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Reducing food insecurity and improving fruit and vegetable intake through a nutrition incentive program in Michigan, USA

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ABSTRACT

Background: Nutrition incentive (NI) programs increase the purchase of fruits and vegetables (FVs) among low-income participants. Double Up Food Bucks (DUFB) is a robust statewide NI program in the United States. The purpose of this paper is to report findings from DUFB in Michigan describing the factors related to FV intake (FVI) and food insecurity among participants in a NI program.

Methods: We administered a repeated cross-sectional survey with a convenience sample of DUFB participants at farmers markets and grocery stores (over the 2016, 2017, 2018 seasons). The survey was conducted online via paper-pencil. Descriptive statistics were calculated for all variables. A logistic regression model estimated household food insecurity and a linear regression estimated FVI with DUFB use/perceptions, sociodemographics, and health status as independent variables (significance level = $p < 0.05$).

Results: Descriptive results revealed that participants that completed surveys at grocery stores tended to be more racially-ethnically diverse and younger than participants that completed surveys at farmers markets. Participants with lower length of time participating in DUFB (i.e., lower dose) ($p < 0.001$), greater FV purchases ($p < 0.05$), and lower perceived health status ($p < 0.001$) tended to report being food insecure more frequently. Participants with increased length of time participating in DUFB ($p < 0.05$), greater FV purchases ($p < 0.001$), being male ($p < 0.01$), and greater perceived health status ($p < 0.001$) tended to report higher levels of FVI more frequently.

Conclusions: Longer participation in DUFB leads to improved outcomes with FVI and food security, suggesting that NI programs do have the intended positive impact they were designed to achieve.

1. Introduction

Obesity recently surpassed tobacco as the number one preventable cause of death in the United States (U.S.) (Mokdad et al., 2018), and poor dietary quality contributes to and can partially be attributed for obesity rates and chronic diseases such as cardiovascular disease, hypertension, type 2 diabetes, and some types of cancer (Lauby-Secretan et al., 2016; Wrobleski et al., 2018). Although the relationship between fruit and vegetable consumption and obesity lacks robust epidemiological evidence (Rolls et al., 2004), there is support for the independent relationship between fruit and vegetable consumption and chronic disease (Carter et al., 2010, Lauby-Secretan et al., 2016; Wrobleski et al., 2018). Low-income populations carry a disproportionate burden of diet-related diseases (Conway et al., 2018; Ogden et al., 2017), in part due to limited access to healthy food and consumption of fruits and vegetables (FV) that are below national dietary guidelines (Darmon & Drewnowski, 2015; Kirkpatrick et al., 2012; Wang et al., 2014). Low-income individuals typically report lower FV purchase and FVI than their higher income counterparts due to limited access to food outlets with *affordable* healthy options (Drisdelle et al., 2020; Evans et al., 2015; Lin et al., 2014). In the United States (U.S.), federal food assistance programs, such as the Supplemental Nutrition Assistance Program

Abbreviations: DSQ, Dietary Screener Questionnaire; DUFB, Double Up Food Bucks; FINI, Food Insecurity Nutrition Incentive; FVs, Fruit and vegetables; FVI, Fruit and vegetable intake; GusNIP, Gus Schumacher Nutrition Incentive Program; NI, Nutrition incentive; NIFA, National Institute of Food and Agriculture; SNAP, Supplemental Nutrition Assistance Program; U.S., United States; USDA, United States Department of Agriculture.

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(SNAP), as well as public and private organizations, have developed initiatives to address affordability-related barriers to healthy eating. SNAP participants have typically reported a lower quality diet when compared to income-eligible and higher-income nonparticipants (Andreyeva et al., 2015). In addition, SNAP participants report purchasing more ultra-processed foods at the beginning of the monthly benefit cycle and storing them in anticipation of food scarcity at the end of the month (Moran et al., 2019). Although obesity and limited FV intake (FVI) among low-income populations is a complex and multi-faceted public health challenge, one promising effort from the United States Department of Agriculture (USDA), National Institute of Food and Agriculture (NIFA) is the investment in nutrition incentive (NI) programs (Bartlett et al., 2014). NI programs aim to increase the purchase of FVs among low-income consumers participating in SNAP by providing incentives at the point-of-purchase (e.g., dollar-for-dollar match on FVs). The 2018 Farm Bill solidified support as part of the Gus Schumacher Nutrition Incentive Program (GusNIP, formerly the Food Insecurity Nutrition Incentive (FINI) program) (Conaway KM.H. R.2- 115th Congress, 2017-2018). USDA's support of NI programs has grown since FINI in 2014 ($100 million over five years) to GusNIP in 2018 ($250 million over five years) (NIFA, 2020; USDA, 2017). A recent national evaluation found these programs have broad appeal from a range of stakeholders who view the program as one that can improve food access, reduce food insecurity, decrease health care costs, and stimulate local economies (Parks et al., 2019).

Farmers markets that offer NI programs tend to have greater participation of low-income consumers (Olsho et al., 2015) and spending of SNAP dollars (i.e., NI programs draw in new SNAP customers with incentives; Baronberg, Dunn, Nonas, Dannefer, & Sacks, 2013; Freedman et al., 2014; Oberholtzer et al., 2012; Lindsay, 2013), which benefits local economies and farmers, as well as demonstrates increased consumer FVI (Bowling et al., 2016; Cohen et al., 2017; Dimitri et al., 2015; Olsho et al., 2016; Pellegrino et al., 2018; Savoie-Roskos et al., 2016; Young, 2013). Conversely, NI participants surveyed at farmers markets are more likely to be poor, female, white, and live in closer proximity to the farmers market, as compared to overall SNAP users and NI grocery store participants (Cohen et al., 2018; Parks et al., 2018).

The overarching goal of NI programs is to not only increase FVI among low-income populations, but also to address food insecurity. Food insecurity is defined as the absence of access to nutritionally adequate and safe food, acquired in socially acceptable ways (Dhurandhar, 2016; Leung et al., 2014). Studies that examined food security status among NI participants suggest that providing incentives for FVs is associated with increased FVI and food security (Durward et al., 2019; Hewawitharana et al., 2019; Moran et al., 2019). However, given the complexity and diversity in how NI programs operate (e.g., types of participating retail outlets, geographic focus, methods for redemption), and the limited of focus of previous studies on food insecurity and dietary quality, additional work is warranted in this area.

Double Up Food Bucks (DUFB) is among the oldest and most established NI programs in the U.S. (Fair Food Network, 2016). Launched in 2009 in Michigan, DUFB has grown into a robust statewide NI program and a national model that has since been adopted in several other communities (Fair Food Network, 2016). DUFB aims to increase healthy food access among low-income families, support local businesses and local economies, and benefit community health (Fair Food Network, 2016). Participants are eligible to participate in DUFB automatically when they spend SNAP dollars on eligible items (farmers markets: any SNAP eligible item, grocery stores: fruits and vegetables). The program doubles the value of SNAP benefits spent on FVs at participating farmers markets and grocery stores (Fair Food Network, 2016). At most farmers market locations, incentives are distributed through a central location in the form of tokens, while a select few sites have individual transaction terminals at each vendor. The program also varies across the state in terms of the financial instrument used in grocery store settings (i.e., vouchers printed on receipts, automatic discounts, loyalty cards). As such, the purpose of this study is to report findings from a large statewide NI program to describe the factors that are related to FVI and food insecurity among SNAP participants in a nutrition incentive program. More specifically, we ask: *What are the significant factors of participant and program characteristics that influence FVI and food security in an NI program?*

2. Methods

2.1. Study sample

Data were collected from consumers at Michigan farmers markets and grocery stores that participated in DUFB during the 2016, 2017, and 2018 seasons (between April–October; selection of these months were based upon farmers market seasonality). A subsample of farmers markets and grocery stores (convenience sample, repeated cross-sectional) were selected for in-person data collection purposively to be geographically representative of the possible sites in the program and taking into consideration factors such as community characteristics (e.g., population, poverty level), past participation in DUFB, and historical distribution/redemption data. DUFB participants (N = 1521) completed surveys at 54 farmers markets (n = 794) and 50 grocery stores (n = 727) across the 2016 (n = 486), 2017 (n = 567), and 2018 (n = 468) seasons (April–October of each year). The data collection sites remained the same over the three seasons of data collection, with some fluctuations and changes year-to-year based on locations closing. This study was deemed exempt from the [BLINDED] Institutional Review Board (i.e., lowest level of risk). Intercept Surveys were administered at grocery stores and farmers markets via the Qualtrics Offline Application on iPad Minis. The survey was self-administered and took approximately 10 min to complete. In order to be included in the sample, survey respondents needed to be a current participant of DUFB. Data collectors were located at a table within the grocery store or farmers market with signage and approached customers to ask if they were a DUFB participant to determine inclusion. A paper-and-pencil option was made available upon request (<5% of respondents completed by paper-and-pencil). Consumers received a $5 incentive in cash for completing a survey.

2.2. Data collection

The survey assessed DUFB program use and program perceptions, FVI, household food insecurity, sociodemographics (5 items: age, race, ethnicity, gender, children in household), and perceived health status (total 42 items). DUFB use and program perceptions were assessed using 9-items: length of time using DUFB program (today is my first time; 1–6 months; 7–12 months; More than 1 year); use of the program at site types (i.e., farmers market, grocery stores); whether the program motivated consumers to shop at the location (5 point Likert, 1 = strongly disagree – 5 = strongly agree); whether the location was their normal food outlet (yes; no); length of time enrolled in SNAP (1–6 months; 7–12 months; 1–2 years; 2–5 years; More than 5 years); ease of identifying qualifying FVs (5 point Likert, 1 = very difficult – 5 = very easy); ease of payment process (5 point Likert, 1 = very difficult – 5 = very easy); and amount of FVs purchased before and during DUFB participation (Never; 1 time per month; 2–3 times per month; 4–5 times per month; 6 or more times per month). FVI was assessed through a 10-item screener from the National Cancer Institute's Dietary Screener Questionnaire (DSQ) that asks consumers about the frequency of foods and beverages consumed in the past month; the 10 items are: green salad, non-fried vegetables, cooked beans, fruit, fried potatoes, other nonfried potatoes, 100% fruit juice, pizza, other tomato sauce, and salsa. Response options included 11 frequencies ranging from 'never' to '6 or more times per day' (National Cancer Institute, 2020). Household food insecurity status was assessed using the USDA 6-item Household Food Security Survey Module (Bickel et al., 2000). Responses were scored based on the number of affirmative

responses ("often true," "sometimes true," "yes"), resulting in a household's raw food security score on a scale of 0–6. Households were stratified into two groups: high or marginal food security (scores of 0–1) and low or very low food security (2–6). For the purposes of this paper, we collapsed these household food security levels to be food insecure and food secure. Self-perceived health status was assessed with one item: "In general, would you say your health is excellent, very good, good, fair, or poor?" (Moriarty et al., 2003), Responses were dichotomized (poor/fair vs. good/very good/excellent). The validity of this measure is supported by several studies showing that this single-item is a strong and independent predictor of morbidity and mortality (DeSalvo et al., 2006).

2.3. Analysis

Participant characteristics were described as percentages for categorical variables, and all Likert scale variables (except for FVI) were converted to categorical (yes = strongly agree, agree; no = neither agree nor disagree, strongly disagree, disagree). Response options for variables were collapsed in order to make clearer comparisons in the analysis and for ease of interpretation. Frequencies and descriptive statistics, including means and standard deviations, were calculated for FVI, and frequencies were calculated for categorical variables. Logistic regression models were used to estimate household food insecurity and a linear regression was used to estimate FVI with length of program participation and program perceptions, sociodemographics, and perceived health status as independent variables (all items described above). These variables were selected as they have been noted in previous studies as potential factors influencing participation and outcomes. Key outcomes of interest for the DUFB program include FVI and food security status, which is the main driver for selection of these two variables as dependent variables. We also ran tests for heterogeneity for food insecurity (Chi Square) to determine if there were any specific factors that differed in our sample. The significance level was set to $p < 0.05$. All analyses were performed in the statistical software package R (R Core Team, 2017).

To calculate monthly intake frequencies of FVs, all responses were converted to daily frequency (meaning all responses are first converted to daily frequencies before the algorithm is applied). For example, for the response option '2–3 times last month,' the median (2.5) was divided by 30 to equal 0.083 times/day. A complete description of how frequencies were converted to FV cup equivalents is available (Thompson et al., 2017). Estimated intakes of cup equivalents of FV were calculated using statistical programs obtained from the Risk Factor Assessment Branch of the National Cancer Institute. The statistical programs were developed to compare the responses from the 2009–2010 National Health and Nutrition Examination Survey (NHANES) dietary screener with the What We Eat in America (WWEIA) 24 h dietary recall data from the 2003–2006 NHANES.[32] For the cups of FV estimates, scores greater than three interquartile ranges above the upper quartile, or below the bottom quartile, were considered outliers and removed (Thompson et al., 2008). This affected 1.9% of the sample (fewer than 3% of cases were removed overall for incomplete data). Extreme outliers were defined as those with nutrients or food groups at least two times the interquartile range lower or higher than the lower and upper bounds of the interquartile range (25th and 75th percentiles).

3. Results

Descriptive characteristics of the sample are shown in Table 1. DUFB participants (N = 1521) completed surveys at 54 farmers markets (n = 794) and 50 grocery stores (n = 727) across the 2016, 2017, and 2018 seasons. Approximately half of the participants were ages 44 years and below (52.1%), with 40.0% indicating they were 45 years and older. Participants that completed surveys at grocery stores tended to be slightly younger (55.2% under 44 years) compared to farmers markets (49.4% under 44 years). The majority of respondents were female

Table 1
Descriptive characteristics of survey respondents.

Characteristics	Farmers Market (n = 794)	Grocery Store (n = 727)	Total Sample (N = 1521)
Age (n (%))			
44 years and younger	392 (49.4%)	401 (55.2%)	793 (52.1%)
45 years and older	369 (46.5%)	238 (32.7%)	607 (40.0%)
Gender (n (%))			
Male	178 (22.4%)	183 (25.2%)	361 (23.7%)
Female	591 (74.4%	520 (71.5%)	1111 (73.0%)
Other	5 (0.6%)	2 (0.3%)	7 (0.5%)
Race (n (%))			
White	487 (61.3%)	214 (29.4%)	701 (46.1%)
Black	215 (27.1%)	415 (57.1%)	630 (41.4%)
Other	80 (10.1%)	68 (9.4%)	148 (9.7%)
Ethnicity (n (%))			
Hispanic	42 (5.3%)	77 (10.6%)	119 (7.8%)
Non-Hispanic	739 (93.1%)	627 (86.2%)	1366 (89.8%)
Perceived health status[a] (n (%))			
Poor	31 (3.9%)	28 (3.9%)	59 (3.9%)
Fair	171 (21.5%)	181 (24.9%)	352 (23.2%)
Good	328 (41.3%)	272 (37.4%)	600 (39.4%)
Very good	163 (20.5%)	147 (20.2%)	310 (20.4%)
Excellent	98 (12.3%)	90 (12.4%)	188 (12.4%)
Food security status[b] (n (%))			
Food secure	377 (47.5%)	304 (41.8%)	681 (44.8%)
Food insecure	417 (52.3%)	423 (58.2%)	840 (55.2%)
Children in household (n (%))			
Yes	390 (49.1%)	439 (60.4%)	829 (54.5%)
No	391 (49.2%)	259 (35.6%)	650 (42.7%)
Shopping with children[c] (n (%))			
Yes	330 (41.6%)	308 (42.4%)	638 (41.9%)
No	60 (7.6%)	129 (17.7%)	189 (12.4%)
Length of time in DUFB (n (%))			
6 months or less	355 (44.7%)	485 (66.7%)	840 (55.2%)
7 months or more	437 (55.0%)	239 (32.9%)	676 (44.4%)
Length of time in SNAP ((n (%))			
Less than 1 year	205 (25.8%)	244 (33.6%)	449 (29.5%)
1 year or greater	577 (72.7%)	477 (65.6%)	1054 (69.3%)
Site is normal location[d] (n (%))			
Yes	668 (84.1%)	593 (81.6%)	1261 (82.9%)
No	48 (6.1%)	99 (13.6%)	147 (9.7%)
I do not normally shop at this site type	75 (9.4%)	29 (4.0%)	104 (6.8%)
Motivation to shop[e] (n (%))			
Yes	465 (58.6%)	520 (71.5%)	985 (64.8%)
No	328 (41.3%)	206 (28.3%)	534 (35.1%)
Ease of identifying eligible FVs (n (%))			
Easy	655 (82.5%)	512 (70.4%)	1167 (76.7%)
Not Easy	138 (17.4%)	209 (35.1%)	347 (22.8%)
Ease of purchase using DUFB (n (%))			
Easy	702 (88.4%)	534 (73.5%)	1236 (81.3%)
Not Easy	91 (11.5%)	187 (25.7%)	278 (18.3%)
Fruit and vegetable purchases (n (%))			
Pre-DUFB			
≤ 2–3 times per month	515 (64.9%)	471 (64.8%)	986 (64.8%)
≥4–5 times per month	275 (34.6%)	252 (34.7%)	527 (34.6%)
Post-DUFB			
≤ 2–3 times per month	305 (38.1%)	361 (49.7%)	666 (43.8%)
≥4–5 times per month	487 (61.4%)	361 (49.7%)	848 (55.8%)
Cup equivalents of FVs[f] (mean ± SD)	2.991 ± 1.379	2.726 ± 1.440	2.869 ± 1.413

[a] Perceived health status measured with this item "Would you say that in general your health is poor, fair, good, very good, or excellent?" Response options on a 5-point Likert scale 1 = poor – 5 = excellent.

[b] Food Security Status measured with the USDA 6-item Household Food Security Survey Module.[28].

[c] This was only asked if they answered yes to having children living in the household.

[d] Site is normal location was assessed with this item "Is this the farmers market that you normally shop at?" Response options: yes; I do not normally shop at a farmers market/grocery store; No – which market do you normally shop at?___.

[e] Motivation to shop was assessed with this item "Without the Double Up Food Bucks program, I still would have shopped at the farmers market today." Response options on a 5-point Likert scale 1 = strongly disagree – 5 = strongly agree.

[f] Cup equivalents of FVs was assessed through a 10-item screener from the National Cancer Institute's Dietary Screener Questionnaire (DSQ) (https://epi.grants.cancer.gov/nhanes/dietscreen/questionnaires.html.

(73.0%), which was fairly consistent across participants that completed surveys at grocery stores and farmers markets. Approximately half of the respondents were white (46.1%) and the other half were black (41.4%). A larger portion of participants that completed surveys at grocery stores were black (57.1%), compared to participants at farmers markets (27.1%). Most respondents were non-Hispanic (89.8%), with slightly more participants that completed surveys at grocery stores reporting to be Hispanic (10.6%) compared to farmers markets (5.3%).

Perceived health status ranged in responses from poor to excellent, with a large portion reporting "good" health (39.4%). Across participants, 54.5% of respondents reported having children under the age of 18 in their household, with more participants that completed surveys at grocery stores having children (60.4%) as compared to farmers markets (49.1%). Over half (55.2%) of respondents were considered food insecure, with a similar distribution across participants that completed surveys at farmers markets and grocery stores. Some respondents (55.2%) had been a participant of DUFB for 6 months or less, with more participants that completed surveys at grocery stores (66.7%) compared to farmers markets (44.7%) participating for 6 months or less. The majority of respondents (69.3%) reported being a SNAP participant for 1 year or greater, with similar distribution across participants that completed surveys at grocery stores and farmers markets.

When participants were asked if this was the farmers market/grocery store that they typically shop at, the majority of respondents said "yes" (82.9%). In terms of the ease with which participants could identify which fruits and vegetables are eligible for DUFB, three-quarters of the respondents agreed it was somewhat easy or very easy (76.7%), with more participants that completed surveys at farmers markets agreeing (82.5%) compared to grocery stores (70.4%). Finally, a majority of respondents agreed it was somewhat easy or very easy (81.3%) to use the program overall, with stronger agreement from participants that completed surveys at farmers markets (88.4%) compared to grocery stores (73.5%).

Participants were also asked to compare the amount of FVs they purchased prior to DUFB participation with currently, during DUFB participation. There were greater proportions of respondents indicating that they purchased FVs 4–5 times per month currently, during DUFB participation (55.8%), compared to prior to DUFB participation (34.6%) (retrospective reporting). The DSQ FV screener and associated algorithm revealed that respondents consumed on average 2.87 cups of FVs per day, with participants that completed surveys at farmers markets reporting slightly higher FVI (2.99 cups) compared to grocery stores (2.73 cups).

3.1. Regression results

Regression analyses were run separately for participants that completed surveys at farmers markets and grocery stores (not shown), but there were no differences between these results, thereby supporting a combined analysis. For food insecurity, participants with lower length of time participating in DUFB ($\beta = -0.69$, SE = 0.14, $p < 0.001$), greater FV purchases currently, during DUFB participation ($\beta = 0.33$, SE = 0.14, $p < 0.05$), and lower perceived health status ($\beta = -0.64$, SE = 0.13, $p < 0.001$) tended to report higher being food insecure (Table 2). The odds ratio for food insecurity relative to the length of time participating in DUFB revealed that those that participated one year or more were 50% less likely to be food insecure compared to those participating in DUFB less than year (exp(-0.69) = 0.50). Tests for heterogeneity for food security revealed that only race ($p < 0.05$) and ethnicity ($p < 0.05$) were significant, with Hispanic respondents reporting food insecurity at higher rates than Non-Hispanic respondents (Hispanic = 66%; Non-Hispanic = 54%) and White respondents reporting food insecurity at higher rates than Black or Other respondents (White = 47%, Black = 41%, Other = 11%). For FVI, participants with increased length of time participating in DUFB ($\beta = 0.22$, SE = 0.02, $p < 0.05$), greater FV purchases prior to DUFB participation ($\beta = 0.42$, SE = 0.09, $p < 0.001$) and currently, during DUFB participation ($\beta = 0.56$, SE = 0.09, $p < 0.001$) DUFB, being male ($\beta = -0.30$, SE = 0.14, $p < 0.01$), and greater perceived health status ($\beta = 0.30$, SE = 0.09, $p < 0.001$) tended to report higher levels of FVI (Table 3). In terms of length of time participating in DUFB and FVI, FVI was on average 0.22 cups per day higher for those that had participated one year or more compared to those that

Table 2
Factors related to food insecurity among DUFB participants.

Predictors	Estimate (β)	Standard Error	P-Value
Length of time in DUFB[a]	−0.68584	0.13998	**<0.001**
Length of time in SNAP[b]	0.22319	0.15141	0.14045
Use of program at other "like" sites (yes)	0.30508	0.20644	0.13946
Do not normally shop at this site type	−0.21535	0.31003	0.48730
Motivation to shop	−0.04952	0.12464	0.69113
Ease of identifying eligible FVs[c]	−0.34755	0.19327	0.07213
Ease of purchase using DUFB	−0.17884	0.21359	0.40241
Fruit and vegetable purchases[d]			
Pre-DUFB	−0.24378	0.14092	0.08363
During-DUFB	0.33237	0.13869	**<0.05**
Age	0.16535	0.13263	0.21251
Gender[e]	−0.08576	0.14484	0.55380
Race			
Black	−0.12567	0.12626	0.31957
Other	0.18211	0.22007	0.40796
Ethnicity	0.32461	0.26410	0.21902
Perceived health status	−0.63589	0.13485	**<0.001**
Children in household	−0.04861	0.13631	0.72139

Note: this was a logistic regression.
[a] Double Up Food Bucks (DUFB).
[b] Supplemental Nutrition Assistance Program (SNAP).
[c] Fruits and Vegetables (FVs).
[d] FV purchases were assessed with retrospective pre-post items.
[e] Gender was coded male = 1, female = 2, and males are the reference category.

Table 3
Factors related to fruit and vegetable intake among DUFB participants.

Predictors	Estimate (β)	Standard Error	P-Value
Length of time in DUFB[a]	0.221565	0.092530	**<0.05**
Length of time in SNAP[b]	0.003488	0.099538	0.972053
Use of program at other "like" sites (yes)	0.018071	0.136856	0.894972
Do not normally shop at this site type	0.271388	0.208227	0.192712
Motivation to shop	−0.061242	0.082656	0.458884
Ease of identifying eligible FVs[c]	0.025182	0.125661	0.841203
Ease of purchase using DUFB	0.162118	0.138512	0.242061
Fruit and vegetable purchases[d]			
Pre-DUFB	0.416405	0.094120	**<0.001**
Post-DUFB	0.563600	0.091297	**<0.001**
Age	0.096209	0.088581	0.277648
Gender[e]	−0.299863	0.095608	**<0.01**
Race			
Black	0.094373	0.084342	0.263396
Other	0.159497	0.143372	0.266158
Ethnicity	−0.003950	0.169196	0.981381
Perceived health status	0.299188	0.087626	**<0.001**
Children in household	0.159333	0.090920	0.079952

Note: this was a linear regression.
[a] Double Up Food Bucks (DUFB).
[b] Supplemental Nutrition Assistance Program (SNAP).
[c] Fruits and Vegetables (FVs).
[d] FV purchases were assessed with retrospective pre-post items.
[e] Gender was coded male = 1, female = 2, and males are the reference category.

participated less than one year.

4. Discussion

The results from this U.S.-based study suggested that longer NI program participation is related to greater likelihood of higher levels of FVI and reporting being food insecure compared to those that have not participated in DUFB as long. Those who participated in DUFB for 7 months or longer reported consuming 3.04 cups per day compared to those who participated for 6 months or less reported consuming 2.74 cups per day. Although these results are cross-sectional in design, they do support the main outcomes of interest (i.e., increased FVI and food security) for the GusNIP program as specified in the 2018 Farm Bill (NIFA, 2020). In addition, current study findings mirror the first large scale randomized trial conducted in Massachusetts that found that FVI was significantly greater among participants in the intervention when compared to respondents that did not receive the intervention (Bartlett et al., 2014). Further substantiation of the positive impact of NI programs on FVI and food security emerged in subsequent implementation studies across the U.S. (An, 2013; Bowling et al., 2016; Young, 2013). Qualitative data from NI programs suggest that these programs help to reduce barriers associated with shopping at farmers markets, allow for greater spending flexibility, and allow parents to provide their children with FVs that did not previously fit in their food budget (Savoie Roskos et al., 2017).

The current study also found that higher levels of perceived health status were related to significantly higher levels of FVI (those who rated their health as 'poor' consumed on average 2.73 cups of FVs a day vs those who rated their health as 'excellent consumed 2.85 cups of FVs a day). This finding is potentially indicative that participants in NI programs that have better perceived health status tend to have greater FVI. Perceived health status is one small "proxy" assessment of health that suggests a promising linkage between NI program and health. A study that assessed cost-effectiveness found that subsidies for SNAP participants to purchase FVs would be expected to reduce the incidence of chronic diseases and provide a societal cost savings in health care dollars (Choi et al., 2017). In terms of FV prescription programs, which are similar to NI programs but typically include more explicit health metrics, it has been reported that access to these programs led to decreased HbA1C concentrations in type 2 diabetic patients (Bryce et al., 2017) and increased household food insecurity (Ridberg et al., 2019).

Together these results suggest that NI programs, such as DUFB could be a useful model for the delivery of financial incentives that encourages low-income shoppers to visit farmers markets and grocery stores for FVs in areas with limited healthy food access. Although DUFB is a large and robust statewide program in the U.S. with over 250 sites, throughout the life of the program, there have been challenges with generating participant interest and trust. The findings from this study also highlighted some potential demographic differences between DUFB between participants shop at farmers markets compared with those that shop at grocery stores. Grocery store DUFB participants were slightly younger, Black or Hispanic, and to have children when compared to DUFB participants that shopped at farmers markets. Given the sample size and cross-sectional nature of this study, these demographic characteristics should be considered as a first step in understanding the reach and representativeness of NI programs. A recent paper described that farmers market and grocery store respondents were mostly middle-aged and female, and grocery store respondents tended to be more diverse than farmers market shoppers (Parks et al., 2018). A recent qualitative study of NI program participants found that although participants were satisfied with the program, barriers to participation included not being aware of the program due to lack of market-level information and the timing and location of the markets being inconvenient (Garner et al., 2020). However, the current study found that the majority of participants reported it was easy to identify eligible FVs (77%) and easy to purchase FVs using DUFB (81%). As NI programs continue to expand, participant characteristics should inform tailored outreach to reach diverse populations to have a greater public health impact.

4.1. Limitations

There were some limitations to this study. This data was collected in one state in the U.S. using a convenience sample, that did not have a large population of Latinos, limiting generalizability. However, the study sample was more diverse than the overall SNAP participant population in the state of Michigan (e.g., 80% White, 14% Black, 4% Hispanic in 2017 compared to our sample being 46% White, 41% Black, and 8% Hispanic). Specific programmatic characteristics such as the location and type of food outlets that offered DUFB may have an impact on who participates, therefore, these results may not generalize to other incentive programs across the U.S. However, given the variety in implementation characteristics across farmers market and grocery stores sites participating in DUFB Michigan, there is increased generalizability. Since these results are repeated cross-sectional in nature, findings from the current study support the effectiveness of DUFB, but cannot address issues of causation. However, we selected data collection sites to be representative of those across the state and these results are reporting on multiple years of data collection, further enhancing the generalizability. We used validated items as much as possible (e.g., FVI, food insecurity, perceived health metrics), other items on the survey were newly created (e.g., program use and perceptions) for the purpose of this project and have not been tested for validity and reliability. Also, self-reported data also introduce a potential bias given individuals may answer in a more "positive" way due to perception as well as memory bias when reporting FVI. Lastly, there is also a risk of confounding of variables given the complexity of food insecurity and the range of constructs assessed. Future studies can assess characteristics of NI programs longitudinally and assess the factors that impact participation as well as important outcomes such as FVI and food insecurity. A strength of the current study is the novel focus on the impact of NI programs on both FVI and food insecurity in a large statewide program that includes farmers markets and grocery stores. These two outcomes are important markers of success of NI programs and should be replicated in future efforts.

5. Conclusions

By describing the factors of program participation and participant characteristics that are related to FVI and food insecurity, we can begin to understand specific ways to enhance the impact of NI programs. The data for the current study was collected from participants of a large statewide program over multiple years, using validated measures. This paper contributes to the literature by summarizing data from three years of a large NI program, providing the evidence supporting the effectiveness of these programs as they continue to grow across the U.S. Specifically, NI programs should consider outreach and recruitment to programs tailored to farm direct and brick and mortar settings to ensure the program is reaching a representative low-income population. In particular, longer participation leads to improved outcomes with FVI and food security, suggesting that NI programs do have the intended positive impact they were designed to achieve. In addition, at a time where now we are seeing huge assault to the food system with the COVID-19 pandemic, leading to higher rates of food insecurity (Shanzenbach & Pitts, 2020), it is even more critical to maintain momentum of NI programs. It is also important to determine the effectiveness of NI programs and to be able to be responsive in times when there is a spike in the number of families experiencing food insecurity.

Author contributions

Parks, C.A., Fricke, H.E., Parker, H.A., Hesterman, O.B., Yaroch, A.L. were all involved with study design and conceptualization and writing (review & editing).

Parks, C.A. and Fricke, H.E. were also involved in data curation, supervision, and validation.

Parks, C.A. was responsible for writing (original draft).

Han, P. was primarily responsible for statistical analysis, reporting outcomes, and writing (review & editing)

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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