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Examining the Relationships between Levels of Reach of Supplemental Nutrition Assistance Program-Education Interventions and Nutrition and Physical Activity-Related Outcomes using Data from the California Health Interview Survey

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Fred Molitor
Nutrition Education and Obesity Prevention Branch
California Department of Public Health

Michael Biehl, Sharon Sugerman, Evan Talmage
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Executive Summary

Introduction
This study combined information on United States Department of Agriculture (USDA) Supplemental Nutrition Assistance Program-Education (SNAP-Ed) interventions with interviews responses from the California Health Interview Survey (CHIS) to investigate the viability of linking these large-scale process and outcome databases at the Census-tract level, and to examine associations between levels of intervention reach and fruit and vegetable consumption, consumption of fast food and sugar-sweetened beverages, and physical activity.

Methods
Information on the actual and eligible number of individuals participating in SNAP-Ed, and the location of intervention sites, as recorded in the Education and Administrative Reporting System (EARS) were used to develop levels of intervention reach across the 1,527 Census tracts meeting the SNAP-Ed eligibility requirements in 2011. The location of 2011/12 CHIS respondents was also geo-coded and then linked with EARS data. Regression analyses examined the levels of intervention reach with self-reported healthful eating and beverage consumption behaviors, as well as participation in physical activity. Analyses were conducted with CHIS data from 4,245 adults, 465 teenagers, and 1,217 children. These analyses included measures for gender, age, race/ethnicity, and education to discount the potential influence of confounding variables.

Results
Intervention reach ranged from no SNAP-Ed interventions (661 of the 1,527 Census tracts); to low (0.01% to 39.99% of the target population reached), to moderate (40%-89.99% reached); to high (90%-100% reached). Adults and children from high reach Census tracts reported eating more fruits and vegetables than adults and children from no intervention Census tracts. Adults from Census tracts with low, moderate, and high levels of SNAP-Ed interventions also reported eating fast food less often. Teenagers from low reach Census tracts reported an increased number of physical activity days than teens not exposed to SNAP-Ed interventions.

Discussion
The greatest concentration of SNAP-Ed interventions was associated with eating more fruits and vegetables among adults and children, and eating less fast food among adults. Limitations of this study include the absence of measures of intervention exposure at the individual-level or differences in the characteristics of the Census tracts; a temporal relationship between presumed intervention exposure and behavior change; the ability to control for non-SNAP interventions and campaigns intended to influence the same behaviors, and limited statistical power for the teen sample.

Introduction

In Federal Fiscal Year (FFY) 2011, the Nutrition Education and Obesity Prevention Branch (NEOPB) of the California Department of Public Health funded 120 contractors to provide one-on-one and group interventions to the Supplemental Nutrition Assistance Program (SNAP) population. Information about individuals who participate in the United States Department of Agriculture (USDA) SNAP-Education (SNAP-Ed) interventions is recorded by contractors into the USDA's Education and Administrative Reporting System (EARS). NEOPB staff train and provide

ongoing technical assistance to contractors on EARS documentation, and clean and summarize the data for annual reports to the USDA and for other purposes such as program planning.

The California Health Interview Survey (CHIS) is an ongoing stratified random digit dial health survey that interviewed by telephone 42,935 adults, 2,799 teenagers, and 7,334 children throughout the State from June 2011 through December 2012. Survey data for children are collected by the adult proxy from the sampled households. The 2011/12 survey instrument included items related to three intended SNAP-Ed outcomes: healthful eating and beverage consumption, and achieving recommended levels of physical activity.

This study was conducted to address two overall questions: Was it feasible to use EARS data to identify levels of intervention activity at the Census-tract level that could be merged with CHIS data to explore relationships between levels of presumed exposure and related self-reported outcomes? Second, were CHIS survey participants from Census tracts with higher levels of interventions more likely to report increased fruit and vegetable consumption, decreased consumption of fast food and sugar-sweetened beverages, and more physical activity?

Methodology

Matching EARS with CHIS Data

The foundation for this study was matching EARS intervention data to CHIS interview data at the Census-tract level. The 2011 EARS database identified each SNAP-Ed intervention site's address, which was geocoded using ArcGIS (version 10.1) based on 2000 Census data. These Census tracts were linked to Census tract information from the 2011/12 CHIS after survey respondents' addresses were geocoded, resulting in available interview data from 4,245 adults, 465 teenagers, and 1,217 children.

Developing the Independent Variable

The Using Census tract information from EARS, we determined that SNAP-Ed interventions occurred in 866 of the 1,527 Census tracts (56.7%) meeting the population eligibility requirements for SNAP-Ed interventions in 2011 (see Appendix). Rather than examining level of interventions as a dichotomous variable, we conducted the following steps to categorize the 866 Census tracts by levels of intervention reach. Four types of interventions from EARS were considered: **Direct Education** represents structured learning interventions facilitated by a trained educator and/or through interactive media. **Social Marketing** is interventions where a participant is actively engaged in one of our targeted group interventions (e.g., Power Play!). Social Marketing differs from Direct Education in that the events and programs are directed towards a specific segment of the population. **Location-Targeted** interventions are defined as participation in one of NEOPB's Retail or Worksite Program events. Information is entered into EARS for each individual who participates in Direct Education, Social Marketing, and Location-Targeted interventions. However, the number of contacts rather than individuals is documented in EARS for **Indirect Education** interventions, which often involve the distribution of information and resources to larger groups of individuals in settings where a specific count of participants cannot be ascertained.

Duplicate counts of participants in Indirect Education as well as the other three types of interventions were identified by the following procedures: The location of each intervention was reviewed for more than one type of intervention. In cases where Direct Education was provided, the counts for all other interventions were removed. Indirect education cases were removed in cases where the intervention location included Social Marketing and/or Location-Targeted, but not Direct Education.

If a site had more than one Direct Education intervention, only the first event was retained. School-based interventions, for example, often have the same cohort of students attend the same event a number of times. A similar approach was taken for Social Marketing interventions. If a school had multiple events only the first event was counted unless different classrooms were identified in EARS.

Finally, the potential for different contractors to record the same individuals as participating in an intervention was addressed by sorting and reviewing the data by location name within cities. Geocoding location address was also used to identify and remove duplicate cases.

These procedures resulted in removing 10.5 million cases, leaving 6.6 million presumed unduplicated individuals to develop a categorical level of reach variable across all four types of interventions.

Levels of reach were established by estimating the proportion of individuals exposed to these interventions within each Census tract. Specifically, the number of cases remaining from the procedures described above were divided by the total number of individuals from the SNAP-Ed target population within each of the 866 Census tracts. Finally, based on the distribution of the proportions

across the 866 Census tracts, three categories of reach were established: "low" (0.01% to 39.99% of the target population reached); "moderate" (40%-89.99% reached); and "high" (90%-100% reached). Along with the CHIS participants from the 661 Census tracts that did not have any NEOPB interventions, the independent variable for this study consisted of four levels of intervention reach: no, low, moderate, and high.

Characteristics of the CHIS Sample

Table 1 displays the characteristics of the CHIS samples of adults, teens, and children across the 1,527 Census tracts by socio-demographics, as well as the number of individuals from the three age groups by levels of intervention reach. No statistically significant differences ($p<0.05$) were found between the intervention and no intervention Census tracts for the socio-demographic variables. The proportion of the sample by levels of intervention reach was similar across the three age groups with roughly 33% to 36% in the no intervention group, 36% to 40% in the low reach group, 10% to 13% in the moderate group, and 15% to 17% in the high group.

Dependent Variables

Answers to CHIS survey questions about eating fruit were combined with those related to vegetables to develop one fruit and vegetable consumption variable for adults, teens, and children.

The questions asked of adults were "During the past month, how many times did you eat fruit? Do not count juices" and "During the past month, how many times did you eat any *other* vegetables like green salad, green beans, or potatoes? Do not include fried potatoes." Responses to these questions were summed and converted to a per-day unit of measurement.

For teenagers, the responses to the questions "Yesterday, how many servings of fruit, such as an apple or banana, did you eat?" and "Yesterday, how many servings of other vegetables like green salad, green beans, or potatoes did you have? Do not include fried potatoes." were combined. Child proxy interviews with adults included the questions "Yesterday, how many servings of fruit, such as an apple or a banana, did (child) eat?" and "Yesterday, how many servings of other vegetables like green salad, green beans, or potatoes did (child) have? Do not include fried potatoes."

The same question was used to assess fast food consumption among adults, teens, and children: "Now think about the past week. In the past 7 days, how many times did you ("he/she" for children) eat fast food? Include fast food meals eaten at work, at home, or at fast-food restaurants, carryout or drive through."

The different types of sugar-sweetened beverages on the market today include regular (non-diet) soda, sweetened fruit drinks, and sports and energy drinks. The 2011/12 CHIS survey of adults focused on consumption of regular sodas only with the question "During the past month, how often did you drink regular soda or pop that contains sugar? Do not include diet soda." Responses were subsequently converted to a per-week basis.

The following two questions to teens were combined to assess levels of sugar-sweetened beverage consumption "Yesterday, how many glasses or cans of soda that contain sugar, such as Coke, did you drink? Do not include diet soda" and "Yesterday, how many glasses or cans of sweetened fruit drinks, sports, or energy drinks, did you drink?" The following question was asked to assess consumption among children: "Yesterday, how many glasses or cans of soda, such as Coke, or other sweetened drinks, such as fruit punch or sports drinks did {he/she} drink? Do not count diet drinks."

Physical activity was also measured differently for adults versus teens and children. Minutes of walking per week for adults was assessed with a series of questions that asked about number of times per week and number of minutes per day of walking for transportation versus relaxation or exercise.

Physical activity for teens was assessed with the question "Not including school PE, in the past 7 days, on how many days were you physically active for at least 60 minutes total per day?" Proxy interviews for children included the similar question "Not including school PE, on how many days of the past 7 days was (child) physically active for at least 60 minutes total?"

Analysis

Outliers were examined across all variables and only removed for minutes walking per week among adults. Responses of more than 750 minutes (over 12 hours) per week were deemed extreme and therefore assigned as outliers.

Statistical modeling was used to control for four potentially confounding factors. Age was collapsed into the following categories: 0-4, 5-11, 12-17, 18-24, 25-44, 45-64, and 65+. The racial/ethnic groups included in the models were White, Hispanic, African-American, Asian and Other. Gender and educational attainment (less than high school versus high school or greater) were also identified as controls.

Table 1. Characteristics of Study Sample by SNAP-Ed Eligible Census Tracts With and Without SNAP-Ed Interventions

	Intervention Census Tracts (n=866)						No Intervention Census Tracts (n=661)					
	Adults (18+ Years)		Teens (12-17 Years)		Children (0-11 Years)		Adults (18+ Years)		Teens (12-17 Years)		Children (0-11 Years)	
	n		n		n		n		n		n	
Age (mean)	2,738	49.35	305	14.39	808	5.54	1,507	49.31	160	14.35	409	5.71
Gender												
Male	1,043	38.09	148	48.52	451	55.82	560	37.16	82	51.25	222	54.28
Female	1,695	61.91	157	51.48	357	44.18	947	62.84	78	48.75	187	45.72
		100%		100%		100%		100%		100%		100%
Education*												
< High School	1,123	41.02	182	59.67	410	50.74	591	39.22	87	54.38	200	48.9
>=High School	1,615	58.98	123	40.33	398	49.26	916	60.78	73	45.63	209	51.1
		100%		100%		100%		100%		100%		100%
Race/Ethnicity												
Hispanic	1,609	58.77	260	85.25	666	82.43	919	60.98	145	90.63	351	85.82
White	558	20.38	21	6.89	62	7.67	262	17.39	2	1.25	17	4.16
Asian	244	8.91	12	3.93	33	4.08	192	12.74	4	2.50	18	4.40
African American	206	7.52	6	1.97	22	2.72	98	6.50	7	4.38	13	3.18
Other Race	121	4.42	6	1.97	25	3.09	36	2.39	2	1.25	10	2.44
		100%		100%		100%		100%		100%		100%
Federal Poverty Level*												
0-99%	1,561	57.01	184	60.33	476	58.91	835	55.41	99	61.88	250	61.12
100-186%	1,177	42.99	121	39.67	332	41.09	835	44.59	61	38.13	159	38.88
		100%		100%		100%		100%		100%		100%
Intervention Reach												
No Intervention							1,507	35.50	160	34.41	409	33.61
Low	1,522	35.85	185	39.78	465	38.21						
Moderate	482	11.35	48	10.32	156	12.82						
High	734	17.29	72	15.48	187	15.37						

* Assigned for teens based on parent or legal guardian providing consent and for children based on adult identified as most knowledgeable about the child's health.

Two multivariate modeling techniques were used to examine the relationship between intervention reach and the dependent variables. Negative binomial models were developed for outcomes based on counts (Fruit and Vegetables Consumption, Fast Food Consumption, Sugar-Sweetened Beverage Consumption, Physical Activity for teens and children). Linear modeling (OLS) was used for the continuous outcome of Physical Activity (minutes per week walking) among adults.

The models take the following forms:

Negative Binomial model for count outcomes:
$\log it(\mu) = \alpha + X\beta + CT$

Linear model for continuous outcomes:
$Y = \alpha + X\beta + CT$

where in both models, α is the intercept, X is the design matrix of the adjusted characteristics, age, sex, race/ethnicity and education, β is a vector of the regression coefficients associated with those confounders. C is a set of indicators for levels of intervention reach; the reference level is the comparison group (no intervention). T is the regression coefficient of the intervention reach. For goodness of fit for the linear models, normality of the residual distributions were checked through Q-Q plots and scatter plots.

We hypothesized that SNAP-Ed interventions have a positive impact on the targeted population and therefore a one-sided *p* values was selected to determine statistical significance at the 0.05 alpha level.

Findings for Relationships Between Levels of Intervention Reach and Outcomes

Higher levels of intervention reach were related to more healthful eating behaviors among adults (Table 2). Specifically, adults from high reach Census tracts reported on CHIS a greater frequency of eating fruits and vegetables. Moreover, adults from Census tracts with low, moderate, and high levels of SNAP-Ed interventions reported eating fast food less often in the past week, compared with CHIS participants living in Census tracts with no SNAP-Ed interventions.

Similar to the finding for adults, children from high reach intervention Census tracts ate more fruits and vegetables than those youngsters from Census tracts with no interventions. Levels of intervention reach were not related to levels of consumption of sugar-sweetened beverages across all three age groups.

In terms of physical activity, teens from low reach Census tracts reported an increased number of physical activity days than teens not exposed to SNAP-Ed interventions. Contrary to expectations, teens living in Census tracts with SNAP-Ed interventions ate fast food more often in the past week than those from Census tracts without SNAP-Ed interventions.

Discussion

The greatest concentration of SNAP-Ed interventions was related to eating more fruits and vegetables among adults and children, and eating less fast food for adults only. These interventions include messages to adults on the health benefits of fruits and vegetables and preparing meals at home, healthful recipes, and demonstrated or hands-on skills to prepare fruits and vegetables, and may have been responsible for significant changes to the snacks and meals made and eaten by parents at home, which in turn translated into increased fruit and vegetable consumption by their children. Decreased fast food consumption among adults may be explained by behavior changes during the day when parents had been more likely to rely on the convenience of fast food. SNAP-Ed interventions may have prompted parents to alter their choices away from fast food when out of the house for work or errands while their children were attending day care or school, for example.

Our counterintuitive findings for teens and fast food could be interpreted as not statistically significant in light of our directional hypotheses, but must be discussed given the strength of the computed *Z* statistics and the implications that SNAP-Ed interventions produce an opposite-than-intended effect. It may be the case that teenagers from Census tracts with SNAP-Ed interventions may opt to use more of their disposable income on fast food in direct response to more healthful snacks and meals being offered at home that resulted from effective SNAP-Ed interventions directed at their parents.

We also found higher levels of physical activity reported by teens from low reach Census tracts, compared with those not exposed to SNAP-Ed interventions. Limited statistical power may be responsible for the lack of significant findings for teens from the moderate and high reach areas. CHIS data for only 48 and 72 teens from these Census tracts, respectively, were available, and the statistical models

Table 2. Relationships Between Reach of SNAP-Ed Interventions and Healthful Eating Behaviors, Consumption of Sugar-Sweetened Beverages, and Physical Activity Among Adults, Teens, and Children

		Fruit and Vegetable Consumption	Fast Food Consumption	Sugar-Sweetened Beverages Consumption	Physical Activity
Adults (18+ Years)	**n**	**Times Per Day *Z*-value**	**Times Past Week *Z*-value**	**Times Drinking Regular Sodas Per Week *Z*-value**	**Total Walking Minutes/Week *T*-value**
Reach					
No Intervention	1,507	--	--	--	--
Low	1,522	0.85	-1.67*	-0.14	-0.53
Moderate	482	0.39	-2.13*	0.40	-1.57
High	734	1.79*	-2.08*	-1.15	1.05
Teens (12 – 17 Years)	**n**	**Servings Yesterday *Z*-value**	**Times Past Week *Z*-value**	**No. of Glasses/Cans of Regular Soda, Fruit, Sports, or Energy Drinks Yesterday *Z*-value**	**Days Physically Active ≥ 60 Minutes Last Week *Z*-value**
Reach					
No Intervention	160	--	--	--	--
Low	185	-1.14	2.78**	1.00	1.81*
Moderate	48	-1.26	2.44**	0.39	1.26
High	72	-0.55	3.28**	1.05	1.13
Children (0 – 11 Years)	**n**	**Servings Yesterday *Z*-value**	**Times Past Week *Z*-value**	**No. of Glasses/Cans of Regular Soda, Fruit, Sports, or Energy Drinks Yesterday *Z*-value**	**Days Physically Active ≥ 60 Minutes Last Week *Z*-value**
Reach					
No Intervention	409	--	--	--	--
Low	465	0.60	0.07	0.65	0.15
Moderate	156	1.08	-0.15	-0.25	-0.14
High	187	2.07*	0.04	-0.44	1.47

All models controlled for gender, race/ethnicity, education, and age for children (0-4 and 5-11 years) and adults (18-24, 25-44, 45-64, and 65+ years)

* p-value <0.05, one-sided, based on hypothesized direction.

** p-value <0.05, two-sided, based on non-hypothesized direction.

were likely further under-powered by including age as a categorical variable along with five racial/ethnic groups as controls. As such, the *Z* statistics for all three rather than only one reach group may have reach or exceeded the one-sided criterion for significance if responses from more (>100) teens had been available.

One advantage of this study is that all Census tracts from which EARS and CHIS data were obtained met the same criteria for SNAP-Ed eligibility. Non-significant differences across intervention groups (no versus low, moderate, and high) when compared on age, gender, race/ethnicity, education, and Federal Poverty Levels strengthen the case that SNAP-Ed interventions may have explained more healthful behaviors among adults and children. However, this study is limited in that we do not know to what extent CHIS participants in the low, moderate, or high intervention reach groups actually participated in an intervention; we only know that increasing levels of reach heightened the probability that a CHIS respondent was also a SNAP-Ed participant. In addition, this study did not compare how the unique characteristics of the Census tracts may have differed across the reach groups. Our high-reach intervention Census tracts, for example, may be located in cities or counties that are more likely to have adopted policies or have environmental supports that promote more healthful eating.

For many cases in this study there was an established time order between presumed SNAP-Ed intervention exposure and behavior change. The independent variable occurred for seven months prior to assessment of the dependent variables, from October 2010 through May 2011. Moreover, CHIS was administered a full three months after FFY 2011 ended. However, the overlap in EARS and CHIS data collection for many cases subjects this study to the limitation of the cross-sectional design in establishing a true temporal relationship between the independent and dependent variables.

Finally, it is unclear if the CHIS participants in this study were exposed to non-SNAP-Ed interventions that may have influenced their behaviors. It is conceivable that other organizations also intentionally targeted in-need populations within our high reach Census tracts to implement interventions or campaigns.

Given these limitations, one should interpret our findings of significant relationships between SNAP-Ed interventions and more healthful dietary intake with caution. The second research question for this study was, can process evaluation data from EARS be linked to behavioral survey data such as assessed for CHIS. The research teams from NEOPB and UCLA were able to establish methodology for the successful merging of the two datasets for this study, as well as establish criteria for the classification of Census tracts into four reach groups. Moreover, these results highlight the viability of utilizing GIS methods to combine process evaluation data with behavioral surveillance data like CHIS, to explore the potential impacts of large-scale interventions like SNAP-Ed.

These processes and the potentially promising findings suggesting that SNAP-Ed interventions may be related to intended behavior changes will be examined in two forthcoming studies. First, the same methodology is being replicated with FFY 2013 EARS data and survey data from California SNAP households (mothers, teens, and children) collected in 2013 using food and beverage items from the Behavioral Risk Factor Surveillance System (BRFSS) survey. Second, the levels of intervention reach established with this study will be applied to EARS data from FFY 2013 through 2016, and merged with longitudinal survey data from mothers, teens, and children from 17 California local health departments. The advantages of this study will include within- and between-cohort changes in food and beverage intake as assessed through valid 24-hour dietary recall methodologies. The new NEOPB funding structure to local health departments has increased the number of contractors providing interventions throughout the state, from 120 in 2011 to over 250 in 2014, for example. As such we may be able to expand into more categories our reach variable and in turn increase the likelihood of finding significant differences across levels of interventions. Finally, guidance from the USDA on allowable SNAP-Ed interventions since FFY 2011 has placed greater emphasis of messages related to reducing sugar-sweetened beverages and increasing physical activity. Thus, in addition to replicating the findings for more healthful eating, these subsequent studies may find significant relationships between SNAP-Ed interventions and the other primary outcomes such intervention are designed to influence.

Appendix

Four criteria were used in 2011 to determine population eligibility for NEOPB interventions. First, the 2000 Census (or the 2005-2009 American Community Survey) tract that the intervention site was located in must have (1) 50% or greater of the population in that tract reside in households at or below 185% of the Federal Poverty Level (FPL) for all race/ethnicities or (2) 50% or more of the residents have incomes at or below 185% of the FPL for a specific race/ethnic group for SNAP-Ed efforts targeting a specific race/ethnic audience segment within the tract. Second, any school where 50% or more of the students qualify for free and reduced price meals was considered eligible. Third, individual sites that were based on the population they served and considered the targeted population (at or below 185% FPL) rather than their physical location were considered eligible. This includes sites like food banks, WIC, Head Start and other low-income programs. Fourth, site surveys were also used in limited circumstances in lieu of other qualifying information. Site surveys collect data about the income information of the people in attendance and were considered eligible if respondents were generally low-income. Site surveys are generally done for a limited number of circumstances and environments including churches, worksites and grocery stores.

This material was produced by the California Department of Public Health's Nutrition Education and Obesity Prevention Branch with funding from the U.S. Department of Agriculture's (USDA) Supplemental Nutrition Assistance Program-Education, known in California as CalFresh. CalFresh provides assistance to low-income households and can help buy nutritious food for better health. For CalFresh information, call 1-877-847-3663. For important nutrition information, visit www.CaChampionsForChange.net.

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