying germs/bacteria that could make people sick.

Respondent-reported reasons for washing produce were examined, particularly with regard to whether respondents washed produce to remove genetically modified organisms (herein referred to as GMOs) and pesticide residues. Logistic regression was used to determine the association between education as the dependent variable and washing to remove GMOs. Logistic regressions were further fitted to both dichotomous outcomes, using categorized education level as the dependent variable. Education is denoted 1 for high school or less; 2 for more than high school but less than bachelors; 3 for bachelors; and 4 for graduate degree. Based on a study by Patil et al., which reported a larger difference between safe food handling and knowledge by education *(24)*, education was the focused respondent characteristic, and this was supported by the formative results.

Last, safe produce handling at the farmers' market was explored, using cross tabulation. Likert scale responses between 1 and 5 were collapsed. A value of 1 meant it was equal to 1–2 (not very likely-not likely), 2 meant it was equal to 3 (neither unlikely or likely), and 3 meant it was equal to 4–5 (likely-very likely); a *P*-value of $P < 0.05$ was significant.

RESULTS

Part one: Semi-structured interviews

Semi-structured interviews took place in January 2016. A total of six vendors participated. Vendors represented organic and conventional farming operations, varying in farmers' market experience (7–44 years), gender (two females), and Good Agricultural Practices Certification (one certification).

Vendors felt they had time to talk to customers during most market events. Customers valued this personal interaction as part of their purchase. Vendors were accustomed to volunteering safe food handling messages to their customers and shared personal anecdotes of their advice being met with mixed reactions, ranging from appreciation to disgust and disbelief. In general, vendors felt customers wanted to learn how to prepare, store, and handle foods safely. Topics that most customers did not fully understand were: (1) sprays and pesticides, (2) GMOs, (3) food safety risks associated with organic produce, and (4) best practices for handling and storing produce. Vendors observed customers eating just-purchased produce in front of them without washing it, or bringing produce back to the vendor a week later because they did not store it appropriately. Vendors mentioned that signs would help address customer questions if they were too busy to talk to customers. When asked to describe those who inquired about safe produce handling, it was typically "women with young kids" and young educated "foodies." The themes of GMOs, pesticide, and safe produce handling were further investigated by means of an online consumer survey.

Part two: Survey results

A total of 230 questionnaires were completed from February to April 2016. Gender identification as "Other" was excluded from analysis, lowering the total number for data analysis to 225.

The majority of respondents identified themselves as female (84.2%, n = 187) *(Table 1)* and held an advanced degree (62.2%, n = 140). The majority of respondents reported having a household total income of $75,000 and above (57.8%, n = 130), followed by responses of "don't know/ refused" (16.0%, n = 36), and $50,000–$74,999 (13.8%, n = 31). The majority identified as White, Caucasian, Non-Hispanic (69.3%, n = 156). However, age was evenly distributed, with no age group representing a majority *(Table 1)*.

Farmers' market characteristics

When survey respondents were asked about various characteristics that were extremely important to them when visiting a farmers' market, those with some college or less were more likely to value recipes (16.7%, n = 2) and price (50.0%, n = 6) *(Table 2)*. Respondents with a college degree were more likely to value the community atmosphere (49.3%, n = 36) and the nutritional value of produce (69.4%, n = 50)) *(Table 2)*. Respondents across all educational levels felt that the flavor of produce procured at farmers' markets was extremely important (92.8%, n = 205).

Food safety

Overall, most respondents did not actively look for food safety recommendations at the farmers' market (16.1%, n = 36), especially those with a graduate degree *(Table 3)*. Respondents were also mindful to keep raw meat and fresh produce in separate bags (80.4%, n = 180). When asked if they eat unwashed produce at the farmers' market, 18.7% (n = 42) said they do *(Table 3)*. Several respondents cited that:

Farmers' market food is all clean, natural, and healthy I assume… Not worried about bacterial contamination on stone fruit/apples… because I eat raw unwashed produce out of my garden to see if it is tasty, I do the same at farmers' markets... only if offered as a sample and I see workers are using precaution.

TABLE 1. Respondent (n = 225) demographics to an online consumer survey about farmers' markets

Demographic characteristics	Some College or Less n (%)	Associate/BS degree n (%)	Graduate degree n (%)	Total n (%)
	Education level of farmers' market respondents[a]			
Education	12 (5.3)	73 (32.4)	140 (62.2)	225 (100.0)
Gender				222 (100.0)
Female	9 (81.8)	64 (87.7)	114 (84.2)	187 (84.2)
Male	2 (18.2)	9 (12.3)	24 (15.8)	35 (84.2)
Age				225 (100.0)
18–34	1 (8.3)	13 (17.8)	23 (16.4)	37 (16.4)
35–44	1 (8.3)	11 (15.1)	25 (17.9)	37 (16.4)
45–54	1 (8.3)	17 (23.3)	28 (20.0)	46 (20.4)
55–64	5 (41.7)	16 (21.9)	27 (19.3)	48 (21.3)
65+	4 (33.0)	12 (16.4)	33 (23.6)	49 (21.8)
Don't know/refused	0 (0.0)	4 (5.5)	4 (2.9)	8 (3.6)
Race/ethnicity				225 (100.0)
African American, Black, Non-Hispanic	0 (0.0)	6 (8.2)	11 (7.9)	17 (7.6)
White, Caucasian, Non-Hispanic	9 (75.0)	47 (64.4)	100 (71.4)	156 (69.3)
Hispanic, Caucasian and African American	1 (8.3)	5 (6.8)	13 (9.3)	19 (8.4)
Other, Don't know	2 (16.7)	15 (20.5)	16 (11.4)	33 (14.7)
Income				22 (100.0)
< $24,9999	2 (16.7)	4 (5.5)	1 (0.7)	7 (3.1)
$25,000–$49,999	3 (25.0)	9 (12.3)	9 (6.4)	21 (9.3)
$50,000–$74,999	6 (50.0)	14 (19.2)	11 (7.9)	31 (13.8)
$75,000+	1 (8.3)	35 (47.9)	94 (67.1)	130 (57.8)
Don't know/refused	0 (0.0)	11 (15.1)	25 (17.9)	36 (16.0)

[a]Percentages cumulated down a column based on the number of completed responses from each educational level, and varied among items.

A significant difference ($P < 0.05$) was observed when respondents were asked if they rinse produce from the farmers' market right before they prepare to eat it raw and, in another question, when asked if they wash produce from the farmers' market right before they cook it. Those with a graduate degree, compared with respondents with some college or less, were more likely to wash produce *(Table 3)*. Respondents said "I always wash, sometimes in vinegar water…I always wash and disinfect all produce!" Respondents felt that remembering to wash produce before they ate or cooked it would be easier if they cared more about the potential health risks of not washing produce (58.1%, n=18) and understood why they should wash produce (35.5%, n = 11) *(Table 3)*.

Few respondents were unsure about storing produce in or outside of the refrigerator (8.9%, n = 19). However, respondents felt appropriately storing produce would be easier to remember if they had the knowledge of why they should refrigerate certain items (51.3%, n = 20). Visual prompts (23.1%, n = 9) *(Table 3)* and caring more about potential health risks (12.8%, n = 5) (data not shown) were possible solutions for positive behavior change.

TABLE 2. Characteristics of farmers' markets that respondents (n = 225) value as extremely important

	Education level of farmers' market respondents[a]			
Consumer values: Extremely important	**Some College or Less n (%)**	**Associate/BS degree n (%)**	**Graduate degree n (%)**	**Total n (%)**
Convenient location	7 (58.3)	47 (64.4)	94 (67.1)	148 (65.8)
Ability to talk to vendor	4 (33.3)	28 (38.4)	40 (28.8)	72 (32.1)[b]
Community atmosphere	4 (36.4)	36 (49.3)	47 (33.8)	87 (39.0)[c]
Supporting local farms	10 (83.3)	64 (87.7)	113 (81.3)	187 (83.5)
How produce is grown	4 (33.3)	50 (68.5)	81 (57.9)	135 (60.0)
Cleanliness	9 (75.0)	58 (79.5)	110 (78.6)	177 (78.7)
Tasting samples	2 (16.7)	14 (19.2)	21 (15.1)	37 (16.5)
Recipes	2 (16.7)	3 (4.1)	7 (5.0)	12 (5.3)
Price	6 (50.0)	33 (45.2)	52 (37.4)	91 (40.6)[b]
Nutritional value	5 (41.7)	50 (69.4)	68 (48.9)	123 (55.2)[d]
Flavor	11 (91.7)	71 (97.3)	123 (90.4)	205 (92.8)[d]

[a]Percentages cumulated down a column based on the number of completed responses from each educational level, and varied among items.

[b]Calculated as a percent of 224 respondents, versus 225 respondents.

[c]Calculated as a percent of 223 respondents, versus 225 respondents.

[d]Calculated as a percent of 221 respondents, versus 225 respondents.

Respondents stated that signs (38.1%, n = 82) would be the favored way to receive produce recommendations at the vendor's table, followed by recipes (14.9%, n = 32) *(Table 3)*, followed by direct education and/or talking to the vendor (9.8%, combined n = 21, data not shown).

Part three: Efficacy of "Wash Your Produce"

A total of 326 surveys were completed from August to September 2016. The demographics of respondents at the control and intervention farmers' market were different ($P < 0.05$), for race/ethnicity, age, education, and income, but not gender *(Table 4)*. More respondents in the control farmers' market had received a HS/GED (n = 54; 34.6%), compared with the intervention farmers' market respondents who had completed a graduate degree (n = 70; 42.4%). More respondents in the control farmers' market were older (55+ years, n = 64; 41.0%), compared with intervention site respondents (55+ years, n = 39; 23.6%) *(Table 4)*. The majority of the control farmers' market respondents identified as Black, African American, Non-Hispanic (n = 84; 55.3%), whereas the intervention farmers' market respondents mainly identified as White, Caucasian, Non-Hispanic (n = 101; 62.0%). Income was evenly distributed among control farmers' market respondents, while intervention farmers' market respondents skewed towards an income of $50,000 and higher (20.1–48.2%) *(Table 4)*.

Results of survey items that addressed respondents' safe produce handling behaviors *(Table 5)* did not differ with regard to the likelihood of respondents, from either the control or intervention sites, to wash raw produce right before they ate it raw (90.1% versus 88.0%) and before cooking it (88.1% versus 87.4%) *(Table 5)*. Respondents at the intervention sites were more likely (although the difference was not statistically significant) to eat produce at the farmers' market without washing it first (but this did not include free tastings) (26.9%), compared with the control site respondents (15.9%) *(Table 5)*.

Of 166 respondents at the two intervention sites, 40 saw the intervention signage (24.1%), and 123 did not; three did not respond. Treating the response variables as numeric, averages were slightly higher for likeliness-to-wash scores for both variables among respondents who observed the intervention signage than for those who did not (4.63 versus 4.50 for "washing before eating" and 4.60 versus 4.47 for "washing before eating" and "washing before cooking," respectively). Wilcoxon-Mann-Whitney rank sum tests reveal that neither difference is statistically significant ($P = 0.41$ and $P = 0.67$ for "washing before eating" and "washing before cooking," respectively).

Of 326 respondents surveyed across all four sites, 155 (48.1%) had the same perception for organic versus non-

TABLE 3. Respondent (n = 225) knowledge, motives, and educational delivery method preferences for safe produce handling at farmers' markets

	Education level of farmers' market respondents[a]			
Food Safety Knowledge and Behavior	**Some College or Less n (%)**	**Associate/BS degree n (%)**	**Graduate degree n (%)**	**Total n (%)**
Health seeking behaviors				
Do you look for food safety recommendations at the farmers' market? yes	3 (25.0)	16 (21.9)	17 (12.2)	36 (16.1)[b]
Food safety knowledge				
Do you know what produce to refrigerate? yes	11 (91.7)	61 (84.7)	125 (89.3)	197 (87.9)[b]
Do you know when to refrigerate produce? yes	9 (81.8)	60 (84.5)	111 (79.9)	180 (81.4)[c]
Storing produce is challenging to me because I: Don't know what produce is stored in our out of refrigeration	2 (16.7)	6 (8.7)	11 (8.3)	19 (8.9)[e]
Food safety behaviors				
Do you keep produce in a separate shopping bag from eggs, raw meat, and/or raw seafood? yes	10 (83.3)	56 (76.7)	114 (82.0)	180 (80.4)[b]
Do you eat raw unwashed produce at the farmers' market? yes	3 (25.0)	14 (19.2)	25 (17.9)	42 (18.7)
Do you wash or rinse your produce from the farmers' market right before you prepare to eat it raw?* yes	7 (63.6)	70 (95.9)	134 (95.7)	211 (94.2)[b]
Do you wash or rinse your produce from the farmers' market right before you prepare to cook it?* yes	8 (66.7)	68 (94.4)	136 (97.1)	212 (94.6)[b]
Cues to action				
Remembering to wash produce before I eat or cook it would be easier if I: Cared more about the potential health risks of not washing my produce	2 (66.7)	8 (66.7)	8 (50.0)	18 (58.1)[d]
Remembering to wash produce before I eat or cook it would be easier if I: Had the knowledge of why I should wash	1 (33.3)	4 (33.3)	6 (37.5)	11 (35.5)[d]
Storing produce would be easier for me to remember if I: Had the knowledge of why I should refrigerate certain produce	1 (50.0)	6 (42.9)	13 (56.5)	20 (51.3)[e]
Storing produce would be easier for me to remember if I: Had visual prompt	0 (0.0)	3 (21.4)	6 (26.1)	9 (23.1)

Continued on next page

TABLE 3. Respondent (n = 225) knowledge, motives, and educational delivery method preferences for safe produce handling at farmers' markets (cont'd)

	Education level of farmers' market respondents[a]			
Food Safety Knowledge and Behavior	Some College or Less n (%)	Associate/BS degree n (%)	Graduate degree n (%)	Total n (%)
Delivery methods for produce handling at farmers' markets				
How would you like to receive produce recommendations at your vendor's stand? Signs	3 (25.0)	27 (38.0)	52 (39.4)	82 (38.1)
How would you like to receive produce recommendations at your vendor's stand? Recipes	3 (25.0)	11 (15.5)	18 (14.9)	32 (14.9)

[a]Percentages cumulated down a column based on the number of completed responses from each educational level, and varied among items.

[b]Calculated as a percent of 224 respondents, versus 225 respondents.

[c]Calculated as a percent of 221 respondents, versus 225 respondents.

[d]Calculated as a percent of 31 respondents.

[e]Calculated as a percent of 39 respondents.

*Significant differences ($P < 0.05$) between some college and less, compared with Graduate degree. Percentages were calculated by the number of respondents who reported their behavior out of the total number of respondents in that group that gave a response, and excluded responses of "don't know" or refused to respond.

organic produce, 131 (40.7%) reported that organic produce is less likely to have germs/bacteria that could make people sick, and 36 (11.2%) reported the opposite; four were non-responses *(Fig. 2)*.

Last, 105 (32.2%) respondents reported washing produce to remove GMOs. In the fitted logistic regressions, a decreasing trend was seen with increasing levels of education (44.4%, 39.2%, 27.8%, and 20.5% for less than or equal to high school, more than high school, bachelor's, and graduate degree, respectively). The difference in proportions compared with the referent education level of high school or less is statistically significant at the 0.05 level for those with bachelor's degrees and graduate degrees ($P = 0.035$ and $P = 0.0014$, respectively) *(Fig. 3)*.

Overall, 269 (82.5%) of respondents reported washing their produce to remove pesticide residues. When a logistic regression was performed, using education as the dependent variable, an increasing trend with increasing education was observed (70.8%, 84.8%, 86.1%, and 87.5% for the ordered education categories, respectively). In the logistic regression with education of high school or less as baseline, the increases of the three other groups relative to this baseline are all statistically significant at the 0.05 level ($P = 0.041$, $P = 0.025$, and $P = 0.01$ for more than high school, bachelor's, and graduate degrees, respectively) *(Fig. 4)*.

DISCUSSION

This study is one of the few food safety studies to focus on consumer education at farmers' markets. It also highlights consumers' lack of knowledge regarding food production. Overall, using formative research to guide the development of evidence-based signage, using health literacy strategies, is an effective means of encouraging modest behavior change in purchasers at farmers' markets. The outcome was a resource provided to vendors to help them educate and encourage consumers about washing produce.

Washing produce is an important message *(30, 31)* but becomes more complex when considering for various surface conditions (smooth vs. netted), and the efficacy of best washing practices. Fishburn et al. used several consumer produce cleaners on different produce, finding running tap water resulted in the greatest reduction of bacterial contamination *(10)*, which supports the current

TABLE 4. Respondent (n = 326) demographics of a farmers' market pilot intervention

Demographic characteristics	Control sites n (%) [a]	Intervention sites n (%) [a]	Total n (%)
Education[b]			321 (100.0)
Less than HS	8 (5.1)	0 (0.0)	8 (2.5)
HS/GED	54 (34.6)	11 (6.7)	65 (20.2)
Technical and some college	36 (23.0)	21 (12.7)	57 (17.8)
BS/Associate degree	38 (24.4)	63 (38.2)	101 (31.5)
Graduate degree	18 (11.5)	70 (42.4)	88 (27.4)
Don't know/refused	2 (1.3)	0 (0.0)	2 (0.6)
Gender			321 (100.0)
Female	111 (71.2)	111 (67.3)	222 (69.2)
Male	45 (28.8)	53 (32.1)	98 (30.5)
Other/Missing	0 (0.0)	1 (0.6)	1 (0.3)
Age[b]			321 (100.0)
18–24	29 (18.6)	10 (6.1)	39 (12.1)
25–34	21 (13.5)	56 (33.9)	77 (24.0)
35–44	13 (8.3)	35 (21.2)	48 (15.0)
45–54	27 (17.3)	25 (15.2)	52 (16.2)
55–64	38 (24.4)	22 (13.3)	60 (18.7)
65+	26 (16.6)	17 (10.3)	43 (13.4)
Don't know/refused	2 (1.6)	0 (0.0)	2 (0.6)
Race/ethnicity[b]			315 (100.0)
Black, African American, Non-Hispanic	84 (55.3)	39 (23.9)	123 (39.0)
White, Caucasian, Non-Hispanic	42 (27.6)	101 (62.0)	143 (45.4)
White, Caucasian, Hispanic	9 (5.9)	9 (5.5)	18 (5.7)
Black, African American, Hispanic	4 (2.6)	4 (2.5)	8 (2.5)
Other, Don't know	13 (8.6)	10 (6.1)	23 (7.3)
Income[b]			317 (100.0)
< $15,000	39 (25.5)	8 (4.9)	47 (14.8)
$15,000–$24,999	21 (13.7)	7 (4.3)	28 (8.8)
$25,000–$49,999	23 (15.0)	29 (17.7)	52 (16.4)
$50,000–$74,999	27 (17.6)	33 (20.1)	60 (18.9)
$75,000+	23 (15.0)	79 (48.2)	102 (32.2)
Don't know/refused	20 (13.1)	8 (4.9)	28 (8.8)

[a]Percentages cumulated down a column based on the number of completed responses from each site, and varied among items.

[b]Significant difference ($P < 0.05$) between control and intervention sites. Percentages were calculated on the basis of the number of respondents who reported their demographic information.

TABLE 5. Produce handling behavior between respondents (n = 326) at control and intervention sites

Survey items on produce handling behavior: Likely response	Control sites n (%) [a]	Intervention sites n (%) [a]	Total n (%)
How likely is it that you wash your produce right before you eat it raw?[b]	144 (90.1)	146 (88.0)	290 (89.2)[c]
How likely is it that you wash your produce right before you cook it?[b]	141 (88.1)	145 (87.4)	286 (87.7)
How likely is it that you eat produce at the farmers' market without washing it first, not including free tastings?[b]	25 (15.9)	44 (26.9)	69 (21.5)[d]

[a]Percentages cumulated down a column based on the number of completed responses from each site, and varied among items.

[b]Likert scale responses between 1 and 5 were collapsed. A value of 1 meant it was equal to 1–2 (not very likely–not likely), 2 meant it was equal to 3 (neither unlikely nor likely), and 3 meant it was equal to 4–5 (likely–very likely).

[c]Calculated out of 325, versus 326 respondents.

[d]Calculated out of 321, versus 326 respondents.

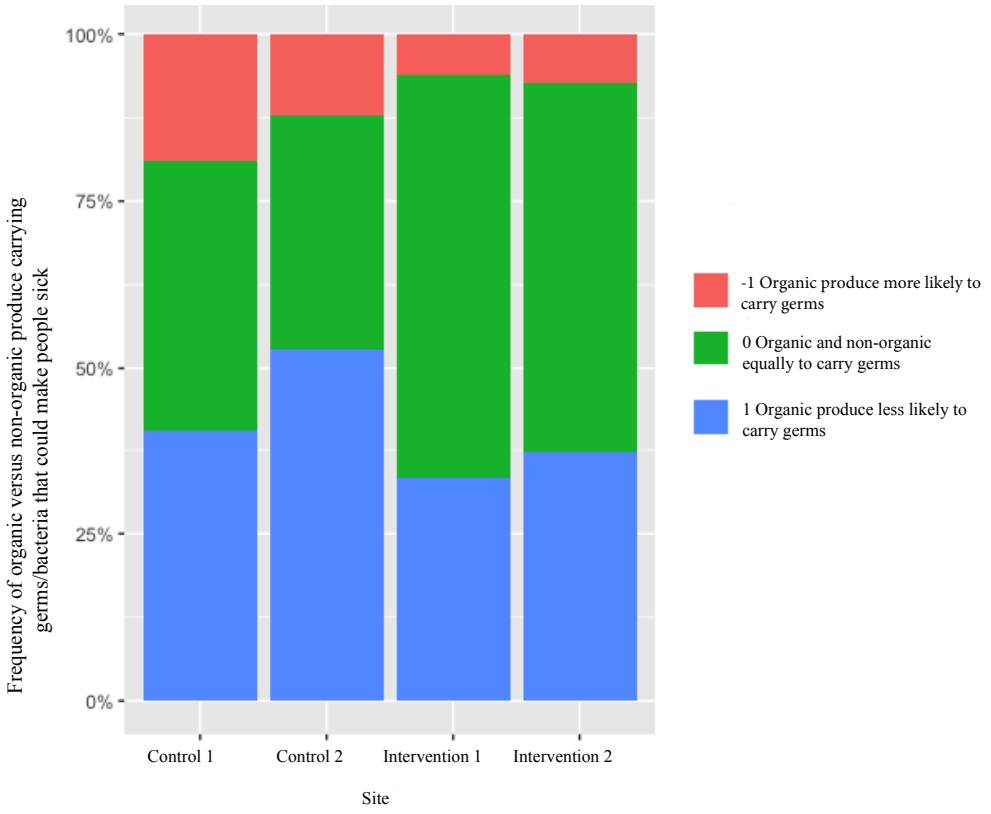

Figure 2. Difference in respondents' perception of the likelihood of organic versus non-organic produce to carry germs/bacteria that could cause illness. A score of 1 means that the individual believes organic produce are less likely to carry germs/bacteria (-1 meaning the opposite).

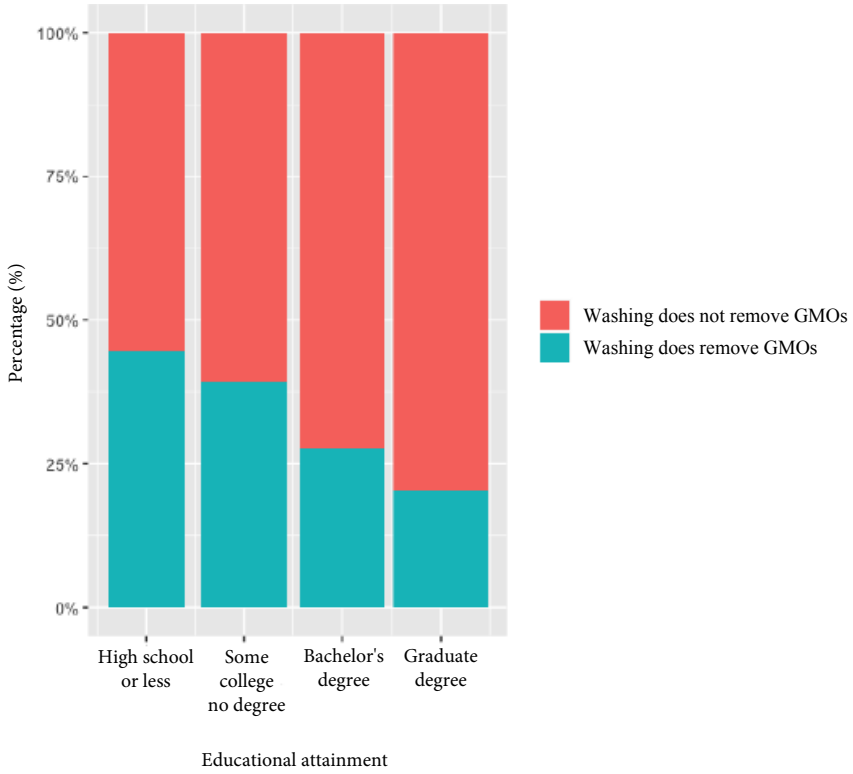

Figure 3. Respondents' washing of produce to remove GMOs. There was an inverse trend of increasing levels of education to knowing that washing produce does not remove GMOs (44.4%, 39.2%, 27.8%, and 20.5% for less than or equal to high school, more than high school, bachelor's, and graduate degree, respectively).

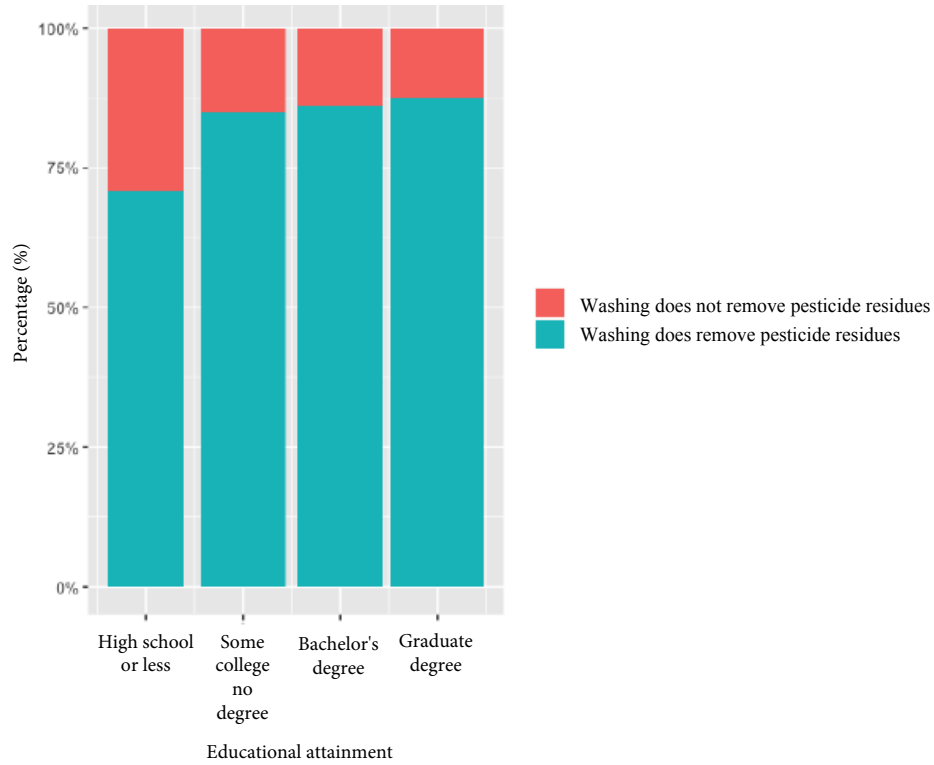

Figure 4. Respondents' washing of produce to remove pesticide residues from produce. There was a trend of increasing education to washing produce to remove pesticide residues (70.8%, 84.8%, 86.1%, and 87.5% for the ordered education categories, respectively).

FDA recommendation for consumers *(3)*. This study provided consumers more context behind the message to satisfy human curiosity by addressing why they should wash produce with only water and how to wash produce, to encourage sustainable behavior change.

About half of respondents believed that organic produce was less likely to have germs/ bacteria that could make people sick. This bias toward the safety of organic produce could cause consumers to modify their safe handling behavior, potentially leaving them vulnerable to foodborne illness. Organic produce and foods have been implicated in outbreaks *(13)*. The prevalence of microbial contamination on organic and conventional produce is relatively low, but risk still exists, and results on studies of whether organic is safer than conventional produce are inconclusive *(33)*. Extension educators can help address consumers' false assumptions on safety *(12, 26)* and quality *(32)* regarding local and organic produce/foods. Tobin et al. suggest emphasizing to consumers a grower's adherence to Good Agricultural Practices *(26)* and presumably the Produce Safety Rule as programs that promote produce quality. Market managers rarely ask about vendors' growing practices *(12)*, and our study showed that very few consumers attend a farmers' market for food safety information. Encouraging a shift in social norms for both market managers and consumers to ask vendors about their growing practices can improve a consumer's knowledge of food production and of general risks related to raw produce.

Respondents' knowledge gaps were illustrated by their perceptions of washing produce to remove GMOs and pesticide residues. Studies involving home food preparation to remove residues on produce demonstrated that home products could not fully eliminate residues, after soaking times of up to 20 minutes. This amount of (soak) time is not realistic for home cooks *(20, 34)* in view of consumers' notions of time poverty when preparing meals *(27)*. There is an outreach need to explain why and how GMOs and pesticides are used in food production, for the purpose of dispelling popular consumer assumptions.

Formative research showed that both market vendors and survey respondents preferred signs for delivery of educational messages at farmers' markets. Both groups acknowledged that consumers eat unwashed produce at farmers' markets and do not always wash produce prior to eating it raw or cooking it at home. These findings reflect national trends of poor adherence to recommendations on produce washing *(17–19, 30)*. The FDA encourages washing produce under clean running water and using a brush for firm produce *(3)*, but this study observed barriers to full compliance. Creating and implementing policies to include food safety education for consumers at farmers' markets at the point of purchase with vendors or at the market manager's table can start a dialogue that is important to many consumers.

Despite both vendors and online consumer survey respondents preferring signage as a delivery method for information about produce handling at farmers' markets, few respondents at the intervention farmers' markets saw the signage. A limitation to the study was that vendors at the intervention farmers' markets could choose where to display the "Wash Your Produce" signs, which changed patrons' ability to view the sign easily. Another reason why few respondents (24.1%) saw the signage was that the intervention sites could be excessively stimulating to them, with the 15-plus vendors, high foot traffic, and multiple items for sale. Even with these constraints, the signs were modestly effective for those who saw the sign about washing produce right before it is eaten raw and before it is cooked. However, more studies on consumer education at farmers' markets are necessary to identify a successful dissemination method for sustainable behavior change. Signs are relatively low cost, but the placement and how they are used at a farmers' market could be more effective than this study anticipated.

Another limitation was a difference in demographics of the respondents at the control and intervention farmers' markets, which could have affected the outcomes in how respondents handle produce. This study was also limited in its ability to explore what commodities farmers' market patrons wash, because there are known differences in how the general U.S. population handles and washes different produce *(17)*. Even with a broader scope of washing produce in this study, findings on safe food handling were consistent with those in the literature *(19, 30)*. Future studies could compare washing knowledge and safe food handling behaviors between smooth (e.g., tomatoes), rough (e.g., cantaloupe), leafy greens (e.g., kale), and root (e.g., carrots) commodities.

Strengths of the educational material was that the signage used health literacy strategies that were appropriate for diverse audiences. Using a magenta skin tone in the artwork reduced the risk of making any race/ethnicity group feel singled out with regard to not washing produce. Similarly, the artwork included regional fruits and vegetables, so a single commodity could not be misinterpreted as "unsafe" and hurt a vendor's sales.

Farmers' markets remain a positive community event capable of nourishing and supporting the community at large. Having safe food handling materials for vendors and the market manager can reinforce safe food handling messages, through signs or by including safe food handling information in recipes. Research that leads to the development of consumer resources should include more context as to the why's and how's of that behavior, to allow consumers to make informed decisions about their food handling behaviors.

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