

# Is participation in food and income assistance programmes associated with obesity in California adults? Results from a state-wide survey

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## Abstract

*Objective:* Public assistance programmes may increase risk of obesity among adults. The current study assessed whether participation in the Supplemental Nutrition Assistance Program (SNAP; formerly the Food Stamp Program), Supplemental Security Income (SSI) or California Work Opportunities and Responsibilities to Kids (CalWorks) was associated with obesity, independent of socio-economic status and food insecurity.

*Design:* A cross-sectional analysis of the 2007 Adult California Health Interview Survey. Outcome measures included BMI and obesity. Distribution of BMI and prevalence of obesity were compared by participation in each programme, using weighted linear and binomial regression models in which BMI or obesity was the outcome, respectively, and programme participation was the predictor.

*Setting:* A population survey of various health measures.

*Subjects:* Non-institutionalized adults ( $n$  7741) whose household income was  $\leq 130\%$  of the federal poverty level.

*Results:* The prevalence of obesity was 27.4%. After adjusting for sociodemographic characteristics, food insecurity and participation in other programmes, the prevalence of obesity was 30% higher in SNAP participants (95% CI 6%, 59%;  $P=0.01$ ) than in non-participants. This association was more pronounced among men than women. SSI participation was related to an adjusted 50% higher prevalence of obesity (95% CI 27%, 77%;  $P<0.0001$ ) compared with no participation. SNAP and SSI participants also reported higher soda consumption than non-participants of any programme. CalWorks participation was not associated with obesity after multivariable adjustment.

*Conclusions:* Participation in SNAP or SSI was associated with obesity independent of food insecurity or socio-economic status. The suggestion that these associations may be mediated by dietary quality warrants further investigation among low-income populations.

## Keywords

Supplemental Nutrition Assistance Program  
Obesity  
BMI  
Supplemental Security Income  
Food insecurity

In California, three of the largest public assistance programmes are the Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program (FSP); Supplemental Security Income (SSI); and Temporary Assistance for Needy Families (TANF), also known as California Work Opportunities and Responsibilities to Kids (CalWorks). These programmes have the potential to increase food-purchasing power and improve dietary behaviours among low-income populations. In particular, SNAP has focused on improving access to healthy food through benefits and nutrition education.

SNAP serves households whose monthly gross income is at or less than 130% of the federal poverty level<sup>(1)</sup>.

In 2007, this threshold was \$US 2237.08 for a family of four. The SSI programme provides benefits to low-income adults aged 65 years or older and to blind or disabled individuals of any age<sup>(2)</sup>. SSI participants are ineligible to receive SNAP benefits because the State of California already adds a monetary supplement to the federal SSI monthly benefits. CalWorks serves deprived families with children aged 18 years or younger, where at least one parent is deceased, disabled, absent from the home or working fewer than 100 hours per month<sup>(3)</sup>. Individuals eligible for either SSI or CalWorks must also have less than \$US 2000 in all resources, including cash, automobiles and land, with some exceptions.

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SNAP benefits may be used to purchase household food items, with the exclusion of alcoholic beverages, dietary supplements, medications and foods hot at the point of sale<sup>(4)</sup>. SSI and CalWorks are both cash-grant programmes, with no restrictions on food purchases. This implied freedom in food choice may have a different effect on beneficiaries in terms of food security status, dietary behaviours and overall health, as compared with SNAP.

The relationship between participation in FSP (SNAP) and obesity among adults has been examined in previous studies, some of which have reported a lack of association<sup>(5)</sup> whereas others showed a positive association<sup>(6–11)</sup>. Three of the latter studies found stronger associations among women than men<sup>(7,9,11)</sup>. Recently, Zagorsky and Smith demonstrated that participation in FSP (SNAP) was associated with a 1 kg/m<sup>2</sup> greater BMI among women, when compared with non-participants of the same socio-economic characteristics<sup>(11)</sup>. This observed effect of SNAP participation on obesity might be modified by food insecurity. Studies have shown that household food insecurity could be related to obesity<sup>(12)</sup>, especially among women<sup>(8,13–18)</sup>. Associations between participation in other programmes including SSI and CalWorks and obesity have not been previously explored.

The present study aimed to examine how participation in SNAP, SSI or CalWorks was associated with BMI and obesity among their beneficiaries in a large, representative sample of low-income adults, and whether this association was modified by food insecurity or gender. A secondary aim was to examine if programme participation was related to dietary intake of specific foods, which could contribute to explain the associations between programme participation and obesity.

## Subjects and methods

### Study population

We used data from the 2007 California Health Interview Survey (CHIS), a population-based, random-digit-dial (RDD) telephone survey of households aimed to be representative of California's non-institutionalized population. CHIS has been conducted every two years since 2001 and all data sets are publicly available (<http://www.chis.ucla.edu/>). We used data from the 2007 CHIS in order to avoid secular effects due to changes in the prevalence of obesity, and to present the most recent findings on the effects of food and income assistance programmes as these would be most relevant from a public health policy perspective. CHIS employed a two-stage sample design among the state's forty-four geographic sampling strata. Within each stratum, residential and cellular telephone numbers were dialled and, within each household, one adult ( $\geq 18$  years) was selected to complete the Adult Questionnaire. Interviews were conducted in English, Spanish, Chinese (Mandarin and

Cantonese dialects), Vietnamese and Korean. Proxy interviews by a spouse/partner or adult child were allowed for persons over 65 years of age. The response rate for CHIS was a product of the screener completion rate and the extended interview completion rate. In 2007, the overall adult response rate was 18.3%<sup>(19)</sup>.

The 2007 CHIS Public Use Files included eighty replicate weights and one final weight to provide valid estimations of variance without the need for geographical strata information, as well as to account for the different sampling probabilities and to adjust for potential non-response biases<sup>(20)</sup>. When using the replicate and final weights together, it can be assumed that the estimates and variances obtained from the 51 048 completed adult responses are representative of 26 873 738 California adults living in households.

The analytical sample was restricted to 7741 adults whose household incomes fell at or below 130% of the federal poverty level, in order to exclude adults who may be ineligible to receive SNAP benefits or to answer questions regarding public programme participation and food insecurity. While one of the eligibility criteria for SSI is being of age 65 years or older, we did not exclude subjects in our sample because a large proportion of SSI beneficiaries (67%) were under 65 years old. The weighted analytical sample consisted of 5 295 856 adults. Data were collected from 20 June 2007 to 3 March 2008<sup>(21)</sup>.

### End points

The outcomes for analyses were BMI and obesity. BMI was calculated from self-reported height and weight data as kg/m<sup>2</sup>. Obesity was defined as BMI  $\geq 30.0$  kg/m<sup>2</sup>.

### Definition of exposures

SNAP participation was defined as answering 'yes' to the survey's question 'Are you receiving food stamp benefits?' SSI participation was defined as answering 'yes' to 'Are you receiving SSI?' CalWorks participation was defined as answering 'yes' to 'Are you now receiving TANF or CalWorks?'

Food insecurity was measured using the US Department of Agriculture (USDA) Household Food Security Survey Module: Six-Item Short Form<sup>(22)</sup>, a reliable substitute for the full eighteen-item US Household Food Security Survey Module when it cannot be implemented. The advantages of the short form are that it poses less respondent burden and produces estimates of food insecurity with minimal bias as compared with the eighteen-item module. The disadvantages are that it cannot capture the most severe levels of food insecurity, does not include questions about children in the household, and is somewhat less reliable than fuller modules. Responses of 'sometimes true', 'often true', 'almost every month', 'some months but not every month' and 'yes' were coded as affirmative. A raw score ranging from 0 to 6 was generated by summing the affirmatives of the questions. Food insecurity was classified

according to the USDA guidelines: 0 or 1, low or moderate food insecurity; 2–4, high food insecurity; 5 or 6, very high food insecurity.

Dietary information collected by the survey included the frequency of consumption of French fries; fruits excluding fruit juice; vegetables excluding fried potatoes; soda excluding diet soda; and fast food. Consumption was measured in times during the week prior to the survey.

Demographic information collected by the survey included age, gender, race, place of birth, education level, household size, smoking status, number of cigarettes smoked per day and health insurance status. Age of the respondent was recoded into four categories (18–29 years, 30–49 years, 50–69 years,  $\geq 70$  years). For race, American Indian/Alaskan Native and Pacific Islander categories were collapsed into the Other single/multiple race category. Education level was recoded into four categories ( $< 12$  years, high-school diploma, some college, bachelor's degree or higher). Household size was recoded into three categories (1 or 2 persons, 3–5 persons,  $\geq 6$  persons).

### Statistical analysis

We first examined the associations between potential sociodemographic confounders, including food insecurity, and the prevalence of obesity. Next, we compared the distribution of BMI and the prevalence of obesity by participation in each programme, using weighted linear or binomial regression models in which BMI or obesity was the outcome, respectively, and programme participation was the predictor. Estimates were obtained by fitting multivariate models that included age (18–29 years as reference), sex (male as reference), race (non-Hispanic white as reference), place of birth (US-born as reference), education level ( $< 12$  years as reference), household size (1 or 2 persons as reference), smoking status (never smoker as reference), number of cigarettes smoked per day, health insurance status (insured all past 12 months as reference) and food insecurity (low or moderate food insecurity as reference) as covariates. Robust estimates of the variance were used in all models. We examined whether food insecurity or gender modified the associations between programme participation and BMI by introducing into the model a cross-product term between each of the potential modifiers and programme participation; statistical significance of this interaction term was determined with the Wald test. The association between programme participation and obesity was significantly modified by gender; thus, we fitted multivariate models separately for males and females. Finally, we compared the distribution of intake of selected foods and food groups by participation in programmes with the use of multivariate linear regression models. All statistical tests were two-sided and significance was considered at  $P < 0.05$ . Statistical analyses were performed using the statistical software package Stata/IC 10.1 for Windows (StataCorp LP, College Station, TX, USA).

### Results

In the weighted sample of 5 295 856 adults, 27.4% were obese. Prevalence rates of obesity were highest among adults aged 30–49 years, of African-American descent, born in the USA, with less than 12 years of formal education, living in a household with six or more persons, who were former smokers and of very high food insecurity (Table 1).

Twenty-five per cent of adults reported receiving assistance from any of the three programmes. Participation rates were highest for SNAP (13.3%), followed by SSI (12.9%) and CalWorks (7.2%). SNAP participants had a  $1.1 \text{ kg/m}^2$  higher adjusted BMI than non-participants ( $P = 0.06$ ; Table 2). SSI participants also had a  $1.8 \text{ kg/m}^2$  higher adjusted BMI ( $P < 0.0001$ ) when compared with non-participants. Participation in either SNAP or SSI was positively associated with obesity. After adjustment for sociodemographic characteristics, food insecurity and participation in other programmes, the adjusted prevalence of obesity was 30% higher among SNAP participants ( $P = 0.01$ ) and 50% higher among SSI participants ( $P < 0.0001$ ) compared with non-participants. No association was observed between CalWorks participation and obesity after adjusting for participation in the other public assistance programmes.

Some adults reported receiving benefits from multiple programmes, with the largest overlap occurring between CalWorks and SNAP: 82% of CalWorks recipients reported receiving SNAP benefits in 2007. In our sample, 549 adults participated in two or more programmes and 2023 adults participated in only one programme. We examined whether participating in two or more programmes was associated with BMI or obesity compared with participation in only one programme, in this subset of 2572 respondents who participated in at least one programme. After adjustment for sociodemographic characteristics and food insecurity, there was no significant difference in BMI ( $P = 0.46$ ) or obesity prevalence ( $P = 0.49$ ) comparing multiple programme participants with single programme participants.

We next examined whether the associations with SNAP or SSI participation and obesity were modified by food insecurity or gender. Among SNAP participants, 28.7% reported high food insecurity and another 23.2% reported very high food insecurity. Among SSI participants, 24.5% reported high food insecurity and 18.5% reported very high food insecurity. There was no evidence of significant modification by food insecurity of the association between participation in SNAP ( $P$ , test for interaction = 0.10) or SSI ( $P$ , test for interaction = 0.84) and the prevalence of obesity. However, the association between participation in SNAP and obesity was stronger in men than women ( $P$ , test for interaction = 0.01; Table 3). Men who received SNAP benefits had a  $2.5 \text{ kg/m}^2$  higher BMI ( $P = 0.003$ ) and a 61% higher prevalence of obesity

**Table 1** Distributions of BMI and obesity (BMI  $\geq$  30.0 kg/m<sup>2</sup>) according to sociodemographic characteristics of adults under 130% of the federal poverty level: California Health Interview Survey, 2007

	N*	Weighted %	SE	BMI (kg/m <sup>2</sup> )		Obesity	
				Mean	SE	Weighted %	SE
Age (years)							
18–29	1345	30.3	0.8	25.8	0.2	19.2	1.6
30–49	2422	39.1	0.8	29.0	0.3	34.5	1.6
50–69	2407	20.7	0.6	28.1	0.2	29.2	1.4
$\geq$ 70	1567	9.9	0.4	26.4	0.2	20.2	1.6
<i>P</i> for trend†				<0.001		0.03	
Gender							
Male	2599	42.6	1.0	27.6	0.2	26.7	1.4
Female	5142	57.4	1.0	27.5	0.2	27.9	0.9
<i>P</i> †				0.88		0.52	
Race‡							
Non-Hispanic white	3073	20.8	0.5	26.9	0.3	25.5	1.6
Latino/Hispanic	2178	42.6	1.0	28.3	0.2	30.5	1.5
Asian	792	11.4	0.5	23.8	0.3	8.0	1.9
African-American	563	7.3	0.5	29.3	0.6	37.4	3.6
Other single/multiple race	1135	17.9	0.9	28.2	0.4	30.2	2.2
<i>P</i> †				<0.001		<0.001	
Birthplace							
US-born	4499	42.7	0.8	27.7	0.2	30.8	1.5
Foreign-born	3242	57.3	0.8	27.5	0.2	24.8	1.1
<i>P</i> †				0.36		0.002	
Education level							
<12 years	2520	44.7	0.7	28.4	0.2	31.4	1.4
High-school diploma	2383	30.8	0.8	27.0	0.3	24.7	0.2
Some college	1839	15.7	0.6	27.4	0.3	27.2	1.6
Bachelor's degree or higher	999	8.8	0.5	25.6	0.3	16.3	2.2
<i>P</i> for trend†				<0.001		<0.001	
Household size							
1 or 2 persons	4027	26.0	0.7	27.0	0.2	25.5	1.3
3–5 persons	2918	51.3	1.1	27.4	0.2	25.7	1.3
$\geq$ 6 persons	796	22.7	1.1	28.5	0.4	33.2	2.1
<i>P</i> for trend†				0.001		0.004	
Smoking status							
Never smoked regularly	4461	64.6	0.9	27.4	0.2	26.0	1.1
Quit smoking	1773	17.3	0.7	28.2	0.3	30.7	1.8
Currently smokes	1507	18.1	0.9	27.6	0.4	29.1	2.2
<i>P</i> for trend†				0.27		0.06	
Health insurance status							
Insured all past 12 months	5471	58.1	1.0	27.5	0.2	27.5	1.0
Uninsured any past 12 months	484	7.3	0.6	27.6	0.5	28.6	3.5
Currently uninsured	1786	34.6	0.9	27.6	0.2	26.8	1.5
<i>P</i> for trend†				0.80		0.32	
Food insecurity§							
Moderate food insecurity	4888	62.2	1.1	27.0	0.2	24.6	1.1
High food insecurity	1772	24.7	1.0	28.3	0.3	30.4	1.9
Very high food insecurity	1081	13.1	0.6	28.9	0.4	34.8	2.8
<i>P</i> for trend†				<0.001		<0.001	

\*Crude *n*: 7741; weighted *n*: 5295856.

†For a variable representing the ordinal categories that was introduced into a univariate linear regression model as a continuous predictor. For gender and birthplace, *P* is from a Wald test.

‡'Other single/multiple race' includes American Indian/Alaskan Native, Pacific Islander and persons of multiple races/ethnicities.

§From US Department of Agriculture's Food Security Survey Module: Six-Item Short Form. Low or moderate food insecurity defined as a score of 0 or 1; high food insecurity defined as a score of 2–4; very high food insecurity defined as a score of 5 or 6.

( $P=0.002$ ) than men who did not receive SNAP benefits, after adjusting for age (18–29 years as reference), race, place of birth, education level, household size, health insurance status, smoking status, number of cigarettes smoked per day, food insecurity and participation in other public assistance programmes. By contrast, women who received SNAP benefits did not have a significantly different BMI ( $P=0.86$ ) or obesity prevalence ( $P=0.43$ ) compared with women did not receive these benefits.

Last, we examined the intake frequencies of certain foods and food groups consumed during the week prior to the survey in relation to programme participation, as this might help to explain whether the associations between programme participation and obesity could be mediated in part through different food choices (Fig. 1). After adjustment for sociodemographic characteristics and food insecurity, soda consumption was significantly higher among both SNAP and SSI participants as compared

**Table 2** Participation in public assistance programmes and associations with BMI and obesity (BMI  $\geq$  30.0 kg/m<sup>2</sup>) among adults under 130% of the federal poverty level: California Health Interview Survey, 2007

	N*	Weighted %	SE	BMI (kg/m <sup>2</sup> )				Obesity			
				Mean	SE	Adjusted difference	95% CI	Weighted %	SE	Adjusted prevalence ratio	95% CI
<b>SNAP</b>											
Non-participants	6737	86.7	0.7	27.3	0.1	Ref.	–	25.9	0.9	Ref.	–
Participants	1004	13.3	0.7	29.1	0.6	1.08†	–0.05, 2.22	36.6	0.3	1.30†	1.06, 1.59
<b>SSI</b>											
Non-participants	6078	87.1	0.6	27.3	0.1	Ref.	–	25.7	0.9	Ref.	–
Participants	1663	12.9	0.6	29.1	0.5	1.83†	0.89, 2.78	38.8	2.7	1.50†	1.27, 1.77
<b>CalWorks</b>											
Non-participants	7216	92.8	0.5	27.4	0.1	Ref.	–	26.9	0.9	Ref.	–
Participants	525	7.2	0.5	29.1	0.7	0.16†	–1.07, 1.40	33.4	3.5	0.84†	0.66, 1.07

SNAP, Supplemental Nutrition Assistance Program (formerly the Food Stamp Program); SSI, Supplemental Security Income; CalWorks, California Work Opportunities and Responsibilities to Kids; Ref., reference category.

\*Crude *n*: 7741; weighted *n*: 5 295 856.

†From linear (BMI as continuous outcome) or binomial (obesity as dichotomous outcome) regression models adjusted for age (18–29 years as reference), sex (male as reference), race (non-Hispanic white as reference), place of birth (US-born as reference), education level (<12 years as reference), household size (1 or 2 persons as reference), health insurance status (insured all past 12 months as reference), smoking status (never smoker as reference), number of cigarettes smoked per day, food insecurity (low or moderate food insecurity as reference) and participation in other public assistance programmes

**Table 3** Participation in SNAP and associations with BMI and obesity (BMI  $\geq$  30.0 kg/m<sup>2</sup>) by gender among adults under 130% of the federal poverty level: California Health Interview Survey, 2007

	N*	Weighted %	SE	BMI (kg/m <sup>2</sup> )				Obesity			
				Mean	SE	Adjusted difference	95% CI	Weighted %	SE	Adjusted prevalence ratio	95% CI
<b>Male</b>											
SNAP non-participants	2335	90.2	1.0	27.3	0.2	Ref.	–	24.7	1.4	Ref.	–
SNAP participants	264	9.8	1.0	30.0	0.7	2.47†	0.85, 4.09	44.5	4.8	1.61†	1.20, 2.16
<b>Female</b>											
SNAP non-participants	4402	84.1	1.0	27.3	0.2	Ref.	–	26.9	1.2	Ref.	–
SNAP participants	740	15.9	1.0	28.7	0.7	0.13†	–1.30, 1.56	33.0	3.2	1.10†	0.86, 1.41

SNAP, Supplemental Nutrition Assistance Program (formerly the Food Stamp Program); Ref., reference category.

\*Crude *n*: 7741; weighted *n*: 5 295 856

†From linear (BMI as continuous outcome) or binomial (obesity as dichotomous outcome) regression models adjusted for age (18–29 years as reference), sex (male as reference), race (non-Hispanic white as reference), place of birth (US-born as reference), education level (<12 years as reference), household size (1 or 2 persons as reference), health insurance status (insured all past 12 months as reference), smoking status (never smoker as reference), number of cigarettes smoked per day, food insecurity (low or moderate food insecurity as reference) and participation in other public assistance programmes. Models were run separately for males and females.

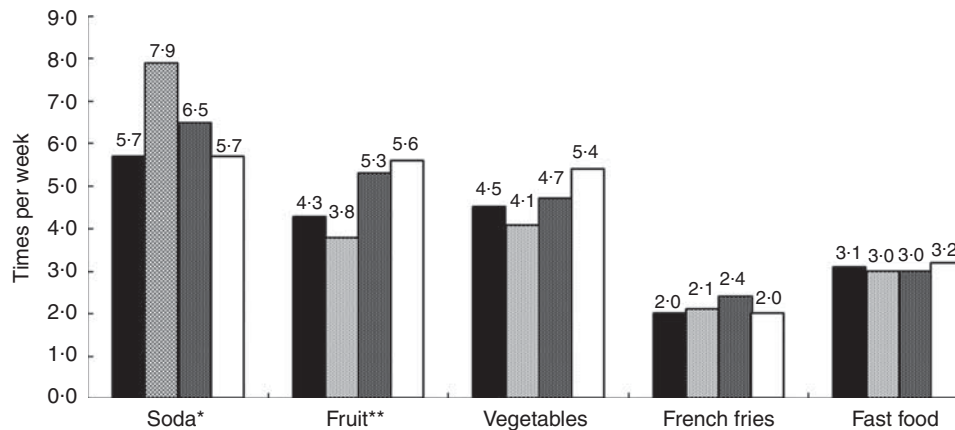
with non-participants of any programme ( $P=0.02$  for SNAP;  $P=0.02$  for SSI). SSI participants also reported greater fruit consumption than non-participants. Intake frequencies of vegetables, French fries and fast food did not differ by public programme participation.

## Discussion

Our study results indicate that participation in SNAP or SSI is associated with obesity, independent of food insecurity or participation in other public assistance programmes. These findings are consistent with previous studies that have demonstrated a positive relationship between SNAP participation and obesity<sup>(8–11)</sup>, although they suggest that these associations may also apply to SSI participants. Due to dual participation, the association between participation in CalWorks and obesity was strongly attenuated after adjusting for participation in SNAP.

Researchers have attributed the association between SNAP participation and obesity to the ‘food stamp cycle’, a cycle where monthly receipt of SNAP benefits may encourage periods of binge eating followed by energy restriction among its participants<sup>(5,8,10,23)</sup>. Continuous exposure to the ‘food stamp cycle’ may subsequently increase fat accumulation and promote obesity<sup>(24)</sup>. Although SSI is a cash benefits programme rather than a food assistance programme, it is possible that SSI recipients also experience a similar cycle of food availability followed by energy restriction, as both programmes issue their benefits monthly. An alternative hypothesis to explain the association between SSI and obesity is reverse causation as obese persons are more likely to be considered disabled than non-obese persons. While the Social Security Administration does not specifically recognize obesity as a disability, persons with medical documentation of severe obesity that impairs their work capacity could qualify for SSI benefits. Furthermore,





**Fig. 1** Adjusted mean weekly intakes of selected foods and food groups among SNAP participants (■), SSI participants (▒), CalWorks participants (▓) and non-participants of any programme (□): California Health Interview Survey 2007. SNAP, Supplemental Nutrition Assistance Program (formerly the Food Stamp Program); SSI, Supplemental Security Income; CalWorks, California Work Opportunities and Responsibilities to Kids. Model adjusted for age (18–29 years as reference), sex (male as reference), race (non-Hispanic white as reference), place of birth (US-born as reference), education level (<12 years as reference), household size (1 or 2 persons as reference), health insurance status (insured all past 12 months as reference), smoking status (never smoker as reference), number of cigarettes smoked per day and food insecurity (low or moderate food insecurity as reference). \*Weekly intake frequencies of soda were significantly different:  $P = 0.01$  for SNAP participants v. non-participants of any programme;  $P = 0.03$  for SSI participants v. non-participants of any programme. \*\*Weekly intake frequencies of fruit were significantly different:  $P = 0.04$  for SSI participants v. non-participants of any programme

persons with health conditions or impairments caused or exacerbated by obesity, including cardiovascular (e.g. IHD), endocrine (e.g. diabetes mellitus) and respiratory conditions (e.g. sleep-related breathing disorders), could also qualify for SSI benefits. For these reasons, it is possible that the relationship between SSI and obesity is not mediated through diet, but that obese persons are more likely to receive SSI benefits based on their existing health conditions.

Several observational studies have identified an association between food insecurity and obesity<sup>(15–18,25)</sup> and it is possible that food insecurity may drive the associations between participating in SNAP or SSI and obesity. Our study showed that SNAP and SSI recipients have high rates of food insecurity and therefore may be more susceptible to the effects of poverty on dietary intake. Mechanisms for this association were proposed by Drewnowski and Specter<sup>(26)</sup>: inverse associations between energy density and food costs can encourage food-insecure individuals to increase purchases of energy-dense foods. This behaviour is then reinforced by the high palatability of excess sugar and fats, which leads to higher energy intake. However, food insecurity did not appear to modify the associations between SNAP or SSI and obesity, suggesting that associations with obesity might be due to programme-specific effects.

In our study, we observed significantly higher soda consumption among SNAP and SSI participants than non-participants. Studies have shown that poverty-stricken individuals are less likely to live in neighbourhoods with access to supermarkets<sup>(27)</sup> and more likely to have access to convenience stores or fast-food restaurants<sup>(28,29)</sup>. For SNAP and SSI participants, it is possible that the monthly

benefits encourage consumption of inexpensive, high-energy foods, rather than improve dietary behaviours and reduce total energy intake. For example, Cason *et al.*<sup>(30)</sup> showed that FSP (SNAP) participants had significantly higher intakes of total fat and total energy than FSP non-participants. Other studies also found that meat products were of high importance to FSP (SNAP) participants<sup>(31,32)</sup>. While these results suggest that certain dietary behaviours may play a role in the associations between programme participation and obesity, other factors like physical inactivity may also contribute to this relationship.

Interestingly, the association between participation in SNAP and obesity appeared to be stronger in men than women. This finding appears to contradict previous studies that showed stronger associations among women<sup>(7,9,11)</sup>. However, a report by Baum found that long-term participation in the FSP (SNAP) was associated with a 10% increase in obesity among females and a 15% increase in obesity among males<sup>(6)</sup>. Because the survey did not collect information on duration of participation in each public assistance programme, it is possible that, on average, men have longer participation than women. Another possibility is misclassification of BMI and obesity prevalences due to the self-reported nature of height and weight data. If women are more likely to under-report their weight than men<sup>(33,34)</sup>, then any association between programme participation and BMI or obesity could be attenuated for women, as we observed in our study. Furthermore, men may have less influence on how SNAP benefits are used to purchase food items while simultaneously consuming a larger proportion of the household food than women. Men who participate in SNAP may also be more likely to

consume some meals outside the home due to their occupation, which could be correlated to higher energy intake. Combined with greater access to less healthful food options through SNAP, it is possible that men participating in SNAP are more prone to increased BMI and obesity compared with their non-participant counterparts.

The main limitation of the present study is the cross-sectional nature of the design. It is not possible to address temporality of the observed associations or to make inferences about causation. A second limitation is the representativeness of the study sample. While the CHIS sample is meant to characterize California's diverse adult population, certain adults at higher need of public assistance or at higher risk of obesity may have been excluded from the original survey design. These include adults without landlines or cellular phones, adults in institutionalized settings and adults without a permanent residence (e.g. homeless or persons residing in shelters).

The overall adult response rate of 18.3% was lower than the CHIS response rates from previous years, but consistent with a general decline in response rates observed in other RDD telephone state-wide surveys<sup>(19)</sup>. When compared with the 2007 California Behavioral Risk Factor Surveillance System (BRFSS), its overall response rate of 24.1% was slightly higher than the response rate from CHIS, but comparable given that the CHIS was more conservative in its calculation of response rates than BRFSS. Because the CHIS sample was weighted to reflect California's demographic distributions, it is unlikely that the low response rate significantly affected the generalizability of the findings.

The use of self-reported data, especially self-reported height and weight data, may have underestimated the true BMI of study subjects, which might have decreased precision in the observed associations between public programme participation and obesity<sup>(35)</sup>. Our analysis found that 27.8% of low-income adults in our study population were obese. This figure is slightly lower than the national figure of 33.8% estimated by Flegal *et al.* using National Health and Nutrition Examination Survey data for 2007–2008<sup>(36)</sup>. This is expected since California is known to have lower rates than the national average<sup>(37)</sup>, possibly due to a state culture that facilitates healthy eating and physical activity. Furthermore, BMI is an imperfect measure of adiposity because it cannot differentiate between lean body mass and fat mass<sup>(38)</sup>. Future studies that examine the effects of public programme participation should include measures of central adiposity, including waist circumference, as a secondary outcome<sup>(39)</sup>. Another potential limitation may include the application of the SNAP eligibility criterion to other programmes that may serve individuals of different demographics. However, both SSI and CalWorks have similar limits on financial resources and the data set did not provide enough information to apply further programme-specific criteria. Lastly, the food intake component of the questionnaire was

limited in its ability to assess dietary intake. Without more accurate measures of individual foods and nutrients, it would be difficult to assess the role of diet in the association between participation in SNAP or SSI and obesity.

In conclusion, these results suggest that participation in the SNAP or SSI is associated with obesity, independent of food insecurity and socio-economic status. The relationship between participation in SNAP and obesity prevalence was stronger in men than in women, suggesting that men are not immune to the relationship between participation in SNAP and obesity as had been previously suggested by other studies. In order to better understand the relationship between public programme participation and obesity, longitudinal studies of the effects of individual programmes with strong dietary assessment methods are needed. If these associations are truly causal, then programmatic changes may help in alleviating the risk of obesity among low-income men and women participating in these public assistance programmes.

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