Effect of a Targeted Subsidy on Intake of Fruits and Vegetables Among Low-Income Women in the Special Supplemental Nutrition Program for Women, Infants, and Children

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Objectives. Intake of fruits and vegetables protects against several common chronic diseases, and low income is associated with lower intake. We tested the effectiveness of a subsidy for fruits and vegetables to the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

Methods. Women who enrolled for postpartum services (n = 602) at 3 WIC sites in Los Angeles were assigned to an intervention (farmers' market or supermarket, both with redeemable food vouchers) or control condition (a minimal nonfood incentive). Interventions were carried out for 6 months, and participants' diets were followed for an additional 6 months.

Results. Intervention participants increased their consumption of fruits and vegetables and sustained the increase 6 months after the intervention was terminated (model adjusted $R^2 = .13$, $P < .001$). Farmers' market participants showed an increase of 1.4 servings per 4186 kJ (1000 kcal) of consumed food ($P < .001$) from baseline to the end of intervention compared with controls, and supermarket participants showed an increase of 0.8 servings per 4186 kJ ($P = .02$).

Conclusions. Participants valued fresh fruits and vegetables, and adding them to the WIC food packages will result in increased fruit and vegetable consumption. (*Am J Public Health.* 2008;98:98–105. doi:10.2105/AJPH.2005.079418)

Fruit and vegetable intake protects against various common chronic diseases.[1–4] Low income is a risk factor for poor dietary quality and for low consumption of fruits and vegetables.[1–5] Interventions using nutrition education to increase consumption of fruits and vegetables have reported some successes, although the magnitude of the behavior change has been modest.[6] Recent analyses have drawn attention to the potential for more "upstream" strategies, including policy, pricing, and environmental change to affect food access and availability as well as consumer information and motivation.[7]

Strategies to promote the choice of targeted foods by lowering their cost relative to those of alternative foods have been little tested, probably because of the cost of implementing such strategies, but the available evidence suggests that they are highly effective. Reducing the prices of lower-fat vending-machine snacks, fresh fruits, and baby carrots in work sites and secondary schools has resulted in substantially increased sales of these items.[8–10] Two published reports on the provision of coupons for the purchase of fruits and vegetables at farmers' markets, one with low-income older adults over a 5-year period[11] and the other for participants in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in Connecticut,[10] showed high levels of coupon use.

The WIC program provides an ideal context for investigating means to improve the consumption of fruits and vegetables. It is targeted to a low-income population and is designed to improve dietary quality both through subsidizing nutrient-dense foods and through nutrition education. The program currently reaches about half of all infants born in the United States, along with their mothers, and about 25% of preschool children.[12] The WIC program was developed prior to appreciation of the relationship of intake of fruits and vegetables to chronic disease risk, and the supplemental foods were selected to provide the nutrients most limited in the diets of women and children—protein, calcium, vitamin A, and vitamin C. To date, the only fruits and vegetables provided have been juice (for all participants older than 4 months) and fresh carrots for breastfeeding women.

An evaluation of nutrition education within the WIC program to increase the consumption of fruits and vegetables in Maryland[13] showed that compared with control participants, intervention participants increased intake by more than one half serving a day on average. Predictors of increased consumption included the number of nutrition education sessions attended, ethnicity, education, and self-efficacy.[13]

There has been considerable discussion about adding fruits and vegetables to the WIC supplemental food "package." A recent report by the Institute of Medicine recommended a number of changes, including the addition of fruits and vegetables to the packages for all participants older than 6 months.[14] The food package for postpartum women at the time we conducted our study included fluid milk, cheese, eggs, iron-fortified cereal, fruit juice, and for breastfeeding women, canned tuna and fresh carrots.

We sought to determine whether an additional economic subsidy for fresh fruits and vegetables for postpartum WIC participants would result in increased consumption of fruits and vegetables. We tested the hypothesis that effective and sustained improvement in fruit and vegetable intake would result from improved economic access to fresh produce for a 6-month period.

METHODS

Participant Recruitment and Data Collection

We used a nonequivalent control group design to measure the effectiveness of 2 interventions to increase the consumption of fresh fruits and vegetables. We recruited 602 women enrolling for WIC services at 3 program centers in Los Angeles, Calif, between February and August 2001. The study sites (2 intervention and 1 control) were selected on the basis of similarity regarding caseload, ethnic backgrounds of participants, and geographical proximity of supermarkets and farmers' markets. To ensure participants' equal access to a variety of fresh fruits and vegetables, there was a major supermarket and a year-round farmers' market within walking distance (less than one half mile) of each of the 3 WIC centers in areas where the participants usually shopped.

Eligibility criteria for the individual participants included that they (1) had recently delivered and recertified for WIC participation as either a breastfeeding or nonbreastfeeding postpartum woman, (2) spoke English or Spanish, and (3) were 18 years or older. Seventy-five percent of recruited participants completed all interviews; the most frequent reason for loss to follow-up was residential relocation.[15] Demographic characteristics differed slightly between participants completing the study and those lost to follow-up ($P<.05$).[15] Participants who were lost to follow-up had lived in the United States on average 2.4 more years and had 0.3 fewer family members and 1.2 more years of education than did participants who remained in the study. They also had a slightly higher proportion of African American and English-speaking participants. Rates of loss to follow-up were 30% for the supermarket, 16% for the farmers' market, and 29% for the control group.

The Intervention

Following a 2-month monitoring period to document baseline fruit and vegetable intake, participants at the 2 intervention sites were issued $10 worth of vouchers per week, in $1 units for the supermarket site and in $2 units for the farmers' market site, to buy produce of the participants' choice. Vouchers were issued bimonthly and could be spent over the ensuing 2-month period. Control participants were provided with a set of coupons of lesser value ($13 per month), redeemable for disposable diapers, in compensation for their time participating in interviews. Participants were interviewed by trained WIC nutritionists, in English or Spanish according to participants' preference, 6 times in the 2 intervention sites and 4 times at the control site over a period of 14 months (at baseline, 2 months after baseline, end of 6-month intervention, and 6 months following the end of the intervention). In the 4 sets of interviews involving all participants, we used the multiple pass method to elicit participants' recall of what they consumed in the past 24 hours.[16,17]

The following data were also collected: household demographic variables—age, income, household composition, ethnicity, education, marital status, language preference and country of origin (at recruitment; income was also ascertained at final interview); program participation—Medi-Cal (California's version of public health care insurance), the Food Stamp Program, Temporary Assistance for Needy Families (TANF; at recruitment and final interviews), or a combination of these programs; pregnancy outcomes—parity, number of weeks postpartum (recruitment interview), and infant feeding practices (all interviews; breastfeeding status was determined by the question, "Are you currently breastfeeding?" [yes/no]); height, weight, and basal metabolic rate—height and weight were measured (at recruitment and final interview), and basal metabolic rate (BMR) was calculated by height, weight, and age; food security status—household food security status was assessed with the US Food Security Survey Module.[18] The initial survey assessed household food security status over the previous 12 months, and interviews at the end of the intervention and 6 months later covered the previous 6 months.

Data Analysis

Dietary data were entered into the Food Intake Analysis System, Version 3.99 (University of Texas, Health Science Center at Houston and US Department of Agriculture, Washington, DC). Participants' descriptions of total food consumption were disaggregated into component food parts and fruits and vegetables converted to standard serving sizes by the same methods outlined by the Department of Agriculture for analysis of national food consumption data.[16,17] To capture infant feeding practice, a variable with the following options was created: exclusively breastmilk, exclusively formula, and combination of breastmilk and formula. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. BMR was calculated by the following formula[19,20]:

$$\text{(1)}\quad \text{BMR} = 655 + (9.6 \times \text{weight in kilograms}) + (1.8 \times \text{height in centimeters}) - (4.7 \times \text{age in years})$$

Estimated energy intake in kilojoules (from the baseline interview) was divided by BMR to calculate the ratio of energy intake to BMR (EI:BMR ratio), which was used as a criterion for the completeness of dietary energy intake estimates.[21,22] We employed a cutoff value of 0.92 BMR because this value has been widely used as a conservative value for minimum plausible intake on the basis of a single 24-hour dietary recall for adults who maintain their weight.[23]

Households were classified according to the Guide for Measuring Household Food Security as food secure, food insecure without hunger, food insecure with hunger, or food insecure with severe hunger.[24]

Analyses

Initial analyses were performed with SPSS for Windows Version 11.0 (SPSS Inc, Chicago, Ill). Descriptive statistics were calculated and analysis of variance, Pearson product moment correlations, and the paired *t* test were used for bivariate analyses. Linear regression analysis was conducted to identify predictors of fruit and vegetable intake 6 months after the intervention. Fruit and vegetable intake at baseline was compared with intake 2 months postpartum, but the difference was not significantly different and the baseline values were retained for modeling.

Mixed Models

A mixed model approach was used to detect the change in fruit and vegetable intake at the end of the intervention period and 6 months after incentives were removed. This approach takes into account the intrasubject

correlation and adjusts for covariates. The intrasubject correlation is a measure of the degree of similarity of the responses of participants within a given cluster as compared with participants across clusters. The outcome data were the longitudinal values at baseline, at the end of the intervention period, and 6 months after the intervention. These analyses were conducted with SAS for Windows version 8.2 (SAS Institute Inc, Cary, NC). The mixed model is written as

$$Y = X\beta + Z\gamma + \varepsilon, \quad (2)$$

where Y denotes the vector of observed values, X is the known fixed-effects design matrix, and β is the unknown fixed-effects parameter vector. Zγ represents the additional random component of the mixed model. Here, Z is the known random-effects design matrix, γ is a vector of unknown random-effects variables, and ε is the unobserved vector of independent and identically distributed Gaussian random errors. We used a random intercept approach that allowed each participant to have her own random intercept. For the longitudinal autocorrelation, we compared an autoregressive to an equicorrelated pattern. Because the results were not significantly different from each other, we used the equicorrelated pattern in all of the mixed models.

The intervention site and time since the baseline interview were included in the models as fixed effects. We used indicator variables for the intervention sites and for time at the end of the intervention as well as for 6 months later. Interaction variables for intervention site and time were also included.

Predictor variables in the model building process included participant's age, income, language preference, ethnicity, family size, years living in the United States, government program participation (Medi-Cal, Food Stamps, TANF), number of years as a WIC participant, infant feeding method, BMI, food security status, and treatment condition (farmers' market or supermarket vs control). Energy intake was included as a control variable. Statistical tests were conducted with total fruit and vegetable intake including beans and potatoes, fruit and vegetable intake excluding beans and potatoes, and fruit and vegetable intake excluding juices as outcomes. Results are shown for fruit and vegetable intake including beans, potatoes, and juices unless otherwise specified. We computed the multiple R^2 as the proportion of reduction in the estimated total variance from the null model, where only the random intercepts were used, to the full model where all the covariates were included. The significance of the full model was based on the χ^2 statistic computed as the difference of −2 log likelihood for the null and full models.

RESULTS

Sample

Demographic characteristics approximated those of the WIC program in Los Angeles; the sample was 89.1% Hispanic, 5.9% African American, 2.8% non-Hispanic White, 1.9% Asian American, and 0.2% American Indian. The average age (±SD) was 27.5 years (±5.8 years; range=17–43 years), average educational level was 9.3 years (±3.2 years; range=0–16 years), and average family size was 4.0 persons (±1.3 persons; range=2–11 persons). Mean (±SD) household income was $1233 per month (±617 per month; range=$0–3120 per month). Participants had lived in the United States for an average of 12.5 years (±9.5 years) and participated in the WIC on average 2.8 years. BMI averaged approximately 28.1 kg/m^2. These characteristics were similar across all 3 sites (Table 1).

Average energy intake was highest at baseline and decreased over the course of the study; average EI:BMR ratio was 1.6 (±0.64). This ratio was significantly lower for the control site than for either of the intervention sites; however, the average reported is within the range of normal values as described by Goldberg et al. in their study of total energy expenditure of adults in affluent societies.[23] Approximately one third of study participants exclusively breastfed their infants at study entry. Participants at the farmers' market site had higher rates of exclusive breastfeeding than did participants at either the supermarket or control site as well as higher rates of Medi-Cal participation and food security.

Consumption of Fruits and Vegetables

Total consumption of fruits and vegetables increased over the course of our study. At baseline, participants at the farmers' market site reported eating on average 2.2 servings of fruits and vegetables per 4186 kJ (1000 kcal) of food consumed (5.4 servings total), at the supermarket site 2.9 servings per 4186 kJ (6.9 servings total), and at the control site 2.6 servings per 4186 kJ (5.0 servings total). The difference between the intervention sites and the control site was not statistically significant when we controlled for energy intake. Figure 1a shows absolute values of average fruit and vegetable consumption for the 3 sites over the course of the study.

At the end of the intervention, participants at the farmers' market reported consuming 3.9 servings of fruits and vegetables per 4186 kJ on average (7.8 servings total), at the supermarket 4.1 servings per 4186 kJ (7.8 servings total), and at the control site 3.0 servings per 4186 kJ (4.8 servings total). The difference between each of the intervention sites and the control site was statistically significant ($F=9.75$; $P<.001$). To ensure that the result was not owing to multiple comparisons, we conducted the Bonferroni adjustment and found the results remained the same. Six months after the intervention, the increase in fruit and vegetable intake reported by participants at the intervention sites was sustained. Participants at both the farmers' market and supermarket sites reported eating an average of 4.0 servings of fruits and vegetables per 4186 kJ (7.5 and 7.4 servings total, respectively), whereas those at the control site reported an average of 3.1 servings per 4186 kJ (4.9 servings total). The difference in consumption between each of the intervention sites and the control site was statistically significant ($F=6.66$; $P=.001$). The pattern of differences between the intervention sites (increased consumption) and control site (little change) was the same when we evaluated consumption of fruits and vegetables excluding beans and potatoes and fruits and vegetables excluding juices.

There was no significant difference in consumption of servings of fruits alone per 4186 kJ between the 2 intervention sites and the control site at baseline ($F=2.15$; $P=.12$). Participants reported consuming on average 1.7 servings of fruits per 4186 kJ (3.8 servings total) at the farmers' market

TABLE 1—Baseline Characteristics of Participants in Intervention Offering Targeted Incentives for Fruits and Vegetables: Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), Los Angeles, Calif, 2001

	Farmers' Market Intervention (n = 168)	Supermarket Intervention (n = 140)	Control (n = 143)	Total Sample (n = 451)
Demographic variables, mean ±SD (range)				
Age, y	27.3 ±5.6 (17–43)	27.8 ±6.0 (18–40)	27.4 ±5.9 (17–43)	27.5 ±5.8 (17–43)
Education, y	9.1 ±3.4 (0–16)	9.6 ±3.0 (0–15)	9.1 ±3.2 (1–16)	9.3 ±3.2 (0–16)
Income, $	1179 ±584 (0–2 958)	1289 ±652 (0–3 120)	1243 ±618 (0–3 068)	1233 ±617 (0–3 120)
Family size,*** no.	3.8 ±1.2 (2–8)	4.1 ±1.4 (2–11)	4.3 ±1.3 (2–9)	4.0 ±1.3 (2–11)
Years in United States	12.2 ±9.8 (1–37)	12.3 ±9.8 (1–40)	13.0 ±9.1 (1–37)	12.5 ±9.5 (1–40)
Years in WIC	2.6 ±3.1 (0–16)	2.8 ±2.9 (0–16)	2.9 ±2.9 (0–13)	2.8 ±3.0 (0–16)
Health variables, mean ±SD (range)				
BMI, kg/m^2	27.9 ±4.9 (20.0–48.2)	28.0 ±4.8 (16.9–44.0)	28.4 ±5.2 (20.1–45.7)	28.1 ±5.0 (16.9–48.2)
EI at baseline,*** kJ	10 674 ±3 851 (1 524–24 199)	10 013 ±3 504 (2 038–24 651)	8 644 ±3 617 (1 934–23 123)	9 829 ±3 759 (1 524–24 651)
EI at end of intervention,*** kJ	8 493 ±3 353 (2 252–21 282)	8 225 ±3 169 (2 252–19 975)	7 053 ±2 901 (1 318–17 824)	7 953 ±3 215 (1 319–21 282)
EI 6 mo postintervention,*** kJ	8 305 ±3 252 (908–21 629)	7 907 ±2 934 (2 344–16 819)	6 748 ±2 687 (816–13 655)	7 690 ±3 052 (816–21 629)
EI : BMR ratio***	1.7 ±0.66 (0.23–3.9)	1.6 ±0.60 (0.28–4.2)	1.4 ±0.60 (0.29–3.9)	1.6 ±0.64 (0.23–4.2)
Ethnicity, %				
Hispanic	86.2	88.9	92.3	89.1
Non-Hispanic African American	6.9	7.4	3.5	5.9
Non-Hispanic White	4.1	1.5	2.8	2.8
Asian American	2.1	2.2	1.4	1.9
Native American	0.7	. . .	. . .	0.2
Language preference, %				
Spanish	68.5	75.5	68.5	70.7
English	30.9	24.5	31.5	29.1
No preference	0.6	. . .	. . .	0.2
Marital status,				
Married	80.4	72.9	79.0	77.6
Not married	19.6	27.1	21.0	22.4
Infant feeding practice,** %				
Exclusive breastmilk	46.3	22.8	18.9	30.2
Formula	15.9	30.1	39.2	27.8
Combination of both	37.8	47.1	42.0	42.0
Medi-Cal participant,* %				
Yes	74.9	67.1	62.2	68.4
No	25.1	32.9	37.8	31.6
Food security status at baseline,** %				
Food secure	48.8	30.6	36.6	39.4
Food insecure	51.2	69.4	63.4	60.6

Note. BMI = body mass index; EI = energy intake; BMR = basal metabolic rate. Medi-Cal is California's version of public health care insurance. Ellipses indicate no participants in that category.
*P = .05, by χ^2 test; **P < .01, by χ^2 test; ***P < .001, by F test.

site, 2.0 servings per 4186 kJ (4.1 servings total) at the supermarket site, and 2.1 servings per 4186 kJ (3.1 servings total) at the control site. At the end of the intervention, there was still no statistically significant difference between the intervention sites and the control site in terms of fruit consumption (F = 0.95; P = .39). This consumption pattern remained the same 6 months after the intervention. Figure 1b depicts absolute consumption of fruits alone by site over the course of the study.

Vegetable consumption alone at the control site at baseline was significantly higher than at the farmers' market, but not at the supermarket site. When beans and potatoes were removed from the total number of vegetables consumed, there was no difference in the pattern of average consumption of servings of vegetables per 4186 kJ at the intervention and control sites (F = 1.7; P = .18). At the end of the intervention, participants at both of the intervention sites reported eating more servings of vegetables per 4186 kJ on average than the control site, and this difference was statistically significant (F = 11.0; P < .001). When we adjusted

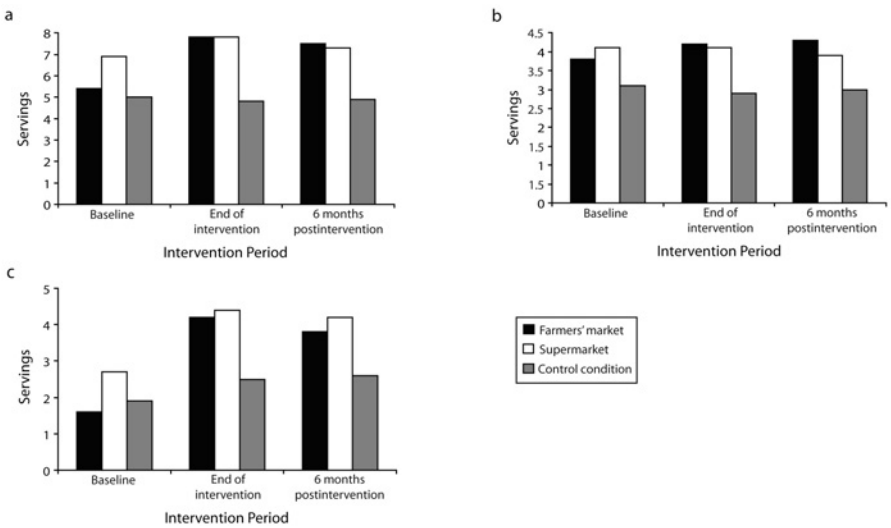

FIGURE 1—Average consumption at baseline, end of intervention, and 6 months after intervention, by treatment group, of (a) fruits and vegetables together, (b) fruits alone, and (c) vegetables alone: Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), Los Angeles, Calif, 2001.

for multiple comparisons, the significance remained. Participants at the farmers' market site reported eating an average of 2.1 servings of vegetables per 4186 kJ (4.2 servings total), those at the supermarket site 2.3 servings per 4186 kJ (4.4 servings total), and those at the control site 1.5 servings per 4186 kJ (2.5 servings total). The pattern of results was similar for consumption of vegetables excluding beans and potatoes (F=8.33; $P<.001$). Figure 1c shows absolute consumption of vegetables alone by site over the course of the study.

Six months after the intervention, both of the intervention sites sustained their higher average intake of servings of vegetables per 4186 kJ compared with the control site. However, after adjustment for multiple comparisons, the difference was statistically significant only when the supermarket site was compared with the control site (for control vs farmers' market, F=−0.40; $P=.13$; for control vs supermarket, F=−0.59; $P=.01$). When beans and potatoes were excluded from the average servings of vegetables consumed per 4186 kJ, both of the intervention sites had higher consumption of vegetables than the control site, and this difference remained statistically significant after adjustment for multiple comparisons (for control vs farmers' market, F=−0.81; $P=.007$; for control vs supermarket, F=−0.75; $P=.023$).

Higher reported intake of fruits and vegetables 6 months after the intervention was associated with higher reported fruit and vegetable intake at baseline, preference for speaking Spanish, and either the farmers' market site or the supermarket site (Table 2). This model explained 14% of the variance in the study ($P<.001$).

Mixed Models

We used mixed models to determine whether there were sustained differences over time in consumption of fruits and vegetables together, fruits alone, and vegetables alone. We used the same set of covariates from the linear regression model. For fruits and vegetables together (which explained 13% of the variance; $P<.001$), compared with the control group, participants in the

TABLE 2—Factors Associated With Sustaining Fruit and Vegetable Intake 6 Months After an Intervention Offering Subsidies on Fruits and Vegetables: Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), Los Angeles, Calif, 2001

	r (95% CI)	SE	*P*
Fruit and vegetable intake	0.32 (0.19, 0.45)	0.07	<.001
Energy intake	-0.0002 (-0.001, 0.000)	0.00	.51
Age	0.03 (-0.07, 0.12)	0.05	.55
Education	0.02 (-0.14, 0.19)	0.08	.81
Income	0.0004 (0.000, 0.001)	0.00	.26
Spanish language preference	2.04 (0.30, 3.78)	0.88	.02
Hispanic	0.29 (-2.6, 3.2)	1.48	.84
Family size	-0.02 (-0.51, 0.47)	0.25	.93
Years in United States	0.008 (-0.09, 0.10)	0.05	.86
Medi-Cal[a]	0.62 (-0.28, 1.53)	0.46	.17
Years on WIC	-0.02 (-0.20, 0.17)	0.09	.87
Infant feeding method[b]	0.06 (-1.13, 1.25)	0.61	.92
BMI	-0.02 (-0.14, 0.08)	0.06	.62
Food secure	0.43 (-0.61, 1.47)	0.53	.41
Farmers' market intervention	2.26 (1.07, 3.44)	0.60	<.001
Supermarket intervention	1.63 (0.39, 2.86)	0.63	.01

Note. BMI = body mass index; CI = confidence interval. Medi-Cal is California's version of public health care insurance. Model-adjusted $R^2=.14$, $P<.001$.
[a]Participation in the Food Stamp Program and Temporary Assistance for Needy Families was included in the model but was not significant. When beans and potatoes were excluded from the list of fruits and vegetables, results were the same for the farmers' market intervention and the control group, but results for the supermarket intervention had only borderline significance ($P=.05$).
[b]Infant feeding method is a composite variable from multiple time points. All other independent variables are from baseline.

TABLE 3—Longitudinal Comparison of Fruit and Vegetable Intake at the End of the Intervention Period (t2) and 6 Months Postintervention (t3) With Intake at Baseline: Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), Los Angeles, Calif, 2001

	r (SE)	*t*	*P*
Age	0.04 (0.01)	2.38	.02
Education	−0.002 (0.03)	−0.07	.94
Income	−0.00005 (0.0001)	−0.37	.71
Spanish language preference	0.51 (0.26)	1.97	.05
Hispanic	−0.16 (0.32)	−0.52	.61
Family size	0.01 (0.08)	0.12	.91
Years in United States	−0.02 (0.01)	−1.58	.11
Medi-Cal	0.09 (0.18)	0.50	.62
Years on WIC	−0.04 (0.03)	−1.06	.30
Infant feeding method	−0.54 (0.19)	−2.85	<.01
Food secure	−0.29 (0.17)	−1.76	.08
Farmers' market (FM) intervention	−0.27 (0.27)	−0.97	.33
Supermarket (SM) intervention	0.25 (0.28)	0.92	.36
End of intervention	0.20 (0.24)	0.86	.39
6 mo postintervention	0.45 (0.24)	1.91	.06
FM×t2	1.40 (0.33)	4.20	<.001
SM×t2	0.81 (0.34)	2.33	.02
FM×t3	1.15 (0.33)	3.45	<.001
SM×t3	0.54 (0.34)	1.56	.12

Note. Medi-Cal is California's version of public health care insurance. Model adjusted $R^2 = .13$, $P < .001$.

farmers' market site increased consumption by a statistically significant 1.4 servings per 4186 kJ from baseline to the end of the intervention and participants in the supermarket site increased consumption by 0.8 servings per 4186 kJ over the same period (Table 3). Among the farmers' market participants, there was also a significant increase compared with the control group of 1.15 servings per 4186 kJ from baseline to 6 months after the intervention.

Regarding fruit consumption, there was a significant increase of 0.51 servings per 4186 kJ from baseline to the end of the intervention for the farmers' market condition compared with the control, and this increase was sustained 6 months after the intervention (data not shown). Consumption among participants at the supermarket site was not significantly different from that of participants in the control condition for either of these time periods. Individuals who had recently immigrated also tended to consume more servings of fruits than did those who had been in the United States longer (marginally significant at $P=.05$).

Vegetable consumption increased significantly both from baseline to the end of the intervention and from baseline to 6 months after the intervention (data not shown). At the end of the intervention period, there was an increase of 0.89 servings per 4186 kJ for participants at the farmers' market site compared with the control ($P<.001$) and 0.57 servings per 4186 kJ for those at the supermarket site compared with the control ($P=.02$). Six months after the intervention, participants in the farmers' market site had increased vegetable consumption by 0.65 servings per 4186 kJ ($P<.01$) compared with control participants, but consumption among supermarket participants was not significantly different from that of control participants. Participants who were older ($P=.05$), bottle fed their infants 6 months after the intervention ($P<.01$), and were either African American or White ($P=.05$) also showed higher consumption of vegetables.

DISCUSSION

The targeted subsidy increased fruit and vegetable intake in both of the treatment conditions, and the increase was sustained 6 months after the end of the intervention. Increases in intake were primarily realized by increases in consumption of vegetables.

English-speaking African American and White participants showed greater increases in vegetable consumption over time, whereas Hispanics showed greater increases in fruit consumption. This finding is similar to results from a previous study we conducted in this population, in which African Americans who had participated for the first time in the WIC program reported increasing their consumption of vegetables, in particular leafy green vegetables.[25] According to the National Health and Nutrition Examination Survey of the National Center for Health Statistics, average consumption of fruits and vegetables for the US population in 2001 was 4.8 servings per day.[26] Our study focused on postpartum women, who are more likely to have a baseline consumption rate higher than the national average. In addition, the national average includes young children and men, who tend to consume fewer fruits and vegetables.

We believe that over the course of the intervention, Spanish language preference, because of its correlation with recent immigration status, was one of the key factors explaining fruit and vegetable intake, being a stronger determining factor than either ethnicity or time spent in the United States. This may be because individuals who live in neighborhoods where their native language is the primary spoken language are more likely to maintain their cultural eating habits and customs. These neighborhoods are also more likely to have ethnic grocery stores where such items can be purchased.

Although we do not have any formal quantitative data to substantiate reasons for farmers' market participants having higher fruit and vegetable consumption than supermarket participants, we do have individual reports that farmers' market participants thought produce at their site was fresher and of higher quality than at the supermarket. Participants who purchased their produce at the farmers' market also mentioned enjoying

the pleasant "community experience" of meeting friends while shopping and interacting directly with growers.

This study had several limitations. The sample was not representative of WIC participants at the national or state levels. However, the sample was reflective of the ethnic makeup of the WIC program studied, and the demographics of each of the study sites were similar.

Participants at the control site reported lower energy intakes than those of either of the intervention sites, although the intakes at every site were plausible in terms of EI:BMR ratios.[23] We have nevertheless reported servings of fruits and vegetables after controlling for energy intake as well as in absolute number of servings.

Finally, our intervention was in an environment characterized by a wide variety of fresh fruits and vegetables available year-round. If such a program were to be implemented in other settings, other forms of fruits and vegetables, such as frozen and canned ones, would have to be considered to accommodate seasonal variation.

We found that postpartum WIC participants who were given a $10 voucher per week for 6 months to purchase fresh fruits and vegetables at either a local, year-round farmers' market or supermarket increased their fruit and vegetable intake and maintained that increase 6 months after the economic subsidy was removed. As we have reported previously,[15] participants redeemed more than 90% of the coupons and purchased a wide variety of fresh fruits and vegetables. Spanish language preference and age were the only sample characteristics that were associated with maintaining a higher intake of fruits and vegetables over time. Income, ethnicity, family size, education, number of years residing in the United States, participation in a government assistance program, number of years as a WIC participant, infant feeding method, BMI, and food security status were not related to fruit and vegetable intake over time.

The recent recommendations for change in the WIC food packages[14] include a similar mechanism for adding fruits and vegetables, in the form of cash-value vouchers for fresh produce but with provision for canned or frozen forms of fruits and vegetables in environments where such forms are more practical. The requirement that revisions to the food packages not result in increased cost to the program dictated that the amounts recommended were substantially lower than those we used in this study: $10 per month for adult women and $8 per month for young children. The proposed rule currently being reviewed recommends $8 per month for women and $6 per month for children. On the basis of our results, we might expect that these amounts would translate into an additional 1 to 2 servings a day if the produce were consumed solely by the designated participant. However, because the items purchased with the coupons become part of the family food supply, we may expect that the change for the individual participant will be smaller.

Indeed, in our study, with a subsidy about 4 times that proposed in the revision to the food packages, adult women participants increased their intakes by about 1 serving per 4186 kJ, or about 2 servings per day for a woman consuming 8372 kJ (2000 kcal). The almost complete use of the coupons by our study participants supports the conclusion that fresh fruits and vegetables are valued items and suggests that the recommendations of the Institute of Medicine to add fresh fruits and vegetables to the WIC food packages will result in the desired outcome of increasing fruit and vegetable consumption. ■

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Contributors

D.R. Herman helped conceptualize the study and supervised all aspects of its implementation, including study design, data entry, data analysis, and writing the article. G.G. Harrison helped conceptualize the study, supervised D.R. Herman in the conduct of the study, and assisted in writing the article. A.A. Afifi assisted in data analysis and in writing the article. E. Jenks assisted with the conduct of the study, supervised the data collectors, and assisted in writing the article.

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Human Participant Protection

This study was approved by the institutional review boards of both the University of California, Los Angeles, and Public Health Foundation Enterprises.

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