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Enhancing food security of low-income consumers: An investigation of financial incentives for use at farmers markets ☆

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ABSTRACT

Enhancing the diet quality of economically disadvantaged households in the United States has long been a policy goal. Recently, select local governments and nonprofit organizations have augmented federal policy by offering federal nutrition beneficiaries vouchers, for use at farmers markets, to match their expenditures at the market. Such incentive vouchers enhance purchasing power of low-income households. Because the incentives can be used only on fresh produce, diet quality has the potential to improve. A longitudinal pilot study examined the effectiveness of such incentives on the frequency of the vegetable consumption of 300 economically disadvantaged women in five farmers markets, in three cities, in the United States. Participants who visited food bank or pantries and those living in areas with limited access to fresh fruits and vegetables were most likely to drop out of the study. For those remaining in the study, those with low levels of education and low levels of fresh produce consumption were most likely to increase vegetable consumption.

Introduction

Low-income households tend to consume diets of poor quality, characterized by inadequate amounts of fruit and vegetables (Darmon and Drewnowski, 2008; Golan et al., 2008; Leung et al., 2012). Two partial explanations are commonly given for this phenomenon. One is that low-income consumers cannot afford to buy healthy food. Another is that economically disadvantaged residents are likely to live in neighborhoods with poor access to healthy food, as a result of an insufficient number of local supermarkets (see, for example, Powell et al., 2007). These explanations form the basis of the bulk of US federal policies addressing domestic food security, which is designed to enhance economic or geographic access to food. Federal food and nutrition assistance programs provide income transfers (that can be used only for food) to qualified low-income consumers, making it possible to purchase food that they would otherwise be unable to afford (Haskins, 2012; FNS USDA, undated). Geographic barriers are targeted by financial incentives offered to entice supermarkets and other types of food stores to locate in areas with limited food access (US Department of Treasury, 2013).

Local jurisdictions have added another dimension to addressing food security in their localities, by instituting policies that facilitate the opening of farmers markets in neighborhoods that lack a sufficient number of food stores (Fang et al., 2013). There are multiple problems with relying on farmers markets for food security. Farmers markets are open for just a few days each week, at most, and many close for the winter months. Another obstacle is the perception that food prices are higher in farmers markets, which may prevent some low-income consumers from shopping at the market (Grace et al., 2007). That said, the ability to use federal food assistance benefits for purchases makes farmers markets more accessible to low income consumers (Jones and Bhatia, 2011). Across the United States, one in four farmers markets accept Supplemental Nutrition Assistance Program benefits (SNAP, formerly known as food stamps), which are electronically distributed to recipients (Variyam, 2014). A spillover effect has been observed, as a pilot study found that total market sales increased by more than the amount of benefits redeemed after the installation of wireless terminals for payment with SNAP benefits (Bertmann et al., 2012).

Current policies addressing food insecurity often fail to consider diet quality of target populations (with the exception of food assistance for pregnant women and young children). For example, the

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primary form of food assistance, SNAP, can be used for any type of food, regardless of nutritional quality.[1] Grassroots programs have attempted to address diet quality by providing financial incentives for the purchase of fresh produce. Such programs aim to change the purchasing behavior of households. Participating consumers receive coupons (referred to as farmers market incentives) to match their redemption of food assistance when used for fruits and vegetables at the farmers market. The coupons or farmers market incentives are delivered in multiple ways: some programs provide a complete match, up to a limit, usually $10 or $20 a day; others provide a partial matched, such as one dollar per five spent; the match may be available for the entire season or for a portion of the season or even just one day (King et al., 2014). The 2014 Farm Act includes a new program that is similar in spirit, called the Food Insecurity Nutrition Incentive Program, which will provide incentives to SNAP recipients to encourage consumption of fruits and vegetables (ERS, USDA, 2014).

The benefits of farmers market incentives are unknown at this time, but one of their primary goals is to encourage low-income consumers, particularly those with limited access to healthy food, to eat greater amounts of fresh fruit and vegetables. First offered in 2008 by Wholesome Wave, a nonprofit based in the Northeastern region of the United States, other nonprofits and several local jurisdictions (for example, New York City, Seattle and Boston) have followed suit by providing farmers market incentives to low-income consumers. In 2012, 500 incentive programs were operated by four nonprofits – Wholesome Wave, Market Umbrella, Roots of Change, and Fair Food Network (Community Science, 2013). The estimate of 500 programs excludes those operated by cities and other nonprofits, and so the actual number of incentive programs is greater. The rapid growth in the number of programs, plus their inclusion in the Farm Act of 2014, suggests that stakeholders perceive there is great promise in farmers market incentives.

The research presented in this paper assesses the impact of this type of incentive, i.e., matching food assistance benefit redemption at farmers markets, on the food consumption behavior of economically disadvantaged consumers. Earlier studies based on cross-sectional survey data reveal that shoppers perceive that receiving farmers market nutrition incentives allowed them to consume more fresh produce (Dimitri et al., 2013; Wholesome Wave, 2013; Blue Cross Blue Shield of Minneapolis, 2012; Fair Food Network, 2012). Yet given that perceptions often deviate from actual behavior, an important policy question is whether actual fresh produce consumption increases in response to incentives. More specifically, we ask if such incentives effectively encourage the recipients to eat vegetables more often. To do so, a pilot longitudinal study was conducted in 2011–2012, in farmers markets located in three US cities.

Materials and methods

A six-month pilot study was carried out during the 2011–2012 farmers market season, with the goal of assessing the effectiveness of incentives on the intake of fresh vegetables by low-income consumers. The participants were female primary caretakers of children between 2 and 12 years old, who shopped at one of five farmers markets: two seasonal markets located in New York City, two seasonal markets located in the Boston area, and one year-round market in San Diego. The markets were located in neighborhoods of varying levels of affluence, with three of the markets in areas where the median income is substantially below the median income of the entire country and two markets with higher median incomes (see Table 1.)

[1] The two exceptions are foods to be eaten in stores, such as prepared meals, or foods that are hot when purchased, such as rotisserie chickens.

The choice of farmers markets used for the study sites was based on several factors, with the two most important being (1) the market's capacity to accept food assistance benefits and incentives for payment and (2) the manager's willingness to allow the research team access for the entire season. Participants received food assistance via one of two federal programs, depending on her city: women in New York City were receiving Women Infants and Children (WIC) while those in Boston and San Diego were receiving Supplemental Nutrition Assistance (SNAP) or WIC. The use of WIC in New York City was driven by the fact that the New York City Department of Health sponsored a program that matched SNAP (Health Bucks), and thus it was not politically feasible for our study to match SNAP.

In each of the three cities, study participants were recruited at the farmers market. In New York City and Boston area markets, recruitment began on the opening day of the market season, which was in June or July. The San Diego market was a newly opened year round market, and enrollment began right after the market opened in late summer. Each market had a member of the research team onsite, who was coordinating the study. The researcher set up a table near the market manager's tent, with a sign displaying information about the study. The market managers and vendors were informed of the study, and shared information about the research with eligible people. The farmers market incentives provided to the participants were study vouchers, marked with serial numbers used to track their use.

In addition to receiving farmers market incentives each time she shopped, each participant received a small cash payment ranging from $5 to $15 after filling out a survey. The dollar amount for each survey increased throughout the study period, intended to encourage the participants to remain in the study. The surveys were administered by researchers versant in Spanish and English, and in Boston, Russian; the survey instruments were available in these languages as well. The same researcher attended the market weekly throughout the study, so the participants and the researcher formed a continued relationship. The research staff provided only weekly farmers market incentive vouchers and cash payments for completing surveys. Information about other activities, such as cooking demonstrations or nutrition programs, during the study period was not collected.

At the time of enrollment, a member of the research team collected data on the characteristics of the study participants; because many had limited reading skills, self-administration of the surveys was not possible. Each participant reported her demographic data, which included age, income and education of the participants at the time of enrollment, as well as household size, years living in the US, and ethnicity. Food intake was collected via a modified National Health and Nutrition Examination Survey food frequency questionnaire, a validated instrument often used in the fields of public health and nutrition (CDC, 2014). A member of the research team collected self-reports of fresh vegetable consumption for each participant, both at the time of enrollment and then 16 weeks later, where she reported the number of times different vegetables

Table 1
Number of participants and median income (2010) in neighborhoods of study sites. *Source:* American Community Survey, 2010.

Market site	City	Median income	Enrolled participants
Copley	Boston	$85,419	13
Lynn	Boston	$39,966	83
East New York	New York City	$33,127	67
La Familia Verde	New York City	$24,537	30
Linda Vista	San Diego	$56,641	88
Total United States		$54,442	

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were consumed during the last month. The last type of data collected concerned shopping habits of each participant, including her typical shopping venues (farmers markets or supermarkets, for example) and whether, at any time in the previous 30 days, she needed to visit a food bank or pantry in order to secure food for her family. A total of five surveys (three shopping surveys and two food frequency questionnaires) were administered to the study participants.

About 100 women were enrolled in each of the three cities. Every time she shopped at the farmers market, the participant received up to $10 in farmers market incentives to be used for purchasing fruits and vegetables at the market. In San Diego, the market was year round and so participants were enrolled for 16 weeks. Because of the shorter market season in New York City and Boston, each participant was enrolled from 12 to 16 weeks, starting from when she enrolled in the study until the end of the market season. The incentives, given in the form of $2 coupons, could be used to purchase of fruits and vegetables from the market vendors. If desired, the coupons could be saved for future trips to the market. Each time she shopped at the market, the study participants signed an affidavit indicating she would match the amount of the incentive voucher (up to $10) with cash or federal nutrition benefit expenditures that day at the market.

Analysis of incentives, retention, and vegetable consumption

A common challenge of studies conducted on human beings is retention: even though incentives are provided to encourage return visits and provide data, essentially it is up to the participants to decide whether to return each week. Longitudinal research conducted in farmers markets is particularly vulnerable to attrition, given that many shoppers attend the market infrequently. Multiple studies indicate that only about half of farmers market shoppers visit the market weekly (Alonso and O'Neil, 2011; Sadler et al., 2013; Kezis et al., 1998). In low-income, urban neighborhoods, such as those in Los Angeles, an even lower percent (40) shopped at the market weekly (Ruelas et al., 2012). Studies involving low-income participants face particular challenges as well; beyond strained finances, low-income households may not be rooted in their communities because of frequent moves (Nicholson et al., 2011). A total of 138 participants completed this study, which represents a retention rate of 49% of the valid participants. This rate is consistent with that of other studies that involve similar populations at farmers markets, with reported retention rates of 54% (Lindsay et al., 2013) and 44% (Anliker et al., 1992; Kunkel et al., 2003).

A key factor in longitudinal studies with attrition is whether there are systematic differences between those who enrolled in the study and those who finish the study. If there are differences, an analysis of only those who remained in the study will yield estimators affected by attrition bias. Two methods are able to account for the attrition bias: a sample selection model, such as that put forth by Heckman (1979), or the use of inverse probability weights to adjust the estimators for attrition (Fitzgerald et al., 1998; Baulch and Quisumbing, 2011). The latter method was selected.

The intuition underlying the methodology is to first identify whether attrition in random. If the statistical testing indicates that attrition is not random, then adjustment of the estimators is necessary. The next step involves estimating a model that adjusts for the attrition; this is accomplished by using inverse probability weights to more heavily weight the remaining consumers that are similar those who leave the sample. Two stages are required to estimate the model with the attrition correction. Both stages are estimated as probit models (since the probit is so commonly used, the theory underlying the model is omitted here). In each of the two stages, we use explanatory variables that are correlated with both the outcome variable (in this case, whether vegetable consumption increased) and attrition. The first stage dependent variable is a discrete variable indicating whether a participant remained in the study ($y = 1$ for those who left the study; $y = 0$ for those who remained in the study). A joint test of the estimated coefficients is conducted, to assess whether attrition is random. In the second stage, if attrition is determined to be nonrandom, the model of interest is estimated with the probability weights used to account for the attrition bias. In this case, the model is whether, after receiving the farmers market incentives, a woman consumed vegetables more often, as represented by a discrete variable ($y = 1$ when the number of times vegetables are consumed increases, and $y = 0$ otherwise).

Explanatory variables included were those thought to influence the likelihood that the consumption of vegetables will increase after receiving the incentives, and were a set of dummy variables. In order to account for differences across communities where the markets are located, particularly those related to relative affluence, a variable is used indicating whether the median income of the neighborhood is above or below the national median income. Next, three variables are included to assess each woman's food security: whether she perceived that she had limited geographic access to fresh fruits and vegetables, whether she visited a food bank or pantry during the month prior to enrollment, and whether the nutrition incentives were an important factor in her decision to use her benefits at the farmers markets. The next set of explanatory variables captures the demographic characteristics of the participants, and includes whether she holds a high school diploma, her age, and whether she had a child that was less four years old. Finally, two variables are included, reflecting the woman's propensity to consume fruit and vegetables at the time of enrollment: one isolates those with low levels of consumption (less than two times daily) and the other holds constant for those with slightly higher, but still inadequate, levels of consumption (at least 2 times, but less than five times daily.)

Results and discussion

Summary statistics of the relevant survey questions were calculated for all participants enrolled in the study as well as for those who finished the study (Table 2). In many ways, the descriptive statistics suggest the two groups are similar. The number of farmers market visits and the value of nutrition incentives redeemed are obviously different. Those who completed the study were less likely to have visited a food bank or pantry in the month prior to joining the study, and this difference was statistically different. In comparison to those who completed the study, the women in enrolled in but did not complete the study were older, and a greater proportion was receiving SNAP benefits. Counter intuitively, those enrolled in the study were more likely to report that farmers market incentives were an important reason for using their benefits at the market. This relationship suggests that factors other than the incentives influence an individual's decision to shop at the market. Lastly, slightly more than half of those who completed the study reported consuming vegetables more frequently at the end of the study period.

Results of stage 1 model: explaining attrition

The first stage of the model assesses which characteristics are related to the likelihood that a woman will leave the study. The results of the first stage estimation indicate that the included explanatory variables explain about 38% of the panel's attrition (Table 3). Two variables are statistically significant: whether food

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Table 2
Demographic characteristics and behavioral changes for participants enrolled and those completing study.

Variable	Enrolled	Completed
	Mean or proportion (standard deviation)	
Visits to the market (number)*	8 (5)	12 (4)
Nutrition incentives spent over the course of the study (value in dollars)*	$71 (53)	$115 (37)
Reported incentives were an important factor using federal benefits at market*	63% (48)	55% (49)
Eats produce fewer than 5 times daily at enrollment	29% (46)	27% (44)
Obtained food from a food bank or pantry in the month prior to enrollment*	71% (41)	39% (49)
Has limited access to fresh fruits and vegetables	27% (44)	28% (45)
Education exceeding HS diploma or GED	28% (45)	24% (43)
Household income below $25,000 per year	77% (42)	75% (43)
Hispanic/Latino ethnicity	60% (49)	64% (48)
Black race	23% (43)	21% (41)
Received women, infants, children benefits	84% (36)	87% (34)
Received supplemental nutrition assistance program benefits*	41% (49)	35% (48)
Average number of years living in US*	18 (13)	17 (13)
Average age of participant	33 (9)	34 (9)
Consumed less than 2 servings fruit and vegetable daily, at time of enrollment	29%(46)	27% (45)
Consumed 2 or more, but less than 5, servings fruit and vegetable daily, at time of enrollment	19%(40)	20% (40)
Fruit and vegetable consumption at time of enrollment, number of times per week	51 (34)	55 (31)
Vegetable consumption increased	N/A	54% (50)

Note: Enrolled includes both those who completed the study and those who did not complete the study. N/A means not applicable.
* Means the two groups were statistically different at the 5% (or greater) level of significance; a *t*-test was used for the continuous variables and a *z*-test for the binary variables.

was received from a food bank or pantry in the previous month and whether participants perceived that access to fresh fruits and vegetables outside the market was limited. A joint test of the parameters, which tests whether all estimated coefficients are 0, is statistically significant, and indicates that attrition is not random (and thus should be accounted for in the final model).

Results of stage 2 model: testing for increased vegetable consumption

The second stage estimates the probability that a woman will consume vegetables more often after receiving farmers market nutrition incentives, adjusting for attrition. The coefficients for the unadjusted and weighted models are presented in Table 4. To estimate the weighted model, the full model (with the entire set of explanatory variables) was first estimated, and the predicted values calculated. The restricted model was estimated, again as a probit, but excluding the two explanatory variables that had a statistically significant influence on the likelihood that a woman would leave the study: limited access to fresh fruit and vegetables and whether she received food from a food bank or pantry in the month prior to enrollment. Again, the predicted values were calculated. The inverse probability weights were set equal to the ratio of the predicted values in the restricted model to the unrestricted model, and were used to estimate the weighted probit model shown in the Table 4.

The model adjusted for attrition explains a slightly larger share of the variation associated with whether vegetable consumption is likely to increase after a woman receives nutrition incentives. The inclusion of the attrition correction influenced the statistical significance of several variables. Visiting a food bank or pantry within the month prior to enrollment is significant after the attrition adjustment is included, as is living in a neighborhood with limited access to fresh fruit and vegetables (this variable is significant at the 10% level). In the unweighted model, neither of these variables was found to be contributing to the probability that a study participant's vegetable consumption increased. On variable – whether a shopping in a neighborhood with median income below the national median – had a significant contribution to the probability a woman increased her vegetable consumption in the unweighted but not the attrition-corrected model.

The model predicts that, after receiving nutrition incentives, women lacking a high school diploma (or GED certificate) had a higher probability of consuming vegetables more often, in comparison to those with higher levels of education. Those who, at the time of enrollment, consumed low levels (less than two times daily) of fresh produce were likely to consume vegetables more

Table 3
Estimated probit model: attrition.

Variable	Estimated coefficient	*p*-Value
No high school diploma or GED	−0.08	0.67
Age	−0.02	0.05
Visited food bank or pantry in the month prior to enrollment	2.63*	0.00
Consumed 2 or more, but less than 5, times fruit and vegetable daily, at time of enrollment	−0.49	0.22
Consumed fruit and vegetables less than 2 times daily, at time of enrollment	0.44	0.21
Market neighborhood below median income	0.18	0.22
Has child under 4 years	−0.05	0.78
Limited access to fresh fruit and vegetables	0.58*	0.02
Nutrition incentives very important	−0.03	0.90
Constant	−1.38	0.01
Number of observations: 267		
LR chi2(9): 139; Prob > chi2 = 0		
Pseudo R2: 0.37		
Joint test that parameters = 0: chi2(9) = 78; prob > chi2 = 0		

* *Note:* indicates a *p*-value less than or equal to 5%.

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Table 4
Estimated probit model: increased vegetable consumption.

Variable	Unweighted model		Weighted model		Marginal effects[a]
	Estimated coefficient	*p*-Value	Estimated coefficient	*p*-Value	
No high school diploma or GED	0.55*	0.04	0.56*	0.03	0.19
Age of participant	−0.02	0.21	−0.05	0.49	−0.01
Visited food bank or pantry within 30 days prior to enrollment	0.34	0.23	0.47**	0.09	0.16
Consumes produce between 2 and 5 times a day, at time of enrollment	−0.62	0.37	−0.75	0.19	−0.14
Consumes produce less than 2 times daily, at time of enrollment	1.41*	0.03	1.47*	0.00	0.54
Market community below national median income	−0.55**	0.09	−0.52	0.11	−0.17
Has child under 4 years	−0.18	0.47	−0.16	0.51	−0.05
Limited access to fresh produce	0.39	0.16	0.47**	0.09	0.15
Nutrition incentives very important	0.09	0.74	0.06	0.81	0.02
Constant	0.42	0.40	0.44	0.51	na
No. observations	124		124		
Pseudo R2	0.15		0.17		
	LR chi2(9) = 25.58		Wald chi2(10) = 27.84		

[a] *Notes:* The marginal effects were calculated for the weighted model, holding all other variables constant at the median. For discrete variables, following Greene (1996), the marginal effect is the discrete change in probability as the variable changes from 0 to 1.
* Variables denoted by are statistically significant at a level of significance of at least 0.05.
** Variables denoted by are statistically significant at alpha = 0.10.

Table 5
Predicted probability of eating vegetables more often at end of study.

	Consumes produce less than two times daily (at time of enrollment)	
Limited access to food	Yes	No
Yes	0.94	0.53
No	0.86	0.35

often. The probability of consuming vegetables more often was not related to whether a participant reported that she consumed vegetables at least two but less than five times a day, at the time of enrollment. None of the other explanatory variables had a significant effect, positive or negative, on the probability that a woman consumed vegetables more frequently.

Marginal effects measure the change in the probability of the dependent variable, in this case that a study participant eats vegetables more often, given a change in one of the explanatory variables (while holding the others fixed at a predetermined level). For the categorical explanatory variables, the marginal effect is best measured as the discrete change in probability as the value of the variable moves from 0 to 1 (Greene, 1996). The variable with the largest marginal effect is low consumption of produce, with a marginal effect equal to 0.54 (Table 4). Thus, in comparison to a study participant who eats produce 2 times a day or more (at the time of enrollment), the probability that those with very low levels of consumption will increase their consumption is 0.54. The marginal effects for the other statistically significant variables – lacking a high school diploma, visited a food bank or pantry prior to enrollment, and lives in a neighborhood with limited access to fresh produce – range from 0.15 to 0.19. The interpretation is that the probability of the study participant will consume vegetables more often will increase by approximately 0.15, for those with limited access to fresh fruit and vegetables, in comparison to those with easy access.

The primary goal of the farmers market incentives is to improve the diet – more specifically increase their consumption of fruits and vegetables – of low-income consumers who live in neighborhoods with poor access to fresh food. Post-estimation analysis provides additional insight into the potential of meeting the goal of increased consumption. The predicted probabilities (Table 5) indicate that the probability of eating vegetables more times each day is 0.94 for study participants with both (1) limited access to fresh fruit and vegetables and (2) very low levels of consumption. The probability of eating vegetables more often, for those with limited access but consume produce two or more times a day at the time of enrollment, is 0.53. The table of predicted probabilities indicates that those with limited access benefit, through increased consumption, but that those with low levels of consumption at the time of enrollment seem to gain more.

Another way of exploring the relativeness effectiveness of the farmers market incentives on the target population is to examine the discrete change (or marginal effect) of the statistically significant coefficients, holding constant for fresh produce access and initial level of produce consumption (Table 6). For those without limited food access, shown in the last row, the marginal effects for both low levels of education and use of the food bank are greater than those for those with limited food access. The differences are larger for participants with low levels of produce consumption at the start of the study. Next turning to the marginal changes across columns, for those with limited access to fresh fruits and vegetables, the probability of increasing vegetable consumption for those who consume produce two or more times daily exceeds that of those who consume produce less often. This holds for both independent variables, less than high school education and procurement of food at a bank or pantry. This suggests that the participant's predisposition for eating fruits and vegetables has an effect on her response, particularly for the women living in neighborhoods with poor access to fresh fruits and vegetables.

Table 6
Marginal effects of education and food bank/pantry usage.

	Consumes produce less than two times daily (at time of enrollment)			
	Yes	No	Yes	No
Limited fresh produce access	*No HS diploma or GED*		*Accessed food bank or pantry*	
Yes	0.09	0.15	0.08	0.13
No	0.22	0.19	0.19	0.16

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Discussion, limitations, and conclusion

Several aspects of the study warrant mention. First, the level of reported consumption by the participants enrolled (including those not retained) exceeds that of other studies; for example, the NHANES 1992–2002 indicates that 89% failed to consume enough produce, as established by the USDA guidelines of two or more servings of fruit and three or more servings of vegetables per day (Casagrande et al., 2007). In contrast, 71% of the participants in this study reported consuming fruit and vegetables 5 or more times daily. One possible reason for this difference is that farmers market shoppers are more likely to be interested in consuming fresh food (Zepeda, 2009; Baker et al., 2009). Other studies have found that farmers market shoppers are more interested in cooking (Wolf et al., 2005). An interpretation of the research on farmers market consumers, in tandem with the levels of reported produce consumption for the participants of this study, is that farmers market shoppers may be good candidates for interventions regarding fresh produce consumption.

Access to food is accepted as a critical element to food security. Yet the literature has mixed results on the influence of food access on healthy food consumption. For example, Rose and Richards (2004) found that higher access to supermarkets was associated with higher fruit consumption for food stamp recipients, while Pearson et al. (2005) found that access and consumption are unrelated. This study has examined the relationship between access (to fresh fruits and vegetables) and consumption from multiple angles. Participants with limited access to food had a higher probability of consuming vegetables more often, but the statistical significance was at the 9% level. Attrition was positively and significantly related to access. However, the marginal effects of those with limited fresh produce access were smaller than those for participants with easy access. Taken together, the findings lend support to an intuitive logic suggesting that geographic access plays an important role in determining whether a consumer can eat a healthy diet.

Retention presents some challenges. The exploration of attrition in the stage 1 model suggests that who dropped out of our study are those facing the most significant barriers to consuming food (those who met some of their food needs through a food bank or pantry, and those who live in areas with limited fresh produce access). Separating the influence of the two effects is not possible given the data collected. On the surface, the use of a food bank or pantry suggests that many of the women are severely income constrained. However, a competing explanation is that the true obstacle is geographic access, which forces some to secure food from a food bank or pantry. This finding suggests that future research needs to attempt to sort out the relative importance of the two influences. Doing so may allow nonprofits and governments to facilitate more refined interventions.

Another limitation is the divergent responses, in terms of produce consumption, of those who remained in the study. One possible explanation for finding the greatest response of those reporting eating produce less than two times daily, at the time of enrollment, is the convergence to the mean, where high and low values converge over time to the average. Second, while half of the participants increased their consumption, the others did not increase their consumption of vegetables. One possible explanation is that the positive response comes from individuals who prefer consuming greater quantities of fresh produce, but are income constrained. Additional research is needed to understand why the consumption for the remaining women did not increase in response to the purchasing power provided by nutrition incentives. Those whose consumption did not increase might require a more active intervention to change their behavior, but designing the intervention depends on obtaining a deeper understanding of the factors contributing to this group's response.

An especially promising finding is that the participants most likely to consume vegetables more often, after receiving the incentives, have characteristics of groups that have been identified as needing to consume more vegetables: those consuming very low levels of produce (fewer than two times a day) at the time of enrollment and those lacking a high school diploma. Other research finds that low socioeconomic status is associated with lower consumption of vegetables (Roos et al., 2007).

Conclusion

Overall, the study suggests that, even though not all consumers increased their consumption of vegetables, nutrition incentives are an attractive intervention for the segment that responds positively. For the segment that responded positively, costly intervention is not essential; instead, the main cost is that of the nutrition incentives. However, for the group of consumers who did not respond by increasing their consumption, the use of a higher cost intervention, such as highly skilled medical care providers or nutrition educators, may be critical. Additional research into determining the best form of costly intervention and which groups of consumers require a higher cost intervention would be extremely helpful in administering these types of on-the-ground programs. Another important area for additional research is how to retain the most vulnerable consumers – those who live in areas with severely limited access to food and those using food bank or pantries.

This study further suggests that distribution of nutrition incentives at farmers markets is an effective way to reach those already interested in healthy foods. The ability of farmers markets to reach a wide audience is constrained, however, by the fact that markets are usually seasonable, with just 24% operating in the winter months in 2012 (USDA, 2012). The cost effective method of distributing nutrition incentives at the farmers market allows scarce resources to be more finely targeted toward groups requiring higher levels of intervention. Thus, from a public health and policy perspective, this type of voluntary intervention holds much promise, and could be an important part of a policy encouraging economically disadvantaged consumers to eat produce more frequently.

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