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# Financial Incentives Increase Purchases Of Fruit And Vegetables Among Lower-Income Households With Children

**ABSTRACT** The high cost of fruit and vegetables can be a barrier to healthy eating, particularly among lower-income households with children. We examined the effects of a financial incentive on purchases at a single supermarket by primary shoppers from low-income households who had at least one child. Participation in an in-store Cooking Matters event was requested for incentivized subjects but optional for their nonincentivized controls. The sample included but was not limited to Supplemental Nutrition Assistance Program participants. Compared to the controls, incentivized shoppers—who were given an immediate 50 percent discount on qualifying fruit and vegetables—increased weekly spending on those items by 27 percent; this change was for fresh produce. There was no change in purchases of frozen and canned produce or unhealthful foods. Estimated annual average daily consumption of fruit and vegetables by the incentivized shoppers and by one designated child per incentivized household did not change. Attendance at Cooking Matters events was low. These findings support financial incentive programs to increase fruit and vegetable purchasing but suggest that effective complementary approaches are needed to improve diet quality.

Poor diet is the leading cause of obesity, cardiovascular diseases, diabetes, and many cancers in the US.<sup>1,2</sup> These diseases place a tremendous burden on the health care system, with annual medical and economic costs of obesity alone estimated to be \$1.42 trillion.<sup>3</sup> Although there have been small improvements over the past decade, the average US diet is poor, and it is worse among people of lower income.<sup>4,5</sup> This socioeconomic gap has only widened over time, in part because consuming a healthful diet rich in fruit and vegetables is cost prohibitive for many low-income households.<sup>4,6,7</sup> The lowest-income children and adults have a disproportionately high prevalence of diet-related dis-

eases, which contribute to significant disparities in health, well-being, and opportunities for economic mobility.<sup>8,9</sup> Improving diet quality is widely seen as a key priority for preventing chronic diseases and reducing health care costs, but evidence on effective interventions is limited.

Interventions that target households are needed to promote sustained healthful dietary behaviors, especially for children.<sup>10</sup> Preferences for fruit and vegetables develop in early childhood and are heavily influenced by availability in the home, maternal dietary intake, and parental modeling of healthful behaviors.<sup>10,11</sup> Exposure to fruit and vegetables in infancy shapes preferences in later childhood.<sup>12,13</sup> Young children may require up to fifteen exposures to vegetables be-

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fore these foods are accepted, and the risk of financial loss in the form of food waste is often too much for low-income households to bear.<sup>7,14,15</sup> Programs and policies that remove financial barriers to purchasing fruit and vegetables hold potential for increasing their consumption by children.

To address the affordability of a healthful diet and rising prevalence of diet-related diseases, Congress has taken legislative action to test programs that better align the Supplemental Nutrition Assistance Program (SNAP) with the Dietary Guidelines for Americans.<sup>16</sup> In fiscal year 2017 SNAP provided food benefits to more than forty million low-income Americans, nearly half of whom were children.<sup>17</sup> The Food, Conservation, and Energy Act (Farm Bill) of 2008 authorized the Healthy Incentives Pilot, which tested a 30 percent rebate on fruit and vegetable purchases and led to a 26 percent increase in daily produce consumption among SNAP participants over one year.<sup>18</sup> The Healthy, Hunger-Free Kids Act of 2010 transformed SNAP's voluntary nutrition education program by allowing states to direct nutrition education funds toward policies, systems, and environmental changes that prevent obesity. The 2014 Farm Bill provided \$100 million in mandatory funding for the Food Insecurity and Nutrition Incentive grant program to support programs that provide SNAP participants with financial incentives for the purchase of fruit and vegetables. However, many of these efforts—other than the Healthy Incentives Pilot—have not been rigorously evaluated, and most Food Insecurity and Nutrition Incentive programs are in farmers markets, where sustained uptake of incentives is low.<sup>19</sup>

Before investments are made in nationwide changes to SNAP, researchers, advocates, and policy makers have called for further study of price incentives as a strategy for promoting healthy dietary behaviors.<sup>20–22</sup> In this randomized controlled trial we tested the effects of a multifaceted supermarket incentive and in-store education intervention on the food purchases and dietary consumption of lower-income households with children, including households participating in SNAP, over eight months. This trial built on a pilot study that demonstrated increased purchases of fruit and vegetables but did not combine financial incentives with nutrition education or measure consumption.<sup>23</sup> The current study adds to the literature by integrating financial incentives into a supermarket point-of-sale system, combining incentives with nutrition education to encourage increased fruit and vegetable intake, using loyalty card scanner data to evaluate changes in purchases over time, examining the effects of incentives on purchases

of fruit and vegetables and of unhealthful foods, and providing incentives to both SNAP participants and nonparticipants to reduce unintended stigma among SNAP participants and to compare responses among households participating in SNAP to responses among households of higher socioeconomic status. We hypothesized that the intervention would increase household purchases and consumption of fruit and vegetables, with larger effects among SNAP participants compared to nonparticipants.

## Study Data and Methods

**STUDY POPULATION AND SAMPLE SELECTION** We enrolled shoppers at one large supermarket in rural Maine during the period October 8–22, 2016. The study store was selected based on an existing relationship between its chain and the research team, the lower income of the clientele at that store compared to other stores in this chain, geographic proximity to the research team, and cooperation from the store manager. Eligibility criteria included being an adult, living with at least one child age eighteen or younger, being the primary shopper in the household, reporting doing at least 50 percent of grocery shopping at the study store, and reading and understanding English. Consenting participants were enrolled in the supermarket's loyalty program and given a study loyalty card containing their name, loyalty number, and a barcode providing a 5 percent discount on all purchases made at the study store throughout the study period. The 5 percent discount was available to all study participants, whether they were in the control or the intervention group, and was intended to incentivize shopping at the study store and using the loyalty card. Subjects were instructed to show the card when checking out to receive the 5 percent discount and were told not to share the card. At baseline and follow-up, the primary shopper completed a dietary assessment on behalf of themselves and one reference child in the household (the youngest child in the household ages 6–10 or the child closest to that age range).

The University of New England Institutional Review Board provided human subjects approval for this project on November 20, 2015, and the trial was registered at [clinicaltrials.gov](http://clinicaltrials.gov) (No. NCT02975232).

**DOUBLE-DOLLAR INCENTIVE AND NUTRITION EDUCATION** Subjects' purchases were tracked during a baseline period of no intervention (that is, there was no double-dollar incentive or nutrition education for anyone beyond the universal 5 percent discount). This lasted from each subject's date of enrollment through December 31,

2016. On January 1, 2017, subjects were randomly assigned to the intervention or control group using 1:1 randomization based on the last digit (4 or 5) of the barcode on the study loyalty card. Loyalty cards were randomly sorted before distribution at enrollment, and cards were distributed sequentially as subjects enrolled. During the intervention period (January 1–June 30, 2017, hereinafter referred to as “follow-up”), the intervention group received a double-dollar (that is, 50 percent off) incentive to buy fresh, frozen, or canned fruit and vegetables, up to \$10 per transaction. All fresh produce was eligible for the incentive; frozen and canned items were eligible if labeled with at least two Guiding Stars—a shelf-tag nutrition rating system that has been used in the study store since 2006 and that labels most food in the supermarket with zero (least healthy) to three (healthiest) stars.<sup>24</sup> When subjects in the intervention arm made a purchase, a coupon providing 50 percent off their eligible fruit and vegetables, up to \$10, was printed. Cashiers were instructed to scan the coupon before totaling the transaction so that shoppers received an instant rebate on their eligible purchases (for more details about the coupons, see the online appendix).<sup>25</sup> We notified subjects of their assignment via their preferred form of communication (for example, text message) and sent reminders to all participants once monthly to use the study loyalty card and the double-dollar incentive (intervention arm only).

The intervention also included a nutrition education event called Cooking Matters, which was held at the study store.<sup>26</sup> The Cooking Matters curriculum included education about food shopping and preparation (emphasizing the use of fruit and vegetables) at four stations. For this study, twelve identical Cooking Matters events were held at various times of day and on different days of the week. These sessions were open to the public. Subjects assigned to the intervention arm were asked to attend at least one event and were sent reminders the day before each session. Subjects assigned to the control group were not asked to attend and were not sent reminders by the study team, but they were free to attend if they wished to. Attendees tracked their attendance at each station by getting stamps on a “passport,” which was returned in exchange for an educational book, shopping bag, and \$10 gift card to the study store. All attendees received these gifts, regardless of their participation in the study or assigned group.

#### **DATA AND MEASURES**

► **ENROLLMENT SURVEY:** All subjects completed an enrollment survey, including questions about sociodemographic characteristics (household size, number of children in the household,

age, race/ethnicity, sex, and household income), height, weight, prior participation in SNAP’s voluntary nutrition education program, and current participation in SNAP.

► **DIETARY ASSESSMENT:** We assessed the dietary intake of each subject and one reference child in the household at baseline (questionnaires administered in October–December 2016) and follow-up (questionnaires administered after the intervention ended in July–September 2017) using validated adult and child semiquantitative food frequency questionnaires.<sup>27,28</sup> Subjects reported the frequency of consuming foods over the past twelve months, with frequencies ranging from less than once per month to six or more times per day. The reference child’s intake was reported by the primary shopper. For each completed questionnaire, subjects were sent a \$20 gift card for purchases at the study store.

► **HOUSEHOLD PURCHASES:** Purchases were tracked at the item level via universal product codes (UPCs) on packaged items and product look-up (PLU) codes for loose, fresh produce entered by cashiers at checkout. Purchases were linked to households via loyalty number.

► **OUTCOMES:** The primary outcomes were change in mean weekly spending per household on eligible fresh, frozen, or canned fruit and vegetables from baseline to follow-up in the intervention compared to the control group, obtained through retail scanner data; and change in estimated annual mean daily consumption of half-cup servings of fruit and vegetables per primary shopper and reference child from baseline to follow-up in the intervention compared to the control group, obtained through food frequency questionnaires. The results are presented overall and stratified by type (fruit or vegetable) and degree of processing (fresh versus frozen or canned). Secondary outcomes included the change in household weekly spending on unhealthy foods and beverages: sugar-sweetened beverages; sweet breads, cookies, and cakes; sweet and salty snacks; frozen desserts; candy; red meat; processed meat; pizza; and alcohol. These categories include foods and nutrients that the Scientific Report of the 2015 Dietary Guidelines Advisory Committee recommended limiting.<sup>1</sup>

**STATISTICAL ANALYSIS** We categorized item-level scanner data into food groups and summed spending in each food group by week for each household. One week of the study was excluded because it spanned the baseline and intervention periods. If subjects did not scan their loyalty cards in a given week, we assumed \$0 was spent on all food groups for that week. We calculated mean weekly spending during the ten-week baseline period and the twenty-five-week interven-

tion period for each food group, and we calculated baseline to follow-up differences by subtracting each subject's measures for each period. We used independent sample *t*-tests with unequal variances to test for differences in means between intervention groups. Subjects who did not scan their loyalty cards at least once during the baseline and once during the intervention period were excluded from the analysis. The final analytic sample included 456 households (75 percent of those initially enrolled; 239 in the intervention group and 217 in the control group) (appendix exhibit A1).<sup>25</sup>

We conducted subgroup analyses stratified by SNAP participation. Participants were coded into mutually exclusive subgroups, with any subjects who reported participating in SNAP or who used SNAP benefits at the study store (information obtained from scanner data) coded as SNAP participants (72 in the intervention and 78 in the control groups), and others coded as non-participants (167 and 139, respectively). Because Cooking Matters participation was very low in the intervention group (12 percent) and several participants assigned to the control group attended a Cooking Matters session (4 percent), we also conducted a per protocol analysis among a subgroup of participants who received the full intended intervention. This sample included 237 subjects assigned to the intervention group who received the financial incentive and attended Cooking Matters ( $n = 29$ ) and subjects assigned to the control group who did not receive the financial incentive and did not attend Cooking Matters ( $n = 208$ ). We calculated the cost of the intervention per household per week by summing the cost of incentives and dividing the result by the number of subjects assigned to the intervention who shopped during the intervention ( $n = 239$ ) and by the average number of weeks shopped during the intervention (14.2).

Baseline and follow-up food frequency questionnaires were matched to each primary shopper and reference child by loyalty number. We converted frequencies of consuming fruit and vegetables into numbers of half-cup servings per day and summed them. Subjects without complete data for both questionnaires were excluded (for more details about data cleaning, see the online appendix).<sup>25</sup> The final analytic sample for the questionnaire analysis included 317 primary shoppers (52 percent of those initially enrolled; 166 in the intervention and 151 in the control groups) and 309 reference children (51 percent; 161 and 148 in the respective groups). We used independent sample *t*-tests with unequal variances to test for differences in means between intervention groups. Analyses were conducted in SAS, version 9.4.

## We found no evidence that the intervention group used financial savings to purchase other, less healthful foods or beverages.

**LIMITATIONS** This study had limitations. First, our analysis of purchases was limited to those made by subjects who shopped during the intervention, and our analysis of consumption was limited to subjects who returned both the baseline and follow-up food frequency questionnaires. However, there were no demographic differences between responders and nonresponders by intervention arm.

Second, we could not measure purchases outside of the study store. Although we enrolled subjects who reported doing most of their grocery shopping at the study store at baseline, shopping patterns may have shifted because of the intervention.

Third, the questionnaire used a long reference period (twelve months) and was administered at different times of year at baseline and follow-up. The longer reference period was intended to better capture usual diet but may have diluted the effects of the intervention. Subjects may have overestimated their consumption at follow-up (because consumption of fruit and vegetables is highest in summer), which could have limited our ability to detect differences between groups.

Fourth, Cooking Matters participation was very low (12 percent for the intervention group and 4 percent for the control group), so our reported intervention effects primarily reflect exposure to the price incentive.

Fifth, only 82 percent of incentives were issued and redeemed because of coupon system outages that occurred during one week in February, four days in March, and one day in May. The outages may have influenced subjects' confidence that they would reliably receive the incentive each time they shopped and biased results toward the null. Similarly, it is unclear whether incentives administered through a supermarket loyalty program would operate in the same manner as incentives administered through SNAP. However, the study mimics incentives provided through the electronic benefit transfer card, with

which SNAP participants receive a rebate on eligible purchases rather than coupons for future redemption.

Finally, given the sociodemographic characteristics of our study participants, it is unclear how generalizable the results might be to different populations.

## Study Results

**SUBJECT CHARACTERISTICS** We enrolled 605 primary shoppers with children in the study. Most primary shoppers were non-Hispanic white and female, nearly one-third participated in SNAP, and nearly half had incomes at or below 185 percent of the federal poverty level (exhibit 1). There were no significant differences in sociodemographic characteristics between the intervention and control groups. Enrolled subjects made 15,328 transactions during the study (data not shown). Of these transactions, 4,180 were eligible for a fruit and vegetable incentive, and 3,432 eligible transactions resulted in the receipt and use of the incentive (82 percent of eligible transactions). On average, participants shopped about once a week (mean: 0.96; standard deviation: 0.78) and spent \$81.42 (SD: \$85.30) per transaction. The incentives disbursed totaled \$20,097, or \$5.92 per household per week.

**MEAN WEEKLY FRUIT AND VEGETABLE SPENDING** At baseline, mean weekly spending per household on eligible fresh, frozen, or canned fruit and vegetables was \$10.64 in the intervention group and \$10.59 in the control group (exhibit 2). The intervention was associated with a mean \$2.83 increase (standard error: \$1.04) in weekly spending on fruit and vegetables (exhibit 3), equivalent to a 27 percent increase per household per week. This association was driven by increased spending on fresh produce (mean: \$2.83; SE: \$1.02). There was no change in spending on frozen or canned fruit and vegetables (mean: \$0.00; SE: \$0.08).

In subgroup analyses, we found a significant increase in mean weekly fruit and vegetable spending among SNAP nonparticipants (mean: \$2.72; SE: \$1.29) (exhibit 3). Among SNAP participants, who spent less on fruit and vegetables at baseline (weekly means: \$6.22 in the intervention group and \$3.59 in the control group) (exhibit 2), the intervention was associated with a large relative increase in spending on fruit and vegetables (45 percent), but this change did not reach statistical significance (mean: \$2.82; SE: \$1.92) (exhibit 3). In the per protocol analysis, the full intervention (that is, the financial incentive plus participation in Cooking Matters) was associated with a mean \$4.68 increase (SE: \$1.80) in weekly spending on fruit and vegeta-

bles (exhibit 3), but baseline weekly spending on fruit and vegetables was much higher among Cooking Matters attendees (mean: \$13.82), compared to all participants (exhibit 2).

**OTHER SPENDING AND CONSUMPTION PATTERNS** We observed no association between the intervention and changes in estimated annual average daily consumption of fruit and vegetables among primary shoppers or reference children (exhibit 3). This was true when we examined effects by subgroup and for specific fruit and vegetable types (for example, citrus fruit and leafy greens). There was no evidence of differences in spending on any unhealthful food category between the intervention and control groups (exhibit 4).

## Discussion

In this randomized controlled trial, a same-day supermarket double-dollar incentive on the purchase of fresh, frozen, or canned fruit and vegetables combined with nutrition education in the

### EXHIBIT 1

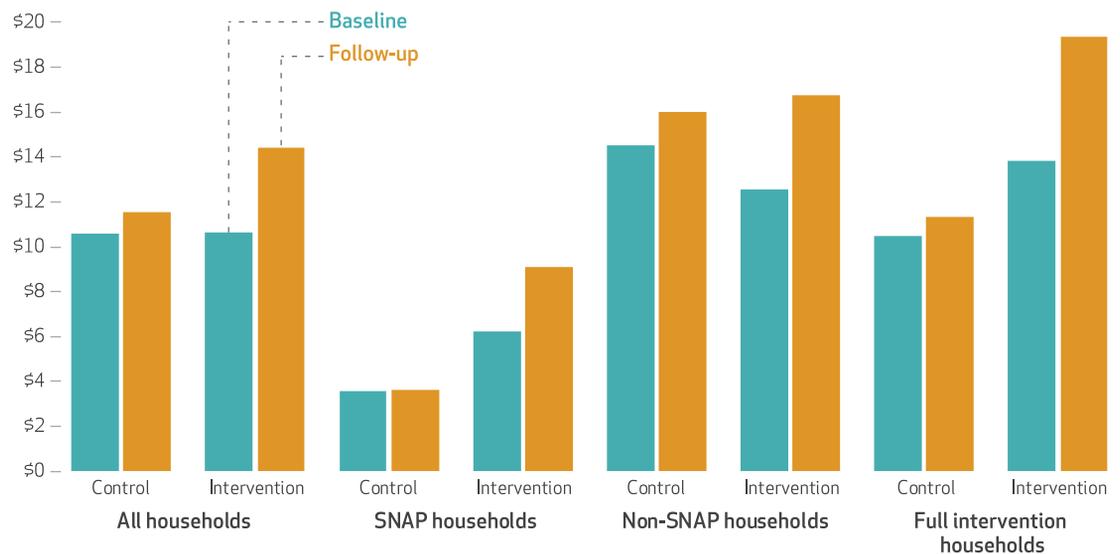
**Baseline sociodemographic characteristics of participants in the study of fruit and vegetable purchase incentives, by assigned intervention arm**

	All (N = 605)	Intervention (n = 313)	Control (n = 292)
<b>HOUSEHOLD CHARACTERISTICS</b>			
Mean size	4.0	3.9	4.0
Mean number of children	1.9	1.9	1.9
Mean number of children younger than age 5	0.7	0.7	0.7
Income as percent of FPL (number) <sup>a</sup>			
100% or less	145	72	73
101-185%	131	66	65
186-300%	168	90	78
More than 300%	106	56	50
SNAP participation (number) <sup>b</sup>	191	92	99
<b>PRIMARY SHOPPER CHARACTERISTICS</b>			
Mean age (years)	37.1	37.4	36.9
Mean BMI (kg/m <sup>2</sup> )	29.0	28.8	29.2
Female (number)	505	257	248
Non-Hispanic white (number)	551	288	263
Previous SNAP-Ed participation (number)	19	10	9

**SOURCE** Authors' analysis of enrollment survey data. **NOTES** The baseline period was October-December 2016. There were no significant differences between the intervention and control groups ( $p < 0.05$ ). The intervention included a 50 percent discount (up to \$10 per transaction) on eligible fresh, frozen, or canned fruit and vegetables at the study store and attendance at one nutrition education event (called Cooking Matters) at the store. Some households and shoppers were missing data on sex ( $n = 10$ ), body mass index (BMI) ( $n = 92$ ), children younger than age five ( $n = 22$ ), household size ( $n = 8$ ), age ( $n = 13$ ), race/ethnicity ( $n = 25$ ), SNAP-Ed participation ( $n = 2$ ), and income as a percentage of the federal poverty level (FPL) ( $n = 55$ ). SNAP is Supplemental Nutrition Assistance Program, and SNAP-Ed is SNAP's voluntary nutrition education program. <sup>a</sup>If annual income was reported, the percentage of FPL was calculated by dividing the median of the annual household income category by the annual FPL for the household size in 2016. If only weekly income was reported, the median of the income category was multiplied by 4.35 to obtain monthly income, which was divided by the monthly FPL for the household size in 2016. <sup>b</sup>Defined as having reported participating in SNAP at enrollment or using SNAP benefits at the study store.

## EXHIBIT 2

Mean weekly spending on fruit and vegetables per household, by intervention arm, study population, and time period



**SOURCE** Authors' analysis of supermarket scanner data. **NOTES** The intervention arms included the 150 households that participated in the Supplemental Nutrition Assistance Program (SNAP) (intervention) and the 306 households that did not (control). Of the 456 households, 237 were included in the per protocol analysis. This sample included subjects assigned to the intervention group who received the full intended intervention—receipt of the financial incentive and attendance at a Cooking Matters event ( $n = 29$ )—and subjects assigned to the control group who did not receive the financial incentive and did not attend Cooking Matters ( $n = 208$ ). The baseline period was October–December 2016. The follow-up period was January–June 2017.

store was associated with a 27 percent increase in spending at the study store on these foods among households with children, driven by increases in purchases of fresh produce. Importantly, we found no evidence that the intervention group used financial savings to purchase other, less healthful foods or beverages. We saw a significant increase in spending on fruit and vegetables among SNAP nonparticipants and a similar increase in spending among SNAP participants, though this was not statistically significant—possibly because of sample-size limitations (only 32 percent of the analytic sample participated in SNAP). Despite strong evidence for increased purchasing, the intervention was not associated with a significant change in reported fruit and vegetable consumption among primary shoppers or reference children.

**POSSIBLE REASONS FOR UNCHANGED FRUIT AND VEGETABLE CONSUMPTION** There are several reasons why we might have seen changes in recorded purchases of fruit and vegetables but not in reported consumption. There may have been small changes in consumption that were not detectable because of the limitations of our dietary assessment tool (that is, the timing of the baseline and follow-up periods, the precision of consumption categories, and the length of the reference period). Indeed, previous studies have observed changes as small as one quarter-cup-

equivalent serving per person per day—which, with about a 50 percent response rate to the follow-up food frequency questionnaire, our study was not powered to detect.<sup>18,29</sup>

Alternatively, it is possible that there was truly no change in dietary intake. This was primarily a purchasing intervention; few participants attended Cooking Matters. Thus, participants may have increased fruit and vegetable purchases at the study store but reduced purchases elsewhere; or purchases may have increased overall, but the additional items either went to waste or were used to feed others in the household whose intake was not assessed.

In the future, multiple twenty-four-hour dietary recalls would provide a more precise measure of changes in dietary consumption.

**COOKING MATTERS ATTENDANCE** As noted above, effects of the intervention primarily reflect the effects of the purchase incentive because only 12 percent of the intervention group and 4 percent of the control group attended any Cooking Matters session. The low attendance was disappointing, particularly given the number of opportunities to attend, frequent reminders from the research team, and the opportunity to earn an additional \$10 incentive. However, these findings are reflective of participation in the SNAP voluntary nutrition education program's many options, in which fewer than

**EXHIBIT 3**
**Change in mean weekly spending on and estimated annual average daily consumption of fruit and vegetables from baseline to follow-up period, by intervention arm and study population**

	Intervention	Control	Difference
Change in mean weekly household purchase of fruit and vegetables (\$) (n = 456)			
Overall	3.79	0.96	2.83***
By type of produce			
Fruit	2.18	0.48	1.70**
Vegetables	1.61	0.48	1.13**
By degree of processing			
Fresh	3.75	0.92	2.83***
Frozen or canned	0.04	0.04	0.00
By household SNAP participation			
Participants (n = 150)	2.87	0.05	2.82
Nonparticipants (n = 206)	4.19	1.47	2.72**
Among recipients of the full intervention (n = 237)	5.55	0.87	4.68***
Change in estimated annual mean daily consumption of fruit and vegetables by primary shopper (half-cup servings) (n = 317)			
Overall	-0.30	-0.04	-0.26
By household SNAP participation			
Participants	0.88	0.43	0.46
Nonparticipants	-0.74	-0.23	-0.51
Among recipients of the full intervention (n = 167)	-0.08	0.03	0.11
Change in estimated annual mean daily consumption of fruit and vegetables by reference child (half-cup servings) (n = 309)			
Overall	0.05	0.27	-0.22
By household SNAP participation			
Participants	-0.11	0.40	-0.51
Nonparticipants	0.11	0.22	-0.11
Among recipients of the full intervention (n = 164)	-0.02	0.27	-0.29

**SOURCE** Authors' analysis of supermarket scanner data and food frequency questionnaires. **NOTES** The baseline period was October–December 2016. The follow-up period was January–June 2017. Responses to questions on the food frequency questionnaire reflect each participant's average consumption over the twelve-month period prior to questionnaire administration (baseline questionnaires were administered in October–December 2016, and follow-up questionnaires were administered in July–September 2017). The intervention is explained in the notes to exhibit 1. Not all members of the intervention group received the full intervention; the notes to exhibit 2 provide details about specific intervention and control groups. Significance was determined by t-tests for independence of means. SNAP is Supplemental Nutrition Assistance Program. \*\* $p < 0.05$  \*\*\* $p < 0.01$

15 percent of SNAP recipients participate.<sup>30</sup> For those who did attend a Cooking Matters session, the intervention had a much larger effect. Because this group was self-selected, it is difficult to know whether effects were induced by Cooking Matters or were related to this group's baseline propensity to purchase more fruit and vegetables and thus a probable propensity to increase their purchases with any intervention.

**BUILDING ON PREVIOUS RESEARCH** This study extends knowledge of the impact of pricing strategies on the food choices of people with lower incomes, and of SNAP participants in particular. First, this study is one of the first to use objective, loyalty card–linked scanner data within a randomized trial to assess the effects of financial incentives on the purchases of lower-income families. Prior studies in supermarkets have used receipt collection or have lacked a control group.<sup>18,31,32</sup> The use of scanner data allowed us to look at changes in spending on other, unhealth-

**EXHIBIT 4**
**Change in mean weekly spending on unhealthful foods and beverages from baseline to follow-up period, by intervention arm**

	Intervention	Control	Difference
Sugar-sweetened beverages	\$0.10	-\$0.23	\$0.33
Candy	-0.14	-0.29	0.14
Sweet breads, cookies, and cakes	-0.68	-0.73	0.05
Frozen desserts	0.18	0.06	0.13
Sweet and salty snacks	0.32	0.38	-0.06
Pizza	-0.05	-0.06	0.01
Red meat	-0.83	-0.72	-0.11
Processed meat	0.06	0.25	-0.19
Alcohol	0.13	-0.27	0.40

**SOURCE** Authors' analysis of supermarket scanner data. **NOTES** The baseline period was October–December 2016. The follow-up period was January–June 2017. The intervention is explained in the notes to exhibit 1. There were no significant differences between groups ( $p < 0.05$ ), as determined by t-tests for independence of means.

ful foods and beverages within the study store, which we found was not affected by the incentive. Second, we were able to examine the effects of the incentive among households participating in SNAP compared to nonparticipating households. We found that the incentives worked well for both groups. Financial incentives could benefit many customers if retailers chose to implement them as a means of increasing the number of loyal customers and overall sales. Third, we were able to integrate the incentive into an existing supermarket point-of-sale system, which demonstrates feasibility for retailers that might wish to implement similar programs. Although 18 percent of the incentives were not redeemed because of system outages, the redemption rate (82 percent) was substantially higher than the average rates reported by industry (7 percent) and higher than the rate in our prior pilot study (53 percent).<sup>23,33</sup> In the future, implementing incentives directly through the SNAP electronic benefit transfer system would likely minimize confusion and increase utilization.

Three prior randomized trials have found benefits of financial incentives for purchasing fruit and vegetables on the purchases and dietary intake of SNAP participants. The Healthy Incentives Pilot randomly assigned approximately 55,000 SNAP households in one county in Massachusetts to receive a 30 percent rebate on fruit and vegetables over one year, and the study found a 26 percent (quarter-cup-equivalent) increase in fruit and vegetable consumption and a small reduction in refined grain intake.<sup>18</sup> Our study, which offered a 50 percent incentive, found a nonsignificant 45 percent increase in fruit and vegetable purchases among SNAP participants, which suggests that larger incentives may lead to larger effects. A trial in Minnesota enrolled adults who were income eligible or nearly so for SNAP into a SNAP-like program that provided benefits each month on a debit card. Participants randomly assigned to receive a 30 percent rebate on fruit and vegetables increased whole-fruit consumption over the sixteen-week study, compared to those assigned to a control arm. Participants who received the incentive combined with restrictions on purchasing sugary foods and beverages had greater improvements in total diet quality.<sup>29</sup> In our pilot randomized trial, a double-dollar incentive increased household spending on fruit and vegetables by \$1.83 per week over four months, with larger increases for SNAP-eligible than for ineligible households.<sup>23</sup> Collectively, research consistently

demonstrates that incentives are associated with positive outcomes for lower-income households, with no evidence of harmful effects on other aspects of the diet.

### Policy Implications

Findings from this study support continued funding for SNAP incentive programs. However, future policies and interventions should address the high cost of providing incentives and their limited effects on consumption. Future research should prioritize testing alternative means of delivery (for example, fruit and vegetable prescriptions) that target the low-income people who may be most likely to benefit, regardless of SNAP participation; identifying the optimal incentive level and delivery system (that is, same-day discounts versus future rebates); and assessing the synergistic effects of incentives and restrictions, which could have a larger effect on diet than incentives alone. The 2018 Farm Bill provides opportunities to test many of these strategies. For example, \$20 million was allocated to Harvesting Health Pilot Projects, which provide financial incentives to purchase fruit and vegetables to low-income people with diet-related diseases through health care settings. In theory, these programs could be sustained through value-based payment models or accountable care organizations, but there have been few rigorous evaluations.<sup>34</sup> The 2018 Farm Bill also increased Food Insecurity and Nutrition Incentive funding to \$250 million over five years. Researchers could partner with states to test the dietary effects of varying incentive levels and delivery systems. Ideally, such incentive programs would be tested with restrictions on items eligible for purchase with SNAP. Testing restrictions would require approval from the Department of Agriculture, which many states have applied for and been denied. Given the urgency of the obesity epidemic, approval of a pilot program implemented as part of a comprehensive strategy to improve nutrition is warranted.

### Conclusion

These findings support continued funding for financial incentive programs as a way to increase fruit and vegetable purchasing among low-income households with children but suggest that effective complementary approaches are needed to improve total diet quality. ■

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## NOTES

- 1 Dietary Guidelines Advisory Committee. Scientific report of the 2015 Dietary Guidelines Advisory Committee: advisory report to the secretary of health and human services and the secretary of agriculture [Internet]. Washington (DC): Department of Health and Human Services; 2015 Feb [cited 2019 Jul 3]. Available from: [https://ods.od.nih.gov/pubs/2015\\_DGAC\\_Scientific\\_Report.pdf](https://ods.od.nih.gov/pubs/2015_DGAC_Scientific_Report.pdf)
- 2 Micha R, Peñalvo JL, Cudhea F, Imamura F, Rehm CD, Mozaffarian D. Association between dietary factors and mortality from heart disease, stroke, and type 2 diabetes in the United States. *JAMA*. 2017; 317(9):912–24.
- 3 Waters H, DeVol R. Weighing down America: the health and economic impact of obesity [Internet]. Santa Monica (CA): Milken Institute; 2016 Nov [cited 2019 Jul 3]. Available from: <https://assets1b.milkeninstitute.org/assets/Publication/ResearchReport/PDF/Weighing-Down-America-WEB.pdf>
- 4 Wang DD, Leung CW, Li Y, Ding EL, Chiuve SE, Hu FB, et al. Trends in dietary quality among adults in the United States, 1999 through 2010. *JAMA Intern Med*. 2014;174(10): 1587–95.
- 5 Wang DD, Li Y, Chiuve SE, Hu FB, Willett WC. Improvements in US diet helped reduce disease burden and lower premature deaths, 1999–2012; overall diet remains poor. *Health Aff (Millwood)*. 2015;34(11):1916–22.
- 6 Rao M, Afshin A, Singh G, Mozaffarian D. Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. *BMJ Open*. 2013; 3(12):e004277.
- 7 Daniel C. Economic constraints on taste formation and the true cost of healthy eating. *Soc Sci Med*. 2016; 148:34–41.
- 8 Bodenheimer T, Chen E, Bennett HD. Confronting the growing burden of chronic disease: can the U.S. health care workforce do the job? *Health Aff (Millwood)*. 2009;28(1): 64–74.
- 9 Bor J, Cohen GH, Galea S. Population health in an era of rising income inequality: USA, 1980–2015. *Lancet*. 2017;389(10077):1475–90.
- 10 Pearson N, Biddle SJ, Gorely T. Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. *Public Health Nutr*. 2009;12(2): 267–83.
- 11 Di Noia J, Byrd-Bredbenner C. Determinants of fruit and vegetable intake in low-income children and adolescents. *Nutr Rev*. 2014;72(9): 575–90.
- 12 Beauchamp GK, Mennella JA. Flavor perception in human infants: development and functional significance. *Digestion*. 2011;83(Suppl 1):1–6.
- 13 Grimm KA, Kim SA, Yaroch AL, Scanlon KS. Fruit and vegetable intake during infancy and early childhood. *Pediatrics*. 2014;134(Suppl 1): S63–9.
- 14 Sullivan SA, Birch LL. Pass the sugar, pass the salt: experience dictates preference. *Dev Psychol*. 1990; 26(4):546–51.
- 15 Holley CE, Farrow C, Haycraft E. If at first you don't succeed: assessing influences associated with mothers' reoffering of vegetables to preschool age children. *Appetite*. 2018; 123:249–55.
- 16 Department of Health and Human Services and Department of Agriculture. 2015–2020 Dietary Guidelines for Americans. 8th ed. [Internet]. Washington (DC): HHS; 2015 Dec [cited 2019 Jul 22]. Available from: <https://health.gov/dietaryguidelines/2015/guidelines/>
- 17 Cronquist K, Lauffer S. Characteristics of Supplemental Nutrition Assistance Program households: fiscal year 2017 [Internet]. Washington (DC): Department of Agriculture; 2019 Feb [cited 2019 Jul 4]. (Report No. SNAP-18-CHAR). Available from: <https://fns-prod.azureedge.net/sites/default/files/ops/Characteristics2017.pdf>
- 18 Olsho LE, Klerman JA, Wilde PE, Bartlett S. Financial incentives increase fruit and vegetable intake among Supplemental Nutrition Assistance Program participants: a randomized controlled trial of the USDA Healthy Incentives Pilot. *Am J Clin Nutr*. 2016;104(2):423–35.
- 19 Cohen AJ, Lachance LL, Richardson CR, Mahmoudi E, Buxbaum JD, Noonan GK, et al. “Doubling Up” on produce at Detroit farmers markets: patterns and correlates of use of a healthy food incentive. *Am J Prev Med*. 2018;54(2):181–9.
- 20 Bleich SN, Rimm EB, Brownell KD. U.S. nutrition assistance, 2018—modifying SNAP to promote population health. *N Engl J Med*. 2017; 376(13):1205–7.
- 21 Government Accountability Office. Food Stamp Program: options for delivering financial incentives to participants for purchasing targeted foods [Internet]. Washington (DC): GAO; 2008 Jul [cited 2019 Jul 3]. (Report No. GAO-08-415). Available from: <https://www.gao.gov/assets/280/278851.pdf>
- 22 Bipartisan Policy Center. Leading with nutrition: leveraging federal programs for better health [Internet]. Washington (DC): The Center; 2018 Mar [cited 2019 Jul 3]. Available from: <https://bipartisanpolicy.org/wp-content/uploads/2019/03/BPC-Health-Leading-With-Nutrition.pdf>
- 23 Polacsek M, Moran A, Thorndike AN, Boulos R, Franckle RL, Greene JC, et al. A supermarket double-dollar incentive program increases purchases of fresh fruits and vegetables among low-income families with children: the Healthy Double Study. *J Nutr Educ Behav*. 2018; 50(3):217–228.
- 24 Fischer LM, Sutherland LA, Kaley LA, Fox TA, Hasler CM, Nobel J, et al. Development and implementation of the Guiding Stars nutrition guidance program. *Am J Health Promot*. 2011;26(2):e55–63.
- 25 To access the appendix, click on the Details tab of the article online.
- 26 Pooler JA, Morgan RE, Wong K, Wilkin MK, Blitstein JL. Cooking Matters for adults improves food resource management skills and self-confidence among low-income par-

- participants. *J Nutr Educ Behav*. 2017;49(7):545–553.e1.
- 27 Rockett HR, Breitenbach M, Frazier AL, Witschi J, Wolf AM, Field AE, et al. Validation of a youth/adolescent food frequency questionnaire. *Prev Med*. 1997;26(6):808–16.
- 28 Yuan C, Spiegelman D, Rimm EB, Rosner BA, Stampfer MJ, Barnett JB, et al. Validity of a dietary questionnaire assessed by comparison with multiple weighed dietary records or 24-hour recalls. *Am J Epidemiol*. 2017;185(7):570–84.
- 29 Harnack L, Oakes JM, Elbel B, Beatty T, Rydell S, French S. Effects of subsidies and prohibitions on nutrition in a food benefit program: a randomized clinical trial. *JAMA Intern Med*. 2016;176(11):1610–8.
- 30 Department of Agriculture. Analysis of Supplemental Nutrition Assistance Program Education (SNAP-Ed) data for all states study [Internet]. Washington (DC): USDA; 2018 Aug [cited 2019 Jul 3]. Available from: <https://fns-prod.azureedge.net/sites/default/files/ops/SNAPED-Data-AllStates.pdf>
- 31 French SA, Rydell SA, Mitchell NR, Oakes JM, Elbel B, Harnack L. Financial incentives and purchase restrictions in a food benefit program affect the types of foods and beverages purchased: results from a randomized trial. *Int J Behav Nutr Phys Act*. 2017;14(1):127.
- 32 Steele-Adjognon M, Weatherspoon D. Double Up Food Bucks program effects on SNAP recipients' fruit and vegetable purchases. *BMC Public Health*. 2017;17(1):946.
- 33 Driggs J. Catalina, Inmar deals mean e-coupons embraced at grocery retail. *Progressive Grocer* [serial on the Internet]. 2014 Sep 4 [cited 2019 Jul 3]. Available from: <https://progressivegrocer.com/catalina-inmar-deals-mean-e-coupons-embraced-grocery-retail>
- 34 Bryce R, Guajardo C, Ilarraza D, Milgrom N, Pike D, Savoie K, et al. Participation in a farmers' market fruit and vegetable prescription program at a federally qualified health center improves hemoglobin A1C in low income uncontrolled diabetics. *Prev Med Rep*. 2017;7(7):176–9.