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Neighborhood Environments, SNAP-Ed Eligibility, and Health Behaviors: An Analysis of the California Health Interview Survey (CHIS)

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Abstract Neighborhood conditions are associated with health outcomes, but whether individual health behaviors are independent of or associated with the settings are not clear. We analyzed the California Health Interview Survey (CHIS) ($N = 11{,}152$) data to determine if the perceptions and behaviors of similar individuals with an income low enough to be eligible for SNAP-Ed services differed based on whether they lived in high- or low-income neighborhoods. We found that SNAP-Ed eligible individuals living in low-income neighborhoods walked for transportation more frequently (3.04 times versus 2.38 times, $p = 0.001$), drank sugary beverages more frequently in the past month (2.93 times versus 1.69 times, $p = 0.000$), and had a higher risk of obesity than similar low-income individuals living in high-income neighborhoods (0.34 versus 0.26, $p = 0.012$).

Keywords SNAP-Ed · Neighborhood · Obesity · BMI · Diet · Nutrition

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Introduction

There is a large and growing literature that examines the role that location plays in health [1, 2]. Specifically, where an individual lives can impact mortality [3], diet and nutrition, physical activity, and obesity [4, 5]. Hot spot analysis indicates that there are clusters of higher BMI in socioeconomically disadvantaged neighborhoods and fewer clusters of high BMI and severe obesity in more affluent areas [6]. Recent research in Los Angeles has found that higher income neighborhoods are linked to a lower likelihood of obesity when also controlling for individual demographic and health-related characteristics [7]. However, whether these disparities are primarily or equally due to both individual differences and/or contextual factors is unknown.

There are multiple mechanisms in which a neighborhood might influence health, independent of a person's characteristics. Bilger and Carrieri (2013) provide several causal mechanisms [8]. First, the neighborhood might cause an increase (or decrease) in exposure to environmental toxins, stressors, and other contextual factors [9, 10]. Second, a neighborhood may have lower levels of positive determinants of health. These include social capital and trust [11, 12]. A lower level of social cohesion or social capital has been associated with higher BMI and higher rates of obesity [13]. Third, the amount of crime within a neighborhood may also impact the likelihood of an individual engaging in a healthy behavior, such as physical activity [13–16]. Fourth, neighborhoods can impact an individual through their day to day social interactions. Who people

meet and socialize with can lead to connections for employment or other benefits [17]. On the other hand, a high concentration of individuals in a neighborhood engaged in unhealthy behaviors, like drug use or violence, can lead to negative outcomes like mental health problems [18]. Finally, another mechanism may be actual geographic proximity to goods and services. Low-income neighborhoods tend to have fewer resources related to the built environment, for example, fewer supermarkets, incomplete or damaged sidewalks, and limited access to parks [13]. Low-income neighborhoods also have greater accessibility to nutrient-poor foods and have been called "food swamps," which are associated with obesity [18, 19]. A review of the literature consistently found relationships between low-income neighborhoods and obesogenic dietary behaviors [19].

Low-income individuals in general face greater barriers for routine leisure physical activity and a healthy diet. Specifically, they report having higher barriers to accessing healthy food items that leads to a lower likelihood of cooking at home [19]. Focus groups with low-income individuals in Texas and California indicate that the most important barriers influencing shopping behaviors are the high price of healthy food and inadequate geographical access to healthy food [20, 21]. While classical economic theory suggests that low-income neighborhoods have fewer store locations that offer nutritious food items, because the demand is lower relative to higher income neighborhoods [22], this does not account for the phenomenon of supermarket "redlining", a practice in which supermarket chains have a deliberate strategy of not locating in low-income neighborhoods [23]. Other studies indicate that low-income consumers desire the same high quality products as wealthier consumers [24], yet due to redlining, low-income neighborhoods tend to have more convenience stores with lower quality foods than do high-income neighborhoods [25].

Communities with a higher socioeconomic status have more recreational facilities and higher levels of physical activity [26], and recent trends indicate that census tracts with a higher median household income are experiencing a greater increase in physical activity facilities when compared with census tracts with a lower median household income. In the city of Los Angeles, low-income parks tend to be less frequently used [27].

Few studies have tried to tease out the relative contribution of neighborhood conditions and average income of residents vs. individual income. Other studies have only examined the association between the average income of a neighborhood and the health behaviors of low-income individuals at the county or state level [28–30]. A study that leverages data at a small area like a census tract is important because studies that are focused on larger geographies such as county or larger are likely suffering from ecological fallacy [31].

The objective of this study is to examine whether differences in average household income within a census tract influence the health behaviors of low-income adults (defined here as having a household income that is 185% or below the federal poverty level). Specifically, we focus on whether individuals of similar economic means have different health behaviors, based on whether they live in a higher or lower income neighborhood. We examine several health behavior outcome variables that are associated with chronic disease risk including measures of physical activity, soda consumption, sweetened beverage consumption, fast food consumption, availability of fruits and vegetables, affordability of fruits and vegetables, body mass index (BMI), and obesity. Understanding the source of health disparities is important to inform the targeting of public health initiatives and policies, particularly for Supplemental Nutrition Assistance Program-Education (SNAP-Ed)—the obesity prevention component of SNAP. This study is part of a larger evaluation of the SNAP-Ed program for the Los Angeles County Department of Public Health.

Methods

We used the California Health Interview Survey (CHIS) restricted files for years 2013, 2014, and 2015 which identify the survey respondent's residential address. These data have been used extensively to examine the effect of the local food environment [32, 33]. We use the sampling weights that are provided by CHIS to account for unequal sampling probabilities and non-response. The survey uses a complex survey design that requires proper weighting and variance calculation and the use of specialized code for analyzing the data. Specifically, the CHIS uses a two-stage geographically stratified random-digit-dial (RDD) sample design. First, telephone numbers are randomly sampled within counties. Second, an adult is selected from all adults of a sampled household. The purpose of the original study was to

evaluate the effect of SNAP-Ed on health outcomes among Los Angeles county residents. As a result, we identified survey respondents in the geocoded data who reside in a Los Angeles county census tract. Subsequently, we categorized census tracts as being either low-income or not. We defined a census tract as being low-income if the percentage of residents who have a household income of 185% the federal poverty level or below was higher than the median percentage of residents across all Los Angeles county census tracts (35.5%). We defined individuals as being SNAP-Ed eligible if their total household income was below 185% of the federal poverty level.

Variables

Our study focused on measures related to physical activity, dietary behaviors, perceptions of neighborhood fruit and vegetable affordability and availability, and BMI. The physical activity measures include the number of times the respondent walked for at least 10 min to get some place within the past 7 days for transportation and the number of times the respondent walked for at least 10 min for leisure. The dietary behaviors measures include: [1] how often the respondent drinks regular soda or pop in the past month; [2] how often the respondent drinks sweetened fruit drinks, sports, or energy drinks in the past month; and [3] in the past 7 days, how many times did the respondent eat fast food. The CHIS also includes a question on how often the respondent can find fresh fruits and vegetables in their neighborhood. A separate question is asked, how often the respondent can find fruits and vegetables in their neighborhood that are affordable. Finally, we calculate the BMI of the individual based on questions on the self-reported height and weight of the respondent. The respondent was asked how tall they are without their shoes. Separately, the respondent was asked how much they weigh without shoes. BMI was calculated based on the weight of the individual kilograms divided by the height in meter squared. We classified respondents with a BMI of 30 or greater as being obese [2]. The CHIS also contains data on various sociodemographic measures for each of the survey respondents. In particular, we focused on measures of the gender of the respondent, the race and ethnicity of the respondent, the self-reported highest education level of the respondent, the marital status of the respondent, whether the respondent has a child, the age of the respondent, and whether the respondent is employed full time or not.

We restricted our analyses only to those individuals in Los Angeles County. No other exclusion to the data was made.

Data Analysis

First, we compared differences among demographic characteristics and health behaviors based on whether the survey respondent lived in a low-income census tract or not. We estimated a linear regression for each of the measures that only included whether or not the census tract is defined as low-income. Second, we calculated differences between each of the health behaviors based on whether the survey respondent is SNAP-Ed eligible and whether or not they reside in a low-income census tract. Specifically, we estimated a regression model limited to low-income individuals for each of the outcome measures, and the only predictor was a dummy variable for whether or not the respondent resided in a low-income census tract or not. Finally, we estimated regression models predicting each of the health behaviors and included our measure of whether or not the respondent is SNAP-Ed eligible, whether or not the respondent resides in a low-income census tract and each of the sociodemographic predictors. We applied the requisite survey weights for each of our analyses. All analyses were done using the Stata version 15.0.

Results

Table 1 shows the weighted demographic characteristics of the Los Angeles county CHIS respondents (N = 11,152) by whether or not their census tract was defined as low-income or not. We found that compared with respondents in high-income census tracts, survey respondents who reside in a low-income tracts were more likely to be younger, African American (11% versus 6%, $p = 0.000$), or Hispanic (62% versus 29%, $p = 0.000$). Survey respondents in a low-income census tract were also less likely to be white (14% versus 45%, $p = 0.000$), Asian (12% versus 18%, $p = 0.000$), or be self-described as another race (1% versus 2%, $p = 0.043$). Similarly, we found that survey respondents in a low-income census tract were more likely to have less than a high school degree (30% versus 10%, $p = 0.000$) or a high school degree (42% versus 39%, $p = 0.028$) and

Table 1 Comparison of demographic characteristics of Los Angeles County CHIS respondents by poverty of their census tract in 2013–2015

Respondent characteristics	Entire sample ($N = 11,152$)	Low-income census tract ($n = 4450$)	Not low-income census tract ($n = 6702$)	p value
Gender				
Male	0.49	0.47	0.50	0.277
Race				
Non-Hispanic White	0.29	0.14	0.45	0.000
African American	0.08	0.11	0.06	0.000
Hispanic	0.45	0.62	0.29	0.000
Asian	0.15	0.12	0.18	0.000
American Indian or Alaska native	0.00	0.00	0.00	0.734
Other	0.02	0.01	0.02	0.043
Highest level of education achieved				
< HS	0.20	0.30	0.10	0.000
High school degree	0.40	0.42	0.39	0.028
College or more	0.40	0.28	0.52	0.000
Marital status				
Married or living with partner	0.53	0.50	0.55	0.007
Divorced	0.17	0.17	0.16	0.364
Single	0.31	0.32	0.29	0.023
Child in the household	0.30	0.34	0.26	0.000
Work full time	0.56	0.56	0.56	0.971
Age				
18–25	0.15	0.17	0.14	0.094
26–34	0.17	0.20	0.14	0.001
35–44	0.19	0.21	0.16	0.001
45–54	0.18	0.18	0.19	0.434
55–64	0.14	0.12	0.17	0.000
65 and over	0.16	0.12	0.20	0.000

Statistical testing between both groups is done using a weighted regression that only contains an indicator for whether or not the respondent resides in a census tract that is defined as low-income or not low-income. Low-income census tract is defined here as having >=35.5% of residents having a household income ≤ 185% of the federal poverty level

less likely to have a college degree or more (28% versus 52%, $p = 0.000$). Survey respondents from a low-income census tract were more likely to be single (32% versus 29%, $p = 0.023$) and more likely to have a child in the household (34% versus 26%, $p = 0.000$). Given the differences between survey respondents in a low- and high-income census tract, we included each of these demographic characteristics in our regression models.

Table 2 reports the weighted outcome measures of the CHIS respondents in Los Angeles county by whether their census tract is defined as low- or high-income. We found that CHIS respondents in a census tract that is defined as low-income were less likely to walk for leisure more than 10 min in the past week (3.02 times versus 2.29 times, $p = 0.000$), drank soda more frequently in the past month (2.48 times versus 1.41 times, $p = 0.000$), drank sweetened fruit, drank more frequently in the past month (8.06 times versus 5.58 times, $p = 0.000$), ate fast food more often in the past week (1.93 times versus 1.70 times, $p = 0.004$), were less likely to report always or usually finding fruits and vegetables in their neighborhood (81% versus 91%, $p = 0.000$), were less likely to report always or usually finding affordable fruits and vegetables in their neighborhood (72% versus 80%, $p = 0.000$), have a higher BMI (28.33 versus

Table 2 Comparison of outcome measures of Los Angeles County respondents by poverty of their census tract in 2013–2015

Respondent behaviors	Entire sample ($N = 11,152$)	Low-income census tract ($n = 4450$)	Not low-income census tract ($n = 6702$)	p value
Physical activity				
Number of times walking for transportation > 10 min in past week	2.65	3.02	2.29	0.000
Number of times walking for leisure > 10 min in the past week	2.77	2.67	2.87	0.183
Diet				
Number of times drank soda in the past month	1.93	2.48	1.41	0.000
Number of times drank sweetened fruit drink in the past month	6.79	8.06	5.58	0.000
Number of times ate fast food past week	1.81	1.93	1.70	0.004
How often can you find fresh fruits and vegetables in your neighborhood? Would you say				
Always or usually	0.86	0.81	0.91	0.000
Sometimes	0.11	0.15	0.07	0.000
Never	0.04	0.05	0.03	0.001
How often are the fresh fruits and vegetables you find in your neighborhood affordable? Would you say				
Always or usually	0.76	0.72	0.80	0.000
Sometimes	0.23	0.27	0.19	0.000
Never	0.01	0.01	0.01	0.604
BMI	27.56	28.33	26.82	0.000
Obese	0.27	0.32	0.22	0.000

Statistical testing between both groups is done using a weighted regression that only contains an indicator for whether or not the respondent resides in a census tract that is defined as low-income or not low-income. Low-income census tract is defined here as having >=35.5% of residents having a household income <=185% of the federal poverty level

26.82, $p = 0.000$), and are more likely to be obese (32% versus 22%, $p = 0.000$).

Table 3 shows differences between SNAP-Ed eligible individuals in census tracts that are high or low-income. SNAP-Ed eligible survey respondents in a low-income census tract were less likely to be non-Hispanic white (6% versus 23%, $p = 0.000$), more likely to be African American (9% versus 5%, $p = 0.002$), more likely to be Hispanic (74% versus 51%, $p = 0.000$), and less likely to be Asian (10% versus 19%, $p = 0.000$). In addition, SNAP-Ed eligible individuals in a low-income census tract were more likely to have less than a high school degree as their highest level of education achieved (45% versus 25%, $p = 0.000$), and less likely to have some college or more as their highest level of education (15% versus 28%, $p = 0.000$). SNAP-Ed eligible individuals in low-income census tracts were also more likely to be married or living with a partner (51% versus 42%, $p = 0.002$), have a child in the household (41% versus 26%, $p = 0.000$), more likely to work full time (48% versus 37%, $p = 0.000$), and had a lower mean age in years (43.05 versus 46.49, $p = 0.001$). Because of the statistically significant differences between SNAP-Ed eligible individuals in a low-income census tract versus or not, we included each of these demographic characteristics in all regression models as controls.

SNAP-Ed eligible survey respondents residing in a low-income census tract walked for transportation in the past week more frequently (3.04 times versus 2.38 times, $p = 0.001$) than SNAP-Ed eligible survey respondents residing in a high-income census tract. We found that, on average, SNAP-Ed eligible individuals who reside in a low-income census tract drink soda more often (2.93 times versus 1.69 times, $p = 0.000$) in the past month than similar SNAP-Ed eligible respondents living in a higher income census tract. We also found that SNAP-Ed eligible respondents in low-income census tracts were less likely to report that fresh fruits and vegetables are available in their neighborhood always or usually (76% versus 88%, $p = 0.000$). We also found that SNAP-Ed eligible respondents in a low-income census tract had a higher BMI on average (28.85 versus 27.81, $p = 0.000$), and that they were more likely to be

Table 3 Comparison of outcome measures of Los Angeles County for SNAP-Ed eligible (adults ≤ 185% federal poverty level) CHIS respondents by poverty of their census tract in 2013–2015 ($n = 3914$)

	Low-income census tract ($n = 2451$)	Not low-income census tract ($n = 1463$)	p value
Demographic measurers			
Gender			
Male	0.44	0.46	0.561
Race			
Non-Hispanic White	0.06	0.23	0.000
African American	0.09	0.05	0.002
Hispanic	0.74	0.51	0.000
Asian	0.10	0.19	0.000
American Indian or Alaska native	0.03	0.02	0.655
Other	0.08	0.02	
Highest level of education achieved			
< HS	0.45	0.25	0.000
High school degree	0.41	0.46	0.068
College or more	0.15	0.28	0.000
Marital status			
Married or living with partner	0.51	0.42	0.002
Divorced	0.19	0.22	0.180
Single	0.30	0.36	0.059
Child in the household	0.41	0.26	0.000
Work full time	0.48	0.37	0.000
Mean Age in year	43.05	46.49	0.001
Outcome measures			
Physical activity			
Number of times walking for transportation > 10 min in the past week	3.04	2.38	0.001
Number of times walking for leisure >10 min in the past week	2.55	2.50	0.813
Diet			
Number of times drank soda in the past month	2.93	1.69	0.000
Number of times drank sweetened fruit drink in the past month	9.01	7.07	0.098
Number of times ate fast food past week	1.92	1.74	0.204
How often can you find fresh fruits and vegetables in your neighborhood? Would you say			
Always or usually	0.76	0.88	0.000
Sometimes	0.18	0.09	0.000
Never	0.05	0.03	0.062
How often are the fresh fruits and vegetables you find in your neighborhood affordable? Would you say			
Always or usually	0.65	0.67	0.499
Sometimes	0.33	0.30	0.306
Never	0.02	0.03	0.258
BMI	28.85	27.81	0.027
Obese	0.34	0.26	0.012

Statistical testing between both groups is done using a weighted regression that only contains an indicator for whether or not the respondent resides in a census tract that is defined as low-income or not. Low-income census tract is defined here as >= 35.5% of residents having a household income <= to 185% of the federal poverty level

overweight or obese. We failed to find a statistically significant difference between SNAP-Ed eligible individuals who reside in high- and low-income tracts in past week's fast food consumption, the number of times walking for leisure more than 10 min in the past week, the number of times drinking sweetened fruit drink in the past month, and always or usually reporting being able to find affordable fruits and vegetables in the neighborhood.

Table 4 reports the regression results for physical activity, diet, and obesity outcomes. Each row represents a separate regression that includes all of the demographic covariates as controls in addition to our measures for a low-income respondent and the respondent residing in a low-income census tract. Being SNAP-Ed eligible leads to being 5% less likely to find fruits and vegetables in their neighborhood ($p = 0.005$) and 12% less likely to finding them affordable ($p = 0.000$). Residing in a low-income census tract leads to being 7% less likely to report always or usually being able to find fresh fruits and vegetables in your neighborhood ($p = 0.000$). Residing in a low-income census tract was predictive of the number of times the respondent reported walking for transportation more than 10 min in the past week (on average 0.56 more times, $p = 0.002$), the number of times the respondent reported drinking a sweetened drink in the past month (on average 0.39 more times, $p = 0.043$), but not the number of times the respondent ate fast food in the past week ($p = 0.932$). While being SNAP-Ed eligible did not predict obesity ($p = 0.628$), living in a low-income census tract did increase the risk of obesity by 4% ($p = 0.048$).

Discussion

Where a low-income individual lives is an important predictor for physical activity, diet, and obesity. Our study using a dataset with geographic identifiers finds that in Los Angeles county, SNAP-Ed eligible individuals residing in a low-income census tract report generally worse dietary behaviors and have higher rate of obesity compared with SNAP-Ed eligible respondents residing in a higher income census tract. These findings have important implications for SNAP-Education because it confirms the importance of policies, systems,

Table 4 Comparison of outcome measures of Los Angeles County for SNAP-Ed eligible (adults ≤ 185% federal poverty level) respondents by poverty of their census tract in 2013–2015 ($N = 11{,}152$)

	Respondent is SNAP-Ed eligible			Low-income census tract		
	Coefficient	SE	*p* value	Coefficient	SE	*p* value
Physical activity						
Number of times walking for transportation more than 10 min in the past week	0.06	0.20	0.770	0.56	0.17	0.002
Number of times walking for leisure more than 10 min in the past week	− 0.17	0.15	0.277	− 0.01	0.15	0.932
Diet						
Number of times drank soda in the past month	0.33	0.21	0.122	0.39	0.19	0.043
Number of times drank sweetened fruit drink in the past month	0.97	0.89	0.278	0.22	0.61	0.716
Number of times ate fast food past week	− 0.03	0.10	0.784	− 0.01	0.09	0.923
How often can you find fresh fruits and vegetables in your neighborhood? – Always or usually	− 0.05	0.02	0.005	− 0.07	0.02	0.000
How often are the fresh fruits and vegetables you find in your neighborhood affordable? – Always or usually	− 0.12	0.02	0.000	0.00	0.02	0.884
BMI	0.48	0.28	0.091	0.38	0.24	0.112
Obese	0.01	0.02	0.628	0.04	0.02	0.048

Each row is a separate linear regression that includes both the measure for whether or not the respondent is defined as low-income or not, and whether or not the census tract the respondent resides in is defined as low-income or not low-income. Additional measures included in each of the regressions are the respondent's gender, race and ethnicity, highest level of education, whether or not a child is in the household, full-time employment status, marital status, age, and survey year. Low-income census tract is defined here as having >=35.5% of residents having a household income <=185% of the federal poverty level. Respondent is defined as being low-income if their total household income is 185% of the federal poverty level or below

and environment (PSE) approaches to addressing diet and physical activity.

Although other studies have also documented the importance of place in influencing health and health behaviors [34–36], this study uses fine-grained geographic data that points to mechanisms through which place may play a role in obesity. Availability of fruits and vegetables was a concern based on being SNAP-Ed eligible, but being obese was only associated with living in a low-income census tract. Compared with SNAP-Ed eligible individuals living in a high-income census tract, SNAP-Ed eligible residents of a low-income census tract reported consuming greater amounts of soda in the past month, a known risk for obesity and other chronic diseases. A possible reason for the higher amount of soda consumption is that low-income neighborhoods tend to have greater accessibility to nutrient-poor foods [25]. Even though residents of low-income tracts report walking for transportation more, the energy expenditure of walking may not balance the energy consumption associated with the excess calorie intake of sweetened beverages, although the CHIS data does not quantify either total walking or total beverage intake.

Limitations

Additional limitations include the few CHIS questions on individual diet. The measures focus on a small number of items and none included serving size. Further, the BMI measure is based on the self-reported height and weight of the respondent which may not accurately reflect objectively measured BMI. Although we are relying on census tract as a marker for neighborhood, it is unknown how well these definitions actually capture a neighborhood. The neighborhood boundaries of census data may not correspond to the daily activities and exposures of the residents [37].

Due to the cross-sectional design of the study, our results are susceptible to residential selection bias. Further, the landline phone response rate for the 2015 CHIS was 12.3%, and the cellular phone response rate was 9.5%. Given the low response rate, we applied the recommended CHIS survey weights in all of our analyses to produce population estimates.

Conclusion

It is still unknown exactly which place-related factors are the most powerful leverage points in influencing critical health behaviors of individuals. Currently, access to goods and services plays a large role in health and well-being. As our society becomes increasingly mobile, and delivery services are growing, the role of place may diminish. Future research should consider capitalizing on the new possibilities of altering accessibility of foods and beverages to assess the impact on diet and chronic diseases. Future research should also look at the compatibility of place-based strategies and individual-level factors that are known to contribute to obesity risk, as in the policy environment, decision-makers often search for ways to accommodate or combine complementary interventions as opposed to relying on just a singular approach.

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